Study of Biodiversity Credits Application to Mangrove Ecosystem in Indonesia

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FOREWORD

Firstly, I would like to thank God the Almighty for His blessing to me to complete the task given by the Yayasan Konservasi Alam Nusantara (YKAN). The task was studying and learning about the biodiversity credit and analysis its feasibility to be applied in YKAN's aquaculture-mangrove site in Berau, East Kalimantan. As biodiversity credit is a very new concept, both in international and national level, this study is the first attempt to understand the biodiversity credit, to be applied in a specific ecosystem in Indonesia.

I would like to thank YKAN for giving me an opportunity to study about biodiversity credit, which challenged me to learn more about many aspects related to the biodiversity quantification, biodiversity credit, and biodiversity market. During the study, several resource persons were kindly shared their knowledge and I would like to thank all resource persons, whom I met personally or via telephone: Prof. Dr. Daniel Murdiyarso, Prof. Dr. Cecep Kusmana, Prof. Dr. Lilik B. Prasetyo, Prof. (R) Dr. Haruni Krisnawati, Dr. Tri Atmoko, Mr. Yus R. Noor, and Mr. Imanul Huda.

Discussion via zoom with YKAN staff (Dr. Aji Wahyu Anggoro, Topik Hidayat, Mariski Nirwan) and Mulawarman University researcher (Dr. Dewi Embong Bulan) in the mid-term helped me to understand about current YKAN's project in Berau and the need of topic to be added in this report. I would like to thank them as well for providing some insight from the field. My thanks also extended to my beloved husband, Dr. Tonny R. Soehartono, who has kindly shared some useful information on Plan Vivo and carbon market in general.

This report is meant to be a living document. Many small details in the methodology being studied is still under development, and thus necessary revision will be needed to cope with the latest development of the methodologies.

I sincerely hope that this study report will be used by YKAN to develop the biodiversity credit in Berau in the future. Other organization might also learn from this report, as the study on the biodiversity credit is the first of its kind, as far as I know. I welcome critics and suggestions to improve this report in the future.

Bogor, May 2024

Ani Mardiastuti
Biodiversity Expert
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EXECUTIVE SUMMARY

Unlike carbon credit that has been successfully implemented in Indonesia and elsewhere, biodiversity credit is a very new concept, that works similar to the carbon credit. In the biodiversity credit system, quantification is much more complex, as biodiversity consists in three levels, namely species and genetic, as well as ecosystem. In the international level, the biodiversity credit has been launched through Kunming-Montreal Global Biodiversity Framework under the CBD, as a mean to fill in the gap of necessary funding for biodiversity conservation originating from private sectors and other funding sources.

The objectives of the study were to (1) summarize the concept of 'biodiversity credits' from various standard organizations including Verra and Plan Vivo and examine its applicability to the mangrove-pond ecosystem context in Berau, East Kalimantan; (2) identify the indicators and methodology/protocol that need to be applied when collecting field data in the mangrove ecosystem, and (3) develop data scoping guidelines for project description document development.

The approach of the study is basically a combination of desk study and interviews to the resource persons (six resource persons having different expertise), followed by desk analysis. An intensive desk study was conducted by studying many publications related to the biodiversity credit, available in the web. The most important publications were publication series of Plan Vivo and Verra, of which both produce a popular scheme for carbon credit in the past and currently also biodiversity credit. The nature of the YKAN's proposed aquaculture-mangrove ecosystem in Berau also has been studied, to analyze whether biodiversity credit would be possible to be implemented in that location.

Currently there is no formal, globally agreed definition of a biodiversity credit. Biodiversity credit (or 'biocredit', 'nature credit', 'nature token') basically is a standardized units of positive biodiversity outcomes. It is a financial instrument designed to generate funding for the conservation, restoration, and sustainable use of biodiversity-rich areas. Therefore, for the conservationists, biodiversity credits are market-based instruments designed to incentivize the conservation and restoration of biodiversity. For private companies, the biodiversity credits are an economic instrument that allow the private companies to finance restoration/conservation activities, that deliver net positive biodiversity gains.

As biodiversity encompass genetic, species, and ecosystem levels, there is no universal metric or unit for biodiversity. This is a fundamental difference between the biodiversity markets and the carbon market, where carbon credit can have the same unit across all trees (and other sources), namely carbon dioxide equivalent (CO_2e; 1 CO_2e equal to one ton of CO_2 reductions or avoided emission). Biodiversity, by its very nature, is more complex and multidimensional than carbon.

Scheme and methodology for biodiversity credit has been developed in many countries by many institution (companies, foundations, etc.). Among the many institutions that developed carbon credit in the past, Plan Vivo and Verra were two of he most used scheme in the world. The two institution currently has developed scheme for biodiversity credit. Plan Vivo scheme is specializing in a small, community-based project, and in December 2023 has been launched their biodiversity credit scheme, named Plan Vivo Nature (PV Nature). Verra is another commonly used scheme for carbon credit, but Verra's scheme for biodiversity credit (Nature Framework; SDVM002) is still underdeveloped, and expected to be launched in mid-2024. This report, therefore, will focus on Plan Vivo scheme, which already available and more appropriate for the proposed project.

Plan Vivo and Verra's scheme for the biodiversity credit is not designed for offsetting purpose. Biodiversity credits are intended to have a net-positive impact on nature and biodiversity, whereas biodiversity offsets, as different market-based tool, are intended to compensate for companies' negative and unavoidable impacts on nature.

The proposed project would be in Berau, where aquaculture activities by local communities will be restored back to its original state, the mangrove ecosystem. Currently the activities have been funded under the SECURE Program, and this study will seek the possibility to find other funding sources through biodiversity credit project by using Plan Vivo's PV Nature scheme.

The PV Nature scheme does not require a reference site, and thus the biodiversity gain would be compare with the baseline (year-0) of the same site. To quantify biodiversity under Plan Vivo PV Nature scheme, species (contain species within the species) and ecosystem need to be quantified, by using five 'Pillar metrics', of which three Pillar metrics related to species through biodiversity field survey, while another two Pillar metrics linked to ecosystem, derived through satellite imagery data. The five Pillar metrics eventually will be summing up, to create the final number called 'Multimetric'.

Pillar 1 is **species richness**, basically collect data on certain target species, selected for the PV Nature scheme. Pillar 2 is **species diversity** of the target species, quantified using Hill's number, similar to the widely used Shannon index. Pillar 3 is **taxonomic dissimilarity** (also for the target species**)**, which looking at the diversity among taxa, under the assumption that a good ecosystem will harbor a much more diverse species from different taxa. All three pillars need to be collected through a good sampling plan, stratified by habitat types. Each data collection event (e.g., for annual monitoring) need to have a different randomized sampling plan.

Pillar 4 and Pillar 5 are linked to ecosystem as habitat for wildlife and biotas, derived from a good satellite imagery data, preferably having a high resolution of 0.5m or finer. Pillar 4 is **habitat health**. This Pillar 4 uses a metric that is less familiar in the remote sensing method, namely SBI (Surface Bearing Index), a further analysis of the commonly used NDVI (Normalized Difference Vegetation Index). To calculate the SBI, *geodiv* package in R is used. Pillar 5 is **habitat spatial structure**, which looking at the connectivity of habitat patches within the project area. Pillar 5 is calculated every five years by using *CPLAND index*, available in R. Other Pillars need to be quantified in an annual basis.

The target species (or actually 'group') for Pillar 1, 2, and 3 need to be selected to represent a significant positive change along the successional stages of the restoration effort. These target species group would be minimum four, of which two target groups has already set by PV Nature: (1) herbaceous and woody plants <2m in height, and (2) birds. Two other target species can be selected according to the species present within the ecosystem/habitat types of the project site (e.g., medium and large mammals, bats, amphibians, woody plants, soil microbes, etc.). These target species need to be consulted with Plan Vivo, to ensure validity of the selected species target.

In addition to the biotic components of the project site, some environmental data (i.e., abiotic components) also need to be collected. The required environmental data for terrestrial projects are: temperature, humidity, rainfall, and wind speed.

Further analysis of the feasibility to use the Plan Vivo's PV Nature for biodiversity credit in the aquatic-mangrove ecosystem in Berau suggests that the applicability is high. The Berau aquaculture-mangrove ecosystem is eligible for PV Nature scheme under the 'restoration' activities (and not eligible for another type, 'conservation'). PV Nature has a different method to quantify biodiversity in three landscapes, namely terrestrial, marine, and mixed habitat (i.e., terrestrial with some aquatic/marine habitat). Berau ecosystem fits with the terrestrial landscape.

The suggested target species to be quantified as indicator for the aquatic-mangrove ecosystem in Berau are as follows:

Biotic data (at least 4 target group):

- Plants: herbaceous and woody plants <2m in height (required, set by PV Nature)
- Animal: birds (required, set by PV Nature)
- The proposed two other target groups, selected according the specific habitat of the study site:
    - Woody plants (trees), palms and bamboo >2m in height
    - Macrozoobenthos (mainly to crabs, shrimps, molluscs)

Abiotic/environmental data:

- Temperature (required, set by PV Nature)
- Humidity (required, set by PV Nature)
- Rainfall (required, set by PV Nature)
- Wind speed (required, set by PV Nature)
- Additional data: salinity, turbidity, tide cycles (proposed; all are optional)

PIN (Project Information Note), as the first step to acquire biodiversity credit need to be filled up, and in this report, summary of the information for the PIN is presented in this report (Chapter VII; too long to be presented in this section). In addition, the need for the human resources, involving the local university, also already listed (Chapter VIII).

The proposed project might face some challenges in planning and implementing the biodiversity credit project under PV Nature. Some identified challenges so far are:

(a) local people participation, as the duration of the biodiversity credit project will be minimum 20 years, meaning that eventually almost all aquaculture activities would be restored into mangrove and thus the revenue from the aquaculture activities will be decreased;
(b) tenuriality: ensuring the legal ownership (or the right to manage a certain area) of the current aquaculture area;
(c) suitability of the required target group, namely herbaceous and woody plants <2m in height, which might not relevant for a 'true mangrove' ecosystem which basically consists of trees of certain mangrove species only (i.e., poor species number).

Until now, there has been no project on biodiversity credit conducted in Indonesia. Policy and regulation by the government of Indonesia (c.q. The Ministry of Environment and Forestry) has not been formulated yet. YKAN's intention to have a biodiversity credit project in the aquaculture-mangrove ecosystem in Berau will be the first project of its kind. Lesson learned derived from the proposed project would be very useful for other biodiversity credit projects, as well as for formulating policy and regulation by the government.

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I. BACKGROUND

The latest data from the Ministry of Environment and Forestry revealed that East Kalimantan Province has 240,005 ha of existing mangrove, with additional 112,972 ha of potential habitat for mangrove[1]. Yayasan Konservasi Alam Nusantara (YKAN) also reported that East Kalimantan has 157,802 ha of mangrove forest[2], lower than the coverage area published by the Ministry of Environment and Forestry.

Based on YKAN's data, in the past decade (2009-2019), about 13% of mangroves in East Kalimantan Province have been converted into other land uses, mainly into aquacultures. The expansion of the aquaculture was due to the fact that the shrimp/fish production has been decreasing. Research on the production of the shrimp in East Kalimantan recorded a drastic reduction from 300-400 kg/ha down to 10-20 kg/ha[3].

In 2019, the primary intact mangrove in East Kalimantan was only about 22% of (35,418 ha), of which about half of these primary mangrove (16,263 ha) can be found in Berau. Berau Regency has 86,043 ha of mangrove ecosystem, the biggest in East Kalimantan Province. However, mapping in 2020 unveiled that 4,449 ha pond in Berau Regency was actually inactive[4].

YKAN has been conducting a project in Berau Regency, called SECURE (shrimp carbon aquaculture). Through initiative, YKAN has been trying to restore the mangrove ecosystem and increase traditional shrimp embankments production by narrowing down the aquaculture areas to 20% of their original size and utilizing the remainder 80% for mangrove.

When undisturbed mangrove is converted into other land-use, in this case is aquaculture, the aboveground biomass would be greatly depleted to only about 10%, from 101.67 Mg C ha^{-1} to 11.01 Mg C ha^{-1}. It means that the habitat for wildlife and other biota will also sharply decrease. Restoring and managing the aquaculture into its original state of mangrove forest will also increase the biodiversity in the mangrove forest.

Conversely, when an aquaculture is restored into its original mangrove forest, carbon is increasing along with the growth of vegetation (**Figure 1-1)**. Eventually, the mangrove will harbor many wildlife and other biotas, creating a higher biodiversity compare to its original state of the aquaculture.

In addition to the carbon credit that already familiar to most conservationist, recently a new environmental services financing mechanism, named "biodiversity credits" has been published by a variety of standard organizations. In the context of degraded mangrove ecosystems, biodiversity credits can channel resources

[1] Keputusan Menteri Lingkungan Hidup dan Kehutanan Republik Indonesia No. 6636 Tahun 2024 tentang Peta Mangrove Nasional Tahun 2023.

[2] YKAN. Undated. Unlocking the potential of mangrove ecosystem for climate change mitigation: A case study in Tabalar Muara, Berau, East Kalimantan; https://www.ykan.or.id/content/dam/tnc/nature/en/documents/ykan/infographic/itp/english/NCS-FACTSHEET_MANGROVE_TABALAR_MUARA_FINAL.pdf.

[3] Ilman M. 2009. Keunikan dan peluang revitalisasi perikanan tambak udang di wilayah pesisir utara Kalimantan Timur. WWF Indonesia.

[4] Prakoso DAR, Hakim L, Pratama DR, Prananda ARA, Bayyan MM, Hidayat T, Fajariyanto Y. 2023. The dynamic of mangroves and ponds changes in East Kalimantan, Indonesia. IOP Conf. Series: Earth and Environmental Science 1220 012020, doi:10.1088/1755-1315/1220/1/012020.

toward restoration efforts, while helping to rebuild lost habitats and revive biodiversity. Furthermore, the prospect of financial returns through credit sales encourages local communities and stakeholders to actively engage in mangrove conservation. Ultimately, biodiversity credits present a holistic strategy, aligning economic interests with environmental stewardship to foster the recovery and resilience of destructed mangrove ecosystems.

The biodiversity credit is very new, and thus need to be understood in order to assess its feasibility to be implemented - in this case – in the aquaculture-mangrove ecosystem in Berau. The target scheme would be Verra and Plan Vivo, two commonly used international standard certification scheme. Unfortunately, Verra's biodiversity standard has not finalized yet and thus this report would be focused on Plan Vivo.

To be more specific, the objectives of the study were:

1. summarize the concept of "biodiversity credits" from various standard organizations including Verra and Plan Vivo and examine its applicability to the mangrove-pond ecosystem context in Berau, East Kalimantan;
2. identify the indicators and methodology/protocol that need to be applied when collecting field data in the mangrove ecosystem. Indicators should be relevant to existing biodiversity standards, be easily monitored, and depict changes in overall mangrove ecosystem quality improvement over time; and
3. develop data scoping guidelines for project description document development.

The results of this study hopefully can assist YKAN in deciding to implement the biodiversity credit program in YKAN's project area in Berau. Lessons learned from other site in Indonesia is unavailable yet, as – if implemented soon - would be the first biodiversity credit program in the country.

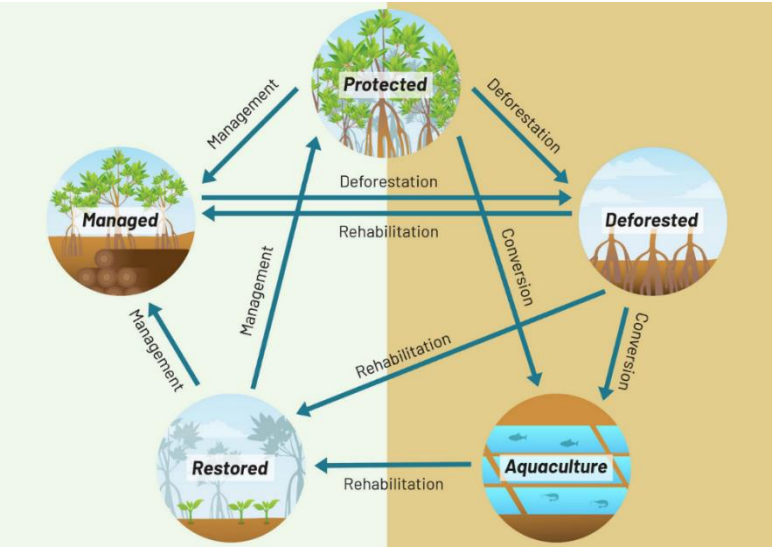


Figure 1-1. Trajectories of mangrove land-use change, involving aquaculture activities and mangrove restoration[5].

Note: the brown shaded: degrading phase or depleted carbon stocks, and the green-shaded area: restoring phase or enhanced carbon stocks.

[5] Murdiyarso D, Swails E, Hergoual'c, Bhomia R, Sasmito SD. 2024. Refining greenhouse gas emission factors for Indonesian peatlands and mangroves to meet ambitious climate targets. PNAS 121 No. 17 e2307219121, https://doi.org/10.1073/pnas.2307219121

II. METHOD

The method in this study was mainly intensive desk study trough web searching, combined with interviews with several relevant resource persons (**Table 2-1**). Following the desk study and interview, various analysis leading to proposed strategies and development of guidelines were conducted accordingly. Summary of the approach and method is presented in **Figure 2-1.** The duration of this study was two months, in mid-March to mid- May 2024.

Table 2-1. Topic of information collected in this study and its sources.

No	Topic	Description	Source
1	Biodiversity credit	Definition, concept, important features, latest development, government policy	Desk study/web searching, interview
2	Certification standard - Verra	Latest development of methodology	Desk study/web searching
3	Certification standard – Plan Vivo	General approach, methodology and data protocol, Project Information Note (PIN)	Desk study/web searching and video released by Plan Vivo, interview
4	YKAN's project in Berau	SECURE project	Desk study/web searching, information from YKAN via zoom, interview
5	Human resources	Faculties under Mulawarman University, Samarinda	Web searching, interview

a. Desk Study

The concept of biodiversity credit and certification standard were studied through a comprehensive desk study. As the concept is new to most researcher, basic concept and its related activities will be studied, focusing on concept used by Verra and Plan Vivo. Webinar video on the launching of Plan Vivo's standard[6] and the explanation on Verra's biodiversity credit (SD VISta Nature Framework)[7] were also accessed to get more understanding, especially on the methodology. The applicability of the concept to mangrove and mangrove-pond ecosystem context in Berau (East Kalimantan) will also be assessed. In addition, Mulawarman University in Samarinda as potential partner for the proposed biodiversity credit project will also be assessed, especially related to faculty that offer specialties related to the biodiversity credit.

b. Interview

Interview with relevant resource persons would be needed to deepen the understanding of the biodiversity credit and its relevant standard. Other aspects that will be covered in this proposal, including indicator, protocol, monitoring, and capacity building will be included in the interview. List of proposed resource persons is provided in **Table 2-2**. The interviews were conducted through direct face-to-face interview or telephone. Results of the interviews were presented in **Appendices**.

[6] https://www.google.com/search?client=firefox-b-&q=plan+vivo+launched#fpstate=ive&vld=cid:0609090a,vid:3KYdL9dAjHA,st:0

[7] https://www.youtube.com/watch?v=ESwArl5fAs8

Table 2-2. List of interviewed resource persons and the topic of interview.

