BeZero Carbon ex ante Rating report

Family Forest Carbon Program – Central Appalachia

October 2024

BeZero

Project details

Particulars	Details
Project name	Family Forest Carbon Program - Central Appalachia
Registry ID	VCS 3996
BeZero Carbon sector group	Nature-Based Solutions
BeZero Carbon sector	Forestry
BeZero Carbon sub-sector	Improved Forest Management
Methodology	VM0045
Project proponent	Family Forest Impact Foundation / American Forest Foundation
Location	USA
Project start date	29 April 2021
Project commitment period	2021 - 2061
Project crediting period	2021 - 2041
Total ex ante forecast	5,886,738 tCO_2e (before buffer pool contribution)
Key reference documents	BeZero Carbon ex ante Rating methodology Project Description Document version 1.0 (2023) Relevant Deeds of Easement Project NPV analysis Treatment and Matched Controls spreadsheets FFCP Feedback and Responses document FFCP Landowner Enrollment Journey document Landowner Interactions 2020-2021 spreadsheet Draft Monitoring Report (29/04/21 - 31/12/22) Non-Permanence Risk Report (2024) BeZero geospatial analyses: biodiversity report, cyclone report, drought report, fire report, forest carbon report, forest loss report, forest plots assessment, NDVI report, mining report, protected areas report, sawmills report, sea level change report (where relevant), sitemaps report, soils report, thinning activities report, dynamic baselines report, and topography report.
Report date	18 October 2024

Contents

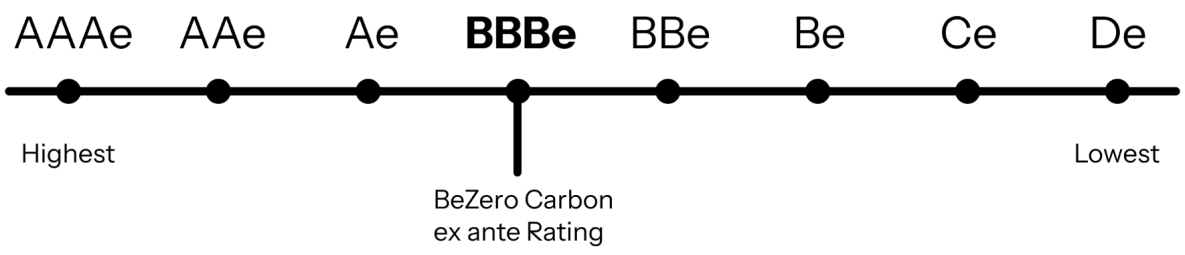
Executive summary

BeZero Carbon has assigned Family Forest Carbon Program - Central Appalachia a '**BBBe**' (pronounced 'triple B', 'e') BeZero Carbon ex ante Rating. This is based on the opinions and reasons expressed below, following our analysis of information made available by the customer, our interactions with the various stakeholders, and related publicly available information. Credits rated 'BBBe' provide a moderate likelihood of achieving 1 tonne of CO_2e avoidance or removal.

The '**BBBe**' rating reflects our view that the project faces very low risk to additionality as project activities are not common practice in the project region and we find substantial barriers to their uptake in the absence of carbon finance. We find that carbon accounting risk is moderate; the project's approach to baseline-setting is highly credible and carbon sequestration estimates appear to be appropriate, but a high likelihood of market leakage is insufficiently accounted for by the project and we find considerable uncertainties associated with the occurrence of adverse selection. The project faces low non-permanence risk, as fire risk is low and we find that the project adequately guards against the risk of landower withdrawal. However, non-permanence risk is introduced by the increasing likelihood of pest outbreaks in the region. On the whole, there is substantial information made available to us regarding the project, however we find moderately high information risk, driven by a lack of detailed information for participating landowners. Finally, we find low project execution risk given that the project is already operational and expected to issue by the end of 2024, although there are uncertainties associated with the project's ongoing financial viability.

Table 1. BeZero Carbon ex ante Rating breakdown for Family Forest Carbon Program - Central Appalachia.

Risk factor	Assessment
Additionality	aa
Carbon accounting	bbb
Non-permanence	a
Information risk	bb
Standalone carbon rating	**bbb (moderate likelihood)**
Project execution risk	a
BeZero Carbon ex ante Rating	**BBBe (moderate likelihood)**



Project description

Family Forest Carbon Program - Central Appalachia (FFCP-CA) is a USA-based improved forest management (IFM) project that is being established by the Family Forest Impact Foundation (FFIF). FFCP-CA is a grouped project located in Central Appalachia, with the 2020 and 2021 cohorts representing land parcels across Maryland, Pennsylvania, and West Virginia (Figure 1). FFIF was established in 2019 to create new opportunities for family forest (or non-industrial private forest) owners to access financial and technical assistance targeted towards more sustainable forest management. FFIF is an affiliate of the American Forest Foundation (AFF), a national conservation organisation. The global environmental organisation The Nature Conservancy (TNC) and advisory firm TerraCarbon LLC are also involved in the project's development.

FFCP-CA provides incentive payments to forest landowners to implement climate-smart practices, resulting in an increase in carbon sequestration and storage. The first iteration of the project, to which this BeZero Carbon ex ante Rating applies, involves 99 landowners implementing IFM practices on a total area of 5,732 hectares. The project activity defining FFCP-CA is Growing Mature Forests (GMF), which is a 20-year, renewable agreement with the landowner to limit timber harvest and increase net forest growth relative to common practice. Common practice in the Central Appalachia region is high grading, according to project documentation, a timber harvesting practice in which only the largest, most economically valuable trees are removed whilst leaving behind all or most poor-quality, low-value trees. FFCP-CA estimates a relative increase in average annual forest carbon sequestration and storage of 3.46 tCO_2e per hectare under the project scenario. The project is conducted on private family and other non-industrial private forestland (NIPF) and FFIF is the owner of all carbon rights on all project instances.

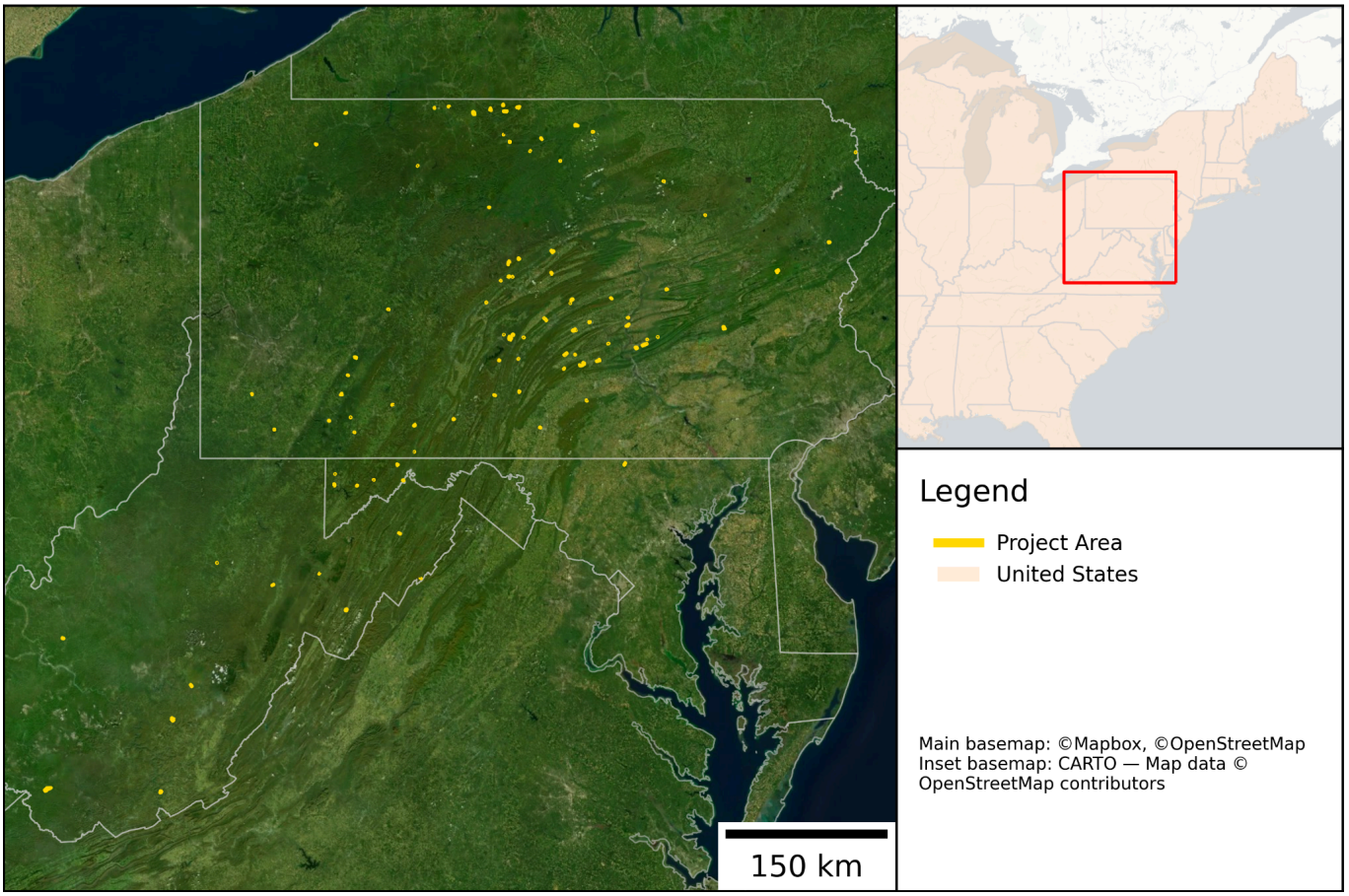


Figure 1. The location of the project boundaries (yellow) in the states of Maryland, Pennsylvania, and West Virginia, USA. Basemap is MapBox and project boundaries are provided by the project developer.

The primary project activities include the following:

- Imposition of minimum residual basal area restrictions on timber harvests
- Imposition of riparian buffers
- Prohibition on high grading/diameter limit cuts (i.e. selectively removing the largest and highest value trees)

As a result of project activities, FFCP-CA has a projected net issuance of 356,989 tCO_2e over the project's lifetime, before buffer pool contributions and only for the forestland enrolled in the 2020 and 2021 cohorts (to which this BeZero Carbon ex ante Rating applies). To calculate and quantify credit issuance, the project uses Verra methodology VM0045. The project is registered under Verra and is in the operational phase (pre-issuance).

Part 1: Standalone carbon rating

The standalone carbon rating assesses the carbon efficacy risk for carbon credits. The standalone carbon rating analyses additionality, carbon accounting, non-permanence, and information risk. Within this framework, we find that this project has a moderate likelihood, **'bbb'**, of achieving 1 tonne of CO_2e removal. This view is driven by strong additionality due to project activities that aren't common practice and substantial barriers to the uptake of project activities in the absence of carbon finance. Low non-permanence risk also bolsters the project's rating, as abiotic and anthropogenic risks are limited. The rating is constrained, however, by moderate carbon accounting risk given the high risk of market leakage and considerable uncertainty associated with adverse selection, despite the project's highly credible approach to baseline setting. The rating is materially affected by information risk, which has been largely accounted for in our assessment of the project's carbon accounting.

Additionality

We assess there to be very low risk to additionality for credits issued by FFCP-CA.

BeZero Carbon is of the opinion that the project faces very low risk to additionality, primarily because project activities generally are not common practice and high grading is commonplace on lands similar to those in the project area. Moreover, we find significant barriers to the uptake of project activities, which include material short-term opportunity costs associated with prohibiting high grading. We also find a lack of effective policy tools in place to enable project activities without carbon finance, which further reduces risk to project additionality. Whilst there may be some instances of non-additional landowners enrolled in the project, this has been largely addressed in our assessment of carbon accounting.

Carbon accounting

We assess there to be moderate risk to carbon accounting for credits issued by FFCP-CA.

BeZero Carbon is of the opinion that FFCP-CA faces moderate carbon accounting risk, primarily driven by the potential for adverse selection occurring, which may result in non-additional emissions reductions and removals being claimed by the project. We also find a high risk of market leakage as a result of project activities, and we deem that this is not sufficiently accounted for. However, the risk to carbon accounting is somewhat tempered by the project's highly credible approach to baseline setting, using a dynamic performance benchmark. The project has also matched project plots to control plots outside of the project area based on covariates that we find to be appropriate. Moreover, the project's estimated carbon sequestration rates are in line with both our in-house analysis and literature values.

