The cost of biodiversity - what nascent biodiversity markets are telling us

Dr Liz Heagney, *Senior Consultant, Aton Consulting,* Dr Karel Nolles, *Director, Aton Consulting,*

An analysis comparing recent transactions in global biodiversity markets on common metrics.

***Abstract*—This discussion paper compares biodiversity credit prices (in $USD) for credit products generated under various global frameworks, having brought the underlying parameters (area, time, conservation outcome) to a common basis. When we compare 5 biodiversity credit products on the approximately equivalent basis of 1% biodiversity improvement over 1 ha, we find a very wide price range, from $0.2 to $1,100 USD per year (or $7 to $41,000 USD per 100 years). We estimate a mean price of $236 USD per year ($8,800 USD per 100 years) and median price of $20 USD per year ($750 USD per 100 years) with all 100-year calculation based on 2.5% annual discount rate.**

I. Towards investable biodiversity

GLOBAL policy papers identify an increasing role for private investment to be directed towards natural ecosystems [1], nature-based solutions [2], [3] and biodiversity conservation [4], [5]. There is also increasing pressure on private companies to include nature and biodiversity impacts in corporate reporting via TNFD, IFRS-ISSB or other emerging frameworks or standards, to invest in biodiversity to offset any adverse impacts [6] and, ideally, to move towards 'nature positive' outcomes [7].

Recent publications report increasing volumes of capital in green funds. We estimate that global biodiversity related Assets Under Management (AUM) is around the USD $80B level as of mid-2023. But given that almost all the world's governments (excluding only the USA and the Vatican) have committed to having 30% of land and sea under conservation by the year 2030 [8], will this be enough? And are there appropriate pathways for corporate entities to invest in biodiversity and meet their ESG reporting requirements in a cost-effective manner? Ultimately, these are questions that relate to the pricing of biodiversity.

Pricing of biodiversity is currently opaque. This arises in part from the variety of different products and investment pathways that exist, ranging from direct government incentives to landholders, to green bonds and biodiversity credit markets. We believe biodiversity credits are the most important of these from an environmental perspective because they require (or should require) measurable improvements in biodiversity to be demonstrated as an outcome of investment [9].

We expect credit products to dominate future biodiversity investment, because, if properly designed, they can be fungible, tradeable and liquid – i.e. they have all the characteristics that facilitate investment. A recent report by the World Economic Forum states that "If the market shows 'effective development', demand for biodiversity credits could reach $2 billion per year in 2030 and $69 billion by 2050" [10]. It also suggests that demand could be as high as $180 billion under a 'Transformational Development' scenario.

Even if we focus exclusively on biodiversity credit products, pricing insights remain difficult to come by. There are few large transactions in these nascent markets, and although most credit issuers express a desire to trade via exchange platforms, transactions to date have almost exclusively been over-the-counter trades and prices, for the most part, are undisclosed.

The newness, thinness and lack of transparency in existing biodiversity credit markets make it difficult to identify the going rate for a biodiversity credit. We try to demystify biodiversity credit pricing by unpacking two key issues:

- Can existing products be assessed against some common metric or quantum of biodiversity to enable price comparisons?
- Are there premium biodiversity products, and if so, what are the factors that might influence the quality (and hence the expected price) of individual products?

II. Standardising biodiversity metrics

There is widespread agreement in the literature that reducing the world's vast array of habitats and species to a single common metric is challenging, if not impossible. But there is also acceptance that finding some level of equivalence amongst different conservation sites with different biodiversity values is important for investment prioritisation, and for measuring and comparing the associated biodiversity outcomes. A range of biodiversity credits (sometimes called certificates) have been designed with a view to providing this equivalence, but paradoxically, each of these use a custom reporting metric, which makes comparisons across different credit types difficult.

Credits that focus on conservation of habitats or ecosystems rather than species (and consider species as a component of these) typically specify three key parameters:

- The area of land impacted by biodiversity management – this can vary by a factor of 1000 between different credit types, from 10m2 up to a hectare.
- The period of restoration and/or conservation management – ranges from 2 months to in-perpetuity (legally defined as 100 years).
- The likely improvement in biodiversity resulting from management.

We have sought to compare the price of 5 biodiversity credit products by making them approximately equivalent with respect to each of these three parameters.

e-mail: liz.heagney@aton.com.au.
web: www.aton.com.au

For area of land impacted, this is straightforward. Most credits are reported on a per hectare basis, and where they are not, we have simply scaled the land area up to enable per-hectare comparison.

For period of restoration and/or conservation management, equivalence is relatively easy to achieve from a technical perspective. We estimate the annual credit price by dividing the total conservation period into equal annual increments, and a price per 100-year conservation period is estimated by applying annual discount rates of 2.5 and 5%. But conceptually, achieving equivalence when biodiversity credits support different conservation periods is more difficult. It is unclear whether short-term contracts (of 2 months, a year or even 5 years as identified in Table 1) can achieve meaningful amounts of restoration and/or biodiversity gains, or how biodiversity improvement could be robustly distinguished from background variability over these relatively short timeframes [9]. Presumably, conservation funding that is initiated via the sale of credits with a short-term conservation period is expected to continue with additional funding from ongoing future credit sales. For the purposes of this comparative analysis, we assume that this is the case, but given that future credit sales are not guaranteed, credit products that do not have the long-term conservation factored into the initial credit price should be treated with caution.