No	Name; Affiliation	Topic of Interview
1	Prof. Dr. Daniel Murdiyarso; Leading blue carbon scientists, IPB University/CIFOR	• Prospect of biodiversity credit in mangrove vs blue carbon in general • Challenges of biodiversity credit for mangrove ecosystem
2	Prof. Dr. Cecep Kusmana; Mangrove specialist, IPB University	• Important features of aquaculture and mangrove forest • Significant parameters for biotic and abiotic monitoring in aquaculture and mangrove forest
3	Prof. (Res.) Dr. Haruni Krisnawati; Special Adviser to the Minister of Environment and Forestry	• View of Government of Indonesia toward biodiversity credit • Readiness of the Government of Indonesia (GoI) on the biodiversity credit scheme
4	Prof. Dr. Lilik B. Prasetyo, remote sensing and spatial analysis specialist, IPB University	• Quantification of habitat/ecosystem by using remote sensing approach • Methods commonly use to quantify ecosystem health and connectivity
5	Mr. Yus Ruslia Noor; Wetlands International – Indonesia	• Mangrove restoration project in Java (Demak) • Lessons learned from community-based mangrove restoration
6	Mr. Imanul Huda; Director of People Resources and Conservation Foundation/Plan Vivo Facilitator in Nanga Lauk	• Carbon project in Nanga Lauk, using Plan Vivo standard • Challenges and lessons learned during project implementation
7	Dr. Tri Atmoko, mangrove and proboscis monkey specialist, BRIN - Samarinda	• Local community of Berau Delta • Biodiversity of Berau Delta

c. Analysis

Following the desk study and interview, further analysis was conducted. The analysis consisted of adjustment analysis for mangrove ecosystem, identify indicators, and identify methods/protocol. Indicators and methodology/protocol that need to be applied when collecting field data in the mangrove ecosystem and mangrove-pond ecosystem was identified. Indicators selected would be relevant to existing biodiversity standards, be easily monitored, and depict changes in overall mangrove ecosystem quality improvement over time.

d. Develop Guidelines and Summary of Concept Document

As a culmination of the study, a guideline to approach biodiversity credit following the Verra was produced. In addition, a summary concept document that explain potential applicability of Biodiversity Credit scheme in Berau (East Kalimantan) will also be produced.

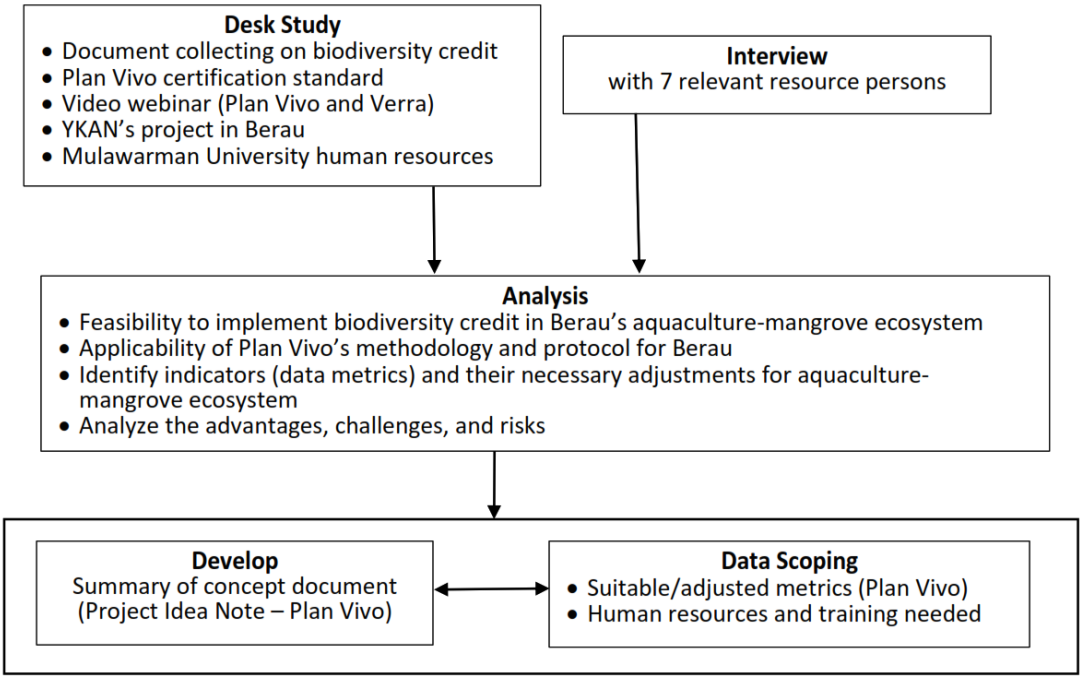


Figure 2-1. Summary of the approach and methods used in this study.

III. UNDERSTANDING BIODIVERSITY CREDIT

A. HISTORY AND DEFINITION

1. History of Biodiversity Credit

In December 2022, 196 Parties to the United Nations' Convention on Biological Diversity (CBD) signed a landmark agreement to protect nature and biodiversity. The terms of this agreement were established under the Kunming-Montréal Global Biodiversity Framework (GBF), which delivers guidance on how to prevent the global biodiversity crisis.

The CBD Secretariat has warned that the current biodiversity finance gap is USD 700 billion per year. In order to bridge this financing gap, a drastic increase in capital mobilization is pivotal for implementing the framework. Target 19 of the Kunming-Montreal Global Biodiversity Framework listed that the Parties to the CBD have committed to increasing biodiversity finance from all sources (domestic and international, pubic, and private) to USD 200 billion per year by 2030 to support biodiversity protection and restoration[8].

Since the adoption of the Global Biodiversity Framework in Montreal, biodiversity credits have gained momentum as one of the instruments that can mobilize additional capital towards biodiversity conservation, restoration and sustainable management[9]. The core purpose of biodiversity credits is to attract private investments toward initiatives aligned with the goals of conserving and restoring biodiversity, as outlined by international agreements such as the Kunming-Montreal Global Biodiversity Framework under the CBD.

Although not the complete solution to financing nature, biodiversity credits are a crucial tool that can enable financial decision makers to put nature-positive actions which benefit people and planet on their balance sheets, while providing the stewards of biodiversity access to much-needed finance. Six months after the GBF agreement, in June last year (2023) the UK and French governments launched the International Advisory Panel on Biodiversity Credits (IAPB) to drive the growth and scaling of high-integrity biodiversity credit markets.

2. Definition of Biodiversity and Biodiversity Credit

Biodiversity refers to the variety and density of life in a region, encompassing the diversity of species, ecosystems, and genetic variations. The biodiversity a crucial component of Earth's life support systems, integral to ecosystem functioning and resilience. Biodiversity is a key indicator of the health of an ecosystem.

Biodiversity credit is a very new concept and currently there is no formal, globally agreed definition of a biodiversity credit[10]. The simplest and yet easily understandable meaning of biodiversity credit is given by The Biodiversity Consultancy[11]: 'a standardized units of positive biodiversity outcomes; these biodiversity

[8] CarbonFinance. 2023. Harnessing biodiversity credits for people and planet. CarbonFinance,
[9] World Economic Forum. 2023. Biodiversity credits: A guide to support early use with high integrity. World Economic Forum.
[10] Fauna & Flora. 2023. Fauna & Flora's position on biodiversity credits and the development of a high integrity biodiversity credit market.
[11] The Biodiversity Consultancy. 2022. Exploring design principles for high integrity and scalable voluntary biodiversity credits. The Biodiversity Consultancy Ltd, Cambridge, U.K.

units are generated through conservation or restoration of biodiversity' (**Figure 3-1**). Another meaning of the biodiversity credit was provided by World Economic Forum[12]: 'biodiversity credits are a verifiable, quantifiable and tradeable financial instrument that rewards positive nature and biodiversity outcomes (e.g. species, ecosystems and natural habitats) through the creation and sale of either land or ocean-based biodiversity units over a fixed period'.

Within this broad definition, biodiversity credits could take many forms. Credits could focus on conserving particular biodiversity features, such as species or habitats, or focus on maintaining ecological processes, such as the functioning or integrity of ecosystems. They could also relate to a particular geography or be global in scope. The biodiversity credit should be applicable across different types of biodiversity, and for terrestrial, marine, and freshwater realms.

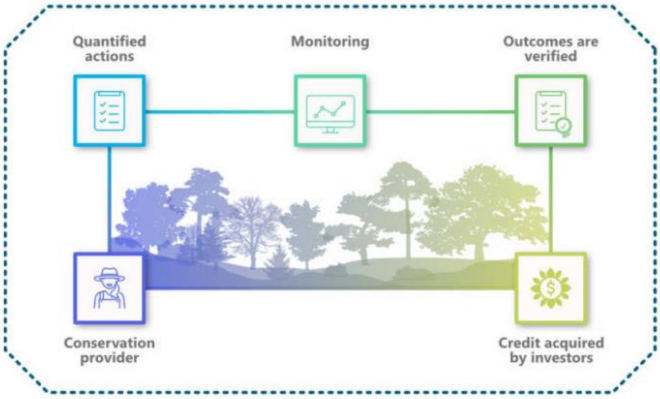


Figure 3-1. Illustration of a biodiversity credit process from creation by a conservation provider to acquisition by investors[13].

To ensure that there are some biodiversity outcomes, all actions/activities by the conservationist (or conservation provider) were monitored over time and verified, similar to the process for the carbon credits. A biodiversity credit represent a unit of biodiversity that is being restored or preserved[14]. Just as carbon credits can be acquired by those seeking to contribute to greenhouse gas emissions reductions, biodiversity credits could be acquired by those wanting to drive positive biodiversity outcomes. Thus, biodiversity credits normally are voluntarily.

The terminology around biodiversity credits is evolving. In the current market, the terms "biodiversity credit", "biocredit", "biodiversity certificate", "nature credit" and "nature token" are used to refer to the same concept[15]. The terms "nature" and "biodiversity" are sometimes used interchangeably but can imply different concepts. "Nature" is a broad term covering both living and non-living elements of the natural world, while "biodiversity" refers specifically to the diversity of life "within species, between species and of ecosystems"

The term 'credit' is broadly used to imply that the owner can make a 'claim' regarding something they have done or that is embodied in a 'credit' (or certificate) that they have purchased. Such a claim may be

[12] https://initiatives.weforum.org/financing-for-nature/home
[13] Biodiversity Consultancy. 2022. *Ibid.*
[14] Ducros A, Steele P. 2022. Biocredits to finance nature and people: emerging lessons. IIED, London.
[15] World Economic Forum. 2023. Biodiversity credits: A guide to support early use with high integrity.

financial, offer the opportunity for profit through trade, or be more of a reputational claim[16]. Biodiversity credits may also gain value when there is a measurable decrease in the threat to biodiversity, and/or to reward stewards of areas that are not under threat[17].

Biodiversity credits are typically created through a certification process that verifies the environmental benefits of the conservation or restoration activities, such as habitat restoration, species protection, or the enhancement of ecosystem services. Biodiversity credits may also gain value when there is a measurable decrease in the threat to biodiversity, and/or to reward stewards of areas that are not under threat. The impact of these projects is quantified, allowing for the creation of credits representing a specific improvement in biodiversity. These credits can then be sold on a market to other developers who need to offset the environmental impacts of their own projects.

The system offers a new way to fund biodiversity projects, encouraging private sector investment in conservation. The credits can be used to finance actions that result in the conservation/restoration of ecosystems and/or measurable, net-positive outcomes for biodiversity e.g. via increase in integrity of species, ecosystems, natural habitats) through the creation and sale of units, largely for gain in biodiversity.

As biodiversity loss continues at an alarming rate, biodiversity credits offer a promising tool to promote and finance conservation efforts worldwide. By valuing the conservation of nature, these credits help bridge the funding gap in biodiversity conservation, aligning economic activities with ecological sustainability.

Broad approaches to biodiversity credits are emerging based on measuring biodiversity outcomes, measuring biodiversity activities, and standardizing projects (nature repair certificates). A preference seems to be emerging for outcomes-based credits based on the market need for a "measurable unit".

However, measuring and verifying biodiversity gains presents challenges, especially given the vast differences between different ecosystems. This means that robust methodologies are needed to ensure the credits represent real, additional, and lasting benefits to biodiversity, making biodiversity credits quite complex to implement.

B. IMPORTANT FEATURES OF BIODIVERSITY CREDITS

1. Biodiversity Credit Schemes

While carbon credits primarily address carbon emissions, biodiversity credits take a more holistic approach by concentrating on preserving and enhancing biodiversity. Biodiversity credit can be applied into various successional stages of an ecosystem, whether the ecosystem is still rapidly developed (through planting and restoration, for example), or when ecosystem is in the climax stage (and need to be maintained in that stage). Ducros & Steele[18] (**Figure 3-2**) have identified that biodiversity credits are being applied broadly in three ways as listed below. Using these three scheme, incentive can be generated for the conservation efforts, even in a location where the biodiversity is not under a threat:

[16] Taskforce of Nature Market. 2023. The Future of Biodiversity Credit Markets: Governing High-Performance Biodiversity Credit Markets. Geneva: Nature Finance.

[17] Biodiversity Credit Alliance. 2023. Communities and nature markets: Building just partnerships in biodiversity credits. Discussion paper. New York: Biodiversity Credit Alliance.

[18] Ducros A, Steele P. 2022. Biocredits to finance nature and people: emerging lessons. IIED, London.

(1) Preserving or avoiding loss of biodiversity:
- Biodiversity credits are applied to an ecosystem, landscape or seascape that already has high levels of biodiversity and that is under threat;
- Sometimes measured against a reference site, to correct for biodiversity loss caused by external factors such as changes;
- A biodiversity credit maintains value if the biodiversity remains the same (i.e., biodiversity indicators do not decrease below those of a reference site);
- Biodiversity credits are used to maintain areas that have not been degraded, but are at risk of being degraded.

(2) Restoration of biodiversity:
- Biodiversity credits are applied to an ecosystem or landscape that requires restoration for biodiversity regeneration and enrichment, improved ecosystem services and/or landscape connectivity enhancement;
- The biodiversity indicators must be increasing relative to a previous measured level;
- A time frame is set out in which the indicators will be measured and over which the desired positive change is evaluated.

(3) Supporting existing efforts:
- Rewarding those who manage or own the land (governments, landowners, local community) who have maintained biodiversity;
- Biodiversity credit schemes are used to generate investment to incentivise further conservation and create opportunities for countries and local community who have succeeded in their conservation efforts and provide support to continue these efforts.

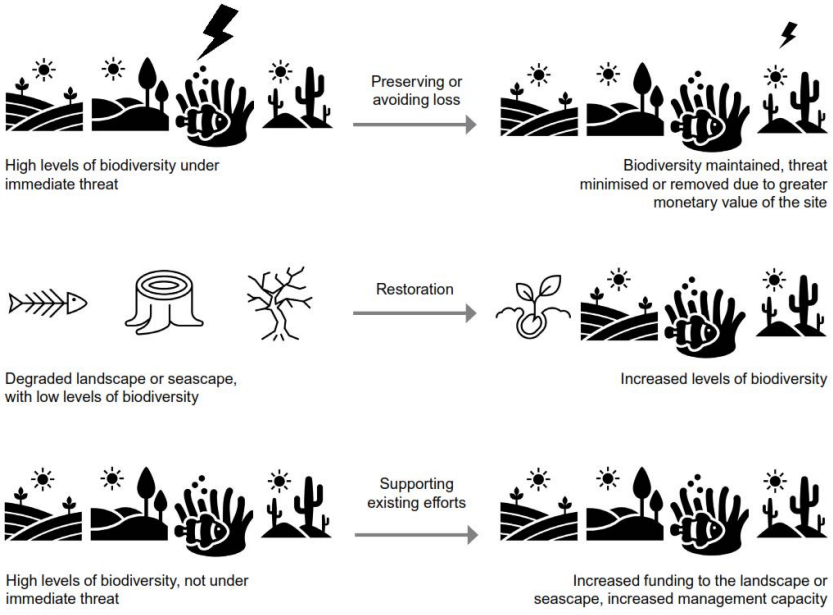


Figure 3-2. Classification and application of three types of biodiversity credit schemes[19].

[19] Ducros A, Steele P. 2022. *Ibid.*.

2. Unit of Biodiversity Credit

For the market to function, there must be clear and accepted metrics underlying biodiversity credits. The metrics must be flexible enough to evolve with improved understanding of what quality biodiversity means and with revisions to frameworks such as the IUCN Red List of Threatened Species and the Global Biodiversity Framework[20].

Unfortunately, there is no universal metric or unit for biodiversity. This is a fundamental difference between the biodiversity markets and the carbon market. For carbon, there is one agreed-upon global unit for measuring climate impact. Theoretically, one carbon credit represents one carbon dioxide equivalent (CO_2 e), equal to one ton of CO_2 reductions or avoided emission. Biodiversity, by its very nature, is more complex and multidimensional than carbon.

The core challenge lies in the intricate and multi-faceted nature of biodiversity itself. Unlike the streamlined processes seen in carbon markets, biodiversity credits struggling with the complexity of valuing and quantifying improvements across genetic, species, functional, and ecosystem diversity. And therefore, building a single-value metric for diversity is an overwhelmingly difficult task. This has implications for the markets' very foundations, logic, and integrity. For this reason, some biodiversity credit methodologies quantify the actions that lead to positive biodiversity outcomes instead of the precise ecological impacts.

Despite facing challenges, this market for biodiversity credits strives to attract both public and private funding, catalyzing investments in projects that yield measurable biodiversity benefits. Currently, the development of biodiversity credits is still fragmented, and most of the biodiversity crediting frameworks and methodologies are under development or in a pilot phase[21], or launched just very recently in December 2023[22].

3. High Integrity Principles of Biodiversity Credit Framework

Building a biodiversity credit framework is not as easy as carbon credit framework, realizing that biodiversity varies highly among sites, in term of function and ecosystem services provided by the biodiversity (mainly from the ecosystem level).

For biodiversity credits to be considered successful, they will need to deliver high integrity outcomes at local and global scales. Local-scale integrity ensures that biodiversity credits deliver tangible positive biodiversity outcomes within the perimeter of a conservation intervention, and these gains are maintained, locally relevant and socially equitable. Global-scale integrity ensures that biodiversity credits make verifiable contributions to achieving societal goals for nature, delivering nature-positive outcomes that are additional to (and not a substitute for) reducing negative biodiversity impacts.

The Biodiversity Consultancy has formulated a set of identified a set of principles ('high integrity principles') for building an effective voluntary biodiversity credit framework (**Table 3-1**). The principles cover ecological, social and financial dimensions, and should be taken into considerations in selecting site and activities.

[20] Ducros A, Steele P. 2022. *Ibid.*.

[21] Compensate Foundation. 2023. From carbon to nature: What the biodiversity markets can learn from the voluntary carbon market? https://assets.ctfassets.net/f6kng81cu8b8/28WY8rKF43LgzZd7drlvPl/990e0fefcf67c38caf5d46104b2ed030/From_Carbon_to_Nature_2023_White_paper.pdf

[22] Plan Vivo. 2023. https://www.planvivo.org/news/plan-vivo-launch-biodiversity-standard

Table 3-1. List of 12 high integrity principles for building an effective voluntary biodiversity credit framework[23].