Non-permanence

We assess there to be low risk of non-permanence for credits issued by FFCP-CA.

BeZero Carbon is of the opinion that credits issued by FFCP-CA face a low risk of non-permanence over the project's 100-year commitment period. Pest and disease outbreaks represent the main source of non-permanence risk to the project, as projections predict considerable loss of oak species over the next few years from spongy moth infestations in the project region. Otherwise, other potential sources of non-permanence risk may be inconsequential to the project's carbon stocks. Abiotic risks, such as fire and drought, are moderate at most, whilst the risk of landowners

withdrawing from the project appears to be well mitigated. Moreover, we believe that the project's proposed risk buffer allocation is sufficient to cover potential future reversals.

Information risk

Information risk is the risk posed to our assessment of a project's carbon efficacy due to the reliability or robustness of the available information. The more information available for our analysis of a project's carbon efficacy, the lower the information risk for the project. BeZero Carbon is of the opinion that credits issued by FFCP-CA face moderately high risk in regard to information disclosure.

In the case of FFCP-CA, we find that there is moderately high information risk due to the lack of detailed information for participating landowners, the entities that control both the decision to enrol in the project and the management practices on the enrolled lands. This risk manifests as a risk of adverse selection in the enrolled landowner pool, and is likely a result of the grouped project design. Information risk is otherwise limited due to the project developer's willingness to provide data where necessary and where possible. We have received substantial information regarding the project's design and implementation, its carbon accounting approach, and otherwise detailed information on the individual landowners enrolled in the project.

Part 2: Project execution risk

The BeZero Carbon ex ante Rating applies project execution risk to the standalone carbon rating. It evaluates the risk that a project will fail to be implemented and become operational as planned.

We are of the view that the project faces low project execution risk at this point in time, as the project is already fully operational and is set to issue credits by the end of 2024. However, risk is present due to the unpredictability of future issuances, which may have an impact on the financial viability of the project moving forward.

BeZero Carbon ex ante Rating conclusion

Within the BeZero Carbon ex ante Rating framework, this project has been assigned a '**BBBe**' rating. Credits with this rating are assessed as providing a moderate likelihood of achieving 1 tCO_2e avoidance or removal.

Key monitorables

The following are important variables to monitor on an ongoing basis:

Financials

- Access to project finance sources, any changes in these sources, and subsequent impacts on project operations
- Changes in credit sale prices during the project's lifetime compared to assumptions in the financial model and its implication on the project's viability
- Fluctuations in stumpage prices and other factors feeding into potential timber revenues in a without-project scenario

Regulations

- Developments in the policy environment and key legislations in Maryland, Pennsylvania, and West Virginia, and their impact on the project

Operations

- Ongoing crediting performance of the project in comparison with ex ante estimations
- Landowner retention between monitoring periods and changes in enrolled acreage
- Fluctuations in the annual performance of (legal and illegal) high grade-cut prevention compared to the project's baseline harvest scenario in the project area
- Occurrence of and accounting for significant natural disturbances including fire events, extreme weather, and pest and disease outbreaks
- Risk buffer contributions

Key stakeholders

- Progress on the full implementation of planned benefit-sharing mechanisms
- Contracts and agreements among key stakeholders throughout the project's lifetime
- Key personnel changes and other internal issues for the project developer, and their implication on the project's progress

2. BeZero Carbon ex ante Rating risk analysis

2.1 Risk factor analysis

2.1.1 Additionality: 'aa'

BeZero Carbon is of the opinion that credits issued by FFCP-CA are likely to face very low risk to additionality. The project's additionality is supported by project activities that are not common practice, and which face significant barriers, in Central Appalachia. Importantly, we find that the project is likely to be successful in overcoming these barriers. There is material risk of adverse selection occurring in the project, but this is considered in our assessment of carbon accounting.

The project activities are not common practice in the Central Appalachia region for the most part. Based on available literature, we believe that project activities exceed common practice in the project region, thereby affording very low risk to the additionality of FFCP-CA. Project activities are defined as 'Growing Mature Forests' (GMF); GMF will involve a 20-year, renewable agreement with each enrolled landowner to limit timber harvest, thereby increasing net forest growth and resulting in carbon sequestered. This limit on timber harvest is achieved through the imposition of maximum basal area removal (25-35%), the establishment of riparian buffers, and a prohibition on high grading (including diameter-limit cutting). The GMF practice also specifies that each enrolled landowner shall consult a professional forester to develop two consecutive 10-year forest management plans, covering the landowner's entire eligible property holdings within a contiguous tract.

Project documentation states that common practice harvesting on small non-industrial private forestland (NIPF) in Central Appalachia is high grading, and we find evidence to support this claim. High grading is a timber harvesting practice whereby only the largest, most economically valuable trees are removed whilst leaving behind all or most poor-quality, low-value trees [1]. Within scientific literature, this is widely considered to be an unsustainable practice which has had a significant impact on forest structure, composition, and stability in the eastern USA. For example, studies have shown that high grading reduces the growth rates of residual trees due to lower vigour [1–4].

Our review of scientific literature indicates that high grading is prominent on NIPFs in particular, with research in both Pennsylvania and West Virginia finding that the majority of commercial harvests occurring on NIPFs are classified as high grades (54% in Pennsylvania and 62% in West Virginia) [5,6]. More recent research found that the proportion of high-grade cuts on NIPFs in Pennsylvania had increased to 58% between 2009 and 2015, and had maintained at 62% in West Virginia [7]. When only considering the harvesting of hardwood stands, the dominant forest type comprising the project area, these values increase to 70% and 73%, respectively (Figure 2).

This practice of high grading has been commonplace in the region since at least the end of the 20th century, likely due to the decision-making structure of the timber extraction and sale process [8]. Where no forest management plans (FMPs) are in place, the decision as to how a harvest is to be implemented is most often that of the timber buyers, and not of landowners or assisting consulting foresters. Since only a small proportion of NIPFs in Central Appalachia have FMPs written and high grading generally results in greater short-term financial gain than other more sustainable harvesting practices, high grading appears to be an obvious consequence of the structure of the timber market in the region [9,10].

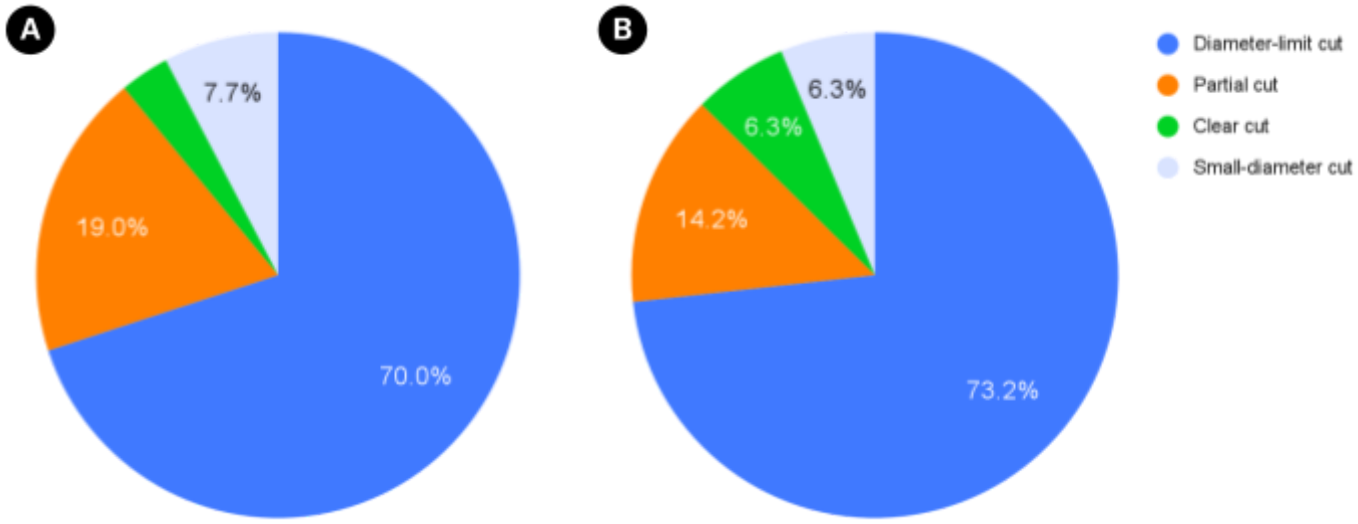


Figure 2. Proportion of harvest practice types implemented in hardwood stands on non-industrial private forestland in (A) Pennsylvania and (B) West Virginia, between 2009 and 2015. Data from Luppold & Bumgardner (2018).

The project's requirement for all enrolled forest parcels to be under FMPs, which is not common practice in the region, provides an important mechanism to enable the project activities (i.e., to promote forest growth and reduce harvest levels in the project area). The project requires the enrolled landowners to engage the assistance of a professional forester to develop an FMP with specific harvesting constraints and the overall goal of increasing timber volume and forest carbon stocks during the 20-year agreement term. Each FMP shall be approved by an applicable state or federal agency and/or subject to oversight by an applicable third party.

According to peer-reviewed literature, FMPs are uncommon on NIPFs in the project region. Whilst a West Virginia-focused survey carried out by the US Forest Service found that approximately 50% of private forest owners surveyed (3,166 in total) ranked 'timber management' as their primary objective, the survey also found that only 21% of harvests were conducted on properties with an FMP in place [5]. More recent data from the US Forest Service indicates that only 5% of NIPF ownerships in the northeast region (which includes Pennsylvania, Maryland, and West Virginia) were under FMPs; this is lower than the nationwide average of 11% [9]. We believe that there are clear barriers to obtaining a written management plan for NIPF owners, which is discussed later in this report. As it relates to common practice, it is clear that FMPs are uncommon for NIPFs, increasing the additionality of credits issued by FFCP-CA.

We do find one aspect of the project's activities that may be common practice in their basal area loss limits. The project stipulates that any harvesting activity occurring during the project term must result in no more than 25-35% (depending on the particular agreement) basal area per acre being removed. However, one peer-reviewed study shows that in Pennsylvania and West Virginia, this harvesting intensity may be common practice [7]. The study examined approximately 5,400 sample plots in which harvesting had occurred from the Forest Inventory and Analysis (FIA) of the U.S. Forest Service, for the period 2009-2015, in the central, northern, and mid-Atlantic hardwoods region. In Pennsylvania, where the vast majority of enrolled forestland parcels are located, the average basal area removed by partial cuts and small-diameter cuts was 36% and 10%, respectively. In West Virginia, the values were lower at 32% and 5%, respectively. In fact, the only harvesting pattern for which average basal area removal was greater than the project-imposed limit was for clear cuts.

Another study examining NIPFs across the USA found the average basal area removal per harvesting event since 2000 was less than 20%. Moreover, we note that for oak-hickory forests specifically,

which generally make up the project area, the largest proportion of harvested plots experienced less than 20% basal area removed out of all forest types examined. Therefore, we are of the view that the common practice of this particular project activity (restrictions on minimum basal area removal) introduces slight risk to the project's additionality, but overall we still find very low risk as the project activities are not common practice for the most part.

The project activities face significant barriers that carbon finance and project provisions may be key to overcome. We find substantial barriers associated with the adoption of the project activities in the absence of the project's incentive payments, conferring very low risk to the project's additionality. Our analysis of peer-reviewed scientific literature and publicly available datasets indicates that multiple categories of barriers are present that may prevent or obstruct a landowner from implementing the sustainable forestry practices described by project activities, for the length of the project term (20 years). These include: (1) short-term opportunity costs, (2) FMP development, and (3) unexpected events or costs.

Firstly, we find that the short-term economic benefit to both a landowner and timber buyer of engaging in high grading presents a large barrier to the uptake of project activities. Amongst the evidence substantiating our view is a 20-year economic evaluation of sustainable harvesting practices and high grading employed on NIPFs in West Virginia [10]. The study found that high grading practices outperform more sustainable harvesting practices in financial terms - a result of the significantly larger initial income derived from high grading and the substantial discounting of larger future timber values associated with the greater rotation lengths of sustainable harvesting practices. Further scientific commentary cites the high first-entry yields and associated revenues of high grading as barriers to project implementation [11].

Price premiums that currently exist in the timber market appear to be insufficient to incentivise landowners to produce larger, better quality timber. Thus, the majority of studies that have compared sustainable silvicultural harvests to high grading have similarly concluded that high grading is at least as financially rewarding for forestland owners under most circumstances [8,12]. We believe that the incentive payments provided to landowners enrolled in FFCP-CA may act to somewhat reduce the barriers associated with short-term opportunity costs, supporting the project's additionality.

