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# Evaluating the Potential of Increased Carbon Stocks and Biodiversity Outcomes to Fund Native Vegetation Management on New Zealand Properties

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## Executive Summary

New Zealand has experienced extensive native forest clearance since human settlement, reducing forest cover from 80.0% to 90.0% to approximately 24.0% of total land area. Introduced pest species have compounded this problem, causing significant biodiversity loss and reduced carbon sequestration capacity. While New Zealand has made international commitments to address climate change and biodiversity decline, current policy settings may be insufficient to incentivize native forest management at the scale required.

The central question in this study examined whether monetized benefits from increased carbon sequestration or positive biodiversity outcomes could offset the costs of undertaking pest management and protection of native vegetation on New Zealand properties. the aim was to evaluate the financial feasibility of using carbon credits or biodiversity credits to fund pest control and fencing infrastructure for native forest conservation, providing evidence-based recommendations for policy and landowner decision-making. This study addresses a critical knowledge gap in conservation finance, providing the first comprehensive economic analysis of both carbon and biodiversity market mechanisms for New Zealand native forest management. The findings directly inform policy development for achieving national climate and biodiversity commitments.

The study employed an embedded case study approach examining five properties in the Manawatū District's Apiti and Pohangina localities, representing different proportions of native forest coverage. Nine scenarios were developed: six carbon additionality scenarios for regenerating forests and three biodiversity additionality scenarios for old growth forests. Management approaches included

property boundary fencing, forest block fencing, and unfenced pest control, with comprehensive cost modelling for each scenario.

Carbon scenarios consistently generated negative Net Present Values (-$5,528 to -$1,607,407), demonstrating that carbon markets cannot support infrastructure-intensive forest conservation. Fencing costs dominated expenses (57.7% to 98.3% of total costs), while carbon income covered only 0.2% to 19.2% of costs. Even under optimized conditions (20.0% carbon additionality, $80 per carbon unit pricing), only unfenced scenarios achieved viability. Biodiversity scenarios operated under fundamentally different cost-coverage frameworks, requiring annual credit values of $88 to $1,265 per ha but offered more viable pathways for conservation financing.

Policy frameworks should prioritize biodiversity credit scheme development over carbon market reliance for native forest conservation. Government should support landscape-scale collaborative approaches to achieve infrastructure cost efficiencies. Research investment is needed to validate carbon additionality assumptions and develop innovative pest management technologies that reduce infrastructure requirements.

Further research is required to measure actual carbon and biodiversity outcomes from pest management, develop landscape-scale conservation models, and establish robust biodiversity credit market mechanisms with stable long-term demand.

# Chapter One: Introduction

## Background

### *History of Forest Cover in New Zealand*

Several thousand years ago, prior to human settlement by Polynesians circa 1000 A.D, New Zealand was nearly entirely covered in native forest, equating to 80 – 90% of New Zealand's landcover (Ewers et al., 2006; Mcglone, 1989). Upon human arrival of early Māori settlers, significant areas of lowland forest were burned to broaden food resources, aid in travel, and improve moa hunting (Stevens et al., 1988). Along with clearance by Māori, climate change, volcanic activity, and natural fires also contributed to native forest clearance (Fleet, 1986) to the extent that when settlers arrived from Europe in the 1800s, there was an estimated 68.0% of New Zealan's original native forest remaining (Salmon, 1975). This land clearance continued by European settles, and today approximately only 24.0% of New Zealand remains in native forest, which equates to only 71.0% of the original area pre human settlement (Ewers et al., 2006). Of the land in New Zealand that remains in native bush at present, 61.5% of this is contained within public conservation land, with a significant amount also found within sheep and beef farms (24.5%), and only small tracts contained within dairy farms (1.4%) and exotic forests (2.8%) (D. Norton & Pannell, 2018).

### *Introduction of Pests*

Whilst also being under threat from clearance of native forest, our indigenous ecosystems have also come under pressures from introduced pests. There are 25 species of mammals introduced to New Zealand that are considered genuinely wild (Fraser et al., 2000), most of which were introduced between 1850 and 1910 (King, 2005).

Deer were originally introduced for both sporting and meat purposes, and with a lack of natural predators, adequate numbers of hunters, a favourable climate, and a large native habitat, deer number soon reached, or surpassed, carrying capacity of their environment (Nugent & Fraser, 1993). Up until the 1930's they had legal protection (Nugent & Fraser, 1993), but now deer are widespread throughout the country. Red deer have established themselves well, now inhabiting an area equivalent to 120,000 $km^2$ (Fraser et al., 2000; Rose et al., 1992). Sika deer are the second most widespread of the species found in New Zealand, covering 8,000 $km^2$, while most fallow deer are contained within the Whanganui and Otago herds (Fraser et al., 2000). There are several more deer species within New Zealand, but these are not widespread and are typically constrained to only a few Department of Conservation conservancies (Fraser et al., 2000). The South Island has traditionally held lower populations of deer (2 – 5 deer/$km^2$) compared to the North Island (5 – 15 deer/$km^2$) (Nugent, 1992). Research initially conducted by King (1990) aimed to estimate introduced mammal populations in New Zealand, and then a further study by Fraser et al. (2000) conducted similar work. A comparison between these two studies shows that pest populations are increasing, with new populations occurring as a result of farm escapes, illegal liberation, and natural dispersal (Fraser et al., 2000).

Possums have also established well in New Zealand, and alongside deer, are now considered one of the two most common forest-dwelling herbivores that have been introduced to New Zealand (Nugent et al., 1997). Deer have altered the vegetation species composition of New Zealand indigenous forests towards a more-browse tolerant vegetation mix through the targeted browsing and removal of fast-growing, light-demanding species (Nugent et al., 2001). Meanwhile, possums are widely recognised as the main contributor to defoliation and dieback of broadleaved forests in New Zealand (Rose et al., 1992).

Other significant pests include feral pigs, which inhabit over 93,000 $km^2$ of New Zealand, and goats, which inhabit over 39,000 $km^2$ (Fraser et al., 2000).

### *New Zealand's International Climate Obligations*

To address the issue of a changing climate, the New Zealand government signed the Kyoto Protocol (Trotter et al., 2005), which is an international agreement that has set emissions reduction targets and limitations for Annex 1 countries (Ford-Robertson et al., 1999; M. U. F. Kirschbaum et al., 2012). The government also signed the Paris Agreement, which has the goal of limiting the increase in global temperature to between 1.5 to 2 °C above pre-industrial levels (Ministry for the Environment, 2023) by committing countries to their own national greenhouse gas reduction plans. These plans set out countries' strategies for addressing climate change, with reductions in greenhouse gas emissions being central to the strategies (Fernandez & Daigneault, 2016; Rogelj et al., 2016). To meet the goals of international agreements, an emissions trading scheme (ETS) was established by the New Zealand Government and encompassed all those greenhouse gases identified within the Kyoto Protocol (Manley & Maclaren, 2012). To further address the issue of climate change, the current government has enacted The Climate Change Response (Zero Carbon) Amendment Bill, which stipulates how New Zealand will transition to a low-emissions economy (MFE, 2019). The Amendment Bill sets out several key targets for achieving the transition. Firstly, the reduction of all greenhouse gases, with the exception of biological methane, to net zero by 2050, and secondly, the reduction of biological methane to between 24 to

47% of 2017 levels by the year 2050, which includes an intermediary target reduction to 10% below 2017 levels (Ministry for the Environment, 2023).

Leining and Kerr (2018) state that the ETS was designed as an instrument that can be used to send price signals to consumers, producers, and investors to facilitate the reduction in greenhouse gas emissions. Emitters of greenhouse gases are liable to surrender emissions units for each tonne of emissions they emit. The theory is that producers who must purchase and surrender emissions units will pass the cost onto consumers, making high-emissions goods more expensive relative to low-emissions goods, and therefore, changing consumer, producer, and investor behaviour toward seeking low emissions production and consumption. This is vital for reducing New Zealand's gross emissions. Conversely, greenhouse gases can be sequestered, for which an emissions unit will be received for every tonne sequestered. This has the effect of reducing New Zealand's net emissions as greenhouse gases that are sequestered offset greenhouse gases that are emitted.

However, the existing ETS settings have failed to promote significant improvements to native biodiversity through reforestation as the carbon credits that can be generated from native afforestation are significantly lower than what can be generated through exotic afforestation (D. Norton et al., 2020). Furthermore, as New Zealand elected not to sign up to Article 3.4 of the Kyoto Protocol, carbon sequestered as a result of management (i.e. above the non-zero business as usual baseline) in pre-1990 forests is not recognised in New Zealand's ETS (Holdaway et al., 2012). However, these units can be traded in voluntary carbon markets. In order for the carbon to be tradable, the additionality created through management of pre-1990 forests must be demonstrable (Holdaway et al., 2012). Providing for the ability to generate carbon credits from pre-1990 native forest and post-1989 regenerating forests less than 1 ha in size could prove a vital inventive for farmers to increase biodiversity (D. Norton et al., 2020).

### *New Zealand's Biodiversity Commitments*

In the past five years there has been an increasing amount of attention given to loss of biodiversity and the subsequent negative impacts on the global economy (Waterford et al., 2023). Of particular relevance to New Zealand is that 80.0% of the nation's exports by value are sold to markets where sustainability standards are either currently mandatory, or are in the process of being implemented (Ernest & Young, 2024). Furthermore, there are international concerns specifically regarding pastoral agriculture's contribution towards biodiversity loss (Poore & Nemecek, 2018), a sector that New Zealand's economy is heavily reliant upon, with 27.0% of the nation's gross domestic product directly linked to land-based ecosystems (Ernest & Young, 2024). There is also increasing global support for biodiversity credit schemes, which are evidenced by the numerous emerging markets (Waterford et al., 2023) and the establishment of €100 million partnership fund to address biodiversity degradation (Présidence de la République française, 2023).

Historically, conservation efforts on private land are commonly taken voluntarily (Kleijjn & Sutherland, 2003). Maseyk et al. (2021) found in a recent survey of 500 sheep and beef farmers that 80.0% of respondents thought native biodiversity on their farms was important to them, and that it should be protected and managed. However, a lack of financial incentive offered to landowners to undertake biodiversity conservation limits efforts (D. J. Pannell et al., 2006; Taylor & Judd, 2024). As the majority of our habitats that are threatened or at risk of extinction are not contained within public conservation land (Ministry for the Environment, 2023), but within New Zealand sheep and beef farms (J. Pannell et al., 2021), well thought out policy framework to financially incentivise biodiversity conservation can greatly enhance the uptake (Maseyk et al., 2021).

The establishment of biodiversity credit schemes is seen by many as an avenue of compensating landowners for biodiversity conservation. Waterford et al. (2023) state that global biodiversity credit schemes will broadly be shaped by three existing frameworks; the Kunming-Montreal Post-2020 Global Biodiversity Framework (GBF), the Taskforce on Nature-Related Financial Disclosures (TNFD), and Science Based Targets Network (SBTN). The GBF has three main goals it wants to achieve by 2030: firstly, to ensure 30.0% of degraded ecosystems are under effective restoration; secondly, 30.0% of all ecosystems are being conserved and managed; and thirdly, to facilitate the mobilisation of $200 billion per year to support biodiversity improvements (Waterford et al., 2023). The TNFD framework was developed as a voluntary framework in which businesses can disclose risks related to their financial performance arising from nature. Of relevance to biodiversity credits is the avenue created that may allow companies to disclose any positive impacts their business is having on the environment, alongside their negative impact disclosures. The SBTN has created guidance, that can be voluntarily adopted, to establish science-based targets for nature. This documentation makes it clear that the full mitigation hierarchy (Transform > Restore and Generate > Reduce > Avoid) must be addressed in order for a company to claim it is having a positive effect on nature. Biodiversity credits are a way of addressing the Transform and Restore/Generate tiers of the mitigation hierarchy.

New Zealand signed the GBF, and is relying upon Te Mana o Te Taiao – Aotearoa New Zealand Biodiversity Strategy 2020 to guide its response to the biodiversity crisis (Ernest & Young, 2024). As a signatory to the GBF, New Zealand is required to create a National Biodiversity Strategy Action Plan (NBSAP), which should outline targets and actions for achieving GBF targets. New Zealand is still to undertake this.

### *Why We Need to Prioritise Native Forest Management*

Inextricably linked to deforestation is loss of biodiversity. Agriculture has indirectly caused a significant reduction in New Zealand's biodiversity through deforestation, with an estimated 14 million ha (71%) of indigenous forest having been cleared (Ewers et al., 2006). Extensive deforestation has significantly reduced biodiversity of New Zealand's forests (Gardner et al., 2009) and been a major factor in the extinction of approximately 40% of New Zealand's land bird species in the post-colonialization era (Atkinson, 1989). Of New Zealand's reptiles, 36.0% are threatened, and 50.0% are at risk, and similarly, 31.0% of marine birds are threatened, and 60.0% are at risk (Department of Conservation, 2020). Moreover, 43.0% of freshwater fish are threatened, and 33.0% are at risk (Department of Conservation, 2020). All of New Zealand's reptiles, frogs and bats, along with 72.0% of birds, are found nowhere else in the world (Department of Conservation, 2020; Ministry for the Environment, 2023). Furthermore, Brown's study examining extinction of indigenous fauna (as cited in Dominati et al., 2019), reported that over 70 species have become extinct. The rates of extinction in New Zealand are some of the worst in the world, and some 63.0% of the nation's ecosystems are threatened, and 30.0% of native species are either threatened or near extinction (Ministry for the Environment, 2023). The long-term effects of native forest clearance on species decline and eventual extinction can be felt for generations after the initial forest clearance (Tilman et al., 1994). Meaning that we cannot fully understand the true impacts of forest clearance until many decades later.

Research has shown that at the landscape threshold (where only 30.0% of original forest cover remains) (Andren, 1994), the rate at which further landscape changes occur, sub-species become more isolated, and a species' reduced ability to persist all significantly increase (Hanski, 1998). Deforestation of New Zealand's native forests has occurred to varying degrees amongst political districts. A study by Ewers et al. (2006) illustrated that deforestation rates ranged from 13.0% to 99.0%, and more than 30 of the political districts had experienced more than 90% deforestation. As of 2002, 55 of New Zealand's 73 districts had surpassed the 30.0% forest cover landscape threshold, and only 10 of the remaining 18 districts had a conservation plan in place for more than 30.0% of the native forest landscape. Not only is New Zealand suffering from historic clearance of native forest cover, but there is a lot of work to be done to restore depleted ecosystems to what they once were. The quantum of restoration required cannot be funded only through public avenues (Taylor & Judd, 2024) so finding alternative sources to funding this restoration will be critical.

New Zealand is still experiencing loss of native forest cover, which is associated with decreases in biodiversity, even in environments that have the smallest quantum of native forest cover remaining (Walker et al., 2006). The conservation priority should be for landscapes that are not yet below the extinction threshold, followed by landscapes that have already fallen below that threshold (Ewers et al., 2006). Indigenous scrub, if left untouched, should eventually revert to native forest, so it can be thought of as future forest. New Zealand has 6.0% of its land classified as indigenous scrub, and when considered as being part of the conservation effort, lifting New Zealand above the 30.0% extinction threshold is much more achievable (Ewers et al., 2006).

## Problem Statement

New Zealand has a history of native vegetation clearance post-human settlement that has seen most country's native forests disappear. This has led to a decrease in native biodiversity and reduced the ability of native forests to sequester carbon dioxide from the atmosphere. There are growing concerns both domestically and internationally about the impact of economic activity on biodiversity and the climate, which New Zealand has attempted to address by making international commitments. However, many would argue that our current policy settings do no go far enough to incentivise the management of native forests for biodiversity and carbon sequestration gains at a scale that will make meaningful differences to the long-term sustainability of native forests.

## Research Aim

The aim of this research is to show that if New Zealand landowners fence off, undertake pest control in, and otherwise manage currently unmanaged native forest areas within their properties that the monetized benefit from an increase in carbon sequestration or positive biodiversity outcomes would offset the costs of undertaking the management.

# Chapter Two: Literature Review

## Impacts of Introduced Pests on Native Forest Sustainability

To understand the impacts that introduced pests have had on our native forests from a forest sustainability standpoint, a summary of existing literature is provided below.