Dimension	No	Principles
Ecological		
	1	Promote robust and verifiable positive impacts
	2	Are additional to actions implementing the mitigation hierarchy
	3	Contribute to recognized global conservation priorities and align with regional and local conservation plans where relevant, to promote effective targeting of conservation finance
	4	Use flexible measurement frameworks that allow aggregation of context-specific metrics into globally comparable units
	5	Apply cost-effective and proportionate monitoring and verification, to prioritize delivering investment to on the-ground actions
Social		
	6	Are co-designed with local stakeholders through a rights-based approach to conservation
	7	Produce locally-meaningful benefits that address and respect diverse local uses of nature
	8	Promote equitable distribution of benefits
	9	Include strong safeguards to prevent adverse social impacts
Financial		
	10	Enable the sustained funding of credited conservation actions
	11	Ensure transparent reporting of project impacts to manage the risk to credit buyers
	12	Link to clearly defined business needs, to promote scaling of investment finance

4. Challenges in Biodiversity Credit

There are two challenges that have been identified by Compensate Foundation in implementing the biodiversity credit, namely permanence and leakage[24]. Permanence means that the positive outcomes and impacts of the biodiversity project are durable in the timeframe of decades or centuries. In the Voluntary Carbon Market, the long-term impacts of projects can be measured, for example, by using satellite data.

For biodiversity, the issue of permanence is more complicated because wildlife species migrate. Species migrate between regions and habitats as a normal part of their lifecycle. Human pressure, such as poaching, forestry, and converting natural habitats to agricultural land, forces species to move. Furthermore, climate change accelerates migration and displacement of species and populations.

Leakage refers to the situation where safeguarding biodiversity in the project area leads to losing biodiversity in another. This happens when harmful actions, such as poaching or slash-and-burn agriculture, are prevented in the project area, but these actions move and continue outside the project area. The net result is that the project does not contribute to reducing the biodiversity loss but only pushes it to a new place.

[23] The Biodiversity Consultancy. 2022. Exploring design principles for high integrity and scalable voluntary biodiversity credits. The Biodiversity Consultancy Ltd, Cambridge, U.K.
[24] Compensate Foundation. 2023. *Ibid.*

C. INTEGRATION OF BIODIVERSITY CREDITS WITH CARBON CREDITS

Biodiversity credits operate on a concept similar to carbon credit, but with a distinct focus on biodiversity preservation rather than offsetting negative impacts. In the carbon credit, biodiversity has been included in the carbon credit as co-benefit ('carbon credit with biodiversity co-benefits'). In the biodiversity credit, the biodiversity can be claimed as a stand-alone credit, or combining it with carbon credit ('hybrid model').

There are three types of hybrid model combining carbon and biodiversity credits: stacked, staple. and bundled (**Figure 3-3**). In stacking, the biodiversity credits and carbon credits are generated on the same land or by the same project, resulting in certified carbon and biodiversity credits; these credits can be sold separately to different buyers. In stapling, the separate carbon and biodiversity credits are sold together as a combined product; the two credits may originate from different lands, projects, or even different types of projects. Meanwhile, in bundling model, the carbon and biodiversity credits are generated on the same land or by the same project, and these credits are tied together and sold as one product to a single credit buyer, unlike in stacking, where the units are separate.

Biodiversity credits can complement carbon credits as a co-benefit by ensuring projects address both climate change and biodiversity loss, promoting a holistic approach to environmental conservation. This integration enhances the ecological value of nature-based carbon credit projects, making them more appealing for companies looking to promote biodiversity as part of their sustainability strategy.

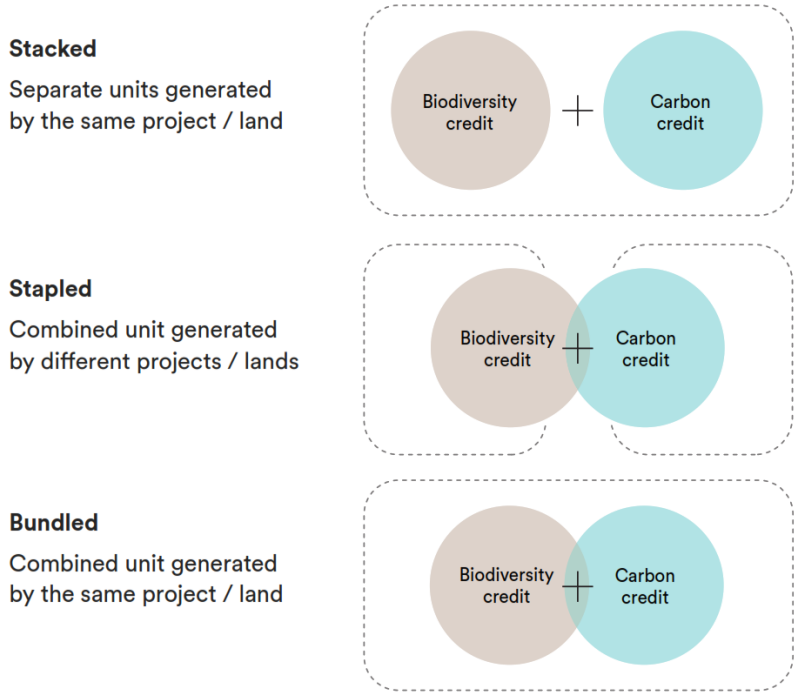


Figure 3-3. Three types of hybrid model combining carbon and biodiversity credits: stacked, staple. and bundled[25].

[25] Compensate Foundation. 2023. *Ibid.*

Biodiversity credits are more complex than carbon credits because biodiversity differs by location and that really complicates the unit of credit. Where we are more comfortable currently is with high integrity carbon credits with strong additional benefits

Although the concept of biodiversity credits has been modelled on carbon credits, unlike the carbon credit market in which companies compensate their emissions through the purchase of credits from companies that reduce or remove greenhouse gas emissions from the atmosphere, biodiversity credits allow companies to invest directly in projects that have a positive impact on nature either by enriching or by restoring biodiversity in areas such as rainforests, oceans, grasslands or other habitats globally.

Unlike carbon offsets, which are payments made by a business to compensate for damaging impacts on ecosystems, biodiversity credits allow companies to support nature-positive action, funding long-term conservation and restoration of ecosystem services.

D. THE LATEST DEVELOPMENT OF BIODIVERSITY CREDIT

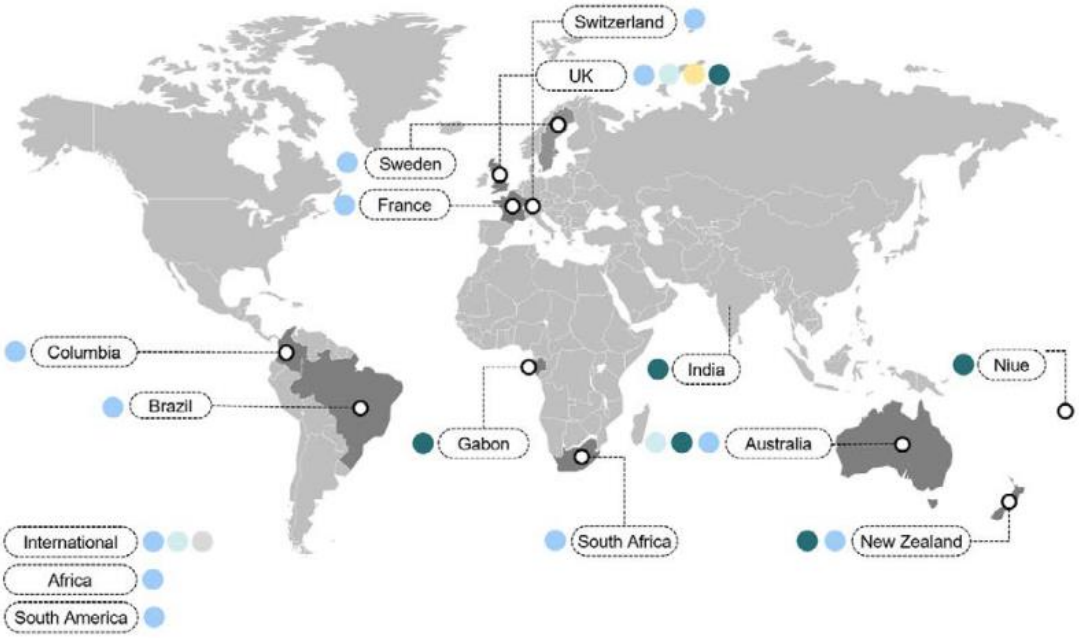
Among recent examples of biodiversity credit generation, the World Economic Forum[26] has recognized the work of several organizations, including Ekos in New Zealand for facilitating the sale of such credits from Sanctuary Mountain Maungatautari to Profile Group Limited in July 2022 and South Pole for launching the EcoAustralia credit combining carbon and biodiversity units. Terrasos and ClimateTrade, alongside XM, IDB Lab and Partnership for Forest have been issuing and commercializing voluntary biodiversity credits generated from the Bosque de Niebla-El Globo Habitat Bank in Colombia.

Global mapping of the location and the initiator of the biodiversity credit is presented in **Figure 3-4**, with the private sector is currently leading the development of biodiversity credit schemes and initiatives, mainly in Australia[27]. For Indonesia, there is no project listed yet. So far the scheme for independent standard are Verra and Plan Vivo. Details of some projects also have been catalogued for further studied[28].

[26] World Economic Forum. 2023. *Ibid.*

[27] The Taskforce on Nature Markets. 2023. Biodiversity credit markets: the role of law, regulation and policy. NatureFinance.

[28] Zynobia N, Steele P, Ducros A. 2023. Biocredit catalogue: a collection of biocredit developers and schemes. IIED, London.



Private sector-led programs

- GreenCollar, NaturePlus™ Credits (*Australia*)
- Terrain NRM, Cassowary Credits (*Australia*)
- South Pole, EcoAustralia™ (*Australia*)
- Wilderlands, Biological Diversity Units (*Australia*)
- Ekos, Sustainable Development Units (*New Zealand*)
- Plan Vivo, PV Nature Biodiversity Certificates (*International*)
- Wallacea Trust, Biodiversity Credits (*International*)
- VERRA, Verified Impact Standard (SD VISta) (*International*)
- Climate Trade/Terrasos, Biodiversity Credits (*Colombia*)
- Ecosulis CreditNature (*United Kingdom*)
- ValueNature Biodiversity Credits (*South Africa*)
- OpenEarth, Marine Ecosystem Credits (*International*)
- Organisation for Biodiversity Certificates (*France*)
- Recelio, Dynamic Biodiversity Tokens (Switzerland)
- Orsa Besparingsskog (*Sweden*)
- BioCarbon Registry (*Colombia*)
- CarbonZ (*New Zealand*)
- Credit Nature (*Scotland*)
- InvestConservation (*International*)
- Single Earth (*International*)
- South Pole (*Colombia*)
- Botanic Gardens Conservation (*International*)
- ERA Brazil (*Brazil*)
- New Atlantis Labs (*International*)
- Rebalance Earth (*Africa*)
- Savimbo (*Colombia*)

Government-led programs

- Proposed Nature Repair Market (*Australia*)
- Ocean Conservation Credits (*Niue*)
- Biodiversity credit system (*Gabon*)
- Green Credit Programme (draft rules introduced) (*India*)
- Biodiversity Credit System (under consultation) (*New Zealand*)

Governance/integrity initiatives

- World Economic Forum Biodiversity Credits Working Group (*International*)
- Biodiversity Credits Alliance (*International*)
- Taskforce for Nature Markets (*International*)
- IUCN Global Standard for Nature Based Solutions (*International*)

University-led programs

- Queen Mary University (*United Kingdom*)

Independent standards

- VERRA (*International*)
- Plan Vivo Foundation (*United Kingdom*)

Figure 3-4. The map and list of voluntary biodiversity credit schemes and initiatives globally[29].

[29] Pollination. 2023. State of voluntary biodiversity credit markets: A global review of biodiversity credit schemes.

IV. CONCEPT OF BIODIVERSITY STANDARD FROM PLAN VIVO AND VERRA

A. PLAN VIVO

1. About Plan Vivo Standard and Plan Vivo

Plan Vivo Standard ('Plan Vivo') was established in 1996 and is the oldest standard for the certification for projects that protect and restore the environment, tackle climate change, and support climate-sensitive community[30]**.** The Plan Vivo Standard is a set of requirements used to certify smallholder and community projects based on their climate, livelihoods and environmental benefits. For the carbon standard in the Voluntary Carbon Market (VCM), Plan Vivo is the longest-standing standard. For the biodiversity standard, Plan Vivo is the first to provide certification standard.

Plan Vivo was developed specially to give small-scale community access to the carbon market. With the latest development of the biodiversity credit, small-scale communities also have an opportunity to obtain incentive from their projects. The projects are based and organized locally, and the small-scale farming families receive at least 60% of the climate protection money. The projects have to pursue a holistic approach, fighting deforestation and poverty while focusing on reforestation. The standard promotes pragmatic climate protection solutions based on participatory approaches that place communities and small-scale farmers at the heart of the solutions. It is these qualities that make Plan Vivo one of the most credible and strongest standards worldwide[31].

Plan Vivo is managed by Plan Vivo Foundation, based in Edinburgh, United Kingdom. The Foundation reviews and registers projects on carbon according to the Plan Vivo Standard, issues Plan Vivo Certificates annually following the submission and approval of each project's annual report and acts as overall 'keeper' of the Plan Vivo Standard which is periodically reviewed in consultation with the Technical Advisory Committee and Stakeholder Groups. It also approves third-party validators and verifiers and registers resellers of Plan Vivo Certificates.

2. Plan Vivo Nature Documents

As for biodiversity standard, after a two-year of intensive preparation and public consultation and field test in seven projects in various countries, Plan Vivo finally finished series on Plan Vivo (PV) Nature documents, launched on December 8, 2023. They the first publications on biodiversity standard among other publications by organization that published similar program for biodiversity certification.

"PV Nature" is the Plan Vivo's Biodiversity Standard, aimed at generating the first high-integrity biodiversity certificates that deliver robust and credible outcomes for nature alongside social and climate benefits[32]. The PV Nature is developed by Plan Vivo in partnership with Fauna & Flora and Carbon Tanzania, to ensure a holistic impact for nature, climate and communities, through a participatory approach, and transparent, equitable benefit-sharing for communities.

[30] Plan Vivo. https://www.planvivo.org/
[31] myclimate. 2024. https://www.myclimate.org/en/information/faq/faq-detail/what-standards-do-our-climate-offset-projects-meet/
[32] Plan Vivo. 2023. About PV Nature. https://www.planvivo.org/pv-nature

Unlike the Voluntary Carbon Market (VCM), these biodiversity certificates are not offsets. The biodiversity certificate is linked to the 'Nature Positive' movement, *a movement aimed at making a positive (and measurable) contribution to reversing biodiversity loss and increasing the resilience of our planet and communities. The Nature Positive is provision of incentive to people, (in particular local communities) to conserve and restore important and threatened species and ecosystems.*

Version 1 of the Plan Vivo Biodiversity Standard (PV Nature) is split across three key documents: Project Requirements, Methodology Requirements and Data Protocol, and Validation & Verification Requirements. These documents are supplemented by various guidance documents, procedural documents, and templates. The PV Nature currently available for public area:

- PV Nature: Project Requirement version 1.0 (https://www.planvivo.org/Handlers/Download.ashx?IDMF=12bedf6a-aaa4-4e6d-b6d8-8f08275fe579)
- PV Nature: Methodology and Data Protocol version 1.0 (https://www.planvivo.org/Handlers/Download.ashx?IDMF=6504e4df-fa6f-4529-9945-767b5c8252e0)
- PV Nature: Validation and Verification Requirement version 1.0 (https://www.planvivo.org/Handlers/Download.ashx?IDMF=15a9b484-cd8c-4c46-b63d-29dd2d1969f4)
- PV Nature: Glossary version 1.0 (https://www.planvivo.org/Handlers/Download.ashx?IDMF=eb5724a5-e563-4b9a-97e3-f4c36f9b2a1b)
- PV Nature: Procedures Manual version 1.0 (https://www.planvivo.org/Handlers/Download.ashx?IDMF=1ab38672-2e16-4653-852c-68a5c971b02c)
- Templates - PV Nature: Prospective Project Questionnaire and Eligibility Check Version 1.0 (in Microsoft Word format) **(**https://www.planvivo.org/pv-nature-documentation**)**
- Templates – PV Nature: Project Idea Note (in Microsoft Word format) (https://www.planvivo.org/pv-nature-documentation**)**
- Tools – PV Nature: Baseline Scenario and Additionality Assessment Tool (in Microsoft Word format) (https://www.planvivo.org/pv-nature-documentation**)**
- Tools - PV Nature: PVBC Calculation Protocol version 1 (https://www.planvivo.org/Handlers/Download.ashx?IDMF=1e4e52d5-4c8d-4288-8b94-3040171947e5**)**
- PV Nature: Validation & Verification Guidance Manual (under development)
- Project Development Guidance Manual (under development)
- Type II Project Participant Guidance (under development)
- Templates – Project Design Document (PDD; under development)
- Templates – Annual Report (under development)
- Tools – Leakage Assessment Tool (under development)

Anyone who wishes to subscribe the latest newsletter from Plan Vivo can subscribe through this link: https://planvivo.us3.list-manage.com/subscribe/post?u=96d76cb06d2eee3a7f8085dc8&id=66948aece0. In addition, Plan Vivo's email for questions and other queries is: biodiversity@planvivofoundation.org

3. Plan Vivo Biodiversity Quantification

The quantification of biodiversity to obtain biodiversity certificate is mainly explained in the Plan Vivo's Methodology and Data Protocol document. This is founded on the principle that certificates will only be issued where there is high quality, auditable data that provides evidence of achieved biodiversity outcomes. In other words, Plan Vivo Biodiversity Certificates (PVBCs) are issued only where there is evidence that species and habitats have benefited.

Building on an initial concept pioneered by the Wallacea Trust[33], the current methodology is an evolution of the original "basket of metrics" approach. To capture the diverse facets of the biodiversity, Plan Vivo uses multiple biodiversity indices, called 'Multimetric' to capture percent change per hectare per year as a unit and can be applied to both restoration and conservation projects, for terrestrial and marine environments.

The new approach is based on key ecosystem attributes, including species-level data across a range of taxonomic groups that are relevant to the project area, to calculate a Multimetric value. Percentage change in the Multimetric per hectare per year forms the unit change that underpins the quantification methodology. The Plan Vivo Multimetric approach is calculated and compared to the same project (i.e., baseline), and thus a reference site is not needed. Details of the methodology and protocol of the Plan Vivo Standard is explained in Chapter V.

B. VERRA

Verra[34] is a non-profit organization based in Washington, DC (USA) founded in 2007 by environmental and business leaders who saw the *need for greater quality.* Verra serves as a secretariat for the various standards it develops and programs it manages, as well as an incubator of new ideas that can generate significant environmental and social value on a large scale.

Currently, Verra manages the following main registries:

(1) Verified Carbon Standard (VCS; formerly the Voluntary Carbon Standard).
The VCS program allows certified projects to transform greenhouse gas emission reductions and removals into tradable carbon credits. This program was launched in 2006, and currently it has become the world's largest voluntary greenhouse gas program. VCS projects include dozens of technologies and measures that result in reductions and removals of greenhouse gas emissions, including conserving and restoring forests and wetlands, managing agricultural land, improving transportation efficiency, and many others.

(2) Climate, Community & Biodiversity Standard (CCB).
The CCB program is the main framework for evaluating land management projects that create net positive benefits for climate change mitigation, local communities and biodiversity. This program can be used in conjunction with a greenhouse gas accreditation program, such as the VCS program, and carbon credits can be labeled with certified co-benefits under the CCB program.