Secondly, we also find evidence to suggest that barriers exist to obtaining written management plans for NIPF owners, which the project facilitates. Data from the United States Department of Agriculture Forest Service's National Woodland Owner Survey show extremely low adoption rates of FMPs amongst NIPF owners [3]. In 2006, it was found that less than 4% of NIPF owners surveyed in the project region (Maryland, Pennsylvania, and West Virginia; n = 836) had a written management plan in place (Figure 3). This has changed little in subsequent surveys, with that figure reaching a maximum of 6% in 2013 and a minimum of 3% in 2018. Considering these states in isolation, Pennsylvania has the lowest average FMP adoption rate across surveys at 3%, followed by West Virginia at 5%, and Maryland has the highest at 10%. Maryland's enrolment rate is above the national average (6%), which may detract from the project's additionality as it suggests that NIPF owners here face lesser barriers than in other states. However, given that 76% of acreage enrolled in FFCP-CA lies within Pennsylvania and only 5% in Maryland, we believe that there are significant barriers to FMP obtainment in the project region as a whole.

Research suggests that the primary barrier to obtaining a written FMP may be economic and disproportionately affects NIPF owners over other ownership types [13]. Whilst the costs of having an FMP written vary depending on acreage and location, they are generally higher for NIPF owners than industrial and public forestland owners. For example, in the Lake States, the costs of an FMP for a NIPF owner ranged from USD 40 to USD 140 per acre, but only USD 9 to USD 40 per acre on

industrial forestlands and USD 5 to USD 25 per acre on public forestlands [14]. According to the project's first monitoring report (unverified at the time of rating) covering the period between 29 April 2021 and 31 December 2022 , the project has facilitated the development of 57 FMPs, contributing more than USD 60,000. If we assume that only one FMP is required for each enrolled landowner, then the project has achieved an FMP adoption rate (58%) that is far higher than the project region's maximum yearly average since 2006 (6%). In summary, our opinion is that the project acts to reduce barriers to obtaining written management plans for NIPF owners, increasing the likelihood of additionality.

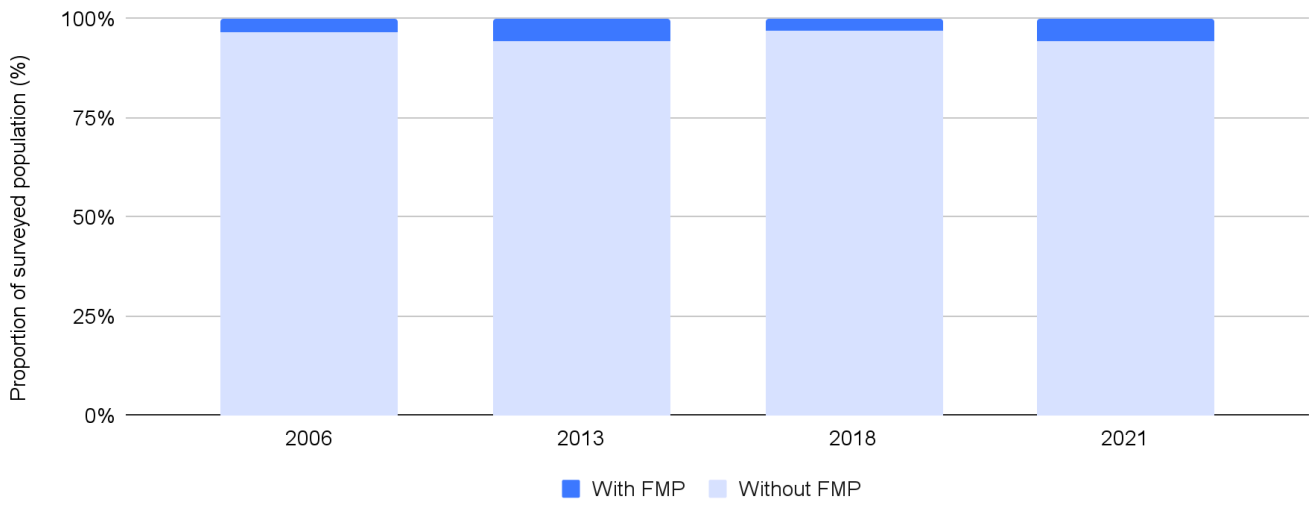


Figure 3. Proportion of surveyed population of non-industrial private forestland owners in Maryland, Pennsylvania, and West Virginia, combined with and without written forest management plans (FMP). Survey years include 2006 (n = 836), 2013 (n = 846), 2018 (n = 841), and 2021 (n = 749). Data from the USDA Forest Service's National Woodland Owner Surveys.

The third key barrier to project activities that we observe relates to unexpected events or costs that prompt poor harvesting decisions. Small-scale landowners, such as those targeted in FFCP-CA, are heavily influenced by external factors in a manner that makes their forest management decisions particularly unpredictable [15,16].

This barrier is evidenced by one nationwide study of NIPF owners, which found that whilst 'timber production' was an important ownership objective for only 9% of those surveyed, more than 50% had conducted commercial timber harvests [15]. Another study specific to West Virginian NIPF owners found that only 21% of those who experienced a timber transaction over a two-year period had a written FMP for their forestland [5].

Indeed, there is an abundance of research to suggest that landowner behaviour is not driven by landowner objectives, but instead by life situations and perceived short-term necessities [15–22]. Property taxes are generally the greatest concern to NIPF owners because they are paid on an annual basis [23]. Moreover, in Pennsylvania NIPF owners generally depend on outside wages as a primary source of income and the vast majority are unlikely to receive any form of annual income from their forestland [6]. Thus, unexpected changes in annual income or expenditures (such as increased medical bills), in conjunction with property taxes, are likely to prompt unplanned harvesting activities, or even property sales.

We find that FFCP-CA aids enrolled landowners to overcome this barrier and be more resilient to external factors in three ways. Firstly, the project necessitates a 20-year commitment by the landowner to implement project activities and desist from unsustainable harvest practices such as high grading. This requirement greatly reduces the likelihood of unpredictable, unplanned

harvesting occurring for short-term gains and the needs of enrolled landowners, and we believe that the project provides strong enough disincentives for disenrolling from the project (discussed further in **Non-permanence**). Secondly, the incentive payments provided to enrolled landowners by the project act to alleviate the burden of unexpected costs previously described. Anecdotal evidence from project participants specifically references project payments as contributing to paying property taxes, thereby reducing a landowner's need to harvest for short-term profits. Lastly, the project's requirement of an FMP for all forestland owned by the enrollee ensures that, if harvesting does occur, it is carried out in a sustainable manner consistent with the net goal of the project to sequester carbon.

In summary, we believe that significant barriers exist to prevent the adoption of more sustainable harvesting practices in the absence of the project. We find one study that appropriately summarises the incompatibility of the NIPF ownership structure for long-term, sustainable forest management [8]. The study laid out four succinct criteria for sustainable management on NIPFs: 1) long and certain ownership tenure, 2) sufficient knowledge of forestry to make sound decisions, 3) a sufficient market premium as a reward for producing quality timber, and 4) ownership objectives that place at least a moderately high priority on timber production. We are of the view that the project provisions in place (e.g., 20-year contractual commitment, requirement of an FMP, and incentive payments) satisfy these criteria and can be reasonably expected to largely overcome existing barriers to sustainable forest management. Therefore, we view there to be very low risk to the project's additionality in relation to our barrier analysis.

The project's use of a dynamic performance benchmark approach increases confidence in its claimed climate benefits being additional. The performance benchmark approach applied by FFCP-CA as per VM0045 acts to ensure that claimed emissions reductions and removals are only claimed when additional to a without-project scenario. Project plots are statistically matched to similar baseline composite plots (FIA plots) based on a set of variables such as, *inter alia*, stand age, forest type group, and quadratic mean diameter. Carbon stocks are then monitored and compared through time in both sets of plots, and credits are only claimed when project plots outperform matched FIA plots in terms of carbon sequestration and storage. This approach is an example of a dynamic baseline.

A dynamic baseline does not attempt to predict future harvest in the project area. Instead, it relies on observing change in control areas with variables that reflect the drivers of harvest. These control areas are algorithmically selected to be similar to the project with respect to the expected stand-level characteristics and harvest activities in the absence of the project's intervention. This approach to baseline setting and crediting is widely agreed within the scientific community to allow for increased confidence that credits represent real avoided emissions and/or increased carbon sequestration [24–28]. Given our confidence in the specific approach to baseline setting adopted by FFCP-CA (discussed in greater detail in our assessment of carbon accounting), we believe there to be a high likelihood that credits claimed by the project are additional to business-as-usual practices on a landscape scale.

A favourable policy environment for sustainable forest management may lack relevance for small private landowners and the management of forests for carbon. We find moderate policy risk to FFCP-CA, with evidence of state and federal policies and programmes in place to support private forestland owners. However, risk is tempered as these policies may not be relevant to the project's participants.

The most notable federal programmes in place that may introduce policy risk to credits issued by the project, in our opinion, are the Conservation Stewardship Program (CSP) and the Environmental Quality Incentives Program (EQIP). CSP is the largest conservation programme in the country and

allows NIPF owners to earn payments for actively managing, maintaining, and expanding conservation activities on their properties. EQIP offers financial and technical assistance to NIPF owners in regard to the planning and implementation of conservation activities. Since 2010, payments made by each of these programmes to landowners within Pennsylvania, West Virginia, and Maryland have increased by at least 140% (Figure 4) [29]. These are well-funded and popular programmes in the USA, and we find evidence of a small portion of those enrolled in FFCP-CA having also received payments from CSP. However, we believe that these policies introduce only moderate risk to credits issued by the project for two reasons. Firstly, the contractual periods offered by CSP (five years) and EQIP (10 years) are incomparable to FFCP-CA's contractual commitment period (20 years). Most importantly, these programmes are not designed to promote carbon sequestration and storage, but more so to maintain working forestland whilst promoting water quality, habitat, and cover cropping. In fact, cover cropping was the most widely implemented activity funded by both programmes in 2023 [29].

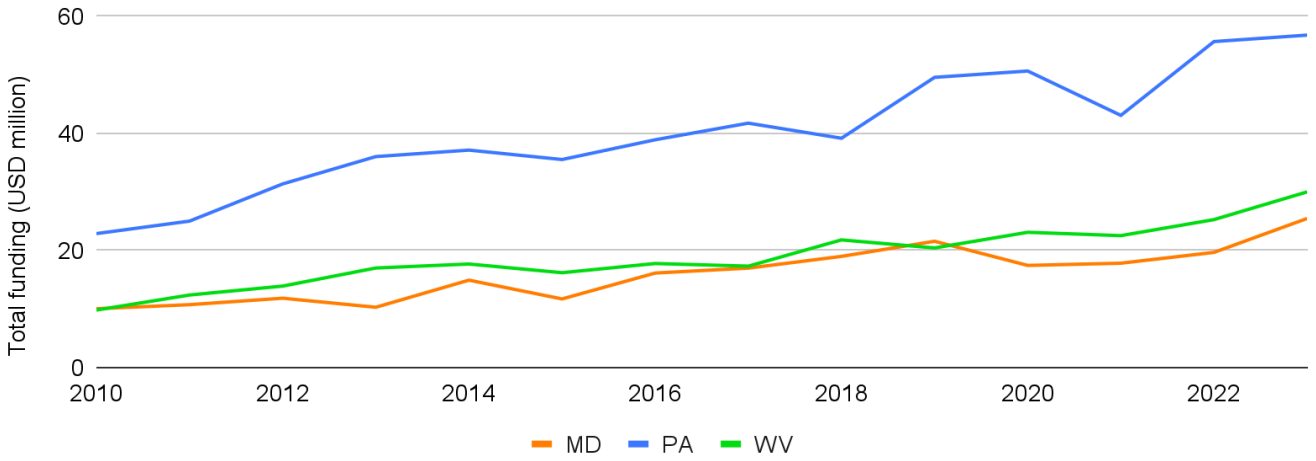


Figure 4. Total combined payments to private forestland owners in Maryland (MD), Pennsylvania (PA), and West Virginia (WV) from the Conservation Stewardship Program and the Environmental Quality Incentives Program, between 2010 and 2023. Data from the USDA's National Planning and Agreements Database (2023).