Standardising different measures of biodiversity improvement into a uniform metric is the challenging element of any biodiversity credit comparison. Ideally biodiversity improvement should be measured as change in 'ecological condition' through time. But different credit products report on different aspects of ecological condition. For example, they may measure improvements in functional ecosystem elements like canopy cover or vegetation characteristics (e.g. the NSW Government Biodiversity Credit methodology) or improvements in biological elements like abundance of specific species or taxa (e.g. Wallacea Trust methodology).

For the purpose of our biodiversity credit price comparison shown in Table 1, we have assumed that the gain in biodiversity measured from any of the ecological condition assessment methods used is approximately equivalent. But this may or may not be the case. It will be difficult for a non-specialist to assess the quality of different biodiversity metrics – this remains the subject of debate even within the scientific community. Investors may be able to determine the robustness of different biodiversity metrics by interrogating the procedures that were followed to develop them (e.g. were they developed in a scientific manner by a credible agency?) and the extent to which they have been verified or audited by an independent third party (like AfN or the Biodiversity Futures Initiative) [11]. Other factors that may be relevant for helping a non-specialist to identify high-quality or 'premium' credits are discussed below.

Some of the credits included in our comparison do not specify a measurable amount of biodiversity gain arising from conservation management. This typically occurs where biodiversity credit sales are being used to fund conservation or preservation to 'maintain' (rather than restore or improve) the ecological condition of a site. These types of credits will deliver a net biodiversity benefit if conservation is required to avoid a real and imminent threat of deforestation or other degradation. This can be difficult to ascertain and introduces some uncertainty as to the quality of these types of investment. For the purposes of this comparison, we have assumed that 'preservation' avoids deforestation and hence delivers 100% uplift in biodiversity at the site over a 100-year period, but we apply a discount factor of 1/3 to account for uncertainty.

III. How much does a biodiversity credit cost?

When we compare 5 biodiversity credit products on the approximately equivalent basis of 1% biodiversity improvement over 1 ha, we find a very wide price range, from $0.2 to $1,100 USD per year (or $7 to $41,000 USD per 100 years). We estimate a mean price of $236 USD per year ($8,800 USD per 100 years) and median price of $20 USD per year ($750 USD per 100 years; using a 2.5% annual discount rate).

Identifying mean and median pricing can help to identify prices that are either too high or too low. Both may be an issue. If prices are too high, then biodiversity outcomes from private investment in conservation will be limited. Prices that are too low may signal that the conservation works being funded are not additional – i.e. they would have occurred even in the absence of the credit purchase, or that local indigenous communities or other landholders are not being appropriately compensated [12].

Investing in these low-value products may open investors up to accusations of greenwashing and/or landholder exploitation. The extent to which a biodiversity credit price matches the opportunity cost of land-use conversion to agriculture may provide some indication of whether the conservation being funded is likely to be additional [13, 14]. A recent article by BNEF suggests that biodiversity payments to landholders may need to be as high as $500 USD per ha per year to match the opportunity cost of rainforest conversion to agriculture [14]. But this figure will vary substantially across countries and regions, so local context should be taken into account.

TABLE I
BIODIVERSITY CREDIT PRICE ($USD) – ESTIMATED PRICE OF 1% BIODIVERSITY IMPROVEMENT OVER 1 HA OF LAND WITH A 100-YEAR CONSERVATION PERIOD

Name	Product description	Published price*	Equiv. annual price	Equiv. 100yr price**
Terrasos	Preservation / restoration of 50m2 for 30 years	110	1,100	23,000 – 41,000
Savimbo	1 ha conserved for 2 months	5	45	937 – 1,685
Plan Vivo	1% gain over 1 ha per year	20	20	417 - 749
RePlanet	1% uplift over 1 ha for 25 years	5	0.2	4 - 7
ValueNature	1 ha of land protected for 10 years	100	15	312 - 562

* as reported in [15], [16] or on relevant credit provider websites as at February 2024. ** range is calculated using annual discount rates of 2.5% and 5%.

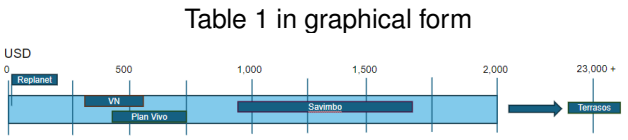

Fig. 1. Biodiversity credit price ($USD) – estimated price of 1% biodiversity improvement over 1 ha of land with a 100-year conservation period. Price ranges have been calculated using annual discount rates of 2.5% and 5%.