(3) Sustainable Development Verified Standard (SD VISta).
The SD VISta program is a flexible framework that establishes rules and criteria for the design, implementation and evaluation of projects that aim to provide high-impact sustainable development benefits. SD VISta allows projects to link their social and environmental impacts to the United Nations Sustainable Development Goals (SDGs) through certified declarations or tradable assets

[33] Wildlife Trust. 2023. Methodology for Quantifying Units of Biodiversity Gain version 3; https://wallaceatrust.org/wp-content/uploads/2022/12/Biodiversity-credit-methodology-V3.pdf

[34] https://verra.org/

such as health or water credits. The standard allows donors and investors to identify, support and help guide funding towards activities that generate measurable sustainable development outcomes.

Verra's biodiversity credit has been developed under the Sustainable Development Verified Impact Standard (SD VISta). While most concept and publication use the terminology "biodiversity credit"[35], Verra currently uses an alternative terminology of "nature credit", for several reasons:

(a) to distinguish the unit from local offsetting frameworks,
(b) efforts to conserve biodiversity also benefit abiotic components (i.e., non-living nature including soil, carbon, water) and other ecosystem services, and
(c) the term "nature credit" would aligns better with corporate efforts to pursue nature-positive strategies, and (d) representatives from indigenous people and local communities have expressed a preference for this terminology during the initial consultations.

Until now (May 2024) Verra's document related to biodiversity credit is still being developed, named "Nature Framework", following several phases of public consultation. The Nature Framework under Verra's Sustainable Development Verified Impact Standard (SD VISta) Program was open for public consultation through November 19, 2023 and now has been developed internally within Verra and their partner, The Biodiversity Consultancy. Verra actually expected to release the first version of the Nature Framework at the end of 2023. However, on December 1, 2023 Verra announced that they extended its "on hold" status designation to the standard.

The 79-pages Verra's draft document on biodiversity credit is entitled "SD VISta SDVM002 Nature Framework – Draft", available through Verra's website:
https://verra.org/wp-content/uploads/2023/09/SD-VISta-Nature-Framework-v0.1-for-Public-Consultation.pdf

Furthermore, to keep up the new progress of the Verra's SD VISta Nature Framework, everybody is welcome to register through this web link:
https://docs.google.com/forms/d/e/1FAIpQLSdts_P_sGer0rsUYI0ADCjGC2ghH1GS5EtNKAEvvHHJ34F3vQ/viewform?pli=1&fbzx=-9098708067262845035

Although still in drafting phase, Verra has already provided a summary of the biodiversity quantification steps, which might be helpful as a general reference to understand the steps toward biodiversity credit (**Figure 4-1**). Plan Vivo's quantification steps is more or less similar, with a slight difference in the reference site (i.e., Verra uses reference site to quantify the biodiversity impact, while Plan Vivo use the same project area).

Considering that Verra's Nature Framework is still under development, proceeding chapters in this report will focused in Plan Vivo. However, to assist in selecting the biodiversity scheme (i.e., Plan Vivo or Verra) for Berau's mangrove-aquaculture ecosystem, in Chapter VI the Plan Vivo and Verra's approach will be compared.

[35] SD VISta SDVM002 Nature Framework – Draft. https://verra.org/wp-content/uploads/2023/09/SD-VISta-Nature-Framework-v0.1-for-Public-Consultation.pdf

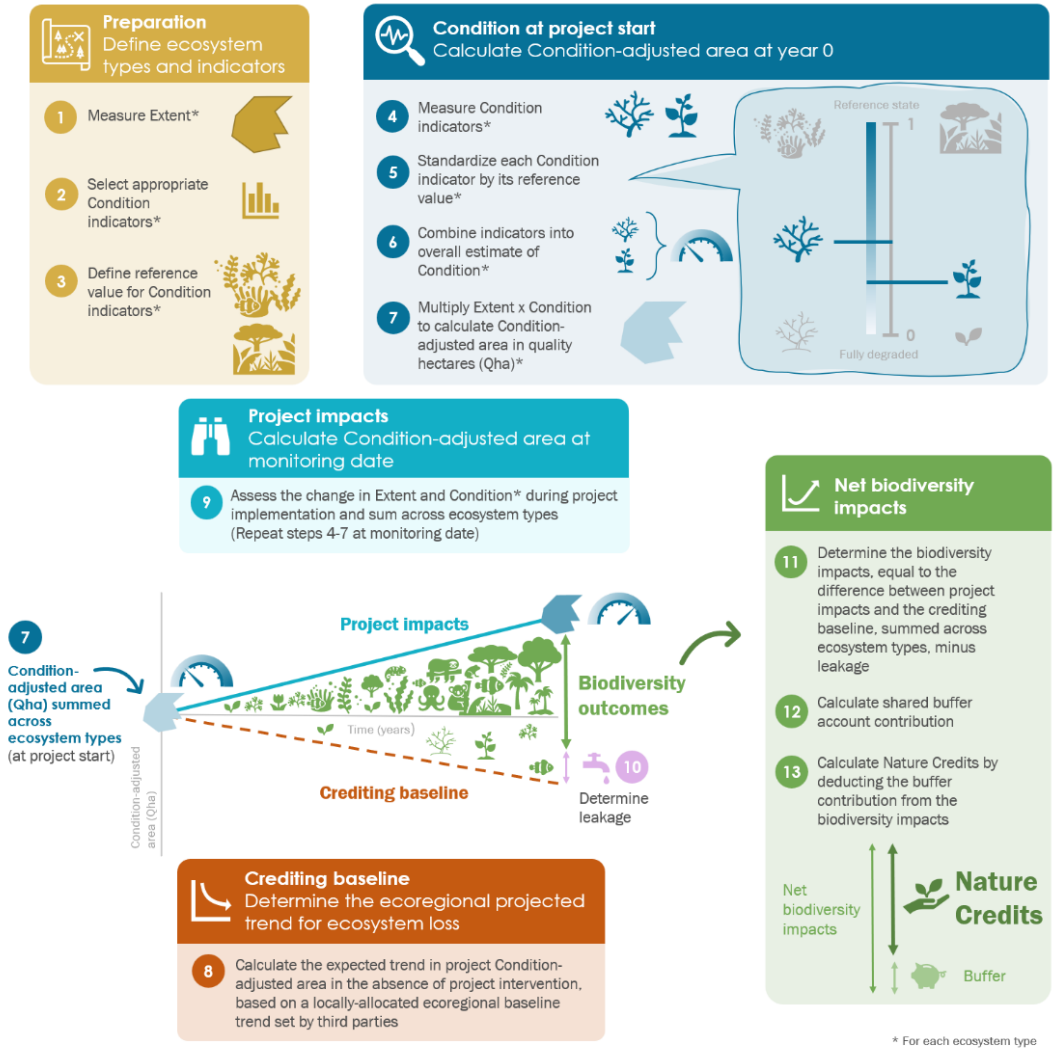


Figure 4-1. Summary of Verra's quantification steps in biodiversity credit[36].

Note: As Plan Vivo does not use the reference site ('reference value' in Verra's terminology), steps 4-7 (dark blue box) would need some adjustments for Plan Vivo.

[36] SD VISta SDVM002 Nature Framework – Draft, *Ibid.*

V. METHODOLOGY AND PROTOCOL FOR BIODIVERSITY CREDIT: PLAN VIVO

A. WORKFLOW OF PLAN VIVO

Similar to carbon certificate, biodiversity certificate also need to undergone a long process before certificates are issued, starting from registration and ended on verification. Plan Vivo Biodiversity Certificate Projects meeting the requirements of Plan Vivo Biodiversity Standard (PV Nature) must be officially registered. The first step towards registration is to submit a Project Idea Note (PIN) as part of a screening process where projects are assessed against basic eligibility criteria (**Figure 5-1**). If a PIN is approved, a project is listed in the project pipeline and can then submit a Project Design Document (PDD) for assessment.

Following this, a project may be validated by a Validation and Verification Body (VVB) or Independent Expert (IE). Upon successful validation, the project will complete registration and become Certified. All Certified projects must submit Annual Reports with details of their monitoring results and any requests for issuance of Plan Vivo Biodiversity Certificates (PVBCs). Projects must then undergo Verification at least every 5 years throughout their Project Period[37]. Along these workflow and process, methodology and protocol to quantify biodiversity are very complex and need to be globally standardized, in order to show the results that can be claimed as biodiversity credits.

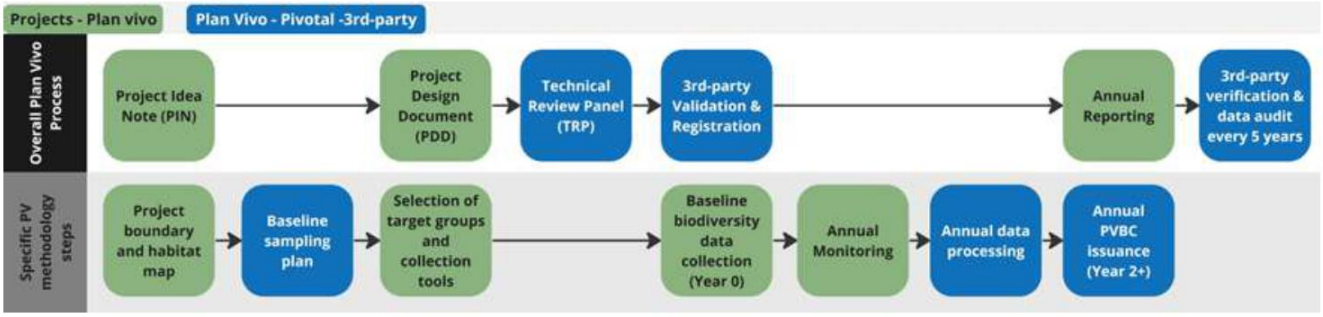


Figure 5-1. The workflow for Plan Vivo Nature Project; boxes in blue are led by Plan Vivo, Pivotal, and third-party organizations[38].

[37] PV Nature – FAQs. https://www.planvivo.org/pv-nature-faqs
[38] Plan Vivo. 2023. PV Nature Methodology & Data Protocol.

B. METHODOLOGY AND PROTOCOL

1. Certificate and Landscape Types

Plan Vivo has been collaborating with another organization/company named 'Pivotal' to design the Plan Vivo Nature Methodology. Pivotal (https://pivotal.earth/) is a biodiversity data and analytics company, based in Cambridge, United Kingdom. These methodologies tries to capture biodiversity in its premium on high-integrity, resulting in auditable data and evidence-based biodiversity outcomes[39].

Pivotal provides a data and analytics platform that enables projects to issue high quality Plan Vivo Biodiversity Certificates (PVBCs). The number of PVBCs a project can generate is calculated via the Pivotal platform and is based on analysing project biodiversity monitoring data to calculate units of change according to a defined sampling plan. This will then be reported to Plan Vivo to confirm the quantity of PVBCs that can be issued provided all other Standard requirements have been met.

Plan Vivo can be conducted in a restoration area or in a conservation area, as Plan Vivo produce two types of certificate:

(1) Restoration Certificate:
- Project to restore an area can be started from zero (e.g., bare land) or an exceptionally low biodiversity (e.g., heavily contaminated land);
- Sampling plan: randomized stratified sampling (i.e., randomized in every habitat); a new, randomized sampling plan is created for each data collection event.

(2) Conservation Certificate
- Eligibility: meet at least 1 of the Key Biodiversity Area (KBA) or two of the Important Plant (IPA) criteria;
- Globally threatened species, or other biodiversity attributes at the project site that trigger/designated the area as KBA or IPA must be included in monitoring activities;
- Sampling plan can be employed, adjusted to the occurrence of the globally threatened species (i.e., fixed sampling point can be applied instead of randomized stratified sampling plan due to the rarity of the target species)

Each type of locations has a specific outcome and requirements of target group, although the metrics of measurement is basically the same. The Methodology and data protocol by Plan Vivo has already launched on December 8, 2023 mostly related to terrestrial habitat.

In term of the landscape or ecosystem selected for a project, Plan Vivo distinguished three landscape types for the program intervention, namely terrestrial, mixed terrestrial-freshwater and marine landscape. Of the three landscape, the main methodology and protocol for the terrestrial landscape has already finished, for marine has partially completed, while for the mixed terrestrial-freshwater is still under development.

For mangrove landscape/ecosystem, there is no specific methodology and protocol funder Plan Vivo Nature. As mangrove ecosystem is basically a mixture of terrestrial and marine ecosystem, the mangrove might also fall under PV Nature's marine landscape. However, judging from indicator requirement for marine landscape which heavily lean on marine abiotic environment, the mangrove ecosystem would be

[39] Plan Vivo. 2023. Plan Vivo launch pioneering Biodiversity Standard, https://www.planvivo.org/news/plan-vivo-launch-biodiversity-standard

more suit the PV Nature terrestrial landscape. Therefore, in this report document, protocol for terrestrial landscape is used for Berau's aquaculture-mangrove ecosystem.

2. Important Features of Plan Vivo Nature Scheme

Summary of some important features of Plan Vivo's scheme is as follows:

- A Project can have more than one Project Areas, as well as more than one Project Region; activities can take place in two or more geographically discrete regions.

- Project Interventions must:
  - restore or conserve land, aquatic area or marine area;
  - provide long term improvements in biodiversity or reductions in biodiversity loss;
  - provide socioeconomic, environmental, and climate benefit

- Project Interventions must be carried out in Project Area(s) that was not intentionally degraded or cleared out within the past 10-year, as shown through satellite imagery or stakeholder consultations.

- The approach of the Plan Vivo methodology is 'within ecosystem change'. It means that reference site is **not needed**, as the change in biodiversity will be compared to its initial state (i.e., baseline).

- Biodiversity crediting methodologies are very new, while biodiversity is highly complex within the three level (i.e., genetic, species, ecosystem). Plan Vivo methodologies will target the biodiversity in species and ecosystem level. They may have an option to quantify biodiversity within genetic level, using eDNA, but this method is still under development.

- Indicators and metrics to quantify biodiversity in a Project Area are rather complicated; advanced knowledge and experience in the field of taxonomy and community ecology (for biodiversity in species level), Geographical Information System (GIS, for biodiversity in ecosystem level), as well as the skill to use computer packages (R and other GIS-related packages for data analysis) would be needed.

- For a large area (more than 10,000 ha), sampling protocols to minimize effort and cost while maintaining scientific rigor is still under development.

- The certification is not intended for offset, unlike the carbon certification.

3. Data Metrics

Data needed for Plan Vivo's methodology basically related to species ('target group'), ecosystem ('habitat') and environment as abiotic factors to support target group and habitat. Plan Vivo has already provided data requirement and metrics, summarized in **Figure 5-1**. The metrics use by Plan Vivo are named 'Pillar Metrics'.

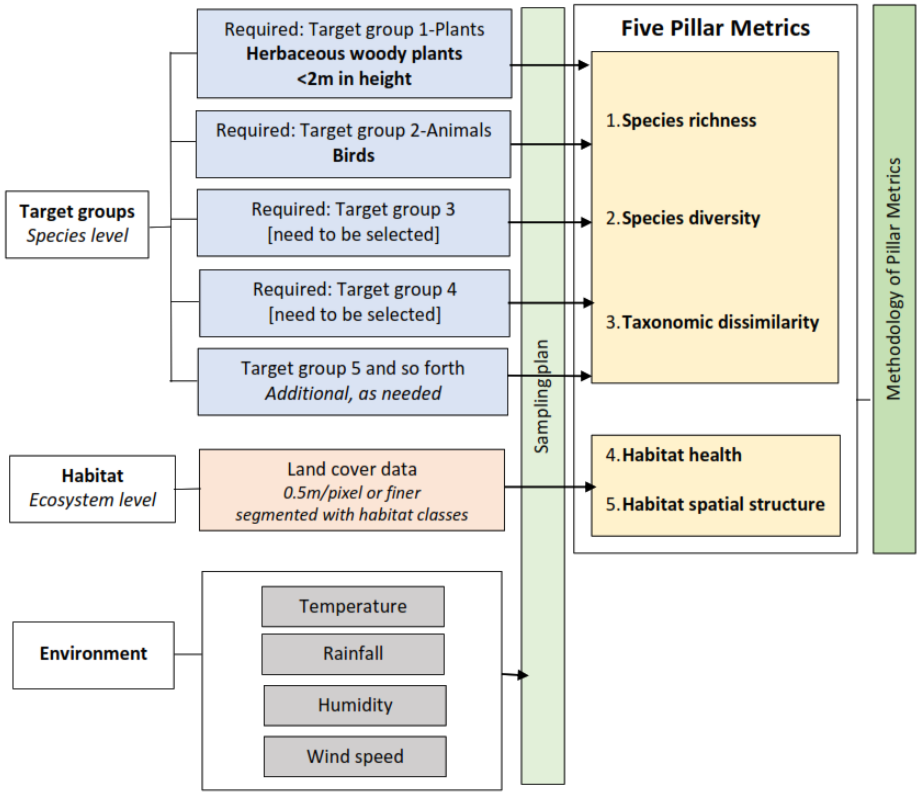


Figure 5-2. *Summary of Plan Vivo's data requirement and metrics.*

Species target groups that need to be monitored are expected to cover a range of taxonomic group, trophic levels, and ecological niches. At least **four** target group is required for terrestrial projects:

- Two target groups that must be included:
  - (1) herbaceous and woody plants <2 m in height, and
  - (2) birds
- At least two other target groups need to be added, that can be selected from the list below:
  - medium and large mammals (weighted >500g, excluding bats)
  - bats
  - one broad group of invertebrates (e.g., flying insects, ground-dwelling arthropods, etc.)
  - amphibians
  - other herpetofauna (i.e., reptiles – tools for data collection are under developed)
  - woody plants (trees), palms and bamboo >2m in height
  - lichens and mosses
  - soil microbes (using eDNA[40]; tools for data collection are under developed)

[40] Environmental DNA (eDNA) is organismal DNA that can be found in the environment. Environmental DNA originates from cellular material shed by organisms (via skin, excrement, etc.) into aquatic or terrestrial environments that can be sampled and monitored using new molecular methods. Such methodology is important for the early detection of invasive species as well as the detection of rare and cryptic species (Source: US Geological Survey; https://www.usgs.gov/special-topics/water-science-school/science/environmental-dna-edna#overview)

The target group selected by a project developer will be reviewed by Plan Vivo Nature Technical Review Panel (TRP) for approval. For a conservation project type, as mentioned previously, the globally threatened species, or other biodiversity attributes at the project site that trigger/designated the area as KBA or IPA must be included in the target group for monitoring activities.

The ecosystem that need to be quantified is basically aiming at the habitat quality for wildlife and other living organisms within the project areas, as well as the connectivity between/among habitat patches. As the habitat covers a large area, good quality satellite images having 0.5m/pixels will be used to analyze the habitat extent and quality.

The environmental data also need to be collected and required. There are four environmental data required for terrestrial project: (1) temperature, (2) humidity, (3) rainfall, and (4) wind speed. Additional data might be added as necessary, depend on the landscape/ecosystem types where project area is located.

For the quantification for species target group and habitat within ecosystem, pillar metrics are used, of which 3 pillar metrics (Pillar 1, 2, and 3) are related to species target group, and the remaining 2 pillar (Pillar 4 and 5) metrics are linked to habitat, to represent ecosystem level. For Pillar 4 and 5, a good satellite imagery is needed, and all quantification will use GIS-based analysis. The environmental data is not quantified as pillar metrics. Summary of the sampling method and calculation for the species target group, ecosystem, environment, and the cumulative of the pillar score is presented in **Table 5-1**.

Pillar 1 is species richness, which has been commonly used in biodiversity survey. The species richness would be surveyed and monitored for species target groups that already previously selected. It seemed that the correct identification to the species level would crucial, as it will link to Pillar 3 on taxonomic dissimilarity. Note that in tropical forest having an enormous biodiversity, some groups of low-taxa animal and plants might not be able to be identified to a species level, for example insects, micro-invertebrates and phytoplankton.