There are also preferential forest property tax programmes provided in each state for private working forests, such as the Farmland and Forest Land Assessment Act in Pennsylvania and the Timberland And Managed Timberland Program in West Virginia. However, these programmes are similarly not designed to promote carbon sequestration and storage, nor do they necessarily promote sustainable forest management [30]. Peer-reviewed research has also shown enrolment in these programmes to be positively correlated with property size, potentially because larger areas command a larger absolute financial benefit (or that forest products are more likely to represent a larger proportion of the landowners' total income) [31]. Regardless, it appears that state-provided tax incentives may not favour the smaller forestland owners associated with FFCP-CA, and thus risk is tempered. Overall, we believe that a favourable policy environment at both a state and federal level introduces material risk to the additionality of FFCP-CA, although this risk is tempered as we believe that the project activities go beyond what the policy environment provides to NIPF owners.

Additionality conclusion

In our view, the project faces very low risk to additionality. This assessment is driven by our view of significant barriers to the uptake of the project activities and we do not find these activities to be common practice for similar landowners in the region. The use of a dynamic performance benchmark approach also increases our confidence in the project's additionality. However, we do find a high likelihood of adverse selection occurring in the project (although this is considered in our assessment of carbon accounting), as well as a somewhat favourable policy environment.

2.1.2 Carbon accounting: 'bbb'

BeZero Carbon is of the opinion that FFCP-CA faces moderate risk in relation to carbon accounting, due to the possibility of market leakage and also adverse selection occurring under the project. Otherwise, we find the project's baseline setting to be highly credible and the project has matched project plots to control plots outside of the project area based on covariates that we find to be appropriate. Further, the project's estimated carbon sequestration rates are in line with both our in-house analysis and literature values.

The project's landowner enrolment process is vulnerable to adverse selection, the extent of which is uncertain. A moderately high risk of adverse selection in the project's landowner enrolment process introduces uncertainty when considering the level of over-crediting that may occur as a result, despite best efforts taken to mitigate this risk. Adverse selection is a primary concern for all forest carbon project types, and particularly in aggregated projects such as FFCP-CA given the quantity of independent landowners enrolled and the difficulty in conducting detailed financial analysis per enrollee [32–34]. Adverse selection occurs when expected harvesting behaviour depends on information known to the project participants at the time of enrolment but unknown to the project developer and therefore not accounted for in the baseline. Crucially, adverse selection occurs if the enrolled landowners are self-selected such that they are, as a group, less likely to harvest under a business-as-usual scenario than the at-large population of landowners of similar forests as represented in FIA data.

Two factors combine to result in adverse selection in voluntary carbon projects: (1) a voluntary element, whereby agents can choose whether or not to enrol in the project, and (2) asymmetric information, given that the agents know more about their own intent in managing their forestland than the project developer does [35]. A systemic adverse selection issue across the population of enrollees would present significant carbon accounting risk.

In scientific literature, adverse selection in IFM projects has most commonly been explored in protocols that compare a project area's initial carbon stocks to regional common practice [34,36]. In these cases, adverse selection may occur where initial carbon stocks are already greater than common practice due to atypical management or natural variation across regions, and the asymmetric information lies between project developers and the standards body. The performance benchmark approach applied by FFCP-CA as per VM0045 negates this methodology-driven source of adverse selection, as the baseline is set ex post and derived from statistically matched forest plots in the region.

However, a source of adverse selection arises in the case of FFCP-CA where the unobserved variables are influencing landowners' decision whether or not to enrol in the project [37]. Here, the asymmetric information lies between the landowners and the project developer. We believe that there is a risk that landowners have enrolled in the project who would have carried out improved forest management practices - in terms of promoting carbon sequestration to a greater extent than similar landowners - regardless of the financial incentive provided by the project, or for whom managing for timber is not an important objective. In this case, whilst we consider project activities to be additional on the whole, instances of 'non-additional landowners' enrolling in the project may lead to an overestimation of the real carbon benefits achieved by the project. Without being able to measure the forest management philosophies of all comparable forestland owners in the project region, including those not enrolled in the project, it is very difficult both to assess and to avoid adverse selection [37].

Using data provided by the project developer, we have been able to carry out a rudimentary screening of all project participants, in order to inform our view of the adverse selection risk in the

case of FFCP-CA. We find some instances of project enrollees who were likely to have carried out project activities in the absence of the project's incentive payments. We note that NIPF owner intentions and management philosophies may not always be strong predictors of landowner behaviour, as discussed under **Additionality**[15–22]. Therefore, the scope for information asymmetry may be reduced and our view tempered somewhat. Nevertheless, a notable example is a direct quote from one landowner in Centre County, Pennsylvania, stating that 'much of the forested area' that they enrolled in the project 'was centred on ridge tops which is listed in [their] 2014 forest management plan as *leaving them as they were*'. In our view, this is an indication that said landowner has been adversely selected within the project enrolment process, presenting carbon accounting risk; this landowner is one of the project's top 10 largest landowners.

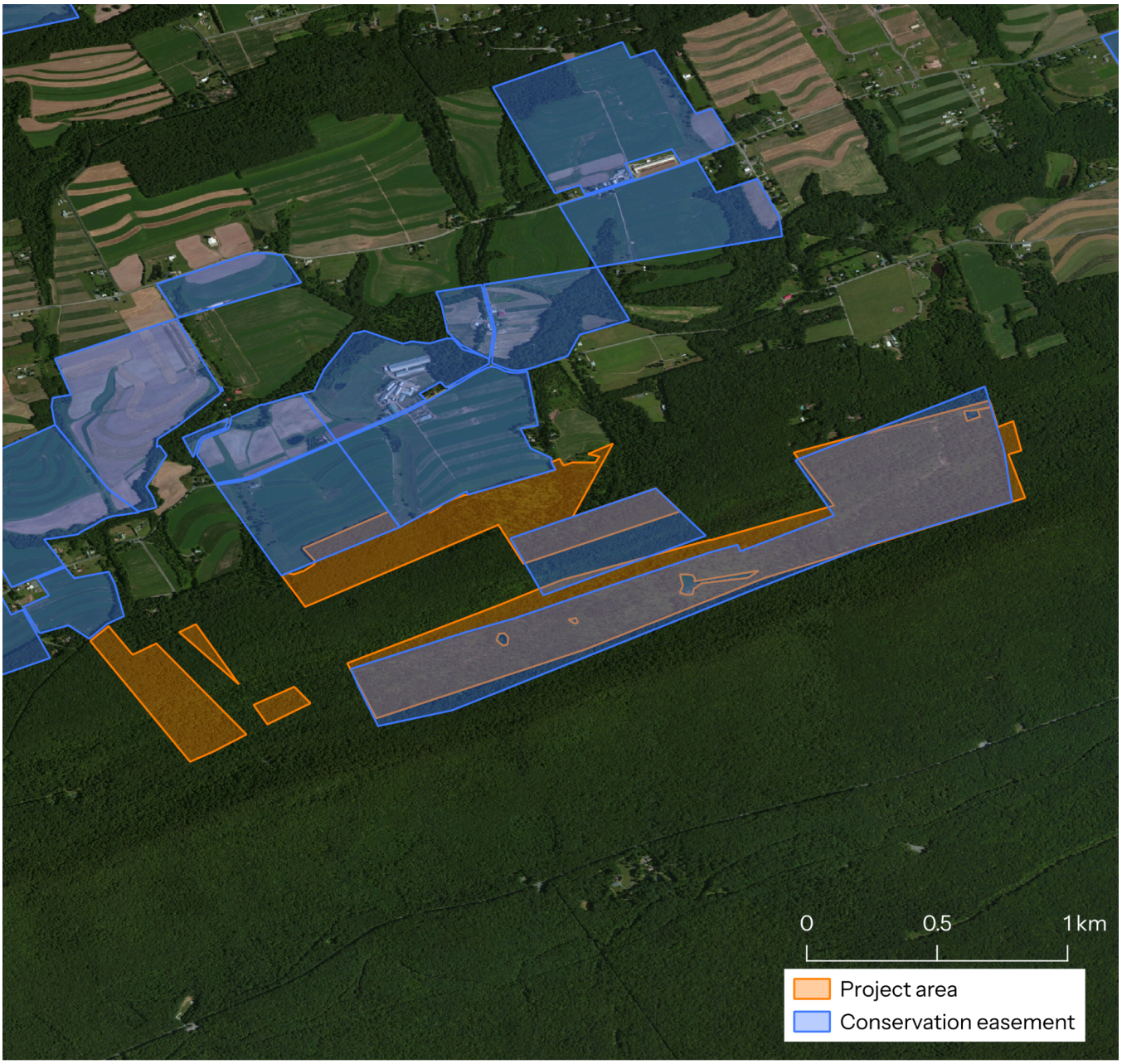


Figure 5. Overlap of the forestland enrolled in FFCP-CA (orange) with conservation easements (blue) held by Manada Conservancy. Project boundaries are provided by the project developer and conservation easement boundaries are from the National Conservation Easement Database. Basemap is Esri World Imagery.

We also identify at least 162 hectares (400 acres) of forestland within Dauphin County, Pennsylvania that are under a conservation easement held by Manada Conservancy and enrolled in the project (Figure 5). Manada Conservancy is a land trust dedicated to preserving the natural and scenic

resources of the county through land conservation, environmental education, and community engagement. According to one Deed of Conservation Easement (dated 2019) covering approximately 91 hectares of this area, only 'sustainable forestry' is permitted within the area by the landowner, which must be in accordance with a forest management plan agreed upon by Manada Conservancy. One of the objectives of this conservation easement cited in the deed is, most notably, to 'sequester carbon' in the forestland. Another overlapping easement held by Manada Conservancy, established in 2009 and covering 17 hectares, allows only sustainable forestry in accordance with a forest management plan, although according to the Deed of Conservation Easement, this is confined to an area of less than half the total easement area. We have confirmed using spatial datasets that only this confined area is included in the project, and not the portion of the easement in which timber harvest is prohibited.

We identify another conservation easement overlapping with the project area located in Pennsylvania. This easement is held by Wildlands Conservancy, a land trust dedicated to protecting and restoring critical natural areas. This 15-hectare easement, established in 2014 in Monroe County, imposes similar forestry constraints to those previously discussed. We are of the view that these easements and their timber restrictions provide further evidence of some degree of adverse selection occurring under FFCP-CA. The easement restrictions on timber harvesting strongly suggest high grading - or other forms of unsustainable timber extraction - are unlikely to occur on these respective forestlands, in perpetuity. However, it should be noted that the areas referenced only represent approximately 3% of the project area. Furthermore, there may be similar landowners represented in the FIA data that underpin the project's baseline. The inclusion of landowners such as these ones is a problem only if the project has a larger proportion of such landowners enrolled when compared to the wider population of similar landowners represented within the FIA plot network. The financial incentives for project participation suggest that this could logically be the case, but the true existence or extent of adverse selection remains unknown.

The financial attractiveness of the programme is likely to be a key determinant of the scope and severity of adverse selection, as carbon payments that fail to compete with disallowed or reduced logging practices might cause landowners with intent to log to self-select out of the programme. We believe that FFCP-CA's incentive payments may be sufficiently competitive with potential timber revenues so as to reduce - but not eliminate - the risk of adverse selection, but this is highly dependent on the intensity and timing of business-as-usual harvest.

The base payment rate for 2020 and 2021 cohorts is set at approximately USD 215 per acre (USD 530 per hectare), with payments scheduled at varying rates throughout the 20-year contractual period. The project developer has provided a detailed net present value (NPV) analysis, carried out for an individual enrollee representing a 40-acre property in Pennsylvania, which includes a standing forest inventory for the property. According to the project's payment structure, this landowner would receive USD 8,600 in payments over the project's lifetime. In a without-project scenario assuming a 4% discount rate, if harvest is assumed to occur in the first year of the project with an intensity of 25% of standing inventory, then timber revenues over a 20-year period total just over USD 6,000 (Table 2). If this harvest were to occur in the final year of the project, then timber revenues would increase to USD 8,900. If harvest intensity is increased to 40% of standing inventory, for example, then timber revenues far exceed the project's total incentive payments regardless of the timing of harvest. On the other hand, enrolment in the programme does not require a landowner to permanently forgo timber harvesting; the landowner can realise revenues from timber harvesting at the end of the commitment period, if desired. In our view, it is possible that the project's incentive payments are competitive with foregone timber revenues, and as such may act to reduce the risk of adverse selection. However, given the high sensitivity of potential timber revenues to harvest intensity and

timing, not to mention stumpage price, we believe that there is uncertainty associated with the competitiveness of the project's payment incentives.

Table 2. Potential timber revenues under a without-project scenario for a 40-acre forestland owner, with varying harvest timings and intensities, assuming a 4% discount rate. Data according to NPV analysis provided by the project developer.