Nugent et al. (1997) undertook a study to compare the diets of red deer and possums in podocarp-hardwood forests to better understand the relationship between pest populations and their impacts. This was a longitudinal study conducted west of Lake Taupo, comprising a 25km$^2$ study area, and involved the collection of plot data within this area. As part of their study, Nugent et al. (1997) established five deer exclosures, which allowed them to undertake plotting and harvesting over time. Nugent et al. (1997) addressed two main arguments: there is a non-linear relationship between deer density and the impact on native forest regeneration; and that deer have the most significant long-term impact on native forests. Rogers and Leathwick (1997) conducted a research study in the Ruahine Ranges of the Manawatu District to measure native forest dieback, which utilised historic and recent aerial photographs, as well as physical helicopter inspections to classify areas of forest into one of five dieback severity classifications. Rose et al. (1992) undertook a similar study in central Westland, utilising aerial imagery captured 1984-85, with physical inspections to verify dieback. This study classified forests into four severity classifications as opposed to five in the study conducted by Rogers and Leathwick (1997).

Nugent et al. (1997) identified 134 plant species within the browse tier (within 2 m of ground level), and total available forage was 288 kg/ha, with the majority of this comprising foliage growing from ground level to 45 cm height (Nugent et al., 1997). By examining the stomachs of deer and possums, it was found that deer only consumed 1.1% of total annual foliage production (AFP) of the plant species that comprised greater than 0.1% of their total annual diet, but they eat a significant portion of all foliage produced in the browse tier. Deer were found to have 191 kg of new foliage growth available to them, and they consumed 8% of this (Nugent et al., 1997). In contrast, possums consumed 3.3% of total annual foliage production. Based on the earliest available aerial imagery to Rogers and Leathwick (1997) from 1946, it was evident that canopy defoliation was beginning to occur, but canopy cover exceeded 95.0% in all measured catchments. When compared against the 1995 aerial imagery, it was evident the near entirety of the canopy had collapsed, and only 18.0% remained intact and 19.0% had only suffered light to heavy collapse (Rogers & Leathwick, 1997). Results presented by Rose et al. (1992) showed that 19.0% of all canopy trees within the 82,819 ha mapped in central Westland were dead as of 1984-85. Similarly to Rogers & Leathwick (1997), only 29.0% of the central Westland forest was found to have light dieback, with most forests showing moderate dieback (mortality of 10.0-30.0%), and 10.0% exhibited heavy dieback (mortality of 30.0-50.0%) (Rose et al., 1992). Forests comprising of possum-preferred species (Northern Rata, Kamahi, Tawa, Hall's Totara, Pahautea, Tree Fuschia, and Red Beech) suffered the most significant dieback (Rogers & Leathwick, 1997), which was found to have caused replacement in higher altitudes of Nothofagus Forest by sub-alpine scrub.

Although initial dieback is caused by possums, sustained canopy loss results from a lack of regeneration of the forest, which occurs when deer and goats are present in moderate numbers (Pekelharing & Reynolds, 1983). Nugent et al. (1997), Rogers and

Leathwick (1997) and Rose et al. (1992) have shown that deer and possums are present in and are causing damage to New Zealand's native forests, which is threatening their long-term sustainability. Furthermore, mature native forests that have had their canopy browsed and opened up by possums also become susceptible to further degradation via wind, fungi and insects, even in the absence of current possum defoliation (Rogers & Leathwick, 1997).

A further note is that while the direct impacts, such as removal of vegetation through browsing by herbivores are well understood (Nugent et al., 1997; Rogers & Leathwick, 1997; Rose et al., 1992), the indirect impacts upon ecosystem processes are much more complicated. For example, one study, which consisted of a global review of literature of 108 studies, found that overall, the removal of large herbivores (>10 kg) resulted in changes to carbon stocks ranging from an increase of 1.96 t C per ha per year to a decline of 0.19 t C per ha per year (Tanentzap & Coomes, 2012). Another study, which investigated the removal of rats from islands in New Zealand found that control measures resulted in a decrease of carbon stocks as the seabird population increased, and therefore, there was more disturbance of plants and soils (Wardle et al., 2007).

In order for a forest to be able to regenerate after the removal of pests, it must meet a minimum resilience threshold (Rogers & Leathwick, 1997), above which, it has the ability to regenerate in the absence of pests. The need for both possum and ungulate control is further corroborated by Nugent et al. (1997), who concluded that control of both possums and deer should be undertaken in tandem, as there is little point in protecting existing native forest canopies from possum browsing if deer and goat population densities prevent the long-term regeneration of the forest (Nugent et al., 1997).

## Carbon Stocks in Native Vegetation

Vegetation assimilates carbon dioxide ($CO_2$) via the process of photosynthesis, which results in the creation of biomass, approximately 50.0% of which is carbon (Case & Ryan, 2020). Therefore, carbon stocks can be defined as the cumulative carbon sequestration of the past up to a chosen point in time at which a measurement is taken. Kirschbaum et al. (2009) state that estimating carbon sequestration rates for native forests is more difficult than for exotic forests for several reasons. Firstly, there is no inventory of native forests in New Zealand that is comprehensive enough to allow for such an estimation, and even if there was, it is highly likely there would be a strong bias towards older, more mature stands of native forest, which are not very relevant for younger age class native forests.

Case and Ryan (2020) undertook a study to spatially map the various types of vegetation on New Zealand sheep and beef farms, relying on multiple national datasets. As part of their research, Case and Ryan (2020) sourced data for 1,183 woody vegetation plots from the Land Use and Carbon Analysis System (LUCAS) plot grid network. Further wood density data was also obtained, and with the combination of these two datasets, estimations of above ground biomass were estimated and formed that basis of this research. By overlaying the multiple national datasets to create a refined layer that best reflected native vegetation on sheep and beef farms, with the sourced plot and wood density data, a national-scale estimation of the carbon position of sheep and beef farms was generated (Case & Ryan, 2020). Similarly, Hall and Hollinger (2000), Hall et al. (2001) and Hall and McGlone (2006) each undertook studies utilising forest growth models (calibrated against National Vegetation Survey (NVS) plot data) to estimate biomass growth rates. Furthermore, Carswell et al. (2009) estimated carbon sequestration for 12 permanent sample plots (six seral exotic shrubland and six native mānuka shrubland) by remeasuring after a minimum 4.5-year period of the initial measurement.

Within their analysis, Case and Ryan (2020) relied upon a range of carbon sequestration rates for the differing forest types. For the mānuka and/or kanuka forest type, sequestration rates were estimated at 3.2 t $CO_2$-/ha/year and 5.3 t $CO_2$-/ha/year for the lower and upper end, respectively. For modelled sites within the studies of Hall et al. (2001) and Hall and McGlone (2006), carbon sequestration varied from 2.0 t $CO_2$-/ha/year to 6.9 t $CO_2$-/ha/year for the first 100 years of growth. Calculating an area-weighted carbon sequestration rate at the national scale based on the area of each species and its corresponding carbon sequestration rate, resulted in a rate of 5 t $CO_2$-/ha/year for the first 100 years of growth, falling to 3.5 t $CO_2$-/ha/year over a 200-year period, and 2.3 t $CO_2$-/ha/year over a 300-year period. For the mānuka shrubland plots estimated by Carswell et al. (2009), the derived annual carbon sequestration rate was 2.0 +/- 1.0 t $CO_2$-e/ha/year, compared to 2.7 +/- 1.5 t $CO_2$-e/ha/year for exotic seral shrubland. These four studies show that while areas of shrubland and successional species have been shown to sequester carbon through photosynthesis, it is at a low rate.

In contrast, mature native forests are estimated to have a neutral sequestration rate (Holdaway et al., 2017), meaning as much carbon decays as is sequestered. Case and Ryan (2020) relied upon a carbon sequestration rate of 1.1 t $CO_2$-/ha/year to 3.3 t

$CO_2$-/ha/year. for the 'Indigenous Tall Forest' type. Holdaway et al. (2014) reported that the average sequestration for all pools (excluding soil) in regenerating pre-1990 forests are 1.39 t C per ha per year, which equates to 5.10 t $CO_2$-e per ha per year. When combined with tall forests, this rate is statistically insignificant from zero. Furthermore, a revision of an earlier study found that through follow up re-measurement of NVS plots that total carbon stocks declined (Peltzer & Payton, 2006). This decline was due to tree mortality being greater than growth of new stems.

This literature indicates that stands of mānuka and/or kanuka have an ability to sequester carbon as they are. Whereas mature native forests are typically have steady state carbon stocks, as the rate of decay offsets the rate of growth.

### Impact of Introduced Mammals on Native Forest Carbon Stocks

To understand the impacts that introduced pests have had on our native forests from a biomass removal/carbon sequestration reduction standpoint, a summary of existing literature is provided below.

Allen et al. (2023) conducted a study to investigate carbon stocks (both below and above ground) in native forests by comparing exclosure plots to adjacent control sites. The exclosure plots were originally established from the 1950s to the 1980s by the New Zealand Forest Service (Wardle et al., 2001), which were perimeter fenced with 1.8 m high fencing to exclude deer, goats and pigs, but not rodents or possums. Exclosures selected for this research were situated in areas with established introduced ungulate populations, they had been fenced for more than 20 years (mean age of the fences was 27), and more than 25.0% of contained species were broadleaved tree species. There were 26 sites (fenced exclosures and paired control) selected for this study. 20 m by 20 m plots were established at each site, with the plots inside the exclosure situated 0.5 m distant from the fence to prevent effects of browsing through the fence being taken into consideration. All trees within the exclosure had their height recorded, and any trees with a diameter at breast height (dbh) greater than 2.5 cm had their aboveground biomass estimated (Allen et al., 2023). Collections of fine woody debris (using 0.1 $m^2$ quadrats) and leaf litter (using 10 cm diameter cores) were taken from 16 sites. The sum of aboveground biomass, woody debris, and leaf litter represents the aboveground carbon stocks.

Allen et al. (2023) concluded that there was no significant difference in total ecosystem carbon stocks (below ground and above ground) between exclosures and the control plots. The carbon pools of small-sized trees (situated within the browse tier) were found to only account for 6.0% of the total carbon in the plots, and the large trees (> 30 cm dbh), which are not affected by ungulate browsing, accounted for 44.0% of total carbon. These results are corroborated by Holdaway et al. (2017), who found that trees > 60 cm dbh account for only 0.8% stems in sample plots taken from New Zealand native forests but equate to 41.0% of total above ground biomass in native forests. The majority of New Zealand's tall tree species (>10 m height) are not typically a main of deer's diet, with only one species being preferred, while 14 are avoided (Nugent et al., 2001). In contrast, short trees (<10 m height) are a larger component of deer's diet, with 16 being preferred and only five being avoided. Allen et al. (2023) concluded that the majority of total carbon stock variation (60.0%) was explained by the biomass of the largest trees in the exclosures, which were not affected by browsing of ungulates.

The most significant finding in the exclosures was that the browse-level vegetation responded well to the exclusion of ungulates and forests with a higher proportion of browse-level vegetation (e.g. regenerating forests) would benefit more from ungulate control than mature forests. However, a key limitation of the study by Allen et al. (2023) is that none of the plots contained early successional forests, or stands that had otherwise been affected by natural events (Wyse et al., 2018), which is where ungulates can have the largest effect (Mason et al., 2010). Therefore, this assumption was never tested.

There have been two literature reviews that sought to find if increased carbon sequestration in native forests can be linked to the control of wild animals. Carswell et al. (2015) undertook a review of existing literature as part of the Wild Animal Control for Emissions Management (WACEM) programme. They concluded that it was very difficult to ascribe any increase in carbon sequestration to control of wild animals. Manaaki Whenua – Landcare Research were commissioned by the New Zealand Game Animal Council (GAC) to investigate if there was a relationship between game animal populations and native forest carbon stocks. Peltzer & Nugent (2023) aimed to assess the impacts of deer (at low, medium, and high population densities) on native forest carbon stocks, compare and contrast the effects of possums relative to deer on native forest carbon stocks, and comment on the restoration of native forests. This research concluded that deer are not the only introduced species that affect native forests in New Zealand. Possums are an introduced herbivore that consumes the canopy of a native forests; pigs and rodents eat seeds and seedlings, and cats and stoats have an effect on rodent populations, which in turn affect vegetation consumption. However, there have been no studies that have investigated the effects of possum control on native forest carbon stocks, let alone the effects in tandem with deer control.

## Impact of Introduced Mammals on Native Forest Biodiversity

There have been numerous studies undertaken in New Zealand's native forests to understand the impact of introduced wild animals on the species composition of native flora. Differences in plant species preference arise traits that prevent herbivory (Forsyth et al., 2002). Plants that have evolved in the presence of herbivores have been shown to have developed both morphological and chemical defences specifically against herbivory, as well as neutral defences that have developed in response to other pressures, but do coincide with defence against herbivory (Edwards, 1989).

Husheer (2005) undertook a study to highlight the effects of introduced deer in the Aorangi Forest on the native forest. 47 permanent plots (20 m by 20 m size) were measured within the forest in 1986, and trees greater than 2 cm dbh were tagged and measured to determine the dbh. These plots were situated on seven random transect lines. Also relied upon were paired fenced plots (by a 2.2 m high deer fence) and unfenced control plots established from 1981-1987 throughout seven river catchments of the Aorangi Forest, which were remeasured in in 2004. A similar study was undertaken by Husheer (2007) in the Pureora Forest, located in the central North Island of New Zealand. Similarly, 32 permanent sample plots and nine paired exclosure sites of 20 m by 20 m were used as the basis of this research. They were also originally established in the 1970s to 1980s and were remeasured in 2002 and 2003. Another similar study was conducted by Husheer & Frampton (2005) in the Wakatipu beech forest. This studied relied upon 49 permanent sample plots (measured 1976 to 2002).

Husheer (2005) found that there was no difference in species composition between all three plot types (randomly located on transect lines, exclosure plots, unfenced control plots) when they were established in the 1980s. Similarly, in 2004, there was no significant difference between exclosure and control plots in terms of species composition, except for the Kanono tree. This finding was attributed to levels of recreational hunting in the Aroangi Forest not being intensive enough to reduce deer populations to a level that would allow for regeneration. In contrast, Husheer (2007) found in the podocarp-tawa-kamahi forest dominated Pureora Forest that paired exclosures showed a significant increase in species composition from 1984 to 2002 measurements, whereas the control sites showed no meaningful difference in species composition. This was the same for the permanent sample plots. Similarly to the Aorangi Forest, recreational hunting of deer had been undertaken in the study area, but there had also been intensive goat culling operations for 30 years prior to this study being conducted. Despite this, very little change to the understorey and species composition of the forest had occurred outside the exclosure plots (Husheer, 2007). Husheer and Frampton (2005) found that in the overstorey, stem density significantly declined but the combined basal area for all species collectively increased (Husheer & Frampton, 2005). Like Husheer (2005), there were no changes to species composition in the understorey.

Husheer and Robertson (2005) undertook a study in the Kaimanawa Ranges specifically to study the effects of high-intensity deer culling on the growth rates of mountain beech seedlings. Aerial culling was implemented alongside medium-intensity ground culling and increased rates of recreational hunting. Monitoring sites (10 m by 10 m) were then established, each comprising of paired fenced and unfenced plots. In

1998 and 1999, 23 aerial culls were undertaken, with a total of 355 deer seen, and 86.0% culled. Then in the 1999/2000 season, 636 deer were seen, and 88.0% of these successfully culled. Lastly, in the 2000/2001, 514 deer were seen and 90.0% were culled. An additional 142 deer were shot by commercial ground hunters over the same three seasons, and recreational hunters reported 1,024 deer were culled. When the 2001/2002 hunting season concluded, deer pellet group density was 67.0% lower in high culling density areas than low density areas.

By the third culling season, seedling growth between fenced and unfenced plots in high culling density areas was largely similar (Husheer & Robertson, 2005). Conversely, seedling growth was significantly slower in the unfenced plots in low and medium density culling areas. This study has shown that when intensive culling operations of deer are undertaken, native forests can begin to recover even when they are not fenced to exclude ungulates. It further reinforces the findings of Husheer (2007) and Husheer (2005) who found that forests were not regenerating when only recreational hunting was relied upon to manage deer populations. Commercial culling has been proven to reduce deer populations to 80.0% of densities pre-culling (Nugent et al., 1987). By the third culling season of their study, Husheer and Robertson (2005) estimated that 11 deer per $km^2$ had been removed by aerial culling operations, which increased to 13 deer per $km^2$ when ground hunting efforts were also considered.