Pillar 2 is species diversity, which essentially combined the species richness (number of species) and abundance (number of individuals for each species). The common quantification for the species diversity is the Shannon (also called Shannon-Wiener) diversity index. However, Plan Vivo use other number/index, called first order of Hill's number. In Hill number, the importance of the abundance distribution increases with increasing Hill order (q). For q = 0, the Hill number is equal to the species richness (the same as Pillar 1). For q = 1, the value is the exponential of Shannon diversity index, and for q = 2, it is the inverse Simpson index. Thus, Pillar 2 is calculated as $e^{H'}$ where e = 2.718 and the H' is the Shannon diversity index. The reason of using the Hill's number instead of Shannon index probably because the Shannon index produce a small number of 0 to 3.5 (or 4.0 for an extremely diverse ecosystem), which might create some biases compare to Pillar 1 that can be tens in number. Hill's number will create a more or less equal value to the species richness.

Pillar 3 is taxonomic diversity. This is a new approach in quantifying species diversity, in relation to the habitat quality and diversity. The basic assumption behind the Pillar 3 is that a good habitat can house various species from various (hopefully far-related) taxa. As an illustration, a habitat containing the same species but still under the same genus, for example *Rhizophora mucronata, Rhizophora stylosa,* and *Rhizophora mucronata* (all are the same genus, and the same family of Rhizophoraceae) would be considered having less scores, compare to another site having different genera or families, for example *Rhizophora mucronata* (family Rhizophoraceae), *Avicennia marina*; family Acanthaceae), and *Xylocarpus granatum* (family Meliaceae). In addition, some species might have different synonyms of Latin names, for example, there are several Latin name for great egret, namely *Egretta alba*, *Ardea alba*, and *Casmerodius albus*. The standardized names and classification used by Plan Vivo is the GBIF Backbone Taxonomy by GBIF Secretariat.

Quantifying the difference in taxonomy of plants and animals surely is very complicated, as the comparison need to be done pairwise using a permutation approach, with different value for comparisons of species-genus, species-family, family-orders, etc. Using computer program is surely needed to calculate Pillar 3, and the Plan Vivo's standard calculation for Pillar 3 is using the *taxa2dist* function (for taxonomic distance within and between-group) and *taxondive* function (for the total value) from the *vegan* package in R.

Pillar 4 is the habitat health, basically quantifying the vegetation health and density (i.e., the 'greenness'; healthier vegetation will produce greener color from the foliage chlorophill). The greenness of a habitat is normally quantified by using NDVI (Normalized Difference Vegetation Index). Plan Vivo does not use NDVI, though. Probably using NDVI poses two obstacles. Firstly, NDVI has a small value between (-1 to +1), which not comparable to values of other Pillars. Secondly, a high NDVI does not mean that the site has a good habitat, as thick bushes actually has much higher values than a good forest[41].

Metric for the Pillar 4 uses SBI (Surface Bearing Index), which derived from NDVI (Normalized Difference Vegetation Index) plus some additional calculation. SBI initially developed to model the roughness of machine surfaces. SBI is a new metric to ecology, and even a GIS expert might not familiar with SBI. SBI is the ratio of the height from the maximum to the 95 percentile of the bearing area curve, to the standard deviation of surface area, calculated by using *geodiv* package in R for gradient surface metrics.

Pillar 5 is the habitat spatial structure. It measures habitat connectivity from one habitat patch(es) to others. The habitat connectivity is very important to ensure that a certain species (land species, freshwater species or marine species) would be able to move around within the landscape to facilitate gene flow among/between individuals/groups. Excellent satellite imageries are needed to analyze habitat structure, Pillar 5 then calculated by using *lsm_c_cpland* function from the *landscapemetrics* package in R. Unlike other pillars that need to be calculated annually, Pillar 5 is calculated at the beginning (baseline data) and every five-year afterwards.

The value of Pillar 1, 2, 3, 4, and 5 eventually will be summed up, to create a Multimetric. This Multimetric is the unit to be used to quantified the success (or not too success) of project intervention to gain Biodiversity Benefit in certification process.

Further explanation of the metrics is available PV Nature Methodology & Data Protocol. Example of each Pillar and Multimetric calculation, however, is not available yet. Due to the complexity of the metric, involving a deep knowledge on ecology, taxonomy, GIS - remote sensing, and the use of R, Plan Vivo plans to provide more guidance documents in the future.

[41] Prof. Dr. Lilik B, Prasetyo, *pers. comm.*

Table 5-1. Five pillar metrics used by Plan Vivo to quantify biodiversity in the project location[42].

Level	Pillar	Meaning	Sampling Method and Calculation
Species	Pillar 1: **Species richness**	The number of species in the project location	• Field survey; every year • Total (sum) of the species within selected target group (e.g., trees, birds, zoobenthos, etc.)
	Pillar 2: **Species diversity**	Combination of number of species (species richness) and their abundance (i.e., relative abundance of each species)	• Field survey; every year • Exponential of the Shannon diversity index[43]: $e^{H'}$ where $e = 2.718$ • Each target group is calculated first, all values then summed to estimate the site-level (project location) species diversity
	Pillar 3: **Taxonomic dissimilarity**	The distance in the taxonomic between the difference species found in the project location	• Desk study based on Pillar 1: Species richness; every year • Use Δ metric (Δ* and Δ+)[44,45] • Total value of within-group dissimilarity (i.e., weighted sum of Δ*) plus the between-group dissimilarity values (i.e., Δ+) • Taxonomic data: use GBIF Backbone Taxonomy by GBIF Secretariat[46] • Use *taxa2dist* function (for taxonomic distance within and between-group) and *taxondive* function (for the total value) from the *vegan* package in R

[42] Summarized from Plan Vivo. 2023. PV Nature Methodology & Data Protocol version 1.0.

[43] Formula for the Shannon diversity index (also known as Shannon-Wiener index):

$$H = -\sum_{i=1}^{s} p_i \ln(p_i)$$

where
H = the Shannon index value
p_i = the proportion of individuals found in the ith species
ln = the natural logarithm
s = the number of species in the community

[44] Warwick RW, Clarke KR. 1995. New 'biodiversity' measures reveal a decrease in taxonomic distinctness with increasing stress. *Marine Ecology Progress Series* 129: 301-305.

[45] Clarke KR, Warwick RM. 1998. A taxonomic distinctness index and its statistical properties. *Journal of Applied Ecology* 35(4): 523-531. https://doi.org/10.1046/j.13652664.1998.3540523.x.

[46] GBIF Backbone Taxonomy, https://www.gbif.org/dataset/d7dddbf4-2cf0-4f39-9b2a-bb099caae36c.

Level	Pillar	Meaning	Sampling Method and Calculation
Ecosystem	Pillar 4: **Habitat health**	Quantifying the vegetation health and density (i.e., the 'greenness' (amount of chlorophyll) of the vegetation)	• Derived from satellite imagery; every year • Use SBI (Surface Bearing Index) derived from NDVI (Normalized Difference Vegetation Index) • Value of NDVI: between -1 and +1; negative NDVIs indicate an absence of vegetation (i.e., water, bare ground); NDVI for shrub and grasses: ~ 0.2-0.3, NDVI for healthy forest: ~ 0.6-0.8 • Analyzed by using 'Sentinel-2 Level-2A Multispectral Instrument'[47] data (freely available), combined with Sentinel-2: Cloud Probability[48] dataset for masking out pixels with a high probability of cloud cover • A mosaic is constructed using the median NDVI value for each pixels ($100m^2$), median is calculated over a three-month period • SBI is the ratio of the height from the maximum to the 95 percentile of the bearing area curve, to the standard deviation of surface area • Calculation of SBI: *geodiv* package in R[49] for gradient surface metrics
	Pillar 5: **Habitat spatial structure**	Quantifying habitat connectivity	• Derived from satellite imagery (high resolution, 0.5m or finer) • Create a polygon habitat map, the polygon will be converted to a raster at resolution of $10m^2$, then calculate a CPLAND index (percentage, from 0 to 100) by using *lsm_c_cpland* function from the *landscapemetrics* package in R[50] • Calculate for baseline study and every five years thereafter, validated and verified by a third party
Project Location	Cumulative of 5 Pillars: **Multimetric**	Year-on-year percentage changes in the pillar metrics	• Cummulation (sum up) of the 5 Pillars above • Calculated every year for Pillar 1, 2, 3, and 4 (i.e., multimetric consists of 4 Pillars); every 5 years the Pillar 5 is also calculated and included in the Multimetric

[47] https://sentinels.copernicus.eu/web/sentinel/user-guides/sentinel-2-msi/product-types/level-2a
[48] https://developers.google.com/earth-engine/datasets/catalog/COPERNICUS_S2_CLOUD_PROBABILITY
[49] https://cran.r-project.org/web/packages/geodiv/index.html
[50] https://r-spatialecology.github.io/landscapemetrics/index.html

C. CALCULATION OF PLAN VIVO BIODIVERSITY CERTIFICATE (PVBC)

The Plan Vivo Nature Methodology is founded on the principle that certificates will only be issued where there is high quality, auditable data that provides evidence of achieved biodiversity outcomes. In other words, Plan Vivo Biodiversity Credits are issued only where there is evidence that species and habitats have benefited.

The net change (net generation) in Multimetric (i.e., after and before/baseline project intervention) during year(s) *t* in a restoration project will be used to calculate the Biodiversity Benefit, and presented in % per ha. In a conservation project, the Multimetric must show a net retention of the biodiversity in the Project Area, at least 95%.

Prior to get the final value for Biodiversity Certification, there are two factors that need to be accounted for, namely (a) Leakage discount and (b) Risk Buffer. The Leakage discount (in percent) and Risk Buffer need to be included in the calculation, i.e., deducted from the net generation or net retained value. Leakage is a potential for significant biodiversity loss outside of the Project Area as a result of Project activities. The Leakage must be estimated, and hopefully the Leakage is very minimal or even zero.

Methodology for the Leakage (PV Nature Leakage Tool) is still under development by Plan Vivo. Meanwhile, the Risk Buffer is set at 20% (meaning that the generation or net retention that can be claimed would be 80% or 0.8 from the net value), similar to the buffer for carbon.

Thus, the final calculation for the Plan Vivo Biodiversity Certificate (PVBC) is as follows:

For restoration project:

- $PVBC_{restore}$ after Leakage discount = Net generation * (100% - %Leakage discount)
- After discounted for Leakage and Risk Buffer, the number of restoration certificate (generated for year t; $PVBC_{restore}$) would be:

$$PVBC_{restore} = [\%\ \text{Net generation in Multimetric}^* (100\% - \%\text{Leakage discount})] * [0.8]$$

- $PVBC_{restore}$ is the number of restoration Plan Vivo Biodiversity Certificates ($PVBC_{restore}$) generated for a certain year.
- One unit of Restoration Certificate is equal to a 1% increase in the Multimetric in one year in one hectare of a site.
- In year *t*, to avoid double counting due to accumulation function, the number of restoration certificate is calculated as the difference in the Multimetric value from the most recent certificate issuance multiplied by the size of the size (in ha).
- After the third measurement (i.e., first measurement for baseline data and two subsequent measurements), Project can choose to begin issuing certificates.

For conservation project, the calculation is similar with the $PVBC_{restore}$:

$PVBC_{conserve}$ after Leakage discount = Net retention * (100% - %Leakage discount)

After discounted for Leakage and Risk Buffer, the number of conservation certificate (generated for year t; $PVBC_{conserve}$) would be:

$PVBC_{conserve}$ = [% Net retention in Multimetric * (100% - %Leakage discount)] * [0.8]

$PVBC_{conserve}$ is the number of conservation Plan Vivo Biodiversity Certificates ($PVBC_{conserve}$) generated for a certain year.

The above calculation presented in this document is a simplification of notation derived from the original Plan Vivo document. For a complete notation and formula of the calculation protocol, please see the Plan Vivo PVBC Calculation Protocol Version 1.0[51].

[51] https://www.planvivo.org/Handlers/Download.ashx?IDMF=1e4e52d5-4c8d-4288-8b94-3040171947e5

VI. APPLICABILITY OF BIODIVERSITY CREDIT SCEHEME IN BERAU

A. YKAN'S SECURE PROGRAM IN BERAU

Berau Regency is listed as the largest mangrove ecosystem in East Kalimantan Province. Unfortunately, the unplanned opening of shrimp/fish farms became the main driver of mangrove deforestation in this region. This change in the function of mangrove land can have a negative impact on the ecosystem, as well as threaten the livelihoods of coastal communities.

Satellite imagery analysis in 2019 revealed that ~22% (35,418 ha) of the mangroves in East Kalimantan remains relatively intact, of which about half (16,263 ha) can be found in Berau. The rate of mangrove conversion in Berau is smaller than the average of East Kalimantan, with ~5% of the mangroves area converted into other land uses from 2009-2019[52]. However, mangroves in Berau face similar threats of mangrove conversion into aquaculture as the major driver (**Figure 6-1**).

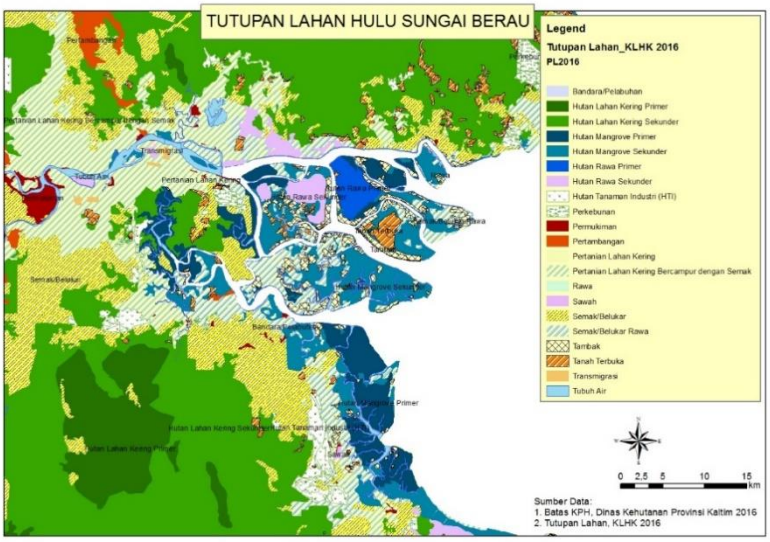


Figure 6-1. Land cover of Berau Delta, East Kalimantan, showing the intensive change of the natural ecosystem to the anthropogenic-related activities. Source of map: Ministry of Forestry and Environment.

Fish and shrimp production in Berau consists of captured fishery (at sea and inland water) and aquaculture (consisted of mariculture, brackish water pond/shrimp aquaculture, freshwater aquaculture, and fish-caged culture (*karamba*). Aquaculture of white-shrimp in Berau was started in 1993, while tiger-shrimp culture was first recorded six years later, in 1999, following a massive conversion of mangrove forests into aquaculture ponds[53].

[52] Prakoso DAR, Hakim L, Pratama DR, Prananda ARA, Bayyan MM, Hidayat T, Fajariyanto Y. 2023. The dynamic of mangroves and ponds changes in East Kalimantan, Indonesia. IOP Conf. Series: Earth and Environmental Science 1220 012020, doi:10.1088/1755-1315/1220/1/012020.

[53] Gunawan BI. 2016. The diversity of fisheries based livelihoods in the Berau Delta, East Kalimantan. *Wacana* 17(1): 5, doi 10.17510/wacana.v17i1.429.

Unfortunately, the shrimp/fish production continued to decline. The peak of the decline in pond productivity in Berau Regency occurred from 2000 to 2010, especially in 2005, where the fish/shrimp production reached only half of the normal production, mainly due to the lack of management of the pond, causing some abandonment of some ponds, and provided an opportunity for mangrove species to regenerate[54].

Since 2020, in Berau Regency YKAN has been conducted an environment-friendly shrimp farming practices in mangrove ecosystems through the Shrimp-Carbon Aquaculture (SECURE) Program[55] (**Figure 6-2**) with two pilot sites in Kampung Pegat Batumbuk and Kampung Tabalar Muara. The general characteristics of brackish water ponds in Berau Regency are for the cultivation of milkfish and tiger-prawns. The problems faced are usually low egg quality, inappropriate management of water and pond soil quality, and uncontrolled use of pesticides.

The SECURE approach was designed to overcome these problems. Through the SECURE program, YKAN is trying to redesign the shrimp pond to a smaller size and combining it with mangrove hydrological restoration[56]. Unproductive ponds – which already caused some environmental problems - were/will be left abandoned and converted into mangrove areas (**Figure 6-3**).

Figure 6-2. Local communities' aquaculture system in Berau's coastal area, originated from conversion of mangrove forest into small-sized shrimp/fish ponds (©YKAN).

[54] Prakoso DAR, Hakim L, Pratama DR, Prananda ARA, Bayyan MM, Hidayat T, Fajariyanto Y. 2023. *Ibid*.

[55] YKANa. No date. Unlocking the Potential of Mangrove Ecosystem for Climate Change Mitigation: A Case Study in Tabalar Muara, Berau, East Kalimantan. Jakarta: YKAN.

[56] YKAN 2022. The SECURE Approach to Support Environment Friendly Shrimp Farming Practices in Berau District. Downloaded from https://www.ykan.or.id/en/publications/articles/press-release/environment-friendly-shrimp-farming-practice/ on April 1, 2024.

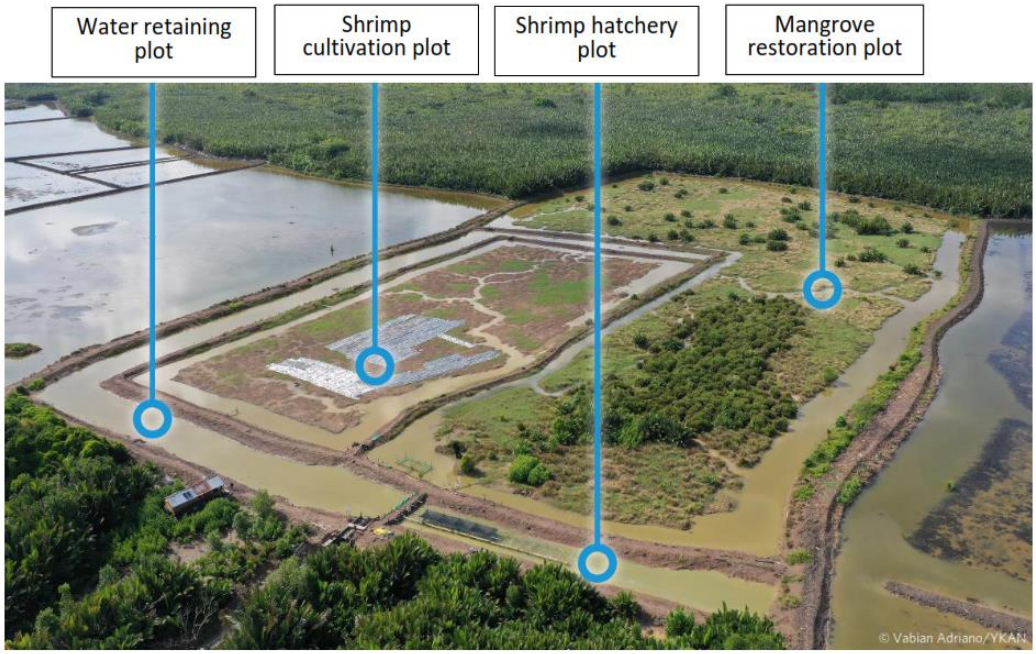


Figure 6-3. Aquaculture-mangrove pond system showing different management plots in Berau Regency, which currently the Shrimp-Carbon Aquaculture (SECURE) Program has been implemented by YKAN (©Vabian Adriano/YKAN).