	Harvest intensity (% of standing inventory)			
Harvest year	**10**	**25**	**40**	**50**
1	USD 2,415	USD 6,036	USD 9,658	USD 12,073
5	USD 2,620	USD 6,549	USD 10,478	USD 13,098
10	USD 2,905	USD 7,263	USD 11,621	USD 14,526
15	USD 3,228	USD 8,069	USD 12,911	USD 16,138
20	USD 3,592	USD 8,981	USD 14,369	USD 17,962

The project has otherwise taken clear and sensible steps to address the risk of adverse selection during the enrolment process. Firstly, the project employed certain safeguards within its marketing approach to landowners. For example, whilst the American Forest Foundation has a large network of landowners available to it through its administration of the American Tree Farm System (ATFS), the project does not explicitly market towards these landowners due to their existing intent to conduct sustainable forest management; indeed, we identify only five project-enrolled landowners who are also enrolled in the ATFS. Moreover, the project applies relevant thresholds to ensure that only woodland parcels with standing merchantable timber are enrolled into the project. This acts to prevent, to a large degree, forestlands being enrolled in the project that would not have been commercially viable for harvesting within the project timeframe.

We also note the potential for *advantageous* selection within the project's enrolment process. Unlike adverse selection, advantageous selection occurs where enrolled landowners are, as a group, *more* likely to engage in business-as-usual harvesting practices compared to the general population of similar forest landowners. Landowners who plan to carry out unsustainable harvesting may be less inclined to disclose this publicly, while those with more sustainable practices might be more transparent. This could result in a bias where the available information overrepresents adverse selection compared to advantageous selection. There are instances where additional, suitable landowners have been enrolled in the project. For example, a Pennsylvania landowner with over 50 forested hectares previously engaged in high-grading to reduce their property tax burden. Similarly, a Maryland landowner, with an on-site sawmill, may have an increased capacity to harvest larger, potentially unsustainable volumes. Overall, while there is potential for advantageous selection, the limited data available somewhat mitigates our concerns about adverse selection in this case.

In summary, we find that actions taken by the project do somewhat limit the risk of adverse selection, as does the potential for advantageous selection to occur. However, a combination of the inherent risk of adverse selection present in aggregated forest carbon projects such as FFCP-CA, landowner-specific evidence, and uncertainty regarding the competitiveness of the project's incentive payments with potential timber revenues somewhat outweighs the project's attempt to prevent adverse selection. This is not to question the overall additionality of the project, which has been previously discussed as being at very low risk, but rather to suggest that some unknown portion

of credits issued by FFCP-CA are likely to be non-additional, thereby leading to over-crediting. Whilst we do not believe adverse selection to represent the majority of enrolled landowners, there is explicit evidence of such individual instances and considerable uncertainty involved. Thus, we believe adverse selection to present a moderately high carbon accounting risk in FFCP-CA.

The project uses a highly credible approach to baseline setting by crediting against a dynamic performance benchmark. The project's adopted methodology, VM0045, uses a dynamic matched baseline approach whereby baseline plots (controls) are established outside of the project area, matched to a project unit, and monitored through time as a dynamic performance benchmark. The donor pool for controls is extracted from the Forest Inventory and Analysis (FIA) database maintained by the US Forest Service. This is an extensive and detailed plot database, providing continuously updated information on many important stand-level characteristics. However, FIA plots are known to be biased, albeit to an unknown extent. Some regions that are known to be actively harvested show minimal harvesting in the FIA database, likely a result of ownerships with active harvesting programmes denying FIA access to the property. Any such bias most likely results in conservative carbon accounting, as it seems probable that bias in FIA participation involves lower participation rates from landowners who harvest more actively.

We are of the view that FFCP-CA takes a rigorous quantitative approach to matching plots in its project area to FIA plots in its surroundings. The project uses Mahalanobis distance matching, a matching algorithm that uses the Mahalanobis distance metric to identify similar units based on continuous variables. The Mahalanobis distance is the distance between two N-dimensional points scaled by the statistical variation in each component of the point. For example, if X_i and X_j are two points from the same distribution with covariance matrix C, then the Mahalanobis distance can be expressed as:

$$D(X_i, X_j) = \{(X_i - X_j)^t C^{-1}(X_i - X_j)\}^{1/2}.$$

The Mahalanobis distance takes into account the covariance structure of the data, allowing for a more flexible matching approach compared to others such as propensity score matching. The choice of Mahalanobis distance is sensible in environmental problems such as this, where we are assessing similarity across two datasets of continuous variables, and is of low risk to carbon accounting.

One important caveat to this approach is that FIA plots are quite sparse on the landscape, and so compared to pixel-matching approaches based on remote sensing it might be common that there will be no FIA plots that strongly match a given project-area inventory plot, or alternatively that a single FIA plot is selected repeatedly as the best match for multiple project-area inventory plots. These issues can increase uncertainty in the FIA-based matched baseline, including in ways (e.g. if single plots are selected many times) that would violate the statistical assumptions underpinning the uncertainty calculations in the baseline, leading the project to underestimate its baseline uncertainty. However, we view this approach to introduce little risk to carbon accounting overall.

The project's choice of covariates to match project units to control plots is appropriate. FFCP-CA matches across a number of appropriate covariates for its approach, including ownership type, forest type, stand origin, road distance code, slope, quadratic mean diameter, relative density, stand age, site class code, and geolocation. This is a comprehensive suite of variables which are likely to give rise to similar FIA plots to the plots in the project area.

In using FIA plots, the project is constrained to matching based on characteristics that are available in the FIA database, and cannot supplement this with remotely sensed information because the precise plot locations are not publicly available. BeZero has performed a complementary exercise in which we

study the important remotely sensed covariates that are strongly predictive of regional harvest patterns near the project area. We note that stand age, forest type, and ownership type tend to be particularly important to control for (Figure 6). Our analysis finds stand age to be the most important covariate, and the only one that was a primary matching covariate in all three groupings (due to the wide geographic distribution of the project area, we split the project into three groups - Pennsylvania, West Virginia, and Maryland - in our analysis). Distance to forest edge was also a primary matching covariate in two out of three groupings. Of particular note, mills were not deemed to be important in our assessment for matching, most likely due to the large number of mills surrounding the project area. The project's approach includes plausible and potentially superior substitutes for most of the important variables that we were able to sense remotely.

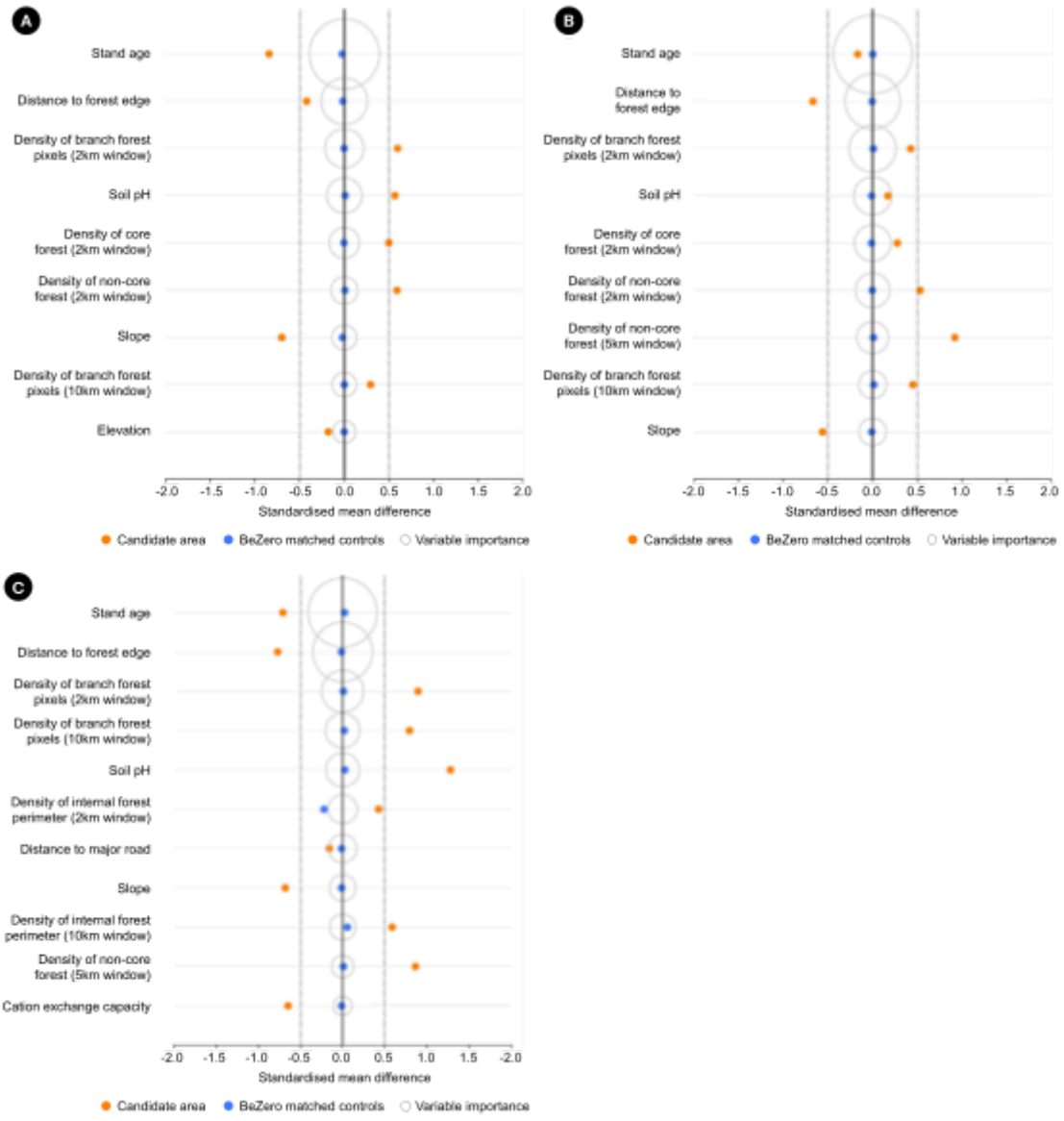


Figure 6. A plot of the matching covariates that we retained in constructing our dynamic baseline for each project grouping (A = Pennsylvania; B = West Virginia; C = Maryland). Orange dots indicate the average difference between pixels in the project area and pixels from the entire candidate area (see Figure 7) across a range of matching covariates. Blue dots indicate the average difference between pixels in the project area and pixels selected as matches. Matching covariates are listed from top to bottom in order of importance.

Among the suite of covariates that we assessed, all of which are plausibly causally connected to harvesting behaviour, we found substantial variation in predictive power and variable importance. Thus, we note that the decision to match based on Mahalanobis distance, which effectively weights all

covariates equally, might drive poorer-than-ideal matches along key, maximally important covariates. However, we do not consider this issue to pose a significant risk to the overall integrity of the project's carbon accounting.

Overall, we believe that the project's choice of covariates within the matching approach is appropriate. The included covariates sufficiently identify plots outside of the project boundaries with similar stand-level characteristics and harvest operability. Whilst explicit historical conditions, such as treatments and disturbances, could provide greater quality in matches, we do not believe them to be essential for quality. Thus, we find the choice of covariates in the case of FFCP-CA to present low risk to carbon accounting.