The aforementioned studies have also highlighted the importance of deer control to ensure the long-term regeneration of native forests. Deer have significantly altered New Zealand's native forests since their introduction (Coomes et al., 2003), and have been proven to suppress species composition of palatable species and slow their growth rates as well (Husheer, 2005). In the Kaimanawa Forest park, it is possible that mountain beech forests will be affected so greatly by forest regeneration failure (brought on by deer herbivory) that the composition of the forest will transition towards a shrubland (Husheer & Robertson, 2005). Palatable sub-canopy plant species are reliant on fast growth rates to extend their readily available vegetation beyond the browse tier of introduced ungulates, whereas unpalatable species rely on other defences, so they don't need to be fast growing (Husheer, 2007). Therefore, this transition to a forest species composition more heavily weighted towards slow-growing species, may not only reduce carbon sequestration rates, but it can have wider ecosystem impacts as the quality of leaf litter will decline, which is relied upon by other invertebrates, and their avian predators (Wardle et al., 2001).

### Restoration Possibility of Native Forests

Given the relatively short timeframe that deer have been in New Zealand, we likely have not seen the full effects of their herbivory on native forests, which contain trees that are over 3,000 years old (Lee, 1998). Even more poorly understood is the response of ecosystems to deer exclusion, as there is only a small number of areas where long-term deer control has been undertaken in New Zealand (Tanentzap et al., 2009).

Coomes et al. (2003) proposed three ideas as to why native forests may not recover after the deer population has been reduced. Firstly, deer may change their behaviour in response to control measures, and with the greater abundance of more palatable plants, the intensity of grazing on these more preferred species may increase. Therefore, reducing the deer population below a threshold at which their selective targeting of newly emerging, preferred species will not stop restoration is key. Secondly, deer may have modified the native forest ecosystem to a point where it cannot recover to what it was pre-herbivory. Thirdly, deer are not the only introduced species that negatively impact native forests in New Zealand, so control of deer alone may not be sufficient to allow for forest recovery.

A study that examined the effects of deer control on vegetation was undertaken by Tanentzap et al. (2009). This study was undertaken over a 518 $km^2$ area in the Murchison Mountains of New Zealand to see if deer control undertaken size 1962 had led to significant changes in vegetation composition on a 39-year timeframe and/or an increase in the abundance of deer-preferred plant species. The deer population was estimated to have peaked at 8.7 deer per $km^2$ in 1964 and troughed at 0.58 deer per $km^2$ in 1988. Deer numbers then increased to 1.1 deer per $km^2$ in the late 1990s. Overall, the deer population is estimated to have decreased 92.0% from 1964 to 2008, which is corroborated by the 94.0% reduction in deer numbers culled. There were 32 permanent plots (20 m by 20 m) utilised in the Murchison Mountains, which were established along random transect lines in 1969 and 1976, measured in 1976 and 1998, and most recently measured from 2002 to 2008. There were an additional five exclosure plots (200 to 400 $m^2$ in size) and paired control plots that were established specifically on fertile soils. These were measured in 1998 and again in 2004. Finally, 22 permanent plots situated on random transect lines in subalpine shrubland were established in 1975 and remeasured in 2005. Furthermore, 19 plots established in alpine grassland (again on randomly selected transect lines) were measured in 1969, 1976 and 2008.

It was found by Tanentzap et al. (2009) that in the permanent forest plots, there was only limited regeneration of seedlings and saplings (in both relative and absolute terms), with the abundance of deer preferred species being most scarce. The density of seedlings and saplings had increased from 1976 to 2008, coinciding with a decrease in deer numbers. The ratio of seedlings to adult trees also increased. By 1998, there was a measurable difference in the sapling density of all palatability classes within the exclosures as compared to the control plots, which indicates that despite control measures, deer were still affecting the abundance of seedlings and saplings, in particular, preferred species. This study observed that in response to deer densities in the study area being reduced below the predicted threshold of 2 deer per $km^2$ to allow for palatable species regeneration, there were greater densities of saplings and seedlings in forests, shrubland crowns grew thicker, palatable tussocks grew taller, and species diversity of grassland species increased. The effects of deer herbivory were found to be persistent up to 46 years after intense culling operations. This was evidenced by fewer saplings in exclosures as compared to control plots, and there being no observable difference to shrubland composition.

## Biodiversity Credit Schemes

### *Need for a Biodiversity Credit Scheme*

With a change in international mindsets to have more of a focus on the relationship between business and the environment, there is growing global support and recognition of the need for pathways to fund positive biodiversity outcomes through biodiversity credit schemes (Waterford et al., 2023). At present, legislation is primarily being used to set lower limits of accepted environmental metrics to prevent further degradation of ecosystem integrity (Deutz et al., 2020; Knight-Lenihan, 2023). However, this protection does not encourage the active protection and restoration of ecosystems.

There is estimated to be an annual biodiversity finance gap of US $598 to $824 billion per annum out to 2030 (Deutz et al., 2020). It is estimated that NZ $26.5 billion will be required on an annual basis to meet the GBF targets in New Zealand, but currently there is only NZ $4 billion spent on biodiversity activities annually in New Zealand (Ernest & Young, 2024). New Zealand developed a biodiversity strategy in 2020, which was intended to provide a strategic direction for New Zealand's biodiversity outcomes over the next 30 years (Department of Conservation, 2020). The overarching strategic direction was to maintain and restore ecosystems and habitats, enhance scarce habitats, and protect populations of indigenous species (Clarkson, 2022). To achieve this, a range of specific goals and actions were outlined (Department of Conservation, 2020).

Ernest and Young (2024) conducted an economic analysis to estimate how much it would cost New Zealand to take specific environmental actions to meet five of its 2030 conservation goals (as laid out in the Kunming-Montreal Global Biodiversity Framework Targets), and what the immediate environmental benefits would be worth economically. By achieving targets two and three, which are to restore 30.0% of degraded ecosystems and conserve 30.0% of land, water and sea by 2030, respectively, the economic benefit to new Zealand was calculated at NZ $272 billion from 2025 to 2080, with a payback period of 11 years (Ernest & Young, 2024). By 2080, this equates to a 4.3% increase in Gross national Income (GNI) over and above the status quo. Achieving these targets created large benefits through increasing carbon sequestration and reducing the need for New Zealand to purchase offshore units to meet commitments and improved ecosystem services that decreased climate-related risk. However, varying sectors within New Zealand would be unequally impacted by the activities undertaken to meet these goals. Notably, the pastoral sector was modelled to decrease its outputs due to water restrictions and land use change. This declining output was modelled to be partially offset by higher commodity prices being achieved and a more sustainable business model being developed. Furthermore, the benefit of additional carbon sequestration was not attributed to the pastoral sector, and instead directly to the GNI. But, in reality, this benefit would be shared with landowners. Modelling predicted that by 2080, the dairy and meat/animal product sectors would contract by NZ $3.4 billion and $1.8 billion, respectively. While this may be seen as a large contraction, it is important to consider the negative impacts of the status quo model on these sectors. The pastoral sector is highly dependent on natural ecosystem services, such as nutrient cycling, climate regulation, and pollination. If we do not address the biodiversity crisis, it is possible that many of these services will fail and the pastoral sector will be negatively affected through more climate variability, reduced yields, less diversity of pollinators, and abandonment by customers in vital markets.

Therefore, the establishment of avenues to fund biodiversity conservation will assist us in achieving our biodiversity goals and help to offset the unequitable transition that many land-based sectors will face.

### *Principles of a Biodiversity Credit Scheme*

Biodiversity net gain (BNG) is the concept of increasing biodiversity values above a level that was present prior to the undertaking of a particular development (Knight-Lenihan, 2023). Waterford et al. (2023) describe a biodiversity credit scheme, which is a way of recognizing BNG, as a scheme that represents measurable, positive biodiversity outcomes in the form of a tradable token. This token is defined as a biodiversity credit (Biodiversity Credit Alliance, 2024).

In 2023, Waterford et al. (2023) undertook an international review of eight biodiversity credit schemes. The crediting approach (the channel through which credits are issued and traded) was commonly found to follow the below formula:

*Biodiversity Credit = X (outcome/activity) over Y (area) for Z (time period)*

This means that a scheme needs to have methodology for establishing baseline biodiversity value, and biodiversity gains, and a period for which funding will be available. Given the old age that New Zealand native forests can reach, we will need a scheme that provides funding over a long period of time, as opposed to just in the short term. A biodiversity credit scheme could be of particular use for funding biodiversity conservation of mature native forest in New Zealand. Research reviewed as part of this study has shown that there is little to no increase to biomass of mature native forests in New Zealand, which means that carbon sequestration additionality created by ungulate and possum exclusion could be hard to prove. In contrast, emerging biodiversity schemes are tending to take a more high-level approach to additionality (Waterford et al., 2023), which considering the evidence scientific available regarding introduced mammals' impact on flora diversity in mature native forests, may allow for greater flexibility in establishing positive biodiversity gains through ungulate and possum control, and therefore, more access to funds to undertake the control.

Undertaking NBS projects to generate carbon credits can simultaneously create biodiversity credits as a co-benefit. These credits typically sell for a premium over and above carbon credits that offer no biodiversity co-benefits, which has been evidenced in overseas voluntary carbon markets (Waterford et al., 2022). When there are benefits of biodiversity improvements alongside carbon credit generation on the same land, this is referred to as 'stacking'. This is often the case, as research has shown that biomass (carbon credits) and species richness (biodiversity credits) in regenerating native forests occur as co-benefits when ungulates are removed (Allen et al., 2023; Mason et al., 2010; Wyse et al., 2018). However, the ability to monetise the additionality created relating to both of these benefits must be carefully managed and the permissibility will be dependent of the settings of the relevant schemes (Waterford et al., 2022). A similar but different concept is that of 'stapling', whereby a carbon credit from one area of land is coupled with a biodiversity credit relating to a separate area of land. This concept allows for the purchaser to claim the full benefits of both the carbon and biodiversity credits, providing the alternate credit hasn't been sold separately to another purchaser, who is also claiming benefit. Lastly, 'bundled' products are those that represent a multitude of benefits created within one project area, not just carbon and biodiversity, that are sold to a single purchaser (Waterford et al., 2022). As New Zealand has made commitments to both climate change and biodiversity conservation targets, these three concepts will need to be considered when creating policy settings. It is likely that management of native forests will be able to be monetised either through the New Zealand ETS or a biodiversity credit scheme, but which avenue will provide the greatest economic return to the landowner will likely dictate which scheme it utilised to undertake the management, which in turn, could impact upon New Zealand's reporting and ability to me its separate climate and biodiversity targets.

### *Existing Biodiversity Credit Schemes*

There are numerous examples of overseas biodiversity credit schemes, operating with and without government intervention. Reviews undertaken by Ministry for the Environment (2023) and Wentworth (2024) found a government-managed scheme is emerging in Australia; VERRA, a non-profit organisation in America, is creating a biodiversity standard to allow participants to create verified credits; the British government introduced BNG legislation, which relies heavily on biodiversity offsets as opposed to biodiversity credits; a private firm, GreenCollar, based in Australia developed a voluntary scheme called NaturePlus; and ClimateTrade and Terrasos, two voluntary carbon markets located in Spain and Colombia, respectively, have teamed up to create a voluntary biodiversity scheme.

Examples of biodiversity schemes currently operating in New Zealand are Ekos BioCredita, with the pilot project being Sanctuary Mountain Maungatautari (Weaver, 2025), and the Toha network (TOHA, 2024). Sanctuary Mountain is a native forest protected by a predator proof fence, and needed to find an alternative source of funding in the face of grant money ceasing (Ekos, 2023). Therefore, in 2022, Ekos (a New Zealand company) launched the first biodiversity credit offering in the country by facilitating a private sale of biodiversity credits to the Profile Group Ltd (Ministry for the Environment, 2023). Credits have since become publicly available for purchase on an ongoing basis though the Ekos BioCredita for NZ $12 per credit, which represents $100m^2$ of biodiversity protection for a period of one year (Weaver, 2025). This private scheme was an example of a scheme that issues credits based on activities that improve biodiversity, as opposed to a scheme where credits are issued by outcome or by project. The TOHA Network is currently in a pilot phase, but also relies upon a variety of approaches to credit (Mahi token) issuance (TOHA, 2024). However, unlike the Sanctuary Mountain Maungatautari biodiversity credit, which offers a standalone biodiversity credit that can be stapled with carbon credits, a Mahi Token represents a bundled credit, encompassing other benefits such as enhancing indigenous land management, providing for access to Mahinga Kai, and flood mitigation (TOHA, 2024). Mahi are currently available for donation at a price of $26 per token, with TOHA network tokens becoming available once the scheme officially launches.

# Chapter Three: Materials, Methods, and Assumptions

## Quantitative Research

This research comprises an embedded case study analysis of part of the Manawatū District, New Zealand, and five individual case study properties situated within this area. An embedded case study approach contains more than one layer of analysis (Yin, 2003), making it useful for understanding underlying factors that help to describe a phenomenon. It is a more useful technique than a traditional case study (which focuses on a single unit of analysis) when there are a diverse range of components to a study phenomenon or there are aspects that need to be separately addressed (LinkedIn, 2023). Furthermore, by selecting multiple case studies as opposed to only a single case, the heterogeneity of sheep and beef farms in New Zealand will be better reflected and the research will have greater validity (Bass et al., 2018; Seawright & Gerring, 2008).

The variable upon which the cases have been selected is the quantum of native forest land within them, expressed as a percentage of total property area. The percentage of a property that is native forest land was grouped into a categorical variable (i.e., 0 to 25%, 26 to 50%, 51 to 75%, and 76 to 100%), so cases that reflected both high and low values could be selected (Seawright & Gerring, 2008). This research has not achieved an acceptable saturation as five cases have been researched (two for the 0.0% to 25.0% category, and one each for the remaining categories of 25.0% to 50.0%, 5.0% to 75.0% and 75.0% to 100.0%). However, as there was only one case per category (apart from the 0.0% to 25.0% category), there is a high likelihood that each case does not fully represent other farms in New Zealand that fall within that category.

Therefore, this research will not be so comprehensive as to render the analysis of additional case studies unnecessary (Small, 2009).