The restored mangrove will support natural food for shrimp and fish, while reducing carbon emissions during the restoration. The SECURE approach hopefully would be able to increase pond productivity by involving local communities in restoring some unproductive ponds into healthy mangroves again.

In 2023, the SECURE Program has successfully converted 20 ponds totaling 210 ha, consisted of restored mangrove (106 ha), protected mangroves area (82 ha) and area for aquaculture (37%). By the year 2030, YKAN has a target to implement 11,000 ha of ecosystem-approach aquaculture (*Akuakultur dengan Pendekatan Ekosistem, ADPE*) and 44,000 ha of sustainable-protected mangrove, while increasing the livelihood of local people form 6 surrounding villages[57].

The creation of the SECURE Program in East Kalimantan obviously was based on many considerations. East Kalimantan has one of the largest mangrove in Indonesia (157,802 ha). In the past decade (2009-2019), ~13% of mangroves in East Kalimantan have been converted into other land uses, of which aquacultures are the most prominent threats to mangroves deforestation and degradation, which cause large carbon emissions that contribute to global climate change.

So far YKAN's SECURE approach is able to increase pond productivity by involving local communities in restoring some unproductive ponds into healthy mangroves again. Efforts to protect the mangrove

[57] YKANb. No date. SECURE (Shrimp-Carbon Aquaculture): Restorasi mangrove melalui pengelolaan praktik budidaya tambak udang tradisional berbasis lingkungan. Downloaded from https://www.ykan.or.id/content/dam/tnc/nature/en/documents/ykan/fact-sheet/iop/bahasa/Factsheet_Shrimp-Carbon-Aquaculture_VA.pdf on April 1, 2024

ecosystem in Berau Regency indirectly support the production of sustainable capture fisheries and aquaculture. As a habitat for shrimp, fish and crabs, the mangrove ecosystem has an important role for fishermen and farmers, as well as the coastal communities of Berau Regency. YKAN's program is supported by other institutions and stakeholders, including Berau District Fisheries Service, the Research Institute for Brackish Water Cultivation Fisheries and Fisheries Extension - Ministry of Maritime Affairs and Fisheries (BRPBAP3 KKP), and the Nusantara Maritime Institute (LEMSA).

B. THE FEASIBILITY OF BERAU DELTA AS PROPOSED BIODIVERSITY CREDIT PROJECT

Assuming that the Project Area of the proposed biodiversity credit program would be overlap (or even the same) as the SECURE Program, further analysis of both program (**Table 6-1**) suggests that the proposed biodiversity credit project is feasible to be conducted. Some challenges and risks surely will emerge, but with a careful and good plan, the challenges would be overcome while the risks would be minimized.

Table 6-1. Analysis of advantages, challenges, and risks of the proposed biodiversity credit program, to be implemented in Berau Regency by YKAN.

Aspects		Advantages, Challenges and Risks
Continuity of the program (switching program from SECURE to biodiversity credit program)	Advantage	• The proposed biodiversity credit program is in line with the theme of SECURE program (sustainable aquaculture) • Strong support from the local government, the related government institution (including Ministry of Maritime Affairs and Fisheries, and Ministry of Forestry and Environment), other organization in Berau Regency, considering the long history of YKAN's program in Berau District
	Challenge	• Securing tenuriality of the selected Project Area at least for the next 20 years • Clear separation of the SECURE program (runs until 2030) and the proposed biodiversity credit program
	Risk	• The proposed biodiversity credit program has to be canceled if the tenuriality is not clear
Project area (assuming that the proposed Project Area would be overlap with SECURE Program)	Advantage	• YKAN has already collected data from previous/on-going SECURE Program • Some required activities might also already conducted or partially conducted under SECURE Program, for instance stakeholder engagement, stakeholder consultation, and FPIC
	Challenge	• The mostly wetland area of the mangrove-aquaculture type need some innovative modification to monitor the animal/wildlife species, as some area might not accessible by the traditional ground survey on foot

Aspects	Advantages, Challenges and Risks	
	Risk	• The pond owner who will agree to participate might distributed in a mosaic, non-contagious area, and thus difficult to draw the boundary of the project, with a high probability of leakage
Human resources	Advantage	• Excellent human resources of YKAN, equipped with previous experience from SECURE program • There are some universities that would be serve as potential partner for the program, including Mulawarman University in Samarinda, University of Borneo in Tarakan, Kaltara University in Tanjung Selor, as well as research center (Badan Riset dan Inovasi Nasional, BRIN in Samarinda)
	Challenge	• Lack of knowledge on the biodiversity credit, simply because biodiversity credit is a new emerging topic
	Risk	• Long-term, dedicated persons to assist the program related to scientific matter (e.g., for the regular annual monitoring and the fifth year monitoring) might increase the risk if the knowledge and skill does not pass from the predecessor to the new persons
Socio-economic and culture	Advantage	• Mutual familiarity of the organization (i.e., YKAN) and YKAN field staffs and local people (mostly Bugis ethnic group)
	Challenge	• The strong family-bonding (i.e., social capital) of the local people might hamper the proposed program if part of the local people do not want to participate in the biodiversity credit program
	Risk	• The proposed biodiversity credit program has to be canceled if only a very small part of the community would participate in the program

C. PROPOSED PROJECT AREAS IN BERAU: SOME CONSIDERATIONS

Again, assuming that the Project Area of the proposed biodiversity credit program would be overlap (or even the same) as the SECURE Program, there will be some pre-requirement that need to be studied and identified before initiating the program. **Table 6-2** provides some points to be considered, basically to be in line with the biodiversity credit scheme, to fulfill requirement of Plan Vivo and Verra.

Table 6-2. Some consideration related to the area management, prior to the initiation of the biodiversity credit program.

Site Level	Consideration
Project location	• In order to qualify as biodiversity credit site, the restored site should be undergone an unplanned deforestation; need an analysis and backing up with satellite imageries of previous land-use changes
Mangrove restoration areas (main areas to be restored and to be claimed for biodiversity credit in the future)	• Verra scheme implies that the larger the better; at present the allocation of mangrove restoration under SECURE Program is 80% mangrove areas (and 20% aquaculture areas); consider to select a large area if Verra scheme will be chosen • Consider to select restoration sites such in a way in order to collectively create a contagious mangrove forest, to serve as habitat and corridor for wildlife and other marine biota; habitat connectivity is one of the Pillar in quantifying habitat in Plan Vivo scheme • Consider to re-examined substrate health be to make sure that unwanted pesticides and other hazardous chemical substances would be absent or minimal prior to planting activities • Selection of mangrove trees might be tricky. Selection of mangrove tree species will depend on the salinity of the brackish water; back-mangrove species might be more appropriate for inland areas, where true-mangrove species would be selected for the upfront, near seashore location. Consider to use a human-assisted regeneration to increase the planting success
Aquaculture areas (areas for intensive aquaculture consisted of cultivation plot, hatchery plot, and water retaining plot)	• Consider to transform all aquaculture areas at the forefront (along shorelines, borders with seashore) as the continuous greenbelt of mangrove forest • Consider to introduce some innovative farm technology[58] • Water distribution through dikes, dams, channels and ditches could be challenging, as the whole project area essentially is one landscape with an inter-related brackish water system; consider to invest more on management of hydrological system

D. OPTIONS OF PLAN VIVO AND VERRA SCHEME OF BIODIVERSITY CREDIT

The analysis of the advantages and challenges of proposed biodiversity credit project in the mangrove-aquaculture ecosystem in Berau Delta is presented in **Table 6-3**. As mentioned in Chapter IV, Plan Vivo is ready with the PV Nature Methodology & Data Protocol, while Verra's SD VISta (Sustainable Development Verified Impact Standard) Nature Framework – SDVM002 is still under development (draft is available, though). Although Verra's scheme probably will not be selected for the Berau Project, analysis of Verra is also included, as a comparison to Plan Vivo.

[58] Project "Building with Nature" by Wetlands International – Indonesia (WII) can be an example; see Appendix 1 for further description, based on the interview with the Director of WII

Table 6-3. Analysis of the advantages and challenges of proposed biodiversity credit project in the mangrove-aquaculture ecosystem in Berau Delta, using Plan Vivo and Verra certification scheme.

Parameter	Remarks
Plan Vivo	
Project type	• Rehabilitation (other option: conservation) • The proposed area is not eligible for conservation (does not meet criteria of Key Biodiversity Area and Important Plant Area)
Project area	• Many small-sized aquaculture ponds, combined with degraded mangroves in Berau Delta
Advantages	• Methodology has been released by Plan Vivo Foundation, some technical matters and calculations will be available soon (under development); supporting documents area easily accessible, while Plan Vivo's help desk is available • Suitable for small-scale, community-based biodiversity credit project • Can be conducted in several small areas and several regions, does not have to be in large contiguous area • It is possible to combine with carbon credit ('stacked'), as long as using the same Plan Vivo's project requirement and methodology for carbon credit • YKAN has been working in Berau Delta for several years, pre-conditioning activities is not necessary; basic data on the proposed project area is available • Being the first of its kind, the biodiversity credit in aquaculture-mangrove project will be a pioneer and role model for other similar project in the future, using the Plan Vivo scheme
Challenges	• Land tenurial need to be secured for long term (expected to be more than 30 years) • Challenge with local communities (fishermen) who does not want to participate in the program because of the lack of other income source or do not believe on the success of the new system[59] • Indicator need to be selected carefully (and consulted/approved by Plan Vivo) to reflect the positive change of the rehabilitation program, while example and lessons learned from similar program elsewhere is not available yet • Complicated calculation for Pillar 3 (taxonomic dissimilarity), Pillar 4 (habitat health) and Pillar 5 (habitat spatial structure, every five years)
Applicability	• **Highly applicable**
Verra	
Project type	• Restoration (other options are: (1) conservation, and (2) sustainable management of biodiversity)
Project area	• Many small-sized aquaculture ponds, combined with degraded mangroves in Berau Delta
Advantages	• Methodology for biodiversity calculation is simpler than Plan Vivo's, by comparing the proposed rehabilitation project with a reference site
Challenges	• Methodology is still under development by Verra, expected to be completed in mid-2024; draft for consultation is already available for public, with some minor unresolved matters

[59] Dr. Tri Atmoko, *pers. comm.* For a complete interview results, please see Appendix 1.

Parameter	Remarks
	• Ideal reference site at the same landscape might be difficult or available some possible alternatives are mangrove of Kakaban Island, or other remaining pristine mangrove along the east coast of Kalimantan (if any); the size of reference site is not specified in the Methodology • Land tenurial need to be secured for long term (expected to be more than 30 years, minimum crediting time is 20 years) • Challenge with local communities (fishermen) who does not want to participate in the program because of the lack of other income source or do not believe on the success of the new system, the same as Plan Vivo scheme
Additional note	• Biodiversity credit earned depend on the size of the project area; maximum credit earned for the Nature Credit would be 80% of the total coverage of the project area; for example within in 10,000 ha the credit earned would be maximum 8,000 QHa, after deducted from buffer risks
Applicability	• **Medium** (pending to the final methodology by Verra)

E. Regulations from the Government of Indonesia Concerning Biodiversity Credit

Biodiversity credit is very new in the global market, and of course also extremely new to Indonesia. Interview with a representative of the Government of Indonesia[60] revealed that:

- The Government of Indonesia (c.q. the Ministry of Environmental and Forestry) has not started a discussion about the biodiversity credit;
- The discussion leading to formulation of related regulation should be conducted across two directorate general within the Ministry of Environmental and Forestry, namely the Directorate General of Climate Change (*Pengendalian Perubahan Iklim, PPI*) and the Directorate General of Conservation of Forest Resources and Ecosystem (*Konservasi Sumberdaya Hutan and Ekosistem, KSDAE*), mainly the Directorate Conservation of Biodiversity and Genetic Resources (*Direktorat Konservasi Keanekaragaman Hayati dan Sumberdaya Genetik, KKHSG*).

The Ministry of Environmental and Forestry has already recognized that YKAN has a plan to have a biodiversity credit project in Berau. As this project would be the first of its kind, lessons learned leading to formulation of policy and regulations would be important for the Ministry of Environmental and Forestry as the regulator of the biodiversity credit in the national level.

[60] Prof. (Res.) Dr. Haruni Krisnawati, see Appendix 1 for a complete interview results

VII. SUMMARY CONCEPT DOCUMENT FOR BERAU'S MANGROVE-AQUACULTURE AREA USING PLAN VIVO SCHEME

Based on the analysis in previous Chapters (Chapter VI - Applicability of Biodiversity Credit Scheme in Berau), the mangrove-aquaculture area in Berau has a high potential and high applicability to be developed as a biodiversity credit project, to obtain a biodiversity credit certificate. Previous analysis also suggests that Plan Vivo scheme is more suitable for the proposed project area, mainly due to the basic theme of Plan Vivo as a certification scheme for community-based activities, and due to the recently available Plan Vivo guidelines for biodiversity credit certification.

The summary concept that explain potential applicability of biodiversity credit scheme in Berau, East Kalimantan is provided below. The format of the concept basically follows and excerpted from Plan Vivo's Nature (PV Nature) Project Idea Note (PIN) template, which can be downloaded from https://www.planvivo.org/pv-nature-documentation.

Submission of the PIN Document is the first step towards becoming a Plan Vivo biodiversity-certified project. The Plan Vivo Foundation reviews PINs to ensure that there are no obvious non-compliances and that the proposed project has the potential to provide quantifiable biodiversity benefit, ecosystem service benefits, and promote sustainable livelihoods over the long-term.

PROJECT OVERVIEW

Project Title	Sustainable mangrove-aquaculture
Location	Berau Regency, East Kalimantan; add latitude, longitude
Project description	Restoring ex-aquaculture area to mangrove-dominated forest to support community livelihood through sustainable aquaculture practice
Project Area	• Pagat Batumbuk Village and its surrounding (to be confirmed) • Tabalar Muara Village and its surrounding (to be confirmed)
Project Coordinator	Name: will be added (TNC – Indonesia/YKAN) Contact: will be added
Project Participants	Local community, xx households from Pagat Batumbuk Village and xx households from Tabalar Muara Village; totaling xx households [consist of xx person]
Project Intervention(s)	1. Re-arrangement of mangrove-aquaculture area 2. Hydrological changes to restore brackish water qualities 3. Mangrove planting 4. Sustainable management of aquaculture
Expected Benefits	1. Increase the ratio of the land to be allocated for mangrove forest and the land for aquaculture to be managed more optimally 2a. Restore the soil condition (i.e., free from pesticides and other hazardous chemical substances) 2b. Restore water quality 3a. Increase the size of mangrove area as habitat of various wildlife and marine biotas 3b. Increase carbon stock from mangrove stands 3c. Increase diversity and abundance of mangrove-dwelling biota 4a. Optimal [or increase?] production of aquaculture to sustain community livelihood
Methodology Design	Project type: Restoration

GENERAL INFORMATION

Project Rationale

- Explain why this project is important, including the benefits to the local communities
- Provide a description of connectivity to surrounding areas of biodiversity value (e.g. wildlife corridors)
- Identify any important existing wildlife habitats
- Describe the ecology, biodiversity and conservation value of the region
- State why the project is appropriate for Plan Vivo Nature

Project Interventions (Restoration and Improved Management): explain about the importance of the project

Project Logic:

Outcomes – [description and assumptions/risks]

Biodiversity benefit: mangrove, habitat for wildlife, diverse species, carbon stock [climate benefit]

Socioeconomic benefit: revenue from aquaculture

Environmental benefit: restore soil and water quality [need to add other environmental service from mangrove forest? It might be possible, but difficult to track the outcomes]

Outputs

Output 1: Restored 80% of the land as mangrove area and maintain 20% for aquaculture (to be confirmed)

Output 2a: Soil condition is restored (pesticide-free soil), covering x ha

Output 2b: Water quality is restored (BOD? Turbidity?) into a normal quality for mangrove forest?

Output 3a: Additional mangrove of x ha

Output 3b: Additional carbon stock of x ton Ce/ha or x ton Ce in total

Output 3c: Species diversity of terrestrial and marine biota increased (the exact number can be estimated by using Shannon diversity indices or Hill's number)

Output 4a: Sustainable income provision of IDR xx/ha aquaculture area (to be confirmed)

Project Boundary: need a map showing clear boundaries; *Annex 1*

Land Management Right: tenuriality need to be clearly explained

STAKEHOLDER ENGAGEMENT [some parts most likely has already conducted completely for SECURE Program]

Stakeholder identification

Project Coordination and Management [need to present project coordinator's registration certificate; *Annex 2*; no information about this in the guiding documents]

Project Participant

Participatory Design

FPIC Process

PROJECT DESIGN

Biodiversity Baseline

- Description of ecosystem and habitat in each site/village
- Species of conservation concern (if any)
- Expected future resource use and aquatic management in the absence of project intervention
- Ecological condition prior to the start of the project
- Expected change under the baseline scenario

Socioeconomic Baseline

- Description of socioeconomic status prior to the start of the project
- Description on how socioeconomic status is expected to change under the baseline scenario
- Description about access to and main uses of land and natural resources, typical assets, income levels and sources, livelihood activities, and other factors important in the context of the project region

Environmental Baseline

- Description the environmental conditions prior to the start of the project and how these are expected to change under the baseline scenario
- Detail description of the main carbon pools and greenhouse gas emissions, and any details about ecosystem services impacted by the project (e.g. water quality, soil quality, pollinator ecology)

Proposed Biodiversity Monitoring

Required Target Groups:

Birds: point counts [combine with and passive acoustic monitoring?]

Plants (herbaceous and woody plants <2m in height): transects [combined with high resolution imagery?

Additional Recommended Target Groups:

Macrozoobentros: substrate sampling using Ekman grab

Phytoplankton: water sampling using plankton net (possibility)

Mangrove trees (sapling, poles, and tree stages): transects [combined with high resolution imagery to estimate coverage]

Additionality

Barrier analysis for each project interventions (refer to the Project Overview table): identification of barrier and how to overcome the barriers

Threat analysis: identification of threat and how to mitigate the threat

Exclusion List

Need to fill in the Exclusion List (*Annex 3*), basically there is none of the list

Environmental and Social Screening (fill in *Annex 4*)

Analysis of the potential risks to certain areas/parties (list is provided), and safeguards provision (i.e., stakeholder engagement, stakeholder consultation, free informed prior consent (FPIC) and grievance mechanism),

Stacking and Double Counting [need to harmonize with SECURE Program, if the duration is overlapping]

Identify any other payment for ecosystem service projects, greenhouse gas emission reduction projects, programmes or initiatives that overlap with the proposed project region(s)

Include details on whether the project also plans to generate carbon credits from the same project area

Explain how the activities in the biodiversity project go above and beyond the proposed carbon project and how these will generate further biodiversity benefits

Relevant Legislation and Policies

Need to fill in a table about the national level legislation, policies and instruments.