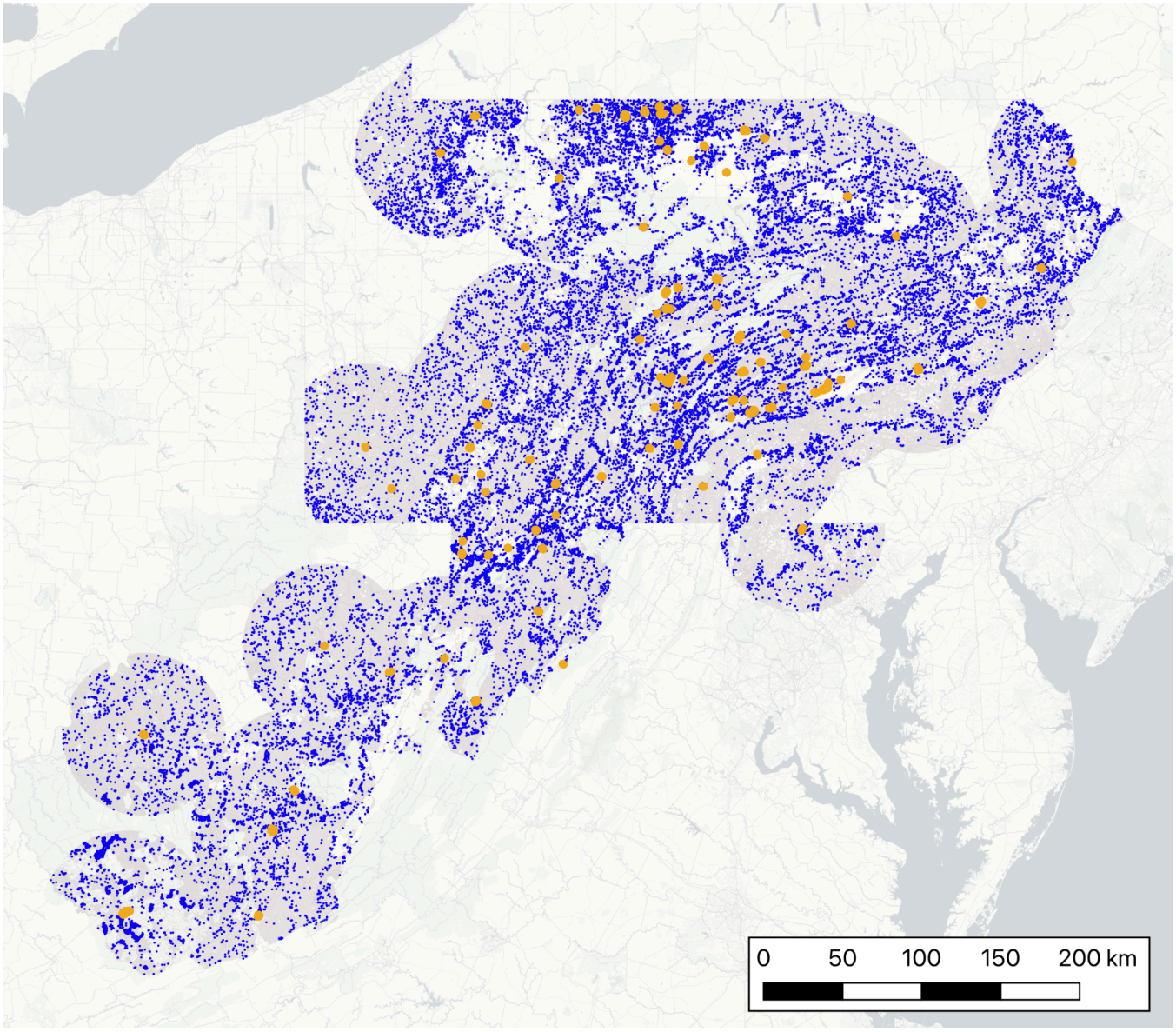


Figure 7. A map of the project area (orange), the candidate area from which statistically matched pixels were drawn (grey), and the location of control pixels that were selected as matches by BeZero (blue).

Carbon sequestration rates claimed in the project scenario are likely to be realistic, despite some uncertainty. Carbon stock change in the project scenario is calculated from periodic direct remeasurement of the permanent sample plots established in a subset of 54 (out of 164) treatment stands. Based on this, the project has achieved a net carbon sequestration rate of 1.66 tC per hectare per year over the reporting period 2021 to 2022, according to the draft monitoring report (unverified at the time of rating) provided by the project developer. Values from peer-reviewed literature for the project region and forest type vary greatly, from 0.85 - 2.34 tC per hectare per year [38–40]. The project's

measured sequestration rate also falls well within the range of estimates for aboveground carbon using FIA inventory plots within a 10 km buffer region surrounding the project area (Figure 8). Our analysis of FIA plots in areas matching the stand-level characteristics (e.g., forest type, stand age, treatment history) of the project area averaged carbon accumulation of 1.89tC per hectare per year.

However, we note one study that found that oak-hickory forests of the Appalachian Plateau province, in which much of the project area lies, reach maximum mean annual aboveground carbon increment at a stand age of 25 years, with substantial subsequent declines in the current annual increment [41]. Given that the youngest stand age of sampled stands is 58 years (the mean stand age across all sampled stands is 77 years) and that some data points in our analysis found negative aboveground carbon accumulation likely due to forest disturbance, there is some uncertainty regarding the sequestration potential of the forestland enrolled in FFCP-CA over the project's lifetime. Otherwise, as the project's claimed carbon sequestration rate falls within the range of literature values, and the project's claims are based on direct measurements within the project area, we believe that claimed removals are likely to be appropriate. Thus, there is low risk to carbon accounting in this regard.

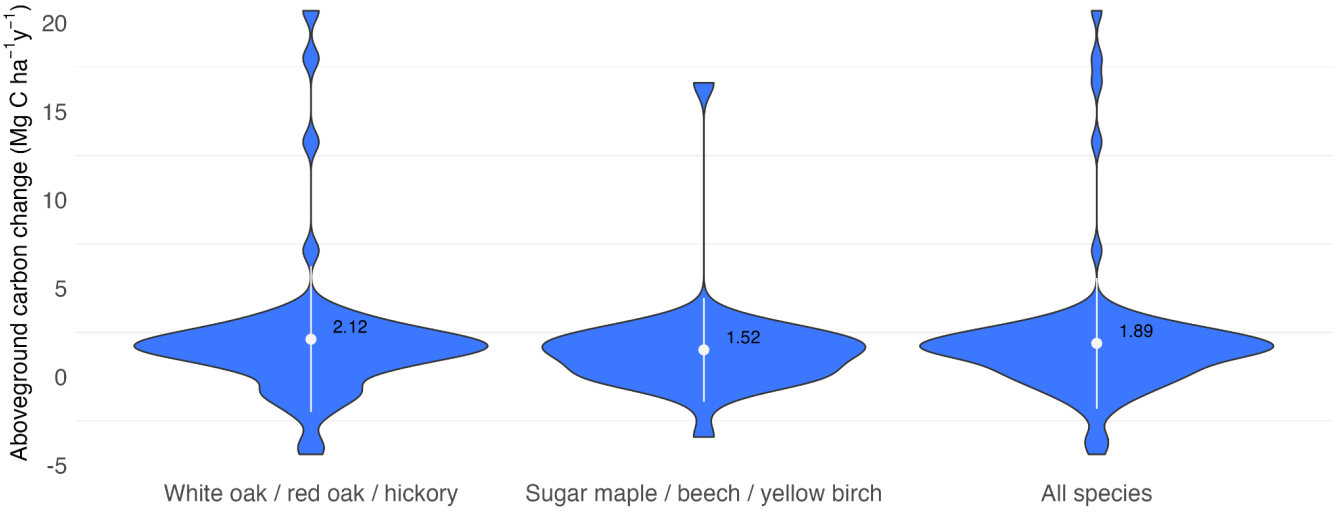


Figure 8. BeZero's violin plots of aboveground carbon change in FIA plots within a 10 km buffer of the project area for two forest types, based on information provided in project documentation, between 2006 and 2021, and all species. Analysis is constrained to stand ages between 58 and 107 years and excludes plots which have experienced clearcuts, in line with the project area conditions. Width of violin represents density of data points, white dots indicate mean, and bars indicate standard deviation.

The exclusion of certain optional carbon pools likely results in conservative carbon stock calculations. FFCP-CA's emission reduction calculations take into account above and belowground biomass, as well as harvested wood products and deadwood. These carbon pools are accounted for in both the baseline and project scenarios. The project does not, however, account for carbon contained in forest floor litter and soil organic carbon. As these exclusions likely reduce issuance, this might be considered a conservative approach by the project. Therefore, we believe that there are greenhouse gas benefits induced by the project that are not being claimed, and this is a potential source of under-crediting.

Market leakage is very likely to occur under the project scenario and associated deductions are insufficient. As project activities will not result in permanent timber harvest reductions within the project area, FFCP-CA deducts only 10% from its gross emissions reductions to account for leakage. We find that there is likely to be material - and unavoidable - risk of market leakage under FFCP-CA, and thus the project's leakage deduction is insufficient. There is a wide range of market leakage

estimates from the literature (7-93%) associated with reduced-harvesting activities akin to those of FFCP-CA, with a mean of approximately 40% [42–44].

One recent global assessment of regional leakage looked specifically at 'carbon' leakage [44]. That is, the actual climate impact of market leakage, as opposed to 'harvest' leakage which refers specifically to harvesting activities and not their associated emissions. The study found a greater likelihood of carbon leakage in extended rotation projects than in logged-to-protected projects, due to intensification and extensification management actions in response to set-aside projects. Carbon leakage in the temperate forest biome, which includes the project area, for extended rotation projects was found to be at least 30%. Under an optimistic scenario of global forest carbon market growth and coverage, carbon leakage rates were at least 40% as more high-value forest area was temporarily taken out of the market.

Our view of leakage risk is somewhat tempered by some uncertainty in assessing market leakage at the project level, as evidenced by the considerable variation in peer-reviewed estimates. However, on the balance of evidence, we believe there to be a high risk of market leakage in the case of FFCP-CA which is not sufficiently accounted for.

Activity shifting is unlikely due to the requirements of the project. Given that a requirement for project participation is that a written forest management plan is obtained for a landowner's entire forestland holdings within a given tract, we believe it to be less likely that harvest activities would shift to forestland owned by a landowner and not enrolled in FFCP-CA. Moreover, landowners are unlikely to own substantial forestland outside of the project area.

However, slight risk is introduced as we are unable to assess the extent and characteristics of forestland that is owned by project participants but not enrolled in FFCP-CA. This raises uncertainty as to the potential for activity shifting, somewhat tempering our view that activity shifting is unlikely.

Carbon accounting conclusion

In our view, FFCP-CA faces moderate carbon accounting risk, driven by the potential for adverse selection to occur within the project. Risk is also introduced by the likelihood of market leakage occurring under the project and the project's insufficient accounting for this source of leakage. Otherwise, the project's carbon accounting approach is rigorous and results in accurate estimations of emissions reductions and removals.

2.1.3 Non-permanence: 'a'

BeZero Carbon is of the opinion that credits issued by FFCP-CA face low risk of non-permanence over the project's 40-year commitment period. The non-permanence risk faced by the project's carbon stocks primarily stems from drought and a high likelihood of pest outbreaks within the project's lifetime. However, other potential sources of non-permanence risk are limited. There is little fire activity in the project region and the project's risk buffer contributions are likely to be sufficient to cover any future reversals. The risk of landowners de-enrolling their forestland is also limited given the project's well-designed payment schedule and certain contractual obligations.

The low likelihood of future substantial fire activity within the project area reduces reversal risk for the project's carbon stocks. Very low historical instances of fire detected in both the project area and the wider region imply low non-permanence risk to the project in this regard. We carry out in-house fire monitoring based on two independent datasets produced by NASA to observe both burned area and active fires. Our analysis of fire data between January 2001 and April 2024 detects burned area within the project boundaries in only one year (2023), which affected 85 hectares (Figure 9). This represents approximately 1.5% of the project area. We also detect only two active fires in the years prior to 2023 within the project area.

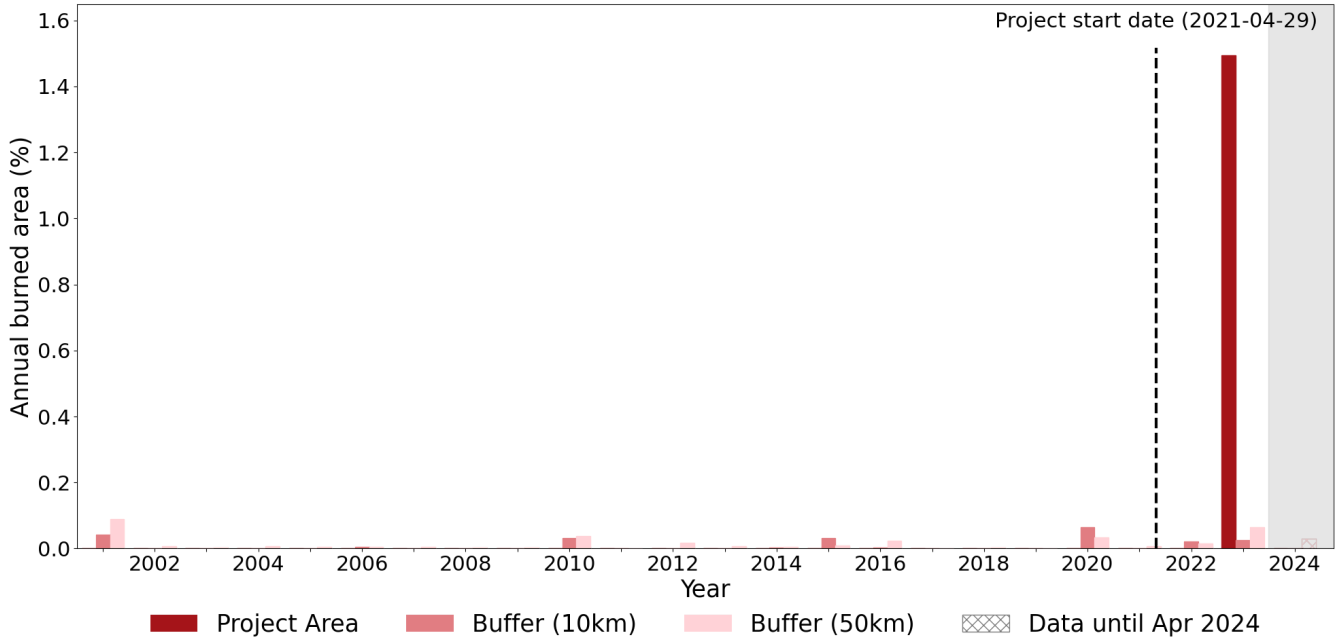


Figure 9. Burned area before and after the project's start date within the project area and 10 and 50 km buffer zones surrounding the project area. Burned area captures the spatial extent of burning. Note that due to the project area's small land parcels, the comparatively coarse resolution fire data plotted here may not be representative for individual parcels but is likely to be representative across the larger landscape. Data from NASA (MODIS MCD64A1 and VIIRS VNP14IMGML).