IV. Do (should) some credits attract a price premium?

Even though we use an 'approximately equivalent' metric to compare biodiversity credits in Table 1, it is clear that not all biodiversity credits are created equal. A number of factors influence the quality of biodiversity outcomes offered by biodiversity credits, and hence may be cause for an investor to pay a price premium for biodiversity credits. These include:

- Additionality – the extent to which the purchase of a credit triggers conservation that would not have otherwise occurred [16] , [17]. Additionality may be limited where credits are claimed for 'avoided deforestation' in areas with low land-clearing risk, or where the investment site has already generated carbon credits or has some other conservation arrangement or development restriction attached to it.
- Permanence – the extent to which biodiversity sites are conserved under legislation after the relevant restoration / conservation period associated with a credit purchase is complete [17]. Conservation must be long-term, and ideally permanent, to match the temporal scale of site restoration and associated ecological processes [9], [16].
- Governance – this is related to issues of permanence, discussed above, but also includes consideration of geo-political stability and potential for conservation efforts to be undermined or reversed by volatile administration.
- Ex-ante versus ex-post credit delivery – this refers to the timing of credit issuance (before or after the proposed conservation works have been undertaken). There are advantages and disadvantages in both cases. Ex-post credit creation carries a high risk, especially in the early stages of market development, that conservation may be non-additional (i.e. it may be generated by works the landholder decided to carry out before being included in a biodiversity credit scheme and/or on land which may have carbon-related or other pre-existing conservation commitments). Ex-ante crediting, where landholders are paid to implement management that is known to improve biodiversity provides much greater certainty around additionality, but both conservation sites and the methods used to forecast the quantum of biodiversity credits that management is expected to generate should be reviewed regularly to ensure that the appropriate quantum of biodiversity improvement is realised.
- Specific conservation values or scarcity - some types of high demand ecosystems may be more expensive than others, perhaps because they have high conservation values. Examples may include ecosystems that are scarce or highly vulnerable to extinction, or which deliver a disproportionately large number of ecosystem services.

V. Can biodiversity investment deliver the desired outcomes?

We identify median price of $750 USD and mean price of $8,800 USD for biodiversity credits that deliver a 1% uplift in biodiversity over 1 hectare, with conservation outcomes maintained over 100 years. We conclude that biodiversity credits appear to offer a cost-effective pathway to delivering robust and measurable conservation outcomes.

But we note that the amount of biodiversity delivered by different biodiversity credit products is difficult to assess. Investors may be able to determine the robustness of different biodiversity metrics by interrogating the procedures that were followed to develop them (e.g. were they developed in a scientific manner bay a credible agency?) and the extent to which they have been verified or audited by an independent third party.

Other considerations relevant for identifying high-quality biodiversity credits include additionality, and the extent to which conservation gains are permanently protected within a strong governance setting.

Will investment in biodiversity credits be sufficient to meet global biodiversity conservation targets? If we have $80B USD in biodiversity related Assets Under Management (AUM) as of mid-2023, we can secure approximately 10 - 100 million ha of land for conservation at current prices (median of $750 or mean of $8,800 per ha for 100 years of conservation; assuming a 1% uplift in biodiversity is sufficient at each site). This represents less than 1% of the Earth's global land mass (and none of its seas).

Much greater levels of investment will be required to meet global 30 x 30 targets.

VI. Looking forward

Many of the prices presented in this paper have been reported from over-the-counter trades that occurred in 2023. Given that biodiversity markets are in their development phase, these prices are subject (and likely) to change. Once markets become more established we expect the definitions applied will standardise, transparency improve, and the price of biodiversity credits will be driven my clearly by supply and demand forces.

We expect demand for biodiversity credits to increase through time as companies seek to address their biodiversity impacts and meet consumer environmental demands. We expect that supply will also increase, but only where credit prices can match or exceed the opportunity cost of conservation in the relevant local context.

Based on these forecast market trends, we expect the price of biodiversity credits to increase in coming years. This means that an even larger quantum of investment will be required to meet global biodiversity targets. We expect this to come, at least in part, from increasing reporting pressures on global corporate entities via TNFD, IFRS-ISSB and other emerging frameworks or standards.

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Dr. Elizabeth (Liz) Heagney is an experienced economic analyst and program manager, having held positions across the government and private sectors over the past 20 years. Before moving into consulting Liz led the Advanced Analytics team within the New South Wales Department of Planning and the Environment, advancing the state's natural capital agenda and helping to secure more than $1B in funding for environmental projects.

Liz holds degrees in Advanced Science and International Economic Development, and a PhD in Statistical Ecology from the University of New South Wales.

Liz has designed and implemented large-scale projects focusing on productivity and efficiency in primary industries in Australia and the Pacific, including the farming, fisheries and forestry sectors.

She has extensive experience in delivering econometric modelling, non-market valuation and cost-benefit analysis for major programs and investments.

Liz has an appointment as an Adjunct Senior Lecturer at Southern Cross University.

Liz has received research, communication, and performance awards from the NSW Government, the University of NSW, the Royal Zoological Society and the Australian Society for Fisheries Biology