GOVERNANCE AND ADMINISTRATION

Governance Structure

Describe the project's governance structure and decision-making process and provide an organigram to demonstrate how the project coordinator, project participants and other stakeholders will be involved in the project

Legal and Regulatory Compliance

Identify the authorities with overall responsibility for land and/or aquatic management and resource use

Include evidence that they have been informed of the project in *Annex 5*, and explain how they will be engaged during project development

Provide a statement that the project will operate in full compliance with all national and international policies, laws and regulations

Financial Plan

Describe how the finance required to fund project development will be obtained

Provide details how the sale of Plan Vivo Biodiversity Certificates will be used, including a brief outline of the how the 60-40% benefit will be used

ANNEXES

Annex 1 – Project Boundaries and Habitat Types
Annex 2 – Registration Certificate
Annex 3 – Exclusion List
Annex 4 – Environmental and Relevant Authorities
Annex 5 – Notification of Relevant Authorities

VIII. DATA SCOPING AND HUMAN RESOURCES GUIDELINES FOR BERAU

A. DATA SCOPING

Data needed for Plan Vivo scheme is obviously aimed for ecosystem in general, not specific to a certain ecosystem. The mangrove ecosystem, as the climax stage of the aquaculture-mangrove ecosystem in Bearu, has specific characteristics that might not be compatible with the Plan Vivo data requirement.

Recall from Chapter V that there are two species groups that must be included for biodiversity quantification using Plan Vivo scheme, one of which is "herbaceous and woody plants <2 m in height". Mangrove is a unique ecosystem, of which creates a specific zone of vegetation association, from the seashore to the inland. In the aquaculture-mangrove ecosystem, the climax vegetation type that can be foreseen would be mangrove forest ('true mangrove'), most likely formed in the inundated areas.

In a mature mangrove forest, the species number of herbaceous and woody plants less than 2 m in height, including seedlings and samplings would be very limited, except in the forest edges and some open areas. Therefore, there is a high possibility that the species number of the herbaceous and woody plants less than 2 m in height might be decreasing (instead of increasing), along with the increasing coverage of mangrove trees. To overcome this problem, the aquaculture-mangrove ecosystem selected need to include the back-mangrove or mangrove-associated species in a more inland area.

Proposed other species data grouping and its adjustment, when necessary, is presented in **Table 8-1**. Additional data that might be needed is depicted in **Table 8-2**. It is necessary to remember that for the Pillar 3 (i.e., Taxonomic Dissimilarity), identification to the species level is crucial to calculate the taxa dissimilarity. Therefore, a careful selection of the lower taxa such as zoobenthos and plankton need to be carefully considered to ensure the ability to identify up to species level. For the spatial data, the list of the data needed is given in **Table 8-3**. All data needed of course still need to be confirmed with the field situation and depend on the specific site(s) selected for the proposed project.

Some quantitative ecological data could be already collected during the implementation of the SECURE Program, and thus can be used, re-assessed or modified for the proposed Plan Vivo's biodiversity credit. As required by Plan Vivo, all indicators for the biodiversity quantification should be consulted with the Plan Vivo's scientific team (Technical Advisory Committee/TAC and the Technical Review Panel/TRP) for approval.

Table 8-1. Proposed data and indicator for biodiversity and environment data of the aquaculture-mangrove ecosystem in Berau.

No	Data Grouping	Adjusted for Aquaculture-Mangrove Ecosystem
Biotic*; Target group - Required		
1	Herbaceous and woody plants <2m in height	Not appropriate for mature mangrove ecosystem; could be replaced or supplemented with a more appropriate indicator to represent plant diversity; still appropriate during successional stage and for back-mangrove plant community
2	Birds	All terrestrial small-sized songbirds and waterbirds (e.g., egrets, herons, cormorants, ibises); resident species only (not included migratory birds)
Biotic*; Target group - Additional target group (minimum 2 target group)		
3	Woody plants (trees), palms and bamboo >2m in height	Trees: primary mangrove in the inundated water habitat and secondary/back mangrove in temporary inundated water habitat (i.e., mangrove associate species)
4	One broad group of invertebrates	Macrozoobenthos in mud substrate (possibly limited to crabs, shrimps, molluscs); other option would be and/or phytoplankton in water
5	Medium and large mammals (weighted >500g, excluding bats)	Not suitable; very few mammals identified in Berau mangrove forest (e.g., proboscis monkey *Nasalis larvatus*)
6	Bats	Not suitable?
7	Amphibians	Not suitable; very few amphibians in this type of ecosystem
8	Other herpetofauna (i.e., reptiles)	Not suitable; reptiles and snakes probably exist in low number (of species and individuals)
9	Lichens and mosses	Not suitable?
10	Soil microbes (using eDNA)	Not suitable?
Abiotic/Environment		
1	Temperature	Required
2	Humidity	Required
3	Rainfall	Required
4	Wind speed	Required
5	Water height and tidal cycles (low and high tide)	Additional useful data for the success of tree selection in planting activity
6	Salinity	Additional data; useful for the success of tree selection in planting activity, as well as the existence of macrozoobentos and phytoplankton

*minimum 4 target group in total (biotic data)

Table 8-2. Proposed additional data for biodiversity target group and environment data of the aquaculture-mangrove ecosystem in Berau.

No	Data Grouping	Additional Data and Information
Biotic*; Target group - Required		
1	Herbaceous and woody plants <2m in height	Invasive species need to be identified and will be excluded from the calculation
2	Birds	• Migratory and visitor species (mainly seabirds and waterbirds); need a certain time schedule for sampling, in accordance to the migatory season • Poultry (e.g., domestic ducks; will be excluded)
Biotic*; Target group - Additional target group (minimum 2 target group)		
3	Woody plants (trees), palms and bamboo >2m in height	• Trees: carbon stock can also be estimated, especially when stacking (i.e., combining biodiversity credit and carbon credit) is also proposed • Invasive species (most likely none)
4	One broad group of invertebrates	Macrozoobenthos; possible also phytoplankton
Abiotic/Environment		
1	Temperature	Site level: on the dates when biodiversity data collection took place from weather station, max 50 km from the Project Location, otherwise, must provide a weather station
2	Humidity	
3	Rainfall	
4	Wind speed	
5	Water height and tidal cycles (low and high tide)	
6	Salinity	

Table 8-3. Proposed spatial and socio-economic data of the aquaculture-mangrove ecosystem in Berau.

Data Grouping	Remarks	Data Acquisition Plan
Spatial data on project area	• Geographic position (latitude, longitude) • Boundary polygon of each site(s), if more than 2 separate sites	Satellite imagery
Spatial data on land use	• Landcover • Delineating habitat patches, labelled with habitat classes • Land-use types in the project area • Coverage and percentage of each land-use types	Recent drone mapping or high resolution satellite imagery (0.5m/pixel or finer); no more than 6 month prior to the data collection

Data Grouping	Remarks	Data Acquisition Plan
Project participants (community)	• Number of persons and number of households (total and broken down by village) • Gender ratio of males and females • Age class • Occupation	Village or District statistics
Socio-economic	• Legal ownership and mapping of legal pond areas • Livelihood activities and options • Revenue from aquaculture • Revenue from other fishery-related activity • Assets	
Stacking and double counting	• Other source(s) of funding (duration, amount, activities covered by the other funding sources)	

B. HUMAN RESOURCES NEEDED

The proposed biodiversity credit project for aquaculture-mangrove ecosystem [or landscape] in Berau will require a support from a team having strong background on biodiversity and its quantification, taxonomy, silviculture, marine/mangrove environmental science, sociocultural-economic, as well as geospatial analysis (i.e., remote sensing and GIS). The closest university that would be able to provide human resources would be Mulawarman University, a Samarinda-based university having a high (A) certification.

Mulawarman University has some faculties that related to the proposed project, namely Faculty of Forestry (*Fakultas Kehutanan*), Faculty of Fisheries and Marine Science (*Fakultas Perikanan dan Ilmu Kelautan*), Faculty of Mathematics and Natural Science (*Fakultas Matematika dan Ilmu Pengetahuan Alam*), and Faculty of Social and Politics Science (*Fakultas Ilmu Sosial dan Politik*). Knowledge and skills needed to conduct the biodiversity credit project for aquaculture-mangrove ecosystem in Berau is presented in **Table 8-4**.

Table 8-4. Human resources needed for development of biodiversity credit project under Plan Vivo scheme.

	Title	Main Tasks and Responsibility
Specific Specialists		
1	Biodiversity Specialist	• Responsible for planning and implementing the data collection of species target (team up with Marine Science Specialist) • Quantifying the species target of terrestrial biota (Pillar 1, 2 and 3)
2	Taxonomy Specialist	• Identify plants and animals (also marine biotas), up to species level; this task can be handled by other specialists, including

	Title	Main Tasks and Responsibility
		biodiversity specialist (for animal/bird identification), silviculture specialist (for plant identification), and marine environmental specialist for marine biota
3	Silviculture Specialist	• Responsible to select plant species for restoration, including all matters related nursery management and caring for planted species, leading to a successful planting
4	Marine Science Specialist	• Quantifying species target of marine biota • Measuring environmental data related to marine environment and possibly also terrestrial environment
5	Sociocultural-Economic Specialist	• Facilitate dialogues with local people, including FPIC (*Free, Prior, and Informed Consent), benefit sharing, and other matters related to socio-cultural-economics*
6	Geospatial Analyst	• Responsible to acquire excellent quality of landsat imageries: high resolution, latest edition, good quality (i.e., covered by less cloud) • Conduct GIS-based spatial analysis (land cover, calculation of Pillar 4 and 5) • Assist sampling design for biodiversity data
Cross-Cutting Specialist		
7	Team Leader	• Coordinate and oversee all activities • Communicating with Plan Vivo Secretariat • Communicating with the Local Government and other related institutions
8	Lead Writer	• Responsible for writing documents, including PIN (Project Information Note), PDD (Project Design Document), Annual Reports, and other necessary reports
9	Scientific Adviser Team	• Assisting the specialists in sampling technique, data collection, and data analysis, as well as approach to the local community; might also assist the Lead Writer in preparing various documents and reports
10	Training Manager	• Identifying training need for the local people • Administering and conducting training for the local people based on need assessment • Managing training for fields surveyor in order to get a standardized approach and techniques
11	Field Facilitators	• As liaison persons between the project and the local people • Facilitating dialogues with local people regarding the role and responsibility of parties involved in the project, ensuring FPIC (free, prior and informed consent), discussing benefit sharing

During the implementation of the SECURE Program, YKAN has been teaming up with tMulawarman University, specifically scientists from the Faculty of Fisheries and Marine Science. In order to successfully implementing the proposed biodiversity credit project in the aquaculture-mangrove in Berau, some trainings to create a stronger human capacity are still needed for the initiation of the proposed project, as listed in **Table 8-5**. The identified training is only for the initiation stage, based on the

assumption that the project proponent would be YKAN and the partner/collaborator of the proposed project would be the University of Mulawarman. Many other training surely still needed, along with the development of the project. Training for the local people is excluded for the

Table 8-5. Training needed for YKAN and Mulawarman University during the initiation of the biodiversity credit project in the aquaculture-mangrove ecosystem in Berau.

No	Training Theme/Topic	Trainer Qualification	Trainee
1	Mangrove ecosystem: characteristics, environmental services, and successional stages from aquaculture to mature mangrove	Mangrove ecology	All persons to be involved in the proposed project (i.e., YKAN and Mulawarman University)
2	Concept of biodiversity credit and biodiversity credit market	Strong knowledge on the biodiversity credit and market, based on the experience of the carbon credit/market	All persons to be involved in the proposed project (i.e., YKAN and Mulawarman, University)
3	Plan Vivo methodology: theoretical basis	Two persons: one has a strong knowledge on Plan Vivo methodology - biodiversity-based, and another has a strong remote sensing and spatial analysis, including data analysis using R	Biodiversity Specialist, Marine Science Specialist Scientific Adviser Team, Team Leader, all team member who would be involved in the data collection
4	Plan Vivo methodology: application (practical working examples in the field, including sampling techniques and data analysis using the real data collected from the field)	Same as above	Biodiversity Specialist, Marine Science Specialist, all team member who would be involved in the data collection
5	Development of Project Information Note (PIN)	Knowledge on the biodiversity credit methodology, and has some experience in the writing of previous PIN (cabon); can be split into two trainers	Lead Writer, Biodiversity Specialist, Marine Science Specialist, Sociocultural-Economic Specialist, Geospatial Analyst
6	Project-community relationship (i.e., the role and responsibility of local people in the proposed biodiversity credit)	Has an intensive experience as a facilitator (carbon project) in other location	All facilitators who will be involved in the proposed project

IX. CONCLUDING REMARKS

1. Currently there is no formal, globally agreed definition of a biodiversity credit. Biodiversity credit (or 'biocredit', 'nature credit', 'nature token') basically is a standardized units of positive biodiversity outcomes. It is a financial instrument designed to generate funding for the conservation, restoration, and sustainable use of biodiversity-rich areas. Therefore, for the conservationists, biodiversity credits are market-based instruments designed to incentivize the conservation and restoration of biodiversity. For private companies, the biodiversity credits are an economic instrument that allow the private companies to finance restoration/conservation activities, that deliver net positive biodiversity gains.

2. As biodiversity encompass genetic, species, and ecosystem levels, there is no universal metric or unit for biodiversity. This is a fundamental difference between the biodiversity markets and the carbon market, where carbon credit can have the same unit across all trees (and other sources), namely carbon dioxide equivalent (CO_2e; 1 CO_2e equal to one ton of CO_2 reductions or avoided emission). Biodiversity, by its very nature, is more complex and multidimensional than carbon.

3. Scheme and methodology for biodiversity credit has been developed in many countries by many institution (companies, foundations, etc.). Among the many institutions that developed carbon credit in the past, Plan Vivo and Verra were two of he most used scheme in the world. The two institution currently has developed scheme for biodiversity credit. Plan Vivo scheme is specializing in a small, community-based project, and in December 2023 has been launched their biodiversity credit scheme, named Plan Vivo Nature (PV Nature). Verra is another commonly used scheme for carbon credit, but Verra's scheme for biodiversity credit (Nature Framework; SDVM002) is still underdeveloped, and expected to be launched in mid-2024. This report, therefore, will focus on Plan Vivo scheme, which already available and more appropriate for the proposed project.

4. Plan Vivo and Verra's scheme for the biodiversity credit is not designed for offsetting purpose. Biodiversity credits are intended to have a net-positive impact on nature and biodiversity, whereas biodiversity offsets, as different market-based tool, are intended to compensate for companies' negative and unavoidable impacts on nature.

5. The proposed project would be in Berau, where aquaculture activities by local communities will be restored back to its original state, the mangrove ecosystem. Currently the activities have been funded under the SECURE Program, and this study will seek the possibility to find other funding sources through biodiversity credit project by using Plan Vivo's PV Nature scheme.

6. The PV Nature scheme does not require a reference site, and thus the biodiversity gain would be compare with the baseline (year-0) of the same site. To quantify biodiversity under Plan Vivo PV Nature scheme, species (contain species within the species) and ecosystem need to be quantified, by using five 'Pillar metrics', of which three Pillar metrics related to species through biodiversity field survey, while another two Pillar metrics linked to ecosystem, derived through satellite imagery data. The five Pillar metrics eventually will be summing up, to create the final number called 'Multimetric'.

7. Pillar 1 is **species richness**, basically collect data on certain target species, selected for the PV Nature scheme. Pillar 2 is **species diversity** of the target species, quantified using Hill's number, similar to the widely used Shannon index. Pillar 3 is **taxonomic dissimilarity** (also for the target species**)**, which looking at the diversity among taxa, under the assumption that a good ecosystem will harbor a much more diverse species from different taxa. All three pillars need to be collected through a good

sampling plan, stratified by habitat types. Each data collection event (e.g., for annual monitoring) need to have a different randomized sampling plan.

8. Pillar 4 and Pillar 5 are linked to ecosystem as habitat for wildlife and biotas, derived from a good satellite imagery data, preferably having a high resolution of 0.5m or finer. Pillar 4 is **habitat health**. This Pillar 4 uses a metric that is less familiar in the remote sensing method, namely SBI (Surface Bearing Index), a further analysis of the commonly used NDVI (Normalized Difference Vegetation Index). To calculate the SBI, *geodiv* package in R is used. Pillar 5 is **habitat spatial structure**, which looking at the connectivity of habitat patches within the project area. Pillar 5 is calculated every five years by using *CPLAND index*, available in R. Other Pillars need to be quantified in an annual basis.

9. The target species (or actually 'group') for Pillar 1, 2, and 3 need to be selected to represent a significant positive change along the successional stages of the restoration effort. These target species group would be minimum four, of which two target groups has already set by PV Nature: (1) herbaceous and woody plants <2m in height, and (2) birds. Two other target species can be selected according to the species present within the ecosystem/habitat types of the project site (e.g., medium and large mammals, bats, amphibians, woody plants, soil microbes, etc.). These target species need to be consulted with Plan Vivo, to ensure validity of the selected species target.

10. In addition to the biotic components of the project site, some environmental data (i.e., abiotic components) also need to be collected. The required environmental data for terrestrial projects are: temperature, humidity, rainfall, and wind speed.

11. Further analysis of the feasibility to use the Plan Vivo's PV Nature for biodiversity credit in the aquatic-mangrove ecosystem in Berau suggests that the applicability is high. The Berau aquaculture-mangrove ecosystem is eligible for PV Nature scheme under the 'restoration' activities (and not eligible for another type, 'conservation'). PV Nature has a different method to quantify biodiversity in three landscapes, namely terrestrial, marine, and mixed habitat (i.e., terrestrial with some aquatic/marine habitat). Berau ecosystem fits with the terrestrial landscape.

12. The suggested target species to be quantified as indicator for the aquatic-mangrove ecosystem in Berau are as follows:
    Biotic data (at least 4 target group):
    - Plants: herbaceous and woody plants <2m in height (required, set by PV Nature)
    - Animal: birds (required, set by PV Nature)
    - The proposed two other target groups, selected according the specific habitat of the study site:
        - Woody plants (trees), palms and bamboo >2m in height
        - Macrozoobenthos (mainly to crabs, shrimps, molluscs)

    Abiotic/environmental data:
    - Temperature (required, set by PV Nature)
    - Humidity (required, set by PV Nature)
    - Rainfall (required, set by PV Nature)
    - Wind speed (required, set by PV Nature)
    - Additional data: salinity, turbidity, tide cycles (proposed; all are optional)

13. PIN (Project Information Note), as the first step to acquire biodiversity credit need to be filled up, and in this report, summary of the information for the PIN is presented in this report (Chapter VII; too long to be presented in this section). In addition, the need for the human resources, involving the local university, also already listed (Chapter VIII).

14. The proposed project might face some challenges in planning and implementing the biodiversity credit project under PV Nature. Some identified challenges so far are:
    (d) local people participation, as the duration of the biodiversity credit project will be minimum 20 years, meaning that eventually almost all aquaculture activities would be restored into mangrove and thus the revenue from the aquaculture activities will be decreased;
    (e) tenuriality: ensuring the legal ownership (or the right to manage a certain area) of the current aquaculture area;
    (f) suitability of the required target group, namely herbaceous and woody plants <2m in height, which might not relevant for a 'true mangrove' ecosystem which basically consists of trees of certain mangrove species only (i.e., poor species number).

15. Until now, there has been no project on biodiversity credit conducted in Indonesia. Policy and regulation by the government of Indonesia (c.q. The Ministry of Environment and Forestry) has not been formulated yet. YKAN's intention to have a biodiversity credit project in the aquaculture-mangrove ecosystem in Berau will be the first project of its kind. Lesson learned derived from the proposed project would be very useful for other biodiversity credit projects, as well as for formulating policy and regulation by the government.

APPENDICES

Appendix 1. Result of interview with resource person: Prof. Dr. Daniel Murdiyarso.