When looking at fire activity within a 50 km buffer region surrounding the project area, we find similarly low fire risk; over the time period for which data is available (January 2001 to April 2024), we observe annual average burned area of less than 0.1% and 0.3 active fire detections per 1,000 hectares. Whilst the 2023 fire event within the project area was not insignificant, we believe it to be anomalous based on fire history in the region. Moreover, the wide geographic distribution and highly fragmented nature of the project area indicates that large fire events are unlikely to impact large portions of the project's carbon stocks. Therefore, we are of the view that fire presents a low non-permanence risk to the project's carbon stocks.

Periods of severe drought within the project area present moderate non-permanence risk to project carbon stocks. Our analysis of climatological conditions within the project area indicates some level of drought risk, as drought is not uncommon. We use the 6- and 12-month Standard Precipitation Index and the self-calibrating Palmer Drought Severity Index to assess evolving drought risk. We observe instances of moderate to severe drought across the time series (Figure 10).

Drought risk is informed by historical trends in both mean annual temperature and precipitation. Whilst we observe relatively stable precipitation levels, with averages never varying by more than 6% across any given decade, mean annual temperature has consistently increased within the project area. Prolonged drought exposure decreases forest productivity and is associated with increased tree mortality [45]. Moreover, drought can result in a magnification of complex forest-insect disease interactions, which can exacerbate concurrent mortality [46,47]. Due to the dispersed nature of the project area, we note that there is some spatial variation in drought conditions, though the decadal variation and key drought years are consistent across all three state-based property groupings. Ultimately, we believe that drought may pose a moderate risk to the project's carbon stocks.

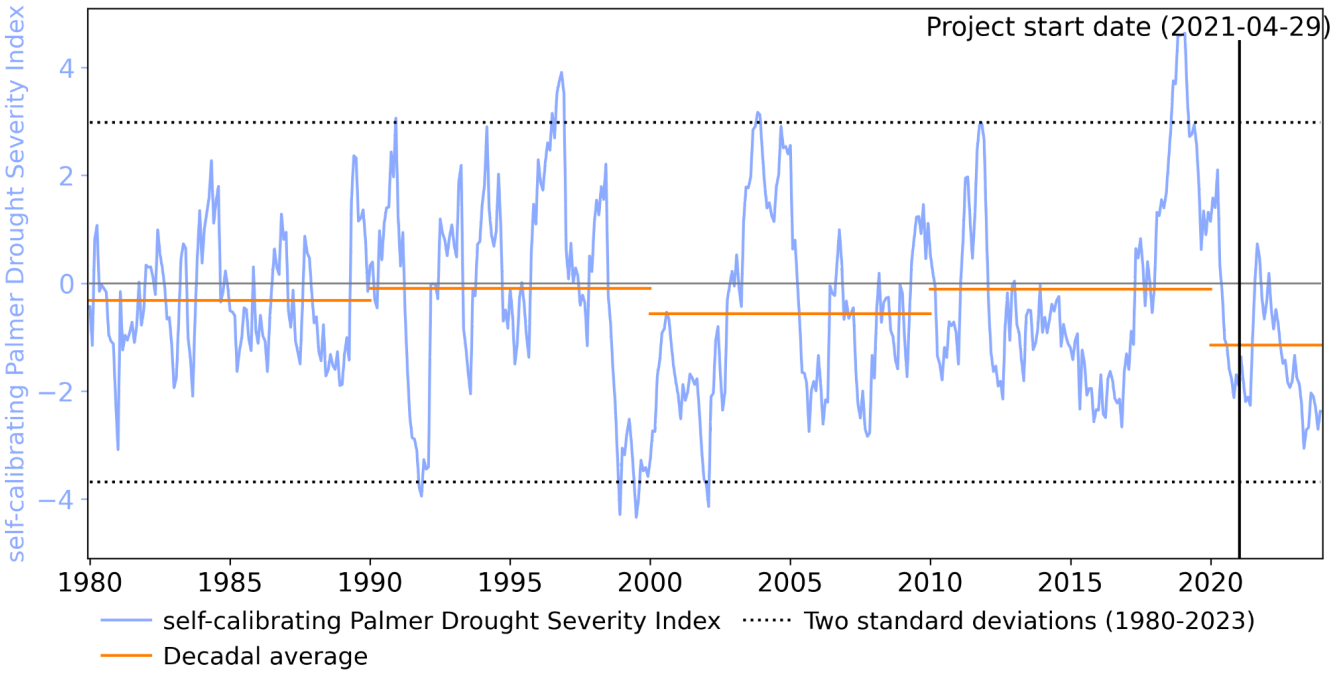


Figure 10. Drought conditions before and after the project's start date within the project area. The self-calibrating Palmer Drought Severity Index (scPDSI) measures meteorological drought conditions based on precipitation, potential evapotranspiration, and soil water-holding capacity. Negative scPDSI values correspond to increased drought risk. Values are relative to typical climatic conditions for the site, and therefore cannot be compared across projects. Two standard deviations (SD, dotted) of the monthly values provide indications of extreme drought (-2 SD) and extreme wetness (+2 SD). Calculated using data sourced from ECMWF (ERA5-Land) and ISRIC (SoilGrids250m).

The project's carbon stocks are threatened by a high likelihood of spongy moth outbreaks in the years to come, although this is slightly tempered by rapid forest recovery times. Pest outbreaks present a material threat to the project's carbon stocks, both now and in the future, increasing non-permanence risk to FFCP-CA. We find several forest pests that pose a threat to forests within the project region; the emerald ash borer (*Agrilus planipennis*) and the hemlock woolly adelgid (*Adelges tsugae*) are both prominent in Central Appalachia and target hardwood species. The former has led to devastating ongoing decline in ash (*Fraxinus*) species in the region, with portions of the region seeing declines in excess of 50% by 2019 [48]. However, the project does not enrol Hemlock stands (rendering the hemlock woolly adelgid an immaterial risk) and limits the percentage of ash enrolled as a safeguard against emerald ash borer effects. One notable forest pest species affecting the project region, and indeed the project area, is likely the spongy moth (*Lymantria dispar*) [49].

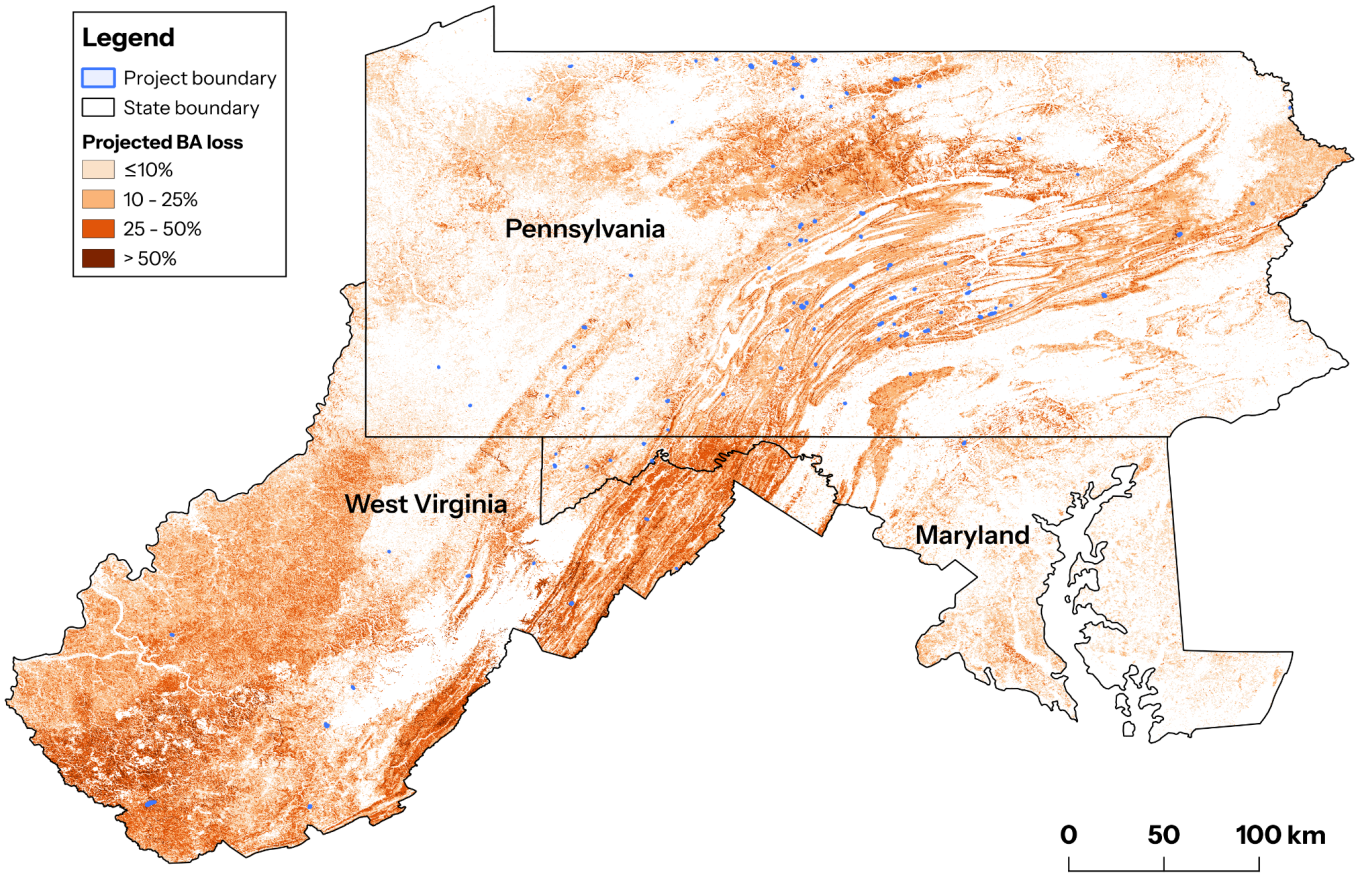


Figure 11. Projected basal area (BA) loss (%) of oak species due to *Lymantria dispar* infestations in Maryland, Pennsylvania, and West Virginia between 2013 and 2027. Darker shading of pixels indicates greater basal area loss and project boundaries are shown in blue. Data from the USDA's 2012 National Insect & Disease Forest Risk Map Report.

For example, in Pennsylvania spongy moth outbreaks have been reported in recent years in nearly 60% of counties in which the project boundaries are located [50]. We find the project area to be at particular risk of spongy moth outbreaks, as it comprises primarily upland hardwood forest and predominantly maple-beech-birch and oak-hickory forest types. These are favoured host species for spongy moths, especially oak (*Quercus* spp.). The USDA's National Insect and Disease Forest Risk Assessment projects that the project area (and wider region) will be greatly affected by the spongy moth in the coming years (Figure 11). Our analysis of spatial data assessing the future impact of spongy moth on oak trees within the project area indicates that more than half of the project area will experience a 10-25% basal area loss for oak species, with a further one third of the project area experiencing up to 50% basal area loss for the 2013 - 2027 timeframe [51]. Indeed, we find evidence in

the public domain that at least two landowners enrolled in the project (both located in Pennsylvania) reported severe impacts of spongy moth outbreaks prior to the project's implementation, including substantial tree mortality.