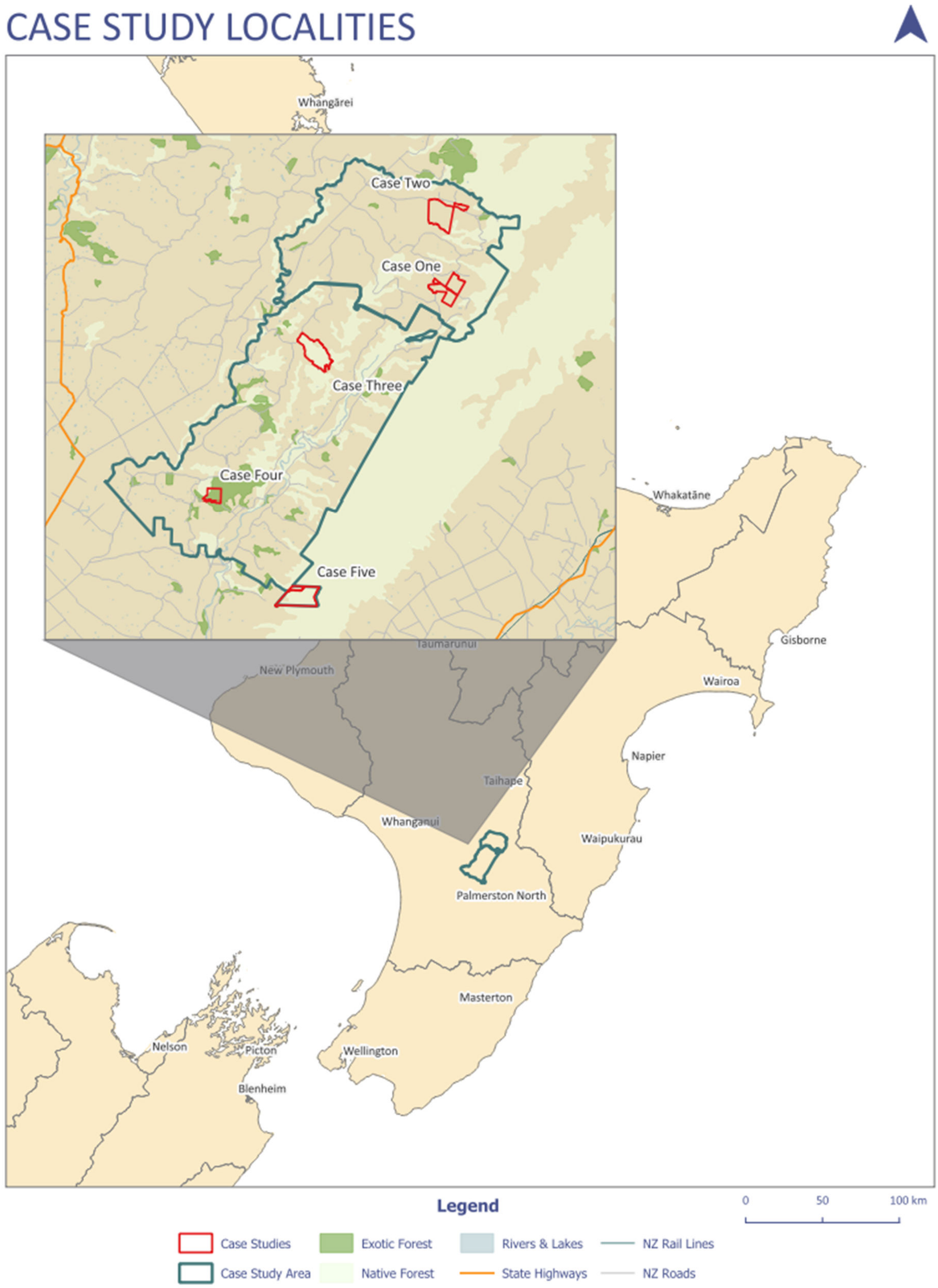
## Case Study Selection

### *Locality within Manawatū District*

The Apiti and Pohangina localities were selected from the NZ Suburbs and Localities dataset to form the overall specific area within the Manawatū District that would be studied within this research. As shown by Figure 1, two of the selected individual case study properties are situated within the Apiti locality, and three are in the Pohangina locality.

The Apiti locality encompasses 149 $km^2$ and has a population of 318, compared to Pohangina, which is larger at 282 $km^2$ and has a population of 872 (Toitū Te Whenua Land Information New Zealand, 2023b). The Apiti and Pohangina villages are situated 61 km and 39 km northeast of Palmerston North City, respectively. The localities are bounded to the north and west by the Orua River, and the Pohangina locality is bisected by the Pohangina River. The eastern boundary of the localities is formed by the Ruahine Ranges, and the southern boundary by pastoral farmland. Altitude ranges from 100 metres above sea level (masl) adjacent to the Pohangina River, rising to 1,180 masl at the western extent in the Ruahine Ranges (Toitū Te Whenua Land Information New Zealand, 2022). Chappell (2015) describes the wider Manawatū-Whanganui Region as generally having a climate of few climatic extremes, rainfall and temperature that are conducive to the growing of pasture, and a predominant westerly wind. More specifically, the study area has a rainfall of 1,100 – 1,800 mm, with the main rainfall months being June to September, inclusive. The median annual average temperature is 10 – 12 °C, with winters typically being June to September, inclusive, and minimum average daily temperatures being 2 – 3 °C. In contrast, daily maximum temperatures in summer months average 17 – 21 °C.

*Figure 1: Map showing location of case study area and individual case study properties*



### *Case Study One*

Case One (unID 328) is situated in the Apiti locality, 15 km east of the Apiti village. The property is predominantly utilised for pastoral farming and is split into three blocks, being bisected by Norsewood Road. Part of the southern and northern boundaries are formed by Pohangina Valley East Road and Umutoi North Road, respectively. In total, the property has 4.3 km of road frontage, which equates to 31.6% of the property's total 13.6 km of boundary. The property borders four other properties, three of which met the requirements to be included within the refined study area.

Case One has a total area of 291.3 ha and there is no regenerating forest contained within it, and only 2.6% of the property's total area was classified as old growth forest. Therefore, this case falls within the 0.0% to 25.0% categorical variable and provides a good case for properties that have little to no indigenous forest contained within them.

### *Case Study Two*

Case Two (unID 986) is situated in the Apiti locality, 10 km northeast of the Apiti village. The property is predominantly utilised for pastoral farming and is split into two blocks, being bisected by Table Flat Road. The southern boundary of the northern block and the northern boundary of the southern block are formed by Table Flat Road. In total, the property has 3.0 km of road frontage, which equates to 27.8% of the property's total 10.8 km of boundary. The property borders four other properties, three of which met the requirements to be included within the refined study area.

Case Two has a total area of 369.8 ha, with only 0.8% of the property comprising of regenerating forest and 14.5% classified as old growth forest, for a total forest classification of 15.3%. Therefore, this case falls within the 0.0% to 25.0% categorical variable.

### *Case Study Three*

Case Three (unID 844) is situated in the Pohangina locality, 20 km south of the Apiti village. The property is predominantly utilised for pastoral farming and is contained within one block. The southeastern boundary of the property is formed by the Pohangina River (1.9 km of frontage), the northwestern boundary is formed by Ridge Road (0.8 km of frontage), and the remaining 7.4 km of boundaries are formed by two adjacent farming properties, which meet the requirements to be included within the refined study area.

Case Three has a total area of 356.7 ha, with 29.2% of the property comprising of regenerating forest and only 8.5% classified as old growth forest, for a total forest classification of 37.7%. Therefore, this case falls within the 25.0% to 50.0% categorical variable.

### *Case Study Four*

Case Four (unID 1037) is situated in the Pohangina locality, 21 km southwest of the Pohangina village. The property is predominantly utilised for exotic forestry and is contained within one block. The property is bounded by Finnis Road to the south for 1.5 km, with all other boundaries (3.1 km) being formed by either forestry properties or properties that are predominantly indigenous forest.

Case Four has a total area of 104.2 ha, with 49.2% of the property comprising of regenerating forest and a further 10.1% classified as old growth forest, for a total forest classification of 59.3%. Therefore, this case falls within the 50.0% to 75.0% categorical variable.

### *Case Study Five*

Case Five (unID 17) is situated in the Pohangina locality, approximately 20 km south of the Pohangina village. The property comprises some pastoral farming and is contained within one block. Technically, the property is contained within two blocks as it is bisected by a paper road. Unlike for other properties, this paper road wasn't dissolved into the property boundary as it provides access to the Ruahine Forest Park, so it is likely that access cannot be readily impeded. Approximately 6.9 km of the property's boundaries are formed by the Ruahine Forest Park, with only the western boundary (1.9 km) being formed by adjacent farming properties, which meet the requirements to be included within the refined study area.

Case Five has a total area of 362.4 ha, with 3.5% of the property comprising of regenerating forest and 76.1% classified as old growth forest, for a total forest classification of 79.6%. Therefore, this case falls within the 75.0% to 100.0% categorical variable.

## Case Study Methods

### *Data Collection*

This research relies on both primary and secondary data collection. Data relating to the impact of introduced pests on indigenous forests, including effects on biomass and species composition, as well as the effects of culling on pest populations will be relied upon in this research as secondary data (Boslaugh, 2007). In contrast, primary data is that which has been collected by the researcher for their specific research problem (Hox & Boeije, 2005). Within this research, primary data has been collected for costs of undertaking biodiversity conservation from a variety of industry professionals through the use of semi-structured interviews, which allowed for a combination of structure and flexibility (Legard et al., 2013).

### *Quantum Geographic Information System*

Quantum Geographic Information System (QGIS), which is an open-source mapping software, was used to generate spatial information relating to numerous aspects of the study area and the case studies. Numerous datasets were used to analyse metrics for both the study area and the case studies, including, but not limited to; the average size of farming properties, land cover breakdown, and Land Use Capability (LUC) class. Furthermore, spatial information was generated by the researcher based upon data collected from the interviews to establish carbon and biodiversity management scenarios. All spatial information created within QGIS was exported into the excel spreadsheet where it was further analysed to formulate inputs for the remainder of the research.

### *QGIS Analysis of Old Growth and Regenerating Native Forest*

The LCDB v5.0 layer (Manaaki Whenua Landcare Research, 2024a), which is a multi-temporal classification on New Zealand's land cover, does not differentiate between regenerating and old growth native forest. Both classifications are grouped under 'indigenous forest' within the layer. Therefore, in line with research undertaken by Norton and Pannell (2018), this study has adopted the 'indigenous forest' and 'broadleaved indigenous hardwoods' classifications within the Land Cover Database (LCDB) layer to represent old growth forest and the 'manuka/kanuka, 'gorse/broom', and 'mixed exotic shrubland' categories to represent the regenerating forest category.

The NZ Property Hybrid Layer 'Property Hybrid' layer has been compiled primarily from the Rating Units data, which aggregates spatial title polygons and united land into a single polygon (Toitū Te Whenua Land Information New Zealand, 2025b). The Hybrid Layer fills any gaps in the primary data source firstly with titles from the NZ Property Titles layer and secondly, with parcels from the NZ Primary Parcels Layer (Toitū Te Whenua Land Information New Zealand, 2025b). As there is not perfect spatial alignment between the NZ Suburbs and Localities and the Property Hybrid layers (likely due to re-surveying of titles since the original forming of the localities boundaries), all properties that predominantly lie within the study area (>95.0%) have been incorporated. Conversely, any properties that primarily reside outside of the study area (<95.0%) have been excluded. This has been done to prevent the creation or artefacts whereby small slivers of properties are contained within the analysis, even though they are only in the study area due to spatial misalignment. Where a property straddles the NZ Suburbs and Localities boundary (i.e. <95.0% resides outside the NZ Suburbs and Localities boundary) the polygon/s that reside within the boundary have been retained, and the balance titles that reside outside the boundary have been excluded. Furthermore, properties under 5.0 ha have been excluded from this study, in an attempt to remove residential, commercial, lifestyle, and otherwise non-farming properties, which follows the methodology of Taylor and Judd (2024). Therefore, there is a discrepancy between the total study area and the area derived directly from the NZ Suburbs and Localities layer for the two localities.

Additional steps have been undertaken to identify the designation and ownership of the polygons within the Property Hybrid layer. Firstly, the NZ Property Titles – Including Owners Layer (Toitū Te Whenua Land Information New Zealand, 2025c) was overlayed with the Property Hybrid layer to identify privately and publicly owned land. Polygons within the Property Hybrid layer that were identified to be sourced from the NZ Primary Parcels layer were identified as ‘road’ and ‘waterway’ designations using aerial imagery and the NZ Primary Road Parcels layer (Toitū Te Whenua Land Information New Zealand, 2025a). Any other publicly owned reserves or estates were also identified.

To estimate the quantum of old growth and regenerating native forest within the study area, the national LCDB layer was reprocessed to be constrained to the study area. A further reprocessing of the LCDB layer was then undertaken to intersect this layer with the Property Hybrid layer. This spatial operation provides a breakdown of the LCDB layer by property. Dunningham et al. (2000) estimated the accuracy of the LCDB layer to be above 93.9%. However, the LCDB layer does a poor job of a accurately mapping small areas of vegetation, which is due to the resolution of the imagery the layer has been derived from (D. Norton & Pannell, 2018). For the study area analysis, this layer has been relied upon to form the basis on analysis, but for the individual case studies, re-mapping of vegetation features has been undertaken.

After the reprocessing was completed, three calculations were run on the resulting layer to determine the complexity of the feature geometry of old growth and regenerating forest polygons. These calculations are outlined below:

Perimeter to area ratio

$$Ratio = \frac{perimeter}{area}$$

Compactness index

$$Index = \frac{4 * \pi * area}{perimeter^2}$$

Form factor

$$Factor = \frac{area}{perimeter^2}$$

### *QGIS Analysis of NZLRI LUC*

To gain an understanding of the land types within the localities, the New Zealand Land Resource Inventory – Land Use Capability 2021(NZLRI LUC) layer ((Manaaki Whenua Landcare Research, 2024b) was reprocessed and constrained to the study area. The NZLRI LUC classification is a nationwide inventory of five physical factors that determine the productive capacity of land. It divides the country into eight classifications (LUC 1 to LUC 8), with LUC 1 land being the most productive and suitable for a diverse range of land uses and LUC 8 land having severe limitations for productive use (Lynn et al., 2009). A further intersection operation has been undertaken with the LCDB layer to determine the distribution of old growth and regenerating forest across the range of productive landscapes.

### *Case Study Selection*

To select appropriate embedded case study properties within the refined study area, properties were grouped into one of the four categorical variables (i.e., 0.0% to 25.0%, 26.0% to 50.0%, 51.0% to 75.0%, and 76.0% to 100.0%), with the quantum of total native forest land (regenerating forest plus old growth forest) being the grouped value. The result of this grouping is presented in Table 1.

*Table 1: Grouping of properties by quantum of forest land*

| | 0-25% | 25-50% | 50-75% | 75-100% | Total |
|---|---|---|---|---|---|
| No. of Properties | 205 | 33 | 11 | 9 | 258 |

As can be seen, most of the 258 properties within the refined study area fell within the 0.0 to 25.0% category, while only nine of the properties have more than 75.0% total forest land cover. To further disseminate the breakdown of properties, this study applied a grouping of properties based on their overall size, which is shown below in Table 2.

*Table 2: Breakdown of properties by size and percentage of forest cover*

| Size Group | 0-25% | 25-50% | 50-75% | 75-100% | Total |
|---|---|---|---|---|---|
| 5-25 Ha | 46 | 6 | 8 | 4 | 64 |
| 25-75 Ha | 50 | 10 | 1 | 2 | 63 |
| 75-200 Ha | 52 | 12 | 2 | 2 | 68 |
| 200-500 Ha | 45 | 4 | | 1 | 50 |
| >500 Ha | 12 | 1 | | | 13 |
| **Total** | **205** | **33** | **11** | **9** | **258** |

Preferably, one embedded case study would have been collected for each combination of size and proportion of forest land cover to best represent the diversity of the dataset (Acharya et al., 2013). However, Table 2 shows that this was not possible for this dataset, as there are no properties returned for several of the combination categories. There was also a heavy weighting of properties (5 to 500 ha in size) that fell into the 0.0% to 25.0% forest land cover category, which decreased significantly as the property size and percentage of total forest increased above 500 ha 25.0%, respectively. This made it harder to fully reflect property heterogeneity within this study.

The average farm size for dairy farms in latest survey statistics is 161 ha within the Manawatū District (DairyNZ & LIC, 2024) and the average size for a sheep and beef hill country farm in the Western North Island: Taranaki and Manawatū-Whanganui

Regions is 481 ha (Beef + lamb New Zealand, 2024). Therefore, to make this research as applicable to the primary sector in the Manawatū District as possible, case study properties have been selected from the category combinations shown in Table 3.

*Table 3: Category combinations that case study properties have been selected from*

| Size Group | Forest land cover | Property unID |
|---|---|---|
| 200-500 Ha | 0-25% | 328, 986 |
| 200-500 Ha | 25-50% | 844 |
| 75-200 Ha | 50-75% | 1037 |
| 200-500 Ha | 75-100% | 17 |

Table 3 also shows the properties (uniquely identified by the 'unID' field in QGIS) that were selected as the embedded case study properties. Simple random sampling was used to select the case study properties within each category as this method of sampling gives each property an equal chance of being selected (Singh, 2003).

For large datasets, computer software can be employed to undertake this sampling (Rahi, 2017). This study utilised the 'Vector Selection – Random Selection' tool within QGIS, which is an algorithm that selects a specified count or percentage value of features within the dataset (QGIS Project, 2025). This algorithm was run once for each of the category combinations specified in Table 3 to ensure that each case within the subset category combination had an equal chance of being selected, as opposed to applying the algorithm to the entire dataset. Two properties were selected within the 200 to 500 ha size group, 0.0% to 25.0% forest land cover combination. Both cases were randomly selected, and unID 328 was retained upon initial selection as it contains a very low total forest land cover (2.6%), compared to the 15.3% total forest land cover within unID 986. The unID 328 property was retained as it was thought to be useful to highlight an extreme scenario of near zero total forest cover.

### *Re-mapping of Case Study Properties*

Given the known inaccuracies of the LCDB layer (Manaaki Whenua Landcare Research, 2024a; D. Norton & Pannell, 2018) an exercise the re-map the case study properties was undertaken to accurately assess the actual area of old growth and regenerating forest within them. The LCDB layer formed the base of this analysis, with the aim to avoid reclassification between old growth and regenerating forest, but to focus on reclassification between forest vs non-forest vegetation types. For example, areas of manuka and/or kanuka were not reclassified as indigenous forest, and vice versa. To undertake this re-mapping, aerial imagery captured in 2021 to 2022 at 30 cm resolution was relied upon (Toitū Te Whenua Land Information New Zealand, 2023a).

Despite this re-mapping, case studies were not re-selected if they were reclassified to have a total proportion of forest outside their originally assessed categorical variable range.

### Development of Protection Scenarios

Once the case studies had been selected, the next step was to develop scenarios for each forest type (old growth and regenerating) for each of the five case studies. Scenarios have been developed for old growth forest that provide biodiversity additionality. In contrast, scenarios for regenerating forest have been developed that focus on carbon additionality. In this study, there have been nine scenarios developed in total, three relating to old growth forest and six relating to regenerating forest. Table 4 summarises the nine scenarios and what is considered within them.

*Table 4: Scenario descriptions*

| Scenario | Forest Type | Description |
|---|---|---|
| One | Regenerating | Fencing of property boundary, pest control of property, FMA plots |
| Two | Regenerating | Fencing of forest blocks, pest control of forest blocks, FMA plots |
| Three | Regenerating | No fencing, pest control of property, FMA plots |
| Four | Regenerating | Fencing of property boundary, pest control of property, no FMA plots |
| Five | Regenerating | Fencing of forest blocks, pest control of forest blocks, no FMA plots |
| Six | Regenerating | No fencing, pest control of property, no FMA plots |
| Seven | Old Growth | Fencing of property boundary, pest control of property |
| Eight | Old Growth | Fencing of forest blocks, pest control of forest blocks |
| Nine | Old Growth | No fencing, pest control of property |

In all scenarios it is assumed that possum control will be undertaken in all old growth, regenerating and other forest within the property. The cost of possum control within regenerating forest for scenarios one to six will be borne 100.0% by that scenario, and the cost of possum control in the other forest will be prorated based on the proportion of regenerating forest in the total native forest. In contrast, the full cost of possum control within old growth forest for scenarios seven to nine will be borne 100.0% by that scenario, with the inverse cost apportionment for other forest. Furthermore, in all scenarios where the property boundary is fenced, or no fencing at all is undertaken, ungulate control is assumed to be undertaken over the entire property. Similarly to possum control, the full cost of ungulate control within regenerating forest will be borne by scenarios one to six, and the full cost within old growth forest borne by scenarios seven to nine. The costs of pest control within the other forest areas and pastoral areas that make up the balance of the properties will be prorated as it was for the possum control. For the remaining scenarios in which the native forest blocks are fenced (as opposed to the property boundary or no fencing at all), ungulate control is undertaken only in these blocks.

### *Carbon Additionality in Regenerating Forests*

Guided by the literature that has been reviewed, this study has modelled carbon additionality for regenerating forests. However, as there is currently no provision within the New Zealand ETS to account for carbon additionality, and there is no existing evidence of by how much carbon sequestration could increase when possums and ungulates are controlled in regenerating forests, several key assumptions have been made. Most notably, costs and practices associated with the New Zealand ETS have been heavily relied upon as a proxy for a voluntary carbon market in which additional carbon credits generated through possum and ungulate control will be traded. These assumptions are outlined in the following paragraphs.

Firstly, to model baseline levels of carbon sequestration by regenerating forest, this study has relied upon the indigenous forest type carbon stocks presented in the Ministry for Primary Industries (MPI) default lookup table (Climate Change (Forestry) Regulations 2022, 2022). To estimate the carbon additionality attributable to possum and ungulate control, the study of Nugent et al. (1997), which found that possums and deer consumed 3.3% and 8.0% of biomass available to them, respectively, was used as a guide. This study has assumed carbon additionality of 10.0% when possums and deer are controlled in regenerating forest. The baseline and assumed additional carbon stocks are summarised in Table 5 and are expressed in t $CO_2$.

*Table 5: Baseline and additional carbon stocks*

| Age (yrs) | Indeg | Indeg (Adj.) | Age (yrs) | Indeg | Indeg (Adj.) |
|---|---|---|---|---|---|
| 1 | 0.6 | 0.7 | 26 | 224.6 | 247.1 |
| 2 | 1.2 | 1.3 | 27 | 233.7 | 257.1 |
| 3 | 2.5 | 2.8 | 28 | 242.2 | 266.4 |
| 4 | 4.6 | 5.1 | 29 | 250.1 | 275.1 |
| 5 | 7.8 | 8.6 | 30 | 257.5 | 283.3 |
| 6 | 12.1 | 13.3 | 31 | 264.3 | 290.7 |

| Age (yrs) | Indeg | Indeg (Adj.) | Age (yrs) | Indeg | Indeg (Adj.) |
|---|---|---|---|---|---|
| 7 | 17.5 | 19.3 | 32 | 270.6 | 297.7 |
| 8 | 24.0 | 26.4 | 33 | 276.3 | 303.9 |
| 9 | 31.6 | 34.8 | 34 | 281.6 | 309.8 |
| 10 | 40.2 | 44.2 | 35 | 286.5 | 315.2 |
| 11 | 49.8 | 54.8 | 36 | 290.9 | 320.0 |
| 12 | 60.3 | 66.3 | 37 | 295.0 | 324.5 |
| 13 | 71.5 | 78.7 | 38 | 298.7 | 328.6 |
| 14 | 83.3 | 91.6 | 39 | 302.0 | 332.2 |
| 15 | 95.5 | 105.1 | 40 | 305.1 | 335.6 |
| 16 | 108.1 | 118.9 | 41 | 307.8 | 338.6 |
| 17 | 120.8 | 132.9 | 42 | 310.4 | 341.4 |
| 18 | 133.6 | 147.0 | 43 | 312.6 | 343.9 |
| 19 | 146.3 | 160.9 | 44 | 314.7 | 346.2 |
| 20 | 158.7 | 174.6 | 45 | 316.5 | 348.2 |
| 21 | 170.9 | 188.0 | 46 | 318.2 | 350.0 |
| 22 | 182.6 | 200.9 | 47 | 319.7 | 351.7 |
| 23 | 193.9 | 213.3 | 48 | 321.1 | 353.2 |
| 24 | 204.7 | 225.2 | 49 | 322.3 | 354.5 |
| 25 | 215.0 | 236.5 | 50 | 323.4 | 355.7 |

To become a participant within the New Zealand ETS, the landowner must register their land, and they then have several obligations they must meet. The initial costs to register land within the ETS are summarised in Table 6 (Ministry for Primary Industries, 2025). This study has adopted the cost for registering regenerating forest in line with these costs for each case study.

*Table 6: Cost of registering land within the New Zealand ETS*

| Area of Land in Application | Cost (incl. GST) |
|---|---|
| Less than 10 Ha | $102.2 |
| From 10 Ha and less than 50 Ha | $2,087.3 |
| From 50 Ha and less than 100 Ha | $2,277.0 |
| From 100 Ha and less than 500 Ha | $3,036.0 |
| 500 Ha and more | $4,743.8 |

Once the land is registered, the participant must pay an annual registration fee of $14.90 per ha, and can file a voluntary emissions return (to claim carbon credits generated by their forest) on an annual basis, which costs $165 (Ministry for Primary Industries, 2025). This study has modelled annual filing of returns.

If a participant in the New Zealand ETS has a forest type registered under the Field Measurement Approach (FMA), then they are required to collect information for their forest by using permanent sample plots (Ministry for Primary Industries, 2024a). Under the FMA approach, the minimum number of plots required for the smallest area (100 ha) of registered indigenous forest is 15, and assuming a plot area of 0.06 ha (Ministry for Primary Industries, 2024a), this equates to a sampled area of 0.9 ha, or 0.9% of the total area. Therefore, this study has adopted a sampling density of 0.9% of the regenerating forest area and divided this by 0.06 ha to estimate the total number of sample plots within each case study. FMA plots only need to be remeasured once every five years (Ministry for Primary Industries, 2024a), and this study has adopted this measuring frequency within its modelling. Costs of FMA plot sampling range from $300 to $500 for plots in exotic forestry, increasing significantly for native forest plots, which can range from $600 to $800 per plot (A. Buswell, personal communication, June 3, 2025). This study has adopted a cost of $600 per plot, which is at the lower end of the spectrum, and represents the relative ease at which the plots will be able to be measured as the case studies typically have good access over them, which helps to reduce cost (A. Buswell, personal communication, June 3, 2025).

An alternative scenario was also modelled whereby a designated lookup table has been created for managed regenerating native forests, which a participant could enter into. This would therefore remove the need for plot sampling once every five years.

A starting carbon credit price of $57.05 has been used within this research.

### *Biodiversity Additionality in Old Growth Forests*

To model biodiversity additionality scenarios, this study has aimed to follow the principles of the Ekos SD (Sustainable Development), which has been developed to meet the need to balance private and public funding for biodiversity outcomes, and is a mechanism to allow for the costs of projects to be recovered by those undertaking the works (Ekos SD Limited, 2025). The Ekos BioCredita scheme has been created in line with this standard.

The Ekos SD Standard (the document outlining the standards for Ekos SD) has established two methodologies for measuring biodiversity gains. Firstly, they can be measured using the Verified Cause Approach, which focuses on verifying the inputs of biodiversity works, and secondly, via the Verified Effect Approach, which focuses on the outputs of biodiversity works (Ekos SD Limited, 2025). Weaver (2025) expects that most of the projects will be verified by the third-party organisation using the Verified Effect Approach. In the absence of any readily available costs, this study has adopted the cost of a certified farm plan as a proxy for third-party verification of biodiversity works. This cost has been modelled to be $5,000 for the initial development of the plan, and $2,000 for the ongoing annual audit (S. Hawkins, personal communication, May 23, 2025).

The value of a BioCredita credit is determined by the costs incurred to generate the credit (Weaver, 2025), which differs from carbon credits. The BioCredita scheme has been designed to facilitate biodiversity conservation by providing landowners with the necessary to funding to undertake the works. This is an important distinction as it does not allow for the 'monetization of nature', which could result in perverse outcomes. To set the value of a BioCredita credit, landowners must provide a cost declaration ex-ante for each year's issuance of credits, and these must be verified expost at each verification milestone. The cost declaration contains a schedule of all expenditure required to deliver the project, including but not limited to; project capital and operational expenditure (establishment and maintenance costs), opportunity costs (e.g. lost farming revenue from the land), and the cost of capital (interest repayments on borrowed capital) (Ekos SD Limited, 2025). The credit price can change from year to year to reflect varying levels of cost incurred to undertake the project (Weaver, 2025), and projects may be grouped, either within or across national, regional, or territorial boundaries (Ekos SD Limited, 2025).

Therefore, instead of modelling the profitability of biodiversity conservation in old growth forests, this study has focused on the costs incurred by the landowner.

### *Fencing Costs*

To allow for fencing costs within this study's modelling, several fencing contractors who operate primarily within the Manawatū-Whanganui region were surveyed as to their current costs of deer fencing. The results of this survey are summarised in Table 7.

*Table 7: Deer fencing costs (materials + labour) on a per metre basis*

| ID | Flat | Rolling | Steep |
|---|---|---|---|
| Contractor 1 | $30/m | | $100/m |
| Contractor 2 | $30/m | $35/m | $40/m |
| Contractor 3 | $30/m | $35/m | |

The above rates account for an angle every 50 m on average, with each angle costing $200. Therefore, when fencing forest blocks that have a complicated boundary, this cost can increase if an angle is required more frequently than every 50 m. Moreover, the $100/m cost supplied by Contractor 1 reflects the cost of erecting fencing where machinery is not able to gain access and the work must be done manually. All other costs assume that machinery can access the site.

Three fencing plans have been modelled. Firstly, a scenario where the property boundary is perimeter deer fenced has been modelled. Secondly, a scenario where blocks of native forest are deer fenced, with no property boundary fencing, has been modelled. In the first two fencing scenarios, it has been assumed that the property boundary and native forest blocks will require all new fencing. Furthermore, there has been no determination made in the first two fencing scenarios as to the most practical/cost-effective fencing lines, and instead the raw property and native forest block polygon boundaries have been relied upon. A third fencing scenario has been modelled in which there is no fencing undertaken within the case study properties at all.

### *Ungulate Control*

To model an effective ungulate control strategy, this study relies upon information provided by a reputable pest control business that operates nationwide in New Zealand. The source wished to remain anonymous to protect intellectual property.

To facilitate ungulate control, population surveys are initially undertaken to estimate how many animals are resident as opposed to transient (anonymous personal communication, May 23, 2025). For deer, two surveys in one month will be undertaken at night using thermal a monocular, and for goats, a single 4WD inspection over the course of one day can suffice. Once the size of the pest population has been established, cullers will be deployed to the property to undertake control. The anonymous source presented a case study of a 600 ha property from which 500 animals were culled (anonymous personal communication, May 23, 2025). It took two cullers ten days of work to cull the pests. Cullers were charged out at $75 per hour during the day and $85 per hour during the night, which reflects the cost of additional equipment. A mix of day and night hunting is recommended to provide effective control of all ungulate species, as well as to keep kill rates high by creating constant disturbance of the animals' behavioural patterns. We have modelled an even split between day and night culling. After the initial knockdown period, one culler visited the property for five days per month for a period of three months. After the three months, there was a client review of the ongoing need for pest control, which saw visits drop down to one day per month on an ongoing basis.

With the above case study in mind, this study has attempted to standardise the costs from the 600 ha operation to a 100 ha property, to allow for ease of comparison against the possum control programme. A summary of the possum control programme implemented is summarised in Table 8.

*Table 8: Summary of ungulate control programme*

| Operation | Year | Cost $/ha |
|---|---|---|
| Population Density Sampling | 0 | $19 |
| Initial Knockdown | 0 | $51 |
| Maintenance (Three months post-knockdown) | 3 months | $36 |
| Maintenance (Year 1) | 9 months | $54 |
| Maintenance (Ongoing) | Ongoing | $72 |
| **Operation Cost Total** | | **$232** |

## *Possum Control*

Effective possum control has been proven to achieve a <5% residual trap catch (RTC), which aligns with the Horizon Regional Council's stated goal for possum population densities (Martyn & Dodd, 2015). To achieve this level of control, Waikato Regional Council utilised 105 AT220 traps in a trial area of 500 ha (Waikato Regional

Council, 2023), equating to a density of one trap every 4.2 ha. This trial by Waikato Regional Council (2023) found that possum densities dropped from 13.75% RTC pre-trial to 3.03% RTS post-trial. However, it must be noted that the native bush areas surrounding the trial site had been subject to aerial application of 1080 poison, which prevented re-invasion of the trial area by populations outside of it (L. Shadbolt, personal communication, June 16, 2025).

This study has adopted a pest control strategy that utilises the AT220 trap in conjunction with existing Horizon Regional Council possum control efforts. The AT220 trap is produced by NZ Auto Traps, and currently markets for $565 per trap (*AT220 Multi Species Auto Resetting and Reluring Pest Trap*, 2025), and need to be serviced once every four to six months. Replacement batteries can be purchased for $63.25, and a 2 litre bottle of replacement lure can be purchased for $50.60 (NZ Auto Traps, 2025). This study has allowed for three days per year to check/re-bait the stations, 350ml of lure per check, and one spare battery per trap to allow for immediate re-arming of the trap. Currently, the Horizons Regional Council undertakes ground-baiting possum control every two to three years (L. Shadbolt, personal communication, June 16, 2025), with this cost comprising part of the annual total regional council rates and being levied at an area rate of $1.05 per hectare (Horizons Regional Council, 2025). We have not included this as a cost within our workings as although it is a cost incurred as part of the biodiversity project, this work would have been undertaken irrespective of whether the additional trapping work was undertaken, and therefore, does not constitute additionality.

L. Shadbolt states that to determine pre-control RTC of possums, population density counts need to be undertaken (personal communication, June 16, 2025). This involves 200 m long transect lines being established and set with wax and bite tags, which are left for seven days and then checked. Over a 100 ha area, ten transect lines will commonly be set, which will take three to four days' labour for one person, at a rate of $75 to $85 per hour. Monitoring density studies should be followed up every three to five years.

Within this study, is has been modelled that possum control will be undertaken within old growth and regenerating native forest, as well as other forest. This has been modelled as previous studies have shown that in order for effective lowering of the possum RTC in an area, surrounding afforested areas also need to be controlled to prevent reinvasion (Waikato Regional Council, 2023).

A summary of the possum control programme implemented is summarised in Table 9.

*Table 9: Summary of possum control programme*

| Operation | Year | Cost $/ha |
|---|---|---|
| Population Density Sampling - Initial (10 Transects) | 0 | $34 |
| AT220 Trap Purchase | 0 | $175 |
| AT220 Trap Maintenance | Annual | $21 |
| Population Density Sampling - Follow Up (10 Transects) | 5-yearly | $34 |

## Discounted Cash Flow Analysis

The outputs from QGIS were compiled in a Microsoft Excel spreadsheet where they were incorporated into a discounted cash flow (DCF) analysis. A DCF analysis can express all revenue and expenditure of an investment at a single point in time, which is usually at the start of the investment period, by 'discounting' all cash flows at a predetermined discount rate (Janiszewski, 2011). Therefore, DCFs can be used to compare profitability of investments with different timing of cash flows (Fogan & Pollard, 2020). Future cash flows have to be discounted to a single point in time due to the time value of money concept, which states that one dollar today is worth more than one dollar received at some point in the future (Maclaren, 1993). There was one DCF prepared for each of the nine scenarios for each of the five case study properties.

This study applied a discount rate of 7.8% for pre-tax cash flows, which was the average discount rate forestry valuers used in 2023 for small (<1,000 ha) forests (Manley, 2024). All costs and revenues have been compounded annually at 1.5%. The investment horizon for the six carbon additionality scenarios for regenerating forests varied depending on the age of the regenerating forest. As the MPI lookup tables only extend to 50 years (Climate Change (Forestry) Regulations 2022, 2022), the age of the forest was subtracted from this maximum age and the result was adopted as the investment horizon. Although native forests can continue to sequester carbon for hundreds of years (Hall & McGlone, 2006), this study has ceased the investment period once the regenerating forest has reached age 50. In contrast, the biodiversity additionality scenarios for old growth forests have utilised a standard 50-year investment horizon.

The Net Present Value (NPV) of an investment is the sum of all revenue minus the sum of all expenditure over a specified period, discounted at an appropriate rate, whereas the IRR is the discount rate that will result in an NPV of zero (Agnes Cheng et al., 1994). Both the NPV and IRR are two metrics upon which capital investments are assessed, however, they can provide different rankings, which leads to differences in the most desirable investment being recommended (Osborne, 2010). As the IRR has only an implicit association with wealth maximisation, and the NPV has an explicit association with the wealth position of the overall business (Agnes Cheng et al., 1994), NPV will be relied upon within this research as the primary metric for assessing profitability of carbon additionality scenarios.

# Chapter Four: Results

## Property Heterogeneity

The study area comprised a total area of 43,324.6 ha, which is 92.8 ha larger than the geographic area of the combined Apiti and Pohangina localities. The discrepancy in the area was due to the reasons outlaid in the methodology regarding prioritising grouping of properties over maintaining a boundary that perfectly reflects the locality boundaries. However, it was also discovered that there has been a coordinate reference system (CRS) issue when the original NZ Property Hybrid Layer was created. This has created gaps and overlaps between some features when they are situated adjacent to a feature that is sourced from one of the other contributory layers.

*Table 10: Property count and size by designation for study area*

| Designation | Count of Properties | Total Area (Ha) |
|---|---|---|
| Private | 652 | 40,371.0 |
| Waterways/Waterbodies | 54 | 967.1 |
| Formed Legal Road | 214 | 583.7 |
| Unformed Legal Road | 151 | 508.5 |
| Local Authority | 35 | 468.8 |
| Crown Land | 36 | 271.3 |
| Scenic Reserve | 6 | 77.0 |
| Recreation Reserve | 3 | 18.6 |
| Soil Conservation Purposes | 2 | 17.9 |
| River Protection Reserve | 2 | 14.7 |
| Gravel Reserve | 19 | 11.6 |
| Conservation Purposes | 11 | 10.3 |
| Cemetery Reserve | 3 | 4.2 |
| **Total** | **1,188** | **43,324.6** |

Table 10 above shows the breakdown of the properties contained within the study area. Private land was found to be the main designation, equating to 54.9% of properties by count but 93.2% of properties by area. Legal Roads also made up a significant portion of the count of properties (30.7%) but only accounted for 2.5% of the total area. Waterways/waterbodies, Local Authorities, Crown Land and reserves all made up relatively small proportions of both the count of properties and the total area.

The results of merging Unformed Legal Roads (‘paper roads’) with private land where they bisected farming properties, removing private properties under 5 ha, as well all properties with a designation other than private land are shown below in Table 11.

*Table 11: property count and size for refined study area*

| Designation | Count of Properties | Total Area (Ha) |
|---|---|---|
| Private | 258 | 39,888.5 |
| **Total** | **258** | **39,888.5** |

It can be seen in Table 11 that while the count of properties fell 60.4% the total area of these properties only fell 1.2%. The median size of a property was 76.9 ha and ranged from 5.0 ha to 1,413.3 ha. The distribution was extremely right skewed (skewness = 2.9). Therefore, a natural log transformation was undertaken to normalise the data. This transformation revealed a relationship between area and shape complexity, with an $R^2$ value of 0.76. Categorization of the properties into five size categories, as shown in Table 12 below, revealed further insights.

*Table 12: Size relationships of properties within refined study area*

| Group | Count of Properties | Mean Area (Ha) | Mean Perimeter (m) | Mean Ratio | vs Perfect Circle |
|---|---|---|---|---|---|
| 5-25 Ha | 64 | 11.2 | 1,827.6 | 0.0181 | 1.54 |
| 25-75 Ha | 63 | 45.5 | 3,675.1 | 0.0086 | 1.54 |
| 75-200 Ha | 68 | 122.3 | 6,112.4 | 0.0051 | 1.56 |
| 200-500 Ha | 50 | 329.3 | 11,994.7 | 0.0037 | 1.86 |
| >500 Ha | 13 | 886.6 | 26,079.7 | 0.0029 | 2.47 |

There is a scaling paradox of properties (polygons) within the refined study area. Smaller polygons exhibited higher perimeter-to-area ratios (0.0181 – indicating relative complexity), but larger polygons demonstrated greater perimeter inefficiency compared to geometric ideals (a circle) despite lower perimeter-to-area ratios (0.0029). Very small polygons (5 to 25 ha) had perimeters 1.54 times longer than equivalent circles, indicating irregular boundaries. However, very large polygons (>500 ha) had perimeters 2.47 times longer than equivalent circles, suggesting highly convoluted boundaries with extensive indentations, protrusions, or fragments edges.

## Quantum of Native Forest Land

The results of land cover analysis of the study area are summarised below in Table 13.

*Table 13: Landcover breakdown of the study area by designation*

| Land Cover Classification | Private | Legal Roads | Waterways/ Waterbodies | Local Authority | Crown | Reserves/ Other | Total Area (Ha) |
|---|---|---|---|---|---|---|---|
| High Producing Exotic Grassland | 31,977.5 | 707.4 | 384.6 | 60.9 | 38.9 | 59.6 | 33,228.8 |
| Old Growth Forest | 4,227.8 | 187.5 | 130.8 | 337.3 | 200.8 | 80.9 | 5,165.0 |
| Exotic Forest | 1,652.5 | 33.1 | 2.9 | 38.1 | 4.3 | 0.9 | 1,731.8 |
| Regenerating Forest | 1,419.4 | 36.9 | 67.3 | 1.6 | 8.0 | 5.8 | 1,539.0 |
| Low Producing Grassland | 450.2 | 10.9 | 31.2 | 0.0 | 0.4 | 0.8 | 493.5 |
| Deciduous Hardwoods | 287.9 | 31.4 | 93.6 | 11.8 | 5.0 | 0.8 | 430.4 |
| River | 89.3 | 38.8 | 158.8 | 8.0 | 5.6 | 3.6 | 304.2 |
| Gravel or Rock | 36.5 | 21.6 | 96.7 | 7.7 | 8.3 | 2.0 | 172.7 |
| Forest - Harvested | 140.4 | 0.8 | | 0.9 | | | 142.1 |
| Sub Alpine Shrubland | 45.4 | | | | | | 45.4 |
| Short-rotation Cropland | 34.6 | 1.1 | | | | | 35.7 |
| Landslide | 9.8 | 1.2 | 1.3 | 1.6 | | | 13.8 |
| Built-up Area (settlement) | 6.3 | 3.5 | | 0.9 | | | 10.7 |
| Lake or Pond | 5.4 | | | | | | 5.4 |
| Herbaceous Freshwater Vegetation | 2.4 | | | | | | 2.4 |
| Matagouri or Grey Scrub | 2.4 | | | | | | 2.4 |
| Orchard, Vineyard or Other Perennial Crop | 1.1 | | | | | | 1.1 |
| **Total Area (Ha)** | **40,388.7** | **1,074.2** | **967.0** | **468.7** | **271.2** | **154.3** | **43,324.2** |

Grassland (including low and high producing) areas account for 77.8% of the total land cover of the study area, and 96.2% of this area is privately owned. The second most common land cover is old growth forest, which accounts for only 11.9% of the total area, and similarly, is predominantly contained within private land (81.9%). The regenerating forest category is the fourth most prominent, comprising a mere 3.6% of the study area, with 92.2% contained within private land. When combining the land cover classifications that would have been present pre-human settlement, only 7,666.7 ha, or 17.7%, of the native land cover remains.

Table 14 summarises the results of the analysis to determine how polygon characteristics for old growth forest and regenerating forest change when property boundaries are overlaid. This analysis provides insight into how ownership may affect the maintenance and protection of remnant native forest area,

*Table 14: Impact of property boundaries on indigenous forest polygons*

| Situation/Forest Type | Count | Mean Area (Ha) | Total Area (Ha) |
|---|---|---|---|
| ***Land Cover (Study Area)*** | ***555*** | ***12.1*** | ***6,704.9*** |
| Old Growth Forest | 362 | 14.3 | 5,165.3 |
| Regenerating Forest | 193 | 8.0 | 1,539.7 |
| ***Land Cover with Property Overlay*** | ***1,467*** | ***4.6*** | ***6,704.0*** |
| Old Growth Forest | 1,034 | 5.0 | 5,165.0 |
| Regenerating Forest | 433 | 3.6 | 1,539.0 |
| ***Land Cover with Property Overlay (Refined)*** | ***889*** | ***6.3*** | ***5,613.2*** |
| Old Growth Forest | 605 | 6.9 | 4,194.9 |
| Regenerating Forest | 284 | 5.0 | 1,418.4 |

When the LCDB layer was constrained to the study area boundary, there were only 555 individual native forest polygons, with an average size of 12.1 ha across both categories. In contrast, when property boundaries are overlaid, the number of individual polygons increases by 164.0% to 1,467 and the average polygon size fell to 4.6 ha. Notably, the polygon size for old growth forest and regenerating forest fell by 65.0% and 55.0%, respectively.

When the study area is refined to exclude all non-private land and private land >5 ha in size, the quantum of privately owned land reduces from 40,388.7 ha to 39,888.5 ha. Grassland remains the dominant land cover (80.2%), followed by old growth forest (10.5%), and regenerating forest being the fourth most common at 3.6% of total area. Furthermore, as evidenced by Table 14 above, the quantum of indigenous forest decreases by 1,090.8 ha when the study area is refined, but the fall in the number of polygons offsets this decline in area to result in the average size of the forest classifications increasing compared to when all designations are included in the analysis. This, however, does not offset the reductions in average size introduced by the property overlay.

### Distribution of Land Cover

The predominant NZLRI LUC class within the study area is LUC 6, comprising 43.2% of the total area. The second largest class is NZLRI LUC 7, comprising 25.3% of the total area. Table 15 shows that in comparison, the remainder of the classes are relatively insignificant within the study area.

*Table 15: NZLRI LUC breakdown of study area*

| LUC Class | Area (Ha) | % of Total |
|---|---:|---:|
| 1 | 1,360.0 | 3.1% |
| 2 | 3,329.0 | 7.7% |
| 3 | 3,937.0 | 9.1% |
| 4 | 1,313.0 | 3.0% |
| 6 | 18,720.0 | 43.2% |
| 7 | 10,947.0 | 25.3% |
| 8 | 3,570.0 | 8.2% |
| river | 152.0 | 0.4% |
| **Total** | **43,328.0** | **100.0%** |

Further analysis revealed that remaining old growth and regenerating forests were restricted to the poorer sites that were not preferred for pastoral farming. The results show that 95.0% of all old growth forest is found on LUC 6 to 8 land, and 97.7% of regenerating forest was found within the same classes. In contrast, 74.2% of pastoral agriculture (predominantly comprising the grassland classifications) land was contained within LUC 6 to 8 land, which is a slight underrepresentation (LUC 6 to 8 for the entire study area comprises 76.7%). The more productive classes of LUC 1 to 4 are dominated by pastoral agriculture, with the grassland classes comprising 94.5% of this area, and old growth forest and regenerating forests only comprising a total of 2.7%. Of the land cover that would have been present pre-human settlement, only 3.7% of these areas are contained within LUC 1 to 4 land.

Of the 258 properties included within the refined study area, only 197 contained any old growth forest and/or regenerating forest, with 61 properties containing no native forest whatsoever.

*Table 16: Distribution of properties with indigenous forest*

| Group | Count with >0% Forest | Total Count | % of Properties with Forest |
|---|---:|---:|---:|
| 5-25 Ha | 41 | 64 | 64.1% |
| 25-75 Ha | 38 | 63 | 60.3% |
| 75-200 Ha | 57 | 68 | 83.8% |
| 200-500 Ha | 48 | 50 | 96.0% |
| >500 Ha | 13 | 13 | 100.0% |
| **Total** | **197** | **258** | **76.4%** |

Table 16 indicates that as the property increases in size, the greater the likelihood that a property includes regenerating and/or old growth forest. This is likely not only due to the larger absolute size increasing the chance that not all of the old growth forest was cleared, but the presence of forest can also be described by the LUC breakdown of the properties. For the 5 to 25 ha and 25 to 75 ha groups, the LUC breakdown was weighted towards LUC 1 to 5 land., comprising 37.3% and 39.4% of 5 to

25 ha and 25 to 75 ha groups, respectively. Whereas, for the 75 to 200 ha, 200 to 500 ha and >500 ha groups, the LUC breakdown comprised of 30.6%, 19.8% and 13.2%, respectively. Indicating a heavier weighting towards LUC 6-8 land.

Table 17 shows the distribution of the two forest types between the properties based on their size.

*Table 17: Forest type by property size group*

| Size Group | Regenerating Forest Area (Ha) | Old Growth Forest Area (Ha) | Total Area (Ha) |
|---|---|---|---|
| 5-25 Ha | 25.7 | 132.6 | 158.3 |
| 25-75 Ha | 167.4 | 189.2 | 356.6 |
| 75-200 Ha | 418.6 | 829.1 | 1,247.6 |
| 200-500 Ha | 538.1 | 1,722.5 | 2,260.6 |
| >500 Ha | 268.7 | 1,321.5 | 1,590.2 |
| **Total Area (Ha)** | **1,418.4** | **4,194.9** | **5,613.3** |

Despite the 5 to 25 ha size group having only 1.8% (713.9 ha) of the refined study area by size, it contained 2.8% of total forest area. The remainder of the size groups had an amount of total forest area that was in line with their percentage share of the area of the refined study area. Furthermore, Table 17 also shows that the majority (74.3%) of the native forest within the refined study area is classified as old growth forest, and only 25.3% is classified as regenerating forest. Furthermore, 10.1% of the properties account for 55.4% (786.0 ha) and 53.4% (2,240.8 ha) of the regenerating forest and old growth forest land cover, respectively, within the refined study area. Furthermore, 10.1% of the properties comprise 46.6% (2,618.5 ha) of the total forest land cover.

When the forest polygons within the study area were examined irrespective of the property boundaries, it was found that there was a total of 1,306 land cover polygons and of these, 362 were classified as old growth forest. It was found that 52.9%

of all old growth polygons by area were contained within only 10 polygons, and the largest 9.9% of polygons accounted for 71.5% of the total old growth forest area. The largest polygons were situated on the periphery of the Ruahine Ranges (Crown-owned land) and adjacent to streams and rivers on steep topography. In comparison, the smaller the polygons are typically long and narrow, and are situated further from the Ruahine Ranges and rivers/streams, being more centrally located within larger grassland polygons. There were also 193 regenerating forest polygons contained within the study area, and 50.6% of the area was contained within 13.0% of the polygons. Unlike the largest of the old forest polygons, the largest regenerating forest polygons were found more centrally located within larger grassland polygons. Their shapes were less uniform than the old growth forests, with the polygons tending to follow the shape of gullies that form the steeper parts of the farming properties, but not as steep as the river and streambanks that the larger old growth forest polygons were found within. The largest old growth forest polygons tended to be more regular in their shape, being confined, or protected, by steeper contour and natural features such as rivers and steep cliffs.

### Land Cover within Case Study Properties

The re-mapping of the studies resulted in a change in landcover for all five of case study properties, as shown in Table 18. Importantly, it can be seen that none of the case studies had re-mapped total forest areas that changed the categorical variable that they originally fell within.

*Table 18: Quantum of total forest within case studies*

| Case Number | Original | Re-mapped |
|---|---|---|
| Case One | 2.6% | 4.2% |
| Case Two | 15.3% | 22.6% |
| Case Three | 37.7% | 44.6% |
| Case Four | 59.3% | 57.7% |
| Case Five | 79.6% | 84.3% |

Case One only contained old growth forest, and the increase in old growth forest area came from a reduction in high producing grassland classification. Case Two saw an increase in both regenerating and old growth forest, which came from the exotic forest (6.2 ha), and high producing grassland (21.0 ha) classifications. Case Three saw a small increase to old growth forest (0.4 ha) and a larger increase to regenerating forest (24.3 ha) all of which was reclassified from the high producing grassland classification. Case Four saw a decrease of 6.9 ha from regenerating forest, which was offset by a 5.2 ha increase in old growth forest. Case Five saw an increase of 17.0 ha to regenerating forest classifications, and no change to old growth forest types.

When examining the accuracy of the original LCDB layer compared to the results of the re-mapping exercise, which are summarised in Table 19, it can be seen that only three of the ten categories were 100.0% accurate.

*Table 19: Producer accuracy of the LCDB layer*

| LCDB Category | Producer Accuracy |
|---|---|
| Broadleaved Indigenous Hardwoods | 84.4% |
| Deciduous Hardwoods | 100.0% |
| Exotic Forest | 73.1% |
| Forest - Harvested | 56.0% |
| High Producing Exotic Grassland | 93.8% |
| Indigenous Forest | 9.0% |
| Low Producing Grassland | 59.7% |
| Manuka and/or Kanuka | 73.5% |
| River | 100.0% |
| Sub Alpine Shrubland | 100.0% |

These results broadly indicate poorer accuracy of the LCDB layer than those reported by Dunningham et al. (2000), who estimated the accuracy of the LCDB layer to be above 93.9%. However, the LCDB layer has been generated from poorer resolution imagery (D. Norton & Pannell, 2018) than what the re-mapped layer has been. Much of the difference in classification has come from boundary realignment.

## Carbon Additionality Feasibility of Regenerating Forests

### *Fencing Costs*

All the case study properties, with the exclusion of Case One, had regenerating forest within them, and therefore, had carbon additionality scenarios developed for them. The largest variable amongst the case study properties and the scenarios was the cost of fencing. The fencing costs modelled in each of the case studies are summarised below in Table 20.

*Table 20: Fencing costs for carbon additionality scenarios*

| | Cost of Fencing | | | | |
|---|---|---|---|---|---|
| | Case One | Case Two | Case Three | Case Four | Case Five |
| Property Boundary | 475,615 | 482,853 | 355,880 | 466,000 | 1,181,700 |
| Regenerating Forest | - | 167,650 | 1,501,875 | 119,000 | 451,000 |

Table 21 summarises the area of the property and the total area of regenerating forest within each case study, as well as the corresponding perimeter.

*Table 21: Length of fencing required for carbon additionality scenarios*

| | Length of Fencing Required | | | | |
|---|---|---|---|---|---|
| | Case One | Case Two | Case Three | Case Four | Case Five |
| Property Boundary | | | | | |
| Area (ha) | 293.3 | 369.8 | 356.6 | 104.2 | 362.4 |
| Perimeter (km) | 13.6 | 10.8 | 10.2 | 4.7 | 11.8 |
| Regenerating Forest | | | | | |
| Area (ha) | - | 15.7 | 128.5 | 3.7 | 29.8 |
| Perimeter (km) | - | 4.8 | 22.3 | 1.2 | 4.5 |

Cases Four and Three have the smallest perimeters of 4.7 and 10.2 km, respectively. However, while Case Three has the lowest property boundary fencing cost of $355,880, Case Four has the second highest property boundary fencing cost of $466,000. Furthermore, Case Five has the second largest property boundary perimeter, which is only 1.6 km longer than that of Case Three, but it has the highest property boundary fencing cost at $1,181,700. This cost is over three times greater than the cost for Case Three, despite the perimeter only being 16.2% longer. For all case study properties other than Case Three, the cost of fencing the property boundary is more expensive than fencing the regenerating forest block boundaries. For Case Three, the perimeter of the property boundary is much smaller than the boundary of the regenerating forest blocks (10.2 km vs 22.3 km length) but the cost for fencing the regenerating forest blocks is $1,145,995 (or more than four times) greater than the cost of fencing the property boundary. The modelled cost of fencing the property boundary of Case Three was $35/m, whereas the modelled cost of fencing the regenerating forest blocks was $100/m, which reflects the inaccessibility of the blocks within this case. Cases Four and Five also have high fencing costs compared to the perimeters of the property boundaries and regenerating forest blocks due to also having the fencing rates modelled at $100/m.

Table 22 summarises the total fencing costs and expresses the cost of fencing as a percentage of total expenses for a given scenario. Scenarios 1 and 4 both comprise fencing of the property boundary, and Scenarios 2 and 5 comprise fencing of the regenerating forest blocks.

*Table 22: Fencing costs as a share of total costs for carbon additionality scenarios*

| | Total Costs & Fencing Costs | | | |
|---|---|---|---|---|
| | Case Two | Case Three | Case Four | Case Five |
| Scenario 1 | - 548,243 | - 617,114 | - 475,240 | - 1,229,756 |
| Scenario 4 | - 539,339 | - 576,781 | - 474,091 | - 1,220,391 |
| Fencing Cost | 482,853 | 355,880 | 466,000 | 1,181,700 |
| % of Total Expenses | 88.1% , 89.5% | 57.7% , 61.7% | 98.1% , 98.3% | 96.1% , 96.8% |
| Scenario 2 | - 208,541 | - 1,700,728 | - 128,184 | - 497,386 |
| Scenario 5 | - 199,637 | - 1,660,395 | - 127,035 | - 488,022 |
| Fencing Cost | 167,650 | 1,501,875 | 119,000 | 451,000 |
| % of Total Expenses | 80.4% , 84.0% | 88.3% , 90.5% | 92.8% , 93.7% | 90.7% , 92.4% |

For all scenarios, except for the property boundary fencing for Case Three, the cost of fencing accounts for over 80.0% of the total costs incurred in the carbon additionality scenario. The reason for the low percentages for Scenarios 1 and 4 within Case Three of 57.7% and 61.7% of total costs, respectively, is because the area of regenerating forest comprises 36.0% of the total property area. This has resulted in the variable costs associated with pest control, ETS registration and FMA plots being higher relative to the cost of property boundary fencing than for the other case study properties, which only comprise between 3.5% and 8.2% of regenerating forest.

## *Pest Control Costs*

The cost of possum control did not vary between scenarios for a given case, but it did vary between case study properties (refer Table 23).

*Table 23: Possum control costs for carbon additionality scenarios*

| | Possum Control Costs | | | |
|---|---|---|---|---|
| | Case Two | Case Three | Case Four | Case Five |
| Total Cost | 17,053 | 97,045 | 4,283 | 21,367 |
| Cost per Ha | 1,083 | 755 | 1,170 | 716 |

Total possum control costs ranged from $4,283 for Case Four, which contained only 3.7 ha of regenerating forest to $97,045 for Case Three, which contained 128.5 ha of regenerating forest. The per hectare costs were slightly lower for Case Three and Case Five ($755/ha and $716/ha, respectively) than the other two case study properties. The reason for the higher per hectare possum control expenditure in Case One is that based upon the estimated age of the regenerating forest, the adopted investment horizon is 26 years, whereas it is only 15 years for the other three case study properties. Case Four has higher per hectare expenditure for possum control because there is 44.1 ha of other forest contained within the property, compared to only 3.7 ha of regenerating forest. As the cost of possum control for the other forest area is accounted for in the carbon additionality scenario on a prorated basis, the cost of possum control when brought back to a per hectare figure appears high. If Case One was restricted to the same investment horizon of 15 years, the cost would drop to $10,666 or $677/ha due to the low proportion of other forest contained within the property (2.1% of total property area), making it the cheapest possum control scenario.

In contrast, the cost of ungulate control varied between scenarios within a given case and between case study properties (refer Table 24).

*Table 24: Ungulate control costs for carbon additionality scenarios*

| | Ungulate Control Costs | | | |
|---|---|---|---|---|
| | **Case Two** | **Case Three** | **Case Four** | **Case Five** |
| Scenarios 1, 3, 4 & 6 | 31,304 | 94,714 | 977 | 9,176 |
| Cost per Ha | 1,989 | 737 | 267 | 308 |
| Scenarios 2 & 5 | 6,805 | 32,333 | 921 | 7,507 |
| Cost per Ha | 432 | 252 | 252 | 252 |

For Scenarios 1, 3, 4 and 6 ungulate control for the entire property was modelled (even though property boundary fencing was modelled for Scenarios 1 and 4, and no fencing whatsoever was modelled for Scenarios 3 and 6). In contrast, Scenarios 2 and 5 modelled ungulate control to only be undertaken in the perimeter fenced regenerating forest blocks. For all case study properties, pest control was found to be more expensive in both absolute terms and on a per ha basis when it was undertaken over the entire property than when it was only undertaken within the perimeter-fenced regenerating forest blocks. The differential in cost is comparatively low for Cases Four and Five, which is a function of these cases having small areas of regenerating forest but large areas of old growth forest. Of the native forest is Case Four, only 6.1% is regenerating forest, and in Case Five, this figure rises slightly to 9.8%. As the carbon additionality scenarios only account for the full cost of ungulate control within regenerating forest areas, and costs of ungulate control for the balance of the property in Scenarios 1, 3, 4 and 6 are prorated, the old growth forest biodiversity additionality scenarios are modelled to cover the vast majority of this cost. Case Two has an inverse proportion of regenerating forest (81.2% of native forest) the cost of ungulate control in Scenarios 1, 3, 4 and 6 is significantly higher on a per ha basis at $1,989/ha. However, when only the regenerating forest blocks are modelled to have pest control undertaken in Scenarios 2 and 5, this cost falls dramatically to $432/ha.

The results in Table 24, when considered alongside the results presented in Table 22, indicate that from a cost perspective, Scenarios 2 and 5 are more desirable than Scenarios 1, 3, 4 and 6 due to the lower costs associated with ungulate control. However, the cost implications must be more clearly understood. Scenarios 1 and 4 have both high fencing costs and ungulate control costs, which exceed those of Scenarios 2 and 5 for all case study properties apart from Case Study 3, which is due to the expensive cost associated with inaccessible land. In contrast, Scenarios 3 and 6, which model no fencing but pest control over the entire property, have high ungulate control costs but no cost associated with fencing.

*Table 25: Total costs for carbon additionality scenarios*

| | | Total Costs | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Case Two | | Case Three | | Case Four | | Case Five |
| Scenario 1 | - | 548,243 | - | 617,114 | - | 475,240 | - | 1,229,756 |
| Scenario 2 | - | 208,541 | - | 1,700,728 | - | 128,184 | - | 497,386 |
| Scenario 3 | - | 65,391 | - | 261,234 | - | 9,240 | - | 48,056 |
| Scenario 4 | - | 539,339 | - | 576,781 | - | 474,091 | - | 1,220,391 |
| Scenario 5 | - | 199,637 | - | 1,660,395 | - | 127,035 | - | 488,022 |
| Scenario 6 | - | 64,571 | - | 220,901 | - | 8,091 | - | 38,691 |

Table 25 shows the total costs for each scenario across the five case study properties. It can be seen that Scenarios 3 and 6 are the cheapest across all of the case study properties, with Scenarios 1 and 4 being the most expensive. Table 26 shows the total costs on a per ha basis. When looking at the expenditure on a per ha basis, this reinforces the hierarchy of least to most expensive scenario as shown by Table 25.

*Table 26: Total costs per ha for carbon additionality scenarios*

| | Total Costs/Ha | | | |
|---|---|---|---|---|
| | Case Two | Case Three | Case Four | Case Five |
| Scenario 1 | 8,062 | 20,134 | 8,422 | 4,460 |
| Scenario 2 | 3,067 | 55,489 | 2,272 | 1,804 |
| Scenario 3 | 962 | 8,523 | 164 | 174 |
| Scenario 4 | 7,931 | 18,818 | 8,401 | 4,426 |
| Scenario 5 | 2,936 | 54,173 | 2,251 | 1,770 |
| Scenario 6 | 950 | 7,207 | 143 | 140 |

### *ETS Registration and FMA Plotting Costs*

Scenarios 1, 2 and 3 were modelled to account for FMA plot measurement, and Scenarios 4, 5 and 6 were modelled on the basis that a specific lookup table for managed regenerating forests would exist. This difference in modelling proved to be of little relevance to the overall financial feasibility of the conservation scenarios. For Scenarios 1 and 2 the cost of FMA plots was responsible for only 0.2% to 6.5% of total costs across all case study properties.

### *Carbon Stock Additionality*

As outlined previously in this study, carbon additionality has been modelled to be 10.0% above baseline carbon stocks. Table 27 summarises the total additional carbon stocks for each case study property, the additional income, and the investment horizon.

*Table 27: Total carbon additionality modelled*

| | Total Carbon Additionality | | | |
|---|---|---|---|---|
| | Case Two | Case Three | Case Four | Case Five |
| t $CO_2$ | 11.9 | 3.7 | 3.7 | 3.7 |
| Additional Income | 12,427 | 30,172 | 860 | 7,005 |
| Investment Horizon | 26 | 15 | 15 | 15 |
| Income/Cost Ratio[1] | 2.3% | 4.9% | 0.2% | 0.6% |
| Income/Cost Ratio[6] | 19.2% | 13.7% | 10.6% | 18.1% |

The results show that there is very limited carbon additionality available under the assumptions made within this study. The level of additionality further reduces with a shorted investment horizon, which is driven by the age of the regenerating forest at the time of this study. When income derived from carbon additionality is expressed as a percentage of total costs for the most expensive scenario (Scenario 1), the income covers only 0.2% to 4.9% of the costs. When it is compared to the least expensive scenario (Scenario 6), the covers 10.6% to 19.2% of the costs.

### *Financial Feasibility of Carbon Additionality Scenarios*

All the previously discussed factors combine to determine the financial feasibility of the scenarios for each of the case study properties.

The NPV results of the analyses are summarised in Table 28 and Table 29, which show the total pre-tax NPV and NPV/ha, respectively.

*Table 28: Pre-tax NPV of carbon additionality scenarios*

| | Pre-Tax NPV | | | |
|---|---|---|---|---|
| | Case Two | Case Three | Case Four | Case Five |
| Scenario 1 | - 506,943 | - 501,930 | - 472,085 | - 1,207,870 |
| Scenario 2 | - 180,326 | - 1,607,407 | - 125,049 | - 476,085 |
| Scenario 3 | - 24,090 | - 146,050 | - 6,085 | - 26,170 |
| Scenario 4 | - 503,806 | - 482,355 | - 471,528 | - 1,203,325 |
| Scenario 5 | - 177,189 | - 1,587,833 | - 124,491 | - 471,540 |
| Scenario 6 | - 20,953 | - 126,475 | - 5,528 | - 21,625 |

*Table 29: Pre-tax NPV/ha of carbon additionality scenarios*

| | Pre-Tax NPV/Ha | | | |
|---|---|---|---|---|
| | Case Two | Case Three | Case Four | Case Five |
| Scenario 1 | - 32,207 | - 3,907 | - 128,985 | - 40,492 |
| Scenario 2 | - 11,457 | - 12,511 | - 34,166 | - 15,960 |
| Scenario 3 | - 1,531 | - 1,137 | - 1,663 | - 877 |
| Scenario 4 | - 32,008 | - 3,754 | - 128,833 | - 40,339 |
| Scenario 5 | - 11,257 | - 12,359 | - 34,014 | - 15,808 |
| Scenario 6 | - 1,331 | - 984 | - 1,510 | - 725 |

The results show that none of the carbon additionality scenarios return a positive NPV, which means that all of the scenarios should be rejected in financial metrics are the deciding factor. The NPV results show that scenarios in which fencing are not modelled (Scenarios 3 and 6) the NPV is the greatest, although still negative. In all case study properties apart from Case Study Three, Scenario 1 is the least profitable.

Given the relative uncertainty around several of the assumptions relied upon for this study, particularly the extent of carbon additionality attributable to possum and ungulate control, sensitivity analyses have been undertaken to analyse the effects of greater carbon additionality and a higher carbon credit price. An increase in the starting carbon credit price from $57.05 to $80.0 still resulted in negative NPV results for all scenarios across all case study properties. Without changing the starting carbon credit price, but adjusting the carbon additionality from 10.0% to 20.0%, positive NPVs resulted for Scenario 3 and 6 for all case study properties. If both the starting carbon credit price and carbon additionality percentage are adjusted, the results shown in Table 30 and Table 31 are returned.

*Table 30: Sensitivity analysis of pre-tax NPV of carbon additionality*

| | Pre-Tax NPV | | | |
|---|---|---|---|---|
| | Case Two | Case Three | Case Four | Case Five |
| Scenario 1 | - 470,130 | - 185,446 | - 463,070 | - 1,134,389 |
| Scenario 2 | - 143,514 | - 1,290,923 | - 116,033 | - 402,605 |
| Scenario 3 | 12,722 | 170,434 | 2,930 | 47,311 |
| Scenario 4 | - 466,993 | - 165,871 | - 462,512 | - 1,129,845 |
| Scenario 5 | - 140,377 | - 1,271,348 | - 115,476 | - 398,060 |
| Scenario 6 | 15,859 | 190,009 | 3,488 | 51,855 |

*Table 31: Sensitivity analysis of pre-tax NPV/ha of carbon additionality*

| | Pre-Tax NPV/Ha | | | |
|---|---|---|---|---|
| | Case Two | Case Three | Case Four | Case Five |
| Scenario 1 | - 29,869 | - 1,443 | - 126,522 | - 38,028 |
| Scenario 2 | - 9,118 | - 10,048 | - 31,703 | - 13,497 |
| Scenario 3 | 808 | 1,327 | 801 | 1,586 |
| Scenario 4 | - 29,669 | - 1,291 | - 126,369 | - 37,876 |
| Scenario 5 | - 8,918 | - 9,895 | - 31,551 | - 13,344 |
| Scenario 6 | 1,008 | 1,479 | 953 | 1,738 |

While the NPVs for Scenarios 3 and 6 become positive for all case study properties, none of the other scenarios do. This can be partly explained by Table 32, which shows the ratio of carbon additionality income to the expenditure incurred under the sensitivity analysis inputs. Despite the assumed carbon stock additionality percentage doubling, and the carbon credit price increasing by $23, the additional carbon income only accounts for between 2.3% and 11.2% for Scenario 1, which is the most expensive scenario for all case study properties, except Case Three.

*Table 32: Sensitivity analysis of total carbon additionality modelled*

| | Total Carbon Additionality | | | |
|---|---|---|---|---|
| | Case Two | Case Three | Case Four | Case Five |
| t $CO_2$ | 44.2 | 36.0 | 36.0 | 36.0 |
| Additional Income | 61,406 | 387,996 | 11,053 | 90,084 |
| Investment Horizon | 26 | 15 | 15 | 15 |
| Income/Cost Ratio[1] | 11.2% | 62.9% | 2.3% | 7.3% |
| Income/Cost Ratio[6] | 95.1% | 175.6% | 136.6% | 232.8% |

## Cost of Biodiversity Additionality of Old Growth Forests

All the case study properties had old growth forest within them, and therefore, had biodiversity additionality scenarios developed for them. Unlike for the carbon additionality scenarios, financial desirability/feasibility of the scenarios has not been modelled, as the value of a biodiversity credit is intended to cover the costs of the conservation works (Weaver, 2025). Therefore, the results in this section are centred around the cost per ha for each scenario in the case study properties. Furthermore, as the guiding principles for cost are the same for the biodiversity additionality scenarios as they are for the carbon additionality scenarios, there is limited further reporting of results and differences between costs incurred, unless there are notable outliers.

Table 33 and Table 34 show the total costs and total costs per ha of the biodiversity additionality scenarios.

*Table 33: Costs of biodiversity additionality scenarios*

| | Total Costs | | | | |
|---|---|---|---|---|---|
| | Case One | Case Two | Case Three | Case Four | Case Five |
| Scenario 7 | 791,488 | 1,020,510 | 565,219 | 734,204 | 2,415,809 |
| Scenario 8 | 188,473 | 900,042 | 1,224,227 | 1,002,083 | 2,082,189 |
| Scenario 9 | 315,873 | 537,657 | 209,339 | 268,204 | 1,234,109 |

*Table 34: Per ha costs of biodiversity additionality scenarios*

| | Total Costs/Ha | | | | |
|---|---|---|---|---|---|
| | **Case One** | **Case Two** | **Case Three** | **Case Four** | **Case Five** |
| Scenario 7 | 64,506 | 15,007 | 18,441 | 13,011 | 8,761 |
| Scenario 8 | 15,360 | 13,236 | 39,942 | 17,758 | 7,551 |
| Scenario 9 | 25,743 | 7,907 | 6,830 | 4,753 | 4,475 |

As with the carbon additionality scenarios, the scenario that modelled the fencing of the property boundary (Scenario 7) proved to be the most expensive for most of the case study properties and the least expensive was the scenario that modelled not fencing whatsoever (Scenario 9). For Case Three, Scenario 8 was more expensive than Scenario 7 as the perimeter of the property boundary was similar to the total perimeter of old growth forest blocks (10.2 km vs 10.5 km) but 100.0% of the old growth forest blocks were fenced at a rate of $100/m, as opposed to $35/m for the property boundary. Case Four had higher total costs for Scenario 8 than Scenario 7, which was on account of the perimeter of the old growth forest blocks being 3.2 km longer than the perimeter of the property boundary.

As the value of a biodiversity can change from year to year (Weaver, 2025), Table 35 has been compiled to summarise the minimum and maximum annual cost per hectare for each scenario in each of the case study properties.

*Table 35: Minimum, maximum and mean annual costs per ha  of biodiversity additionality scenarios*

| | Minimum, Maximum and Mean Annual Costs/Ha | | | | |
|---|---|---|---|---|---|
| | **Case One** | **Case Two** | **Case Three** | **Case Four** | **Case Five** |
| Scenario 7 | | | | | |
| Minimum | 323 | 88 | 66 | 46 | 48 |
| Maximum | 40,196 | 7,637 | 12,120 | 8,803 | 4,623 |
| Mean | 1,265 | 294 | 362 | 255 | 172 |
| Scenario 8 | | | | | |
| Minimum | 33 | 37 | 50 | 34 | 35 |
| Maximum | 12,404 | 9,657 | 34,801 | 14,392 | 4,335 |

| | Minimum, Maximum and Mean Annual Costs/Ha | | | | |
|---|---|---|---|---|---|
| | Case One | Case Two | Case Three | Case Four | Case Five |
| Scenario 9 | | | | | |
| Minimum | 323 | 88 | 66 | 46 | 48 |
| Maximum | 1,434 | 536 | 509 | 545 | 338 |
| Mean | 505 | 155 | 134 | 93 | 88 |

In all scenarios across all case study properties, the maximum cost is incurred in Year 0 when the large upfront costs of fencing, biodiversity baseline verification, and pest population surveys are outlaid. The largest maximum cost is incurred in Scenario 1 of Case One, which is due to there being 13.6 km of property boundary fence being attributed to only 12.3 ha of old growth forest. Year 1 is when the minimum cost is incurred as this excludes any costs associated with biodiversity plan verification and follow-up pest population surveys. It also applies the smallest amount of annual cost compounding of the investment horizon.

# Chapter Five: Findings and Discussion

## Property Heterogeneity

The results of property heterogeneity analyses highlight the difficulties and complexities associated with the management and restoration of remnant old growth and regenerating forest.

While in the refined study area there were only 258 privately owned properties, these properties will still bound publicly and privately owned properties that were within the study area, but not in the refined study area. Just because these properties were excluded from the refined study area, does not mean they aren't key stakeholders in the management of forest areas within the study area. Several of the modelled scenarios in this study involve deer fencing of property boundaries, and for all case studies, this involves shared boundaries with other property owners. Therefore, consideration will need to be given to the concerns of neighbours as to whether they want deer fencing on their boundary. An equally important consideration will likely be how the control of possums and ungulates is implemented. The scenarios modelled for the case studies vary between control specifically in native forest blocks, to control over the entire property, with and without deer fencing of the property boundary. If adjoining landowners object to the control of pests due to safety concerns around cullers operating near dwellings, or possum bait stations and traps posing a risk to domestic pets, this could significantly hamper conservation efforts.

Furthermore, the analysis of perimeter-to-area ratio and regularity of the property polygons highlights the difficulty in selecting appropriate properties to boundary fence to remove ungulates. The higher absolute inefficiency in larger polygons indicates that they accommodate more complex absolute boundary configurations as compared to smaller polygons. This is likely due to polygon boundaries following the natural contour of the land as opposed to the most direct path, as well as following other natural features such as rivers and lakes. Furthermore, as properties have been amalgamated and changed ownership over time, subdivision may have occurred, and new property boundaries are also altered by the addition of new parcels when neighbouring properties are purchased. While it would be intuitive to target fewer, larger properties for biodiversity conversation works, the scenarios where boundary fencing is proposed will come at an unequitable high cost due to the relative complexity of the property boundaries as compared to smaller properties. There may be also limited opportunity to improve biodiversity on land owned by Local Authorities or owned as Recreation or Conservation Reserves due to competing land uses. For example, schools, cemeteries, gravel reserves and public service facilities will likely be limited by their existing land use.

### Distribution of Land Cover

The results of this study corroborate those of Pressey and Tully (1994), who stated that remaining tracts of original native forest cover tend to be situated on land of lower productivity and economic viability. However, there were also found to be large tracts of non-forest areas within the lower productivity LUC classes. As the study area is predominantly comprised of LUC 6 to 8 land (refer Table 15) there is a significant amount of land contained within private properties (>5 ha) that could be afforested, either through new plantings of standalone regenerating forests, or through supplemental planting of already regenerating forests. Table 36 outlines the quantum of this area.

*Table 36: Potential for further afforestation*

| LCDB Class | 7 | 8 | Total Area (Ha) |
|---|---|---|---|
| High Producing Exotic Grassland | 6,179.5 | 952.6 | 7,132.2 |
| Low Producing Grassland | 302.2 | 32.8 | 335.0 |
| Regenerating Forest | 906.1 | 247.8 | 1,153.9 |
| **Total Area (Ha)** | **7,387.8** | **1,233.2** | **8,621.0** |

The LUC 7 to 8 land equates to a total of 19.9% of the study area, of which only 13.4% is currently classified as regenerating forest. Therefore, if landowners focused on native reforestation of the least productive land in the refined study area, the area of regenerating forest in the refined study area would increase by 7,467.2 ha, which equates to 17.2% of the total study area. When combing this additional area with existing old growth and regenerating forest, the total area of native forest would increase to 14,171.2 ha, or 32.7% of the study area. This increase in native forest would lift the study area above the landscape threshold (Andren, 1994), and slow the rate at which further landscape changes occur (Hanski, 1998). However, this reforestation will not address the issue of the productive land within the study area (LUC 1 to 4) only containing 2.7% of remnant native forest area. As more productive land tends to have higher biodiversity value (Scott et al., 2001), relying only on reforestation of the poorer productivity land is likely not a preferred scenario. Landscape-level reforestation of native forests on the least productive land within the study area would also likely partially address the fragmentation of currently existing remnant native forest blocks. Furthermore, it is likely that this strategy will result in greater additions to carbon stocks than managing existing native forests for pests (Carswell et al., 2015).

## Carbon Additionality Feasibility of Regenerating Forests

### *Fencing Costs*

Fencing emerges as the dominant cost driver across all carbon additionality scenarios, representing between 57.7% and 98.3% of total project expenses. This infrastructure cost creates fundamental barriers to the economic viability of regenerating forest biodiversity projects, as the substantial upfront capital requirements must be justified against modest carbon income streams extending over 15 to 26 year investment horizons. The dramatic variation in fencing costs per metre ($35 to $100 per metre) reflects site-specific accessibility challenges that can render otherwise suitable regenerating forest areas economically unviable. Case Three highlights this challenge, where several inaccessible regenerating forest blocks require $100/m fencing compared to $35/m for accessible property boundaries. This 186.0% cost premium for inaccessible areas fundamentally alters project economics, with regenerating forest block fencing costing $1,501,875 compared to property boundary fencing at $355,880, despite the property boundary being shorter (10.2 km vs 22.3 km). The relationship between perimeter length and total fencing costs reveals additional complexity beyond simple linear scaling. Case Five demonstrates this with a property boundary only 16.2% longer than Case Three but fencing costs over three times higher ($1,181,700 vs $355,880). This disproportionate cost increase reflects terrain challenges not captured in simple perimeter measurements, highlighting the importance of detailed site assessment in project planning.

The strategic choice between property boundary fencing versus regenerating forest block fencing creates important trade-offs in project design. While property boundary fencing typically covers larger perimeters and may be more expensive in total, it often provides better access for construction and maintenance while enabling property-wide pest management benefits. Conversely, regenerating forest block fencing targets specific conservation areas but frequently encounters accessibility challenges that drive up per-metre costs. This study suggests that neither approach achieves viability under current carbon market conditions.

### *Pest Control Costs*

Pest control represents the second-largest cost component in carbon additionality scenarios, but unlike fencing costs, these expenses scale more predictably with forest area and management approach. Possum control costs exhibit relatively consistent per-hectare rates ($677 to $1,170 per ha) across the case study properties, with variation primarily driven by investment horizon length and forest composition.

The investment horizon effect is particularly evident in the possum control cost analysis. Case Two's 26-year investment horizon results in higher total costs compared to the 15-year horizons of other properties, but when standardized to the same timeframe, reveals the most cost-effective possum control scenario at $677 per ha. This temporal variation highlights how forest age at project initiation significantly influences total project costs and economic viability.

Ungulate control costs demonstrate more complex patterns, with dramatic differences between property-wide management ($267 to $1,989 per ha) and forest block-specific management ($252 per ha). Case Two highlights the challenge with property-wide ungulate control costing $1,989 per ha compared to $432 per ha for block-specific control – a 4.6-fold increase reflecting the