Name	**Prof. Dr. Daniel Murdiyarso**
Affiliation	CIFOR/IPB University
Date of interview	6 May 2024
Modes of interview	By phone
Main interview topic	• Blue carbon in general and prospect of biodiversity credit in mangrove • Challenges of biodiversity credit for mangrove ecosystem
Important points	*Blue carbon and biodiversity credit:* • Mangrove is a source of blue carbon for Indonesia, contribution of sea grasses is low compared to mangroves • Mangrove has high below ground carbon content, in some area the below ground carbon shares up to 5 times greater than the aboveground carbon/biomass • Biodiversity credit usually is included (as additionality) within the biodiversity credit, for example CCBA (he Climate, Community & Biodiversity Alliance) scheme • Research topics that has been conducted by Prof. Murdiyarso is basically related to climate change, carbon (including blue carbon), and sea level rise; biodiversity is not included in his umbrella topic *Challenges:* • We do not know much about the trend/trajectory biodiversity components in the mangrove ecosystem, so desk studies and pre-studies are needed • Species in the 'pseudo-mangrove' (back-mangrove, mangrove associate) ecosystem highly varied and important in carbon credit, and surely also for biodiversity credit • If diversity species is required for the quantification of biodiversity credit, project boundary should be selected in such a way to include pseudo-mangrove plant communities • Plan Vivo for carbon credit is simple and straight forward, although sometimes facing challenges in justifying the outcome • In the global level, there is a scientific community and regular scientific meeting, named MMM (Mangrove and Macrobenthos Management); results of the regular meeting (especially related to macrobenthos) can be used for biodiversity management and biodiversity credit in mangrove ecosystem *Other additional information:* • Data and spatial distribution map of the Indonesian mangrove forest is still in dispute between the Ministry of Environment and Forestry and BRGM (*Badan Rehabilitasi Gambut dan Mangrove*; Body of Peat-swamp and Mangrove Rehabilitation) • CIFOR has created the "Blue Carbon Deck", launched in UNFCCC CoP 28 in Dubai, as a platform for discussion and exchange information regarding blue carbon, including carbon for mangrove • Prof. Murdiyarso recently just published a paper that might enlightening us in relation with the biodiversity credit in mangrove forest. The link is: https://doi.org/10.1073/pnas.2307219121
Conclusion/Implication for proposed biodiversity credit project	The requirement of Plan Vivo for biodiversity credit is much complicated than of carbon credit; need a stronger scientific back-up

Appendix 2. Result of interview with resource person: Prof. Dr. Cecep Kusmana.

Name	**Prof. Dr. Cecep Kusmana**
Affiliation	Researcher on mangrove and academic staff, Department of Forest Management, Faculty of Forestry and Environment, IPB University
Date of interview	April 3, 2024
Modes of interview	Direct interview, face-to-face in his office in Darmaga
Main interview topic	(a) Important features of aquaculture and mangrove forest (b) Significant parameters for biotic and abiotic monitoring in aquaculture and mangrove forest
Important points	*Features of aquaculture and mangrove forest* • The striking difference between the aquaculture area and mangroves are land cover, tree density, and regeneration • In pond (aquaculture area), the source of seed for trees is very limited and even close to none • Pons has very limited vegetation species than mature mangrove stand • In a mature mangrove, number of trees is high but the large-diameter tree is limited • For regeneration, stages for monitoring are seedlings and poles • Some characteristics of a mature mangrove: - many detritus, leading to many macrozoobenthos on the forest floor, mainly shells, crabs, and shrimps - rich of soil organic matter • Macrozoobenthos is very limited in aquaculture area • Feed for shrimp/fishes is seldom provided in community-led aquaculture, so the feed rely on the remaining organic matter from previous mangrove forest • Pesticides and other stuff sometimes were added; pH in aquaculture mostly acid, so limestone sometimes added to decrease acidity *Parameters* • Significant parameters of soil properties in mangrove and ponds, related to carbon and climate change: - Soil organic matter - Organic carbon - Bulk density • There about 90% carbon in mangrove substrate/soil; so soil actualy stored a lot of carbon in mangrove forest • In the mangrove forest, tree and chemical cycles is about 5 years, and thus parameters need to be monitored 5 year after planting, not immediately after planting • Along the mangrove succession, diversity of vegetation and faune are increasing; among the fauna group in mangroves, macrozoobenthos will serve as good indicator • Other abiotic parameter which stay the same during mangrove succession and thus not good for indicators are: - Salinity - Water temperature - Air temperature • Water in mangrove forest has many plankton (high density), especially phytoplankton, which may served as a good indicator as well
Conclusion/Implication for proposed biodiversity credit project	• Suggested parameters in the transformation of fishpond to mangrove forest: - Biotic: diversity/richness of vegetation (trees and other flora)

phytoplankton (in water)
macrozoobenthos (in soil): shells, crabs, shrimps

- Abiotic:
  soil organic matter
- Ecosystem/landscape:
  land cover

Documentation of the interview with Prof. Cecep Kusmana in his office (Division of Forest Ecology, Department of Forest Management, Faculty of Forestry and Environment, Darmaga Campus, IPB University

Appendix 3. Result of interview with resource person: Prof. (Res.) Dr. Haruni Krisnawati.

Name	**Prof. (Res.) Dr. Haruni Krisnawati**
Affiliation	Ministry of Environment and Forestry (MoEF), Special Adviser to the Minister of Environment and Forestry on Energy
Date of interview	April 16, 2024
Modes of interview	By phone
Main interview topic	(a) View of Government of Indonesia toward biodiversity credit (b) Readiness of the Government of Indonesia (GoI) on the biodiversity credit scheme
Important points	*View of Government of Indonesia* • **MoEF and biodiversity credit**. The GoI awares that the biodiversity credit has been internationally discussed as an option to obtain funding to fill in the financial gap • Some field experience on biodiversity credit from other country, mainly in Brazil, has been taken as a good example to be applied in Indonesia in the future • **YKAN activities in Berau**. In the past, YKAN has already conducted collaborative research with various partners, including with BRIN (formerly FORDA, Forestry Research and Development Agency), university, and research institutions; this is a good example of NGO collaboration on scientific-related research and policy formulation • This research on biodiversity credit by YKAN can fill in the gap on the knowledge on biodiversity credit, as well as to find out the opportunity or potential development, and hopefully also can contribute to the regulation that will be formulated in the future • The YKAN activities in Berau, along with this study (on biodiversity credit) will serve as a good role model for conversion of aquaculture/pond to mangrove forest, while maintaining the livelihood of local people *Readiness of Government of Indonesia* • Until now there has been no discussion within the Ministry of Environment and Forestry (MoEF) regarding biodiversity credit in Indonesia • The future discussion should involve the Directorate General (DG) Climate Change (*Pengendalian Perubahan Iklim, PPI*) and the DG Conservation of Forest Resources and Ecosystem (*Konservasi Sumberdaya Hutan and Ekosistem, KSDAE*), mainly the Directorate Conservation of Biodiversity and Genetic Resources (*Direktorat Konservasi Keanekaragaman Hayati dan Sumberdaya Genetik, KKHSG*) • The eastern shore of East Kalimantan Province has been undergone a rapid change from mangrove to aquaculture, an ecosystem that has a very high GHG emission rate • The challenge would be: how the local people still prosper while the ponds are able to be converted back to mangrove forest • Education to the local people/fishermen is very important, specifically to re-planting mangrove as part of a restoration project • Restoring coastal area and increase land cover by re-planting mangrove for habitat of birds and other aquatic biota has a good opportunity for a reward • **Carbon/biodiversity market**. So far the price of Indonesia's carbon is very low, averaging only USD 5/ton Ce and this low pricing hopefully not happen to the biodiversity market; we need to get a premium price for our biodiversity • International standard such as Plan Vivo and Verra might not be needed for domestic voluntary market; Indonesia has many opportunities to have a good

	market, with local mining and industry as potential buyers, as long as the market and trade follow a good mechanism • The MoEF hopes that there will be an open communication between players in the field [who conducted carbon and biodiversity credit], so both parties will gain benefit; the past experience of the cancellation of the right to manage certain areas by private company for carbon trading hopefully will not happen in the biodiversity credit scheme • When developing a certain project related to carbon/biodiversity credit, the MoEF expects that private sectors/NGOs create a good open communication with GoI, so the GoI would be able to provide feedback to the project
Conclusion/Implication for proposed biodiversity credit project	• As the biodiversity credit is very new and has not been discussed within the MoEF, the study of YKAN on aquaculture-mangrove in Berau will fill in the gap of knowledge on biodiversity credit development in Indonesia • MoEF expects that there will be open communication about projects/activities related to carbon/biodiversity credit; so exchange information through this interview is appreciated

Appendix 4. Result of interview with resource person: Prof. Dr. Lilik B. Prasetyo.

Name	**Prof. Dr. Lilik B. Prasetyo**
Affiliation	Faculty of Forestry and Environment, IPB University
Date of interview	6 May 2024
Modes of interview	Face-to-face
Main interview topic	Quantification of ecosystem/habitat for Plan Vivo Methodology: Surface Bearing Index (SBI) Alternative habitat quantification for mangrove forest
Important points	*Habitat quantification* • Plan Vivo use SBI to quantify the habitat health; SBI is not a common technique in remote sensing science, SBI is based on NDVI (Normalized Difference Vegetation Index) to quantify habitat health; Prof. Prasetyo thinks that the NDVI is not a good representation for the habitat health • Based on his previous research, in the mangrove forest, the NDVI for the woody shrubs was much, much higher than the mature mangrove; meaning that the shrubs would be 'better' than the mangrove, not true in the field • In one of the study area in Cilacap (Central Java, southern part), mangrove has been invaded by *Derris trifoliata*, a climber species, which made the NDVI was very high, although the mangrove was degraded and in a poor condition; this is an example that NDVI in the tropics is easily biased • For the habitat connectivity, Plan Vivo use the habitat spatial structure, eventually calculated by using CPLAND index; and this is also not commonly used *Alternative method* • If the Plan Vivo methodology for habitat health and connectivity still can be changed or can be replace with other alternatives, then we should do it • Alternative approach for forest health is the Forest Cover Density (FCD), which already include 4 other components: (1) NDVI, (2) bare/barren land index, (3) shadow index, and (4) temperature • FCD has been tested in mangrove ecosystem, and has proven that FCD (calculated from satellite imagery) is highly correlated with the Leaf Area Index (calculated direstly from the field) • FCD for the high topographic area need to be corrected accordingly; for mangrove that most likely flat, no need further correction • For the habitat spatial structure, index connectivity can be used (e.g., McGarigal method, using FRAGSTATS) which is more commonly used and has a good metric or numerical value, and can be easily distinguished between fragmented habitat and a more compact habitat • Standard quantification for mangrove health has already available, and need to be checked whether it will be appropriate for Berau case
Conclusion/Implication for proposed biodiversity credit project	Quantification for habitat need to be carefully re-thinked

Documentation of the interview with Prof. Lilik B. Prasetyo in front of his office (Division of Environmental Analysis and Geo-Spatial Modelling, Department of Forest Resources Conservation and Ecotourism. Faculty of Forestry and Environment, Darmaga Campus, IPB University

Appendix 5. Result of interview with resource person: Mr. Yus Rusila Noor.

Name	**Mr. Yus Rusila Noor**
Affiliation	Director, Wetlands International - Indonesia
Date of interview	April 14, 2024
Modes of interview	By phone
Main interview topic	(a) Mangrove restoration project in Java (Demak) (b) Lessons learned from community-based mangrove restoration
Important points	*Mangrove restoration project*: • The Project of mangrove restoration under the theme "Building with nature" was conducted in North Java/Demak (main location), Aceh, Flores, and Nias, in 2015-2023 • The Project had 4 components/activities: (1) Hybrid engineering: build some kind of dam on the shallow seashore (initially was made from bamboo, later on was replaced by concrete) to prevent damage from abrasion while capturing sediment for mangrove natural regeneration (2) Greenbelt, resulting from hybrid engineering; the regeneration is basically natural, without any human-assisted planting (3) AMA (Associated Mangrove Aquaculture): the aquaculture was placed more inland, while the frontline of the seashore was for mangrove regeneration (human-assisted regeneration through hybrid engineering); the fishermen worked collectively in a group to share revenue and subsidized each other (as the owner along the seashore did not get any revenue due to the land conversion into mangroves) (4) Fishpond revitalization: ensuring high quality production of fishes (milkfish, Nile tilapia – *nila*, shrimp), without using chemical substances; various MOL (*Mikro Organisme Lokal*; local microorganisms) were developed to feed the fishes, and was able to increase the fish production by 30%. • Formation of mangrove greenbelt was a success, up to 66 bird species were observed in Demak at year 5 of the project within a new greenbelt habitat of about 100 m thick • The 'dam' made through hybrid engineering system has successfully trapped various species of mangrove seeds and eventually created a mixed stand of mangrove forest • Water management was done by providing gates (loose gates) and surface management to ensure a good flow of water in and out the aquaculture and mangrove forest; to do this, the Project hired a forest/aquaculture hydrology expert, to conduct planning in general, calculate various parameter, and monitor the water flow (including water quality, quantity, and continuity) • Fishermen have to formed a group; and all decisions were made by the group through discussion and group consensus • Monitoring was conducted by the fishermen (local people), after receiving sufficient training by the Project *Lessons learned* • Policy support from local government (*Peraturan Desa*; village regulation) worked better compared to national regulation • Impact was evaluated after year 5, when results were significant • Before the Project produce a significant revenue, Project provided support to the participants (local people); the participants discussed their need, wrote a proposal, and endorsed by the head of the village

- The Project provided support (equipment, skill/training, fingerlings/juvenile fish, new technology, etc.) as needed
- If fresh money was needed, it will be treated as loan; when the loan was returned to the Project, it will be used as revolving fund. When a farmer showed an exceptional result, the loan will be waived
- Ownership of the land were clear; in Demak, the average land/pond owned by the local people was only 1 ha/household; the Project covered about 120 ha of mangrove, owned by 120 household
- The biggest challenge (in Demak) was land subsidence, with a rapid rate of 7-10 cm/year, while sedimentation rate was only 2-4 cm/year
- Activities and problem solving in each location was site-specific, depend on the natural characters and socio-economic-culture of the local people
- There was several staffs (facilitators) who stay and work full time with the local community; these facilitators played important roles to the success of the Project

Conclusion/Implication for proposed biodiversity credit project

- Innovative approach is needed
- Good facilitators would be important
- Activities are site specific, basically selected to fulfill local people's need
- Written agreements are needed, witnessed by the head of the village

dam construction (permeable dam)

For further information, visit: https://www.wetlands.org/case-study/building-with-nature-indonesia/

Appendix 6. Result of interview with resource person: Mr. Imanul Huda.

Name	Mr. Imanul Huda
Affiliation	People Resources and Conservation Foundation – Indonesia (PRCF); Plan Vivo Facilitator, Nanga Lauk
Date of interview	April 15, 2024
Modes of interview	By phone
Main interview topic	(a) Carbon project in Nanga Lauk, using Plan Vivo standard (b) Challenges and lessons learned during project implementation
Important points	*Carbon project in Nanga Lauk* • The project was in Nanga Lauk, Central Kalimantan, covering an area of 1,430 ha of protection forest consists mainly of peatland • The title of the project is "Forest for Life Sustainable Forest and Biodiversity Management in Nanga Lauk Village, Kapuas Hulu, West Kalimantan, Indonesia"; Project Document Development (PDD) is available via https://www.planvivo.org/Handlers/Download.ashx?IDMF=d3dec2f1-6851-40a6-bbdf-b29bc94b5b16 • The main problem before the implementation of Plan Vivo was illegal logging; other resources as alternatives are honey and freshwater fish • The preparation (PIN, PDD and all related activities) was funded by Asian Development Bank (ADB) • After PDD was approved, there was 2-year 'waiting time', of which the project was able to negotiate with Plan Vivo to have only 1 year waiting time, before the certificate can be marketable *Challenges and lessons learned* • The benefit sharing was 65% for the local community and 35% for the project • Leakage that usually pose a problem in carbon credit has been under control, following intensive discussion and agreement with the local people • All of the decision and planning was formulated in the RPJM (*Rencana Pembangunan Jangka Menengah Desa*/Village Medium Term Development Plan) • The initiation of the project was quite challenging, especially on the biodiversity data collection and training for the local people who will be involved in the monitoring (of carbon) • The writing of the PDD was assisted by Plan Vivo, even one of the Plan Vivo personnel was listed as the document writer • Plan Vivo facilitator has already engaged with the local people, even when project has not started yet • The project duration was 25 years, validated every 5 years • There is a new standard for Plan Vivo (climate/carbon), and thus all project proponent should follow the new standard • During the time lag (i.e., before funding from selling carbon certificate was available), the project proponent had to find alternative revenue for the local people • There were three pillar activities as alternative revenues for the local people: institutional building, livelihood development, and forestry sectors • The main personnel consisted of 4 field persons and 1 finance person; of whom 3 persons are always in the field (Nanga Lauk) and 2 persons are in the office (Kapuas Hulu/Putussibau) • The current biggest challenge was the change/succession within the local government, who want to revise/change the activities that already planned
Conclusion/Implication for proposed biodiversity credit project	The process of certification has been challenging and need a strong funding

Appendix 7. Result of interview with resource person: Dr. Tri Atmoko.

Name	**Dr. Tri Atmoko**
Affiliation	Researcher of BRIN based in Samarinda, conducted PhD research on proboscis monkey in Berau Delta, 2019-2022
Date of interview	March 23, 2024
Modes of interview	By phone
Main interview topic	(a) Local community and biodiversity of Berau Delta (b) Biodiversity of Berau Delta
Important points	*Local community* • **Settlement and local people.** There are many settlements (villages) in Berau Delta, mainly Begese ethnic group. Some of the villages were big and may inhabited by hundreds of people. They live on raised wood houses (*rumah panggung*) along the riverbank. • The local people managed fish/shrimp ponds and heavily rely on the fish/shrimp production for their revenue; some (if they have a good size of boat) may fish from the sea. In his research area, most ponds were for milkfish (*bandeng*) production, only a few for shrimp production. Harvested fishes were sold to middlemen who regularly visited the village. • **Fishpond and its management**. Local people mostly owned a small-size fish pond, or work for owner(s) for big sized ponds. Big size fishponds usually owned by outsiders, mostly people from big cities who had a strong funding to convert natural forest to fishpond and to employ local people to daily manage the pond. During the conversion, heavy equipment was introduced to excavate the land/mud. • The ownership of the fishpond is somewhat unclear, as many of them just claimed the land and probably illegally transformed the mangrove forest into fishpond • The local people believed that the existence of mangroves and other tree species (mostly along fishpond bank) will reduce the productivity of the pond, and thus, they prefer not having any tree near the fishpond. *Biodiversity* • **Plant species**. Forest types in Berau Delta mostly consisted of mangrove forest and swamp forest. Nypa stands were also common. Intact and contagious forest were scarce, confined only in the northern part where proboscis monkeys still rather abundant. Plant species in the mangrove (muddy sites with higher salinity) was rather poor, while swamp forest (very low salinity or freshwater) had much richer plant species • **Wildlife species**. Several species of highly important conservation are proboscis monkey, long-tailed macaques, saltwater crocodile, Mahakam dolphin (*pesut*), waterbirds (lesser adjutant, darter, egret, purple heron, and some seabirds); these species can be found only is areas where mangrove forest is still in a good condition, fat from settlement; some waterbirds sometimes can be found on mudflats or near fishpond in late afternoon, foraging for fishes and/or shrimps from unattended fishpond
Conclusion/Implication for proposed biodiversity credit project	• Tenuriality might be the biggest challenge before the project begins • Stakeholder engagement might be difficult because the owner of the pond might not resided in the project area