One peer-reviewed study found that a spongy moth infestation in an oak-dominated forest in the Great Lakes region in Canada caused the forest to turn from a 10-year mean carbon sink - with a mean annual net ecosystem productivity (NEP) of 2.28 tC per hectare - to a large carbon source with annual NEP of -3.87 tC per hectare [46]. However, the study also found that the forest recovered quickly, reverting to a carbon sink in the next year with a NEP value of 3.28 tC per hectare. We believe this acts to somewhat temper the risk to the project's carbon stocks, alongside frequent consultations between landowners and professional foresters. Overall, we are of the view that pest and disease outbreaks represent a moderately high risk to the project's carbon stocks.

Contractual obligations and landowner payment schedules act to ensure landowner retention for the project's lifetime. We believe that there is low risk associated with landowner withdrawal from FFCP-CA, primarily driven by provisions put in place in contractual agreements between the Family Forest Impact Foundation (FFIF) and enrollees. According to documents provided by the project developer, if a landowner terminates their agreement they must pay a termination fee to FFIF. Subject to this, all carbon rights are immediately and automatically transferred back to the landowner. Landowners may also remove a portion of their enrolled acreage from the project during the project's lifetime, as long as 30 acres (~12 hectares) are maintained in the project area. However, this constitutes an 'intentional reversal' of those acres. Intentional reversals trigger a contractual obligation for the landowner to pay back (with interest) the sum of payments received to FFIF, plus 27% of the total sum. We believe that these provisions put in place under the project are likely to facilitate landowner retention, and the risk of intentional reversals from de-enrolled acreage is low. Moreover, it is important to note that any de-enrolled acres would still have to be managed in accordance with the FMP put in place under the project. Therefore, any loss of carbon stocks above project harvest levels is likely to be negligible.

We also believe that the project's incentive payment schedule acts to promote landowner retention. Enrolled landowners receive 20% of their total payments upon signing the agreement and 10% in the last year of the contract life. The rest of the payments are spread throughout the contract life, starting at 3% and rising to 5% per year. This acts to encourage landowners to maintain their forestlands within the project for the full time commitment, further reducing risk to the project's carbon stocks. However, should stumpage prices increase significantly so as to make withdrawal from the project a financially sound decision (considering penalties for said withdrawal), with the intention of carrying out harvesting exceeding the allowed project levels, then material risk to landowner retention may occur. Overall, we believe this scenario to be unlikely and thus low risk remains.

The project's risk buffer contributions are likely to be sufficient in countering future reversal events. Under the standards body, Verra, nature-based projects must assess non-permanence risks and deposit a proportional volume of credits into the Standards Bodies Agriculture, Forestry, and Other Land Use pooled buffer account (the 'risk buffer'). These credits can be cancelled to account for reversals of sequestered carbon. For the most part, we believe that the project's proposed risk buffer contributions are appropriate in mitigating the non-permanence risks faced by FFCP-CA.

The project allocates a total 16% of net emissions reductions and removals to the buffer pool, with the greatest proportion of contribution accounting for natural risk (Table 3). We agree that natural risk presents the greatest threat to the project's carbon stocks over the project's lifetime. However, we believe that its buffer contributions for 'pest and disease outbreaks' may be underestimated for the reasons previously discussed. However, mitigating this is the acknowledgement of changing climatic conditions in the project's risk assessment. As per Verra's recent version 4.1 of the Non-Permanence Risk Tool for AFOLU projects, final buffer contributions incorporate future climate change impacts on natural risks. In line with this, calculated overall natural risk (excluding geological risk) is multiplied by a factor of 1.12. Given the generally low-to-moderate non-permanence risk faced by FFCP-CA, we are of the view that the project's buffer contribution is likely to be sufficient in covering any future reversals.

Table 3. Categorised risk buffer contributions for FFCP-CA

Risk category	Risk factor	Buffer contribution (%)
Internal risk	Project management	0
	Financial viability	0
	Opportunity cost	0
	Project longevity	5
External risk	Land tenure and resource access/impacts	2
	Stakeholder engagement	0
	Political risk	0
Natural risk*	Fire	2.5
	Pest and disease outbreaks	2.5
	Extreme weather	2
	Geological risk	1
Total		**16**

*Future climate impact factor of 1.12 is applied to all natural risks, except for geological risk.

Non-permanence conclusion

We believe that FFCP-CA faces low non-permanence risk given minimal fire activity within the project area and the wider region and an appropriate buffer pool contribution that factors in future climate impacts. Moreover, we find that landowners on the whole are likely to be retained for the course of the project's lifetime. However, some risk is present; periods of severe drought are not uncommon within the project area and spongy moth infestations are likely to occur in the future.

2.1.4 Information risk: 'bb'

We define information risk as the risk posed to our assessment of a project's carbon efficacy by the reliability or robustness of the information available to carry out such an assessment. A project's commitment and enforceability would be significantly linked to the reliability of the information used.

Our assessment of information risk is informed by the degree of available data provision, its quality, and its sources, from both a top-down perspective and project-specific assessment.

Based on the level of detail of information provided by the project developer, we believe that this project faces **moderately high** information risk.

Despite exemplary disclosure of available information by the project developer, FFCP-CA faces an overarching information risk related to our inability to examine detailed profiles, including financial information, of the landowners who control both enrolment and management decisions in the context of the project. This is largely a consequence of the highly aggregated nature of the project, with 99 different landowners enrolled. Financial analyses often play a key role in shaping our view of additionality in carbon projects, but are unavailable in the case of FFCP-CA. Moreover, we are unable to assess forestland owned by project participants but not enrolled in FFCP-CA; this primarily has consequences on our assessment of activity-shifting leakage.

2.2 Project execution risk: 'a'

In the BeZero Carbon ex ante Rating, projects that are in either the design or implementation stage must be assessed for their likelihood of achieving full implementation and stable operational status.

Execution risk is assessed at the project level and applied as a discount factor to the standalone carbon rating. For a project to be executed, the following risks need to be analysed:

Table 4. Methodological summary for our assessment of project execution risk

Technical risk	Refers to the risk that the project's chosen technology, design, and configuration may not work as planned.
Project proponent past experience risk	An assessment of the project proponent's background and past experience is a critical component of our assessment of implementation risk. A new, inexperienced project proponent will increase project risk as compared to an experienced project proponent.
Financial risk	Refers to the risk that a project may not be implemented or operate as planned if it has not secured adequate funding.
Legal and regulatory risk	Encompasses risk to the project from current and evolving regulations, government policies, the permissions/licences required, rights over the project land etc.
Operational risk	Refers to the risk associated with operating the project as planned, post-implementation. This is an equally important component of the project risk assessment, as a well-executed project that cannot operate efficiently renders the project infeasible.

Project execution risk: low risk

The BeZero Carbon ex ante risk assessment evaluates the risk that a project will fail to be implemented and become operational as planned.

On the whole, we are of the view that FFCP-CA faces low project execution risk at this point in time. This view is primarily driven by the project having already been successfully implemented and in its fifth year of operation, with its first issuance expected towards the end of 2024. The project proponent (Family Forest Impact Foundation) is an affiliate of the American Forest Foundation (AFF), a national conservation organisation with considerable experience working with small non-industrial private forest owners. AFF owns and manages the American Tree Farm System, the oldest and largest woodland certification programme in the USA and recognised internationally. Moreover, The Nature Conservancy (TNC) was heavily involved in the design of FFCP-CA. TNC is a global environmental organisation which has been directly involved in the implementation of more than 30 nature-based carbon projects across the three major standards bodies (American Carbon Registry, Climate Action Reserve, and Verra). At least 19 of these are improved forest management projects, including FFCP-CA. In our view, the experience of the involved parties increases confidence in the ongoing successful implementation of the project, reducing project execution risk.

However, some risk is present due to the project's crediting approach (i.e., a dynamic baseline set ex post), imparting financial risk to the project moving forward. Dynamic baselines make project financing - and more relevantly here, a project's ongoing financial viability - more challenging because such an approach inherently increases uncertainty regarding expected carbon credit returns [27]. Indeed, project documentation explains that the crediting approach taken by FFCP-CA results in variations in net emissions reductions and/or removals in any given monitoring period. For example, within the project's first monitoring report (unverified at the time of rating), total achieved emissions reductions and removals were 17% lower than ex ante estimates. Project documentation also suggests that participant enrolment in the project was lower than expected, further decreasing the reliability of ex ante estimations of credit issuance. In our view, this indicates that project execution risk does exist due to the potential for underestimated and insufficient revenues from the sale of carbon credits to adversely impact the project's ongoing financial viability. However, on the balance of evidence, when also considering the project proponents' past experience, we believe there to be low project execution risk overall.

3. CORSIA eligibility

The Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) has been adopted by the International Civil Aviation Organisation (ICAO), a UN agency for the aviation sector, as complementary to the broader package of measures to help achieve its aspirational goal of carbon-neutral growth from 2020 onwards. It is the first global market-based measure for any economic sector and represents a cooperative approach that moves away from a 'patchwork' of national or regional regulatory initiatives.

Credits are assigned CORSIA eligibility if they meet the CORSIA Emissions Unit Eligibility Criteria. These criteria must be met by both the project itself and the registry that the project chooses to use. A credit is eligible if:

1. Crediting period eligibility: The project's first crediting period started on or after 1 January 2016.

2. Clear methodologies and protocols, and their development process: Programmes should have qualification and quantification methodologies and protocols in place and available for use. There should be a process for developing future methodologies. These methodologies should be publicly disclosed.

3. Scope considerations: Programmes should define and publicly disclose the level at which activities are allowed under the programme.

4. Offset credit issuance and retirement procedures: Programmes should have in place procedures for how offset credits are: (a) issued; (b) retired or cancelled; (c) subject to any discounting; and, (d) the length of the crediting period and whether that period is renewable. This should be publicly disclosed.

5. Identification and tracking: Programmes should have in place procedures that ensure that: (a) units are tracked; (b) units are individually identified through serial numbers: (c) the registry is secure; and (d) units have clearly identified owners or holders. The programme should also stipulate (e) to which, if any, other registries it is linked; and, (f) whether and which international data exchange standards the registry conforms with. This should be publicly disclosed.

6. Legal nature and transfer of units: Programmes should define and ensure the underlying property aspects of a unit. This should be publicly disclosed.

7. Validation and verification procedures: Programmes should have in place validation and verification standards and procedures, as well as requirements and procedures for the accreditation of validators and verifiers. This should be publicly disclosed.

8. Programme governance: Programmes should publicly disclose who is responsible for the administration of the programme.

9. Transparency and public participation provisions: Programmes should publicly disclose (a) what information is captured and made available to different stakeholders; (b) its local stakeholder consultation requirements; and (c) its public comments provisions and requirements, and how they are considered (if applicable).

10. Safeguards system: Programmes should have environmental and social safeguards in place. This should be publicly disclosed.

11. Sustainable development criteria: Programmes should publicly disclose the sustainable development criteria used.

12. Avoidance of double counting, issuance, and claiming: Programmes should provide information on how they address double counting, issuance, and claiming.

3.1 FFCP-CA and CORSIA eligibility

BeZero Carbon identifies CORSIA eligibility for projects assigned BeZero Carbon ex ante or ex post Ratings. Presently, Verified Carbon Units (VCUs) issued by FFCP-CA would not be eligible for use under CORSIA.

The VCUs issued by FFCP-CA will have a vintage beyond 2020 and will therefore be required to fulfil eligibility criteria from the first phase of the CORSIA mechanism (2024 to 2026 CORSIA compliance period). At present, the Verified Carbon Standard (VCS) programme is not fully approved for the first phase of the CORSIA mechanism by the International Civil Aviation Organisation.

Verra indicates that full approval is expected by September 2024, at the latest, along with detailed confirmation of eligible VCUs. It should be noted that the project's methodology, VM0045, is not eligible under the pilot phase of CORSIA (2021 to 2023 compliance period). First phase criteria are expected to widen in scope to cover more nature-based solutions (NBS) methodologies and add additional criteria.

The main additional criteria for the first phase of CORSIA concerns Article 6 authorisation; VCUs from crediting periods 2021 and later will need a CORSIA label and an 'Article 6 Authorised: International Mitigation Purposes' VCU label. Prior to being labelled, the project must receive a letter of authorisation (LoA) from the host country to prove no double claiming. Further details regarding the VCS under CORSIA can be found on the Verra website (VCS under CORSIA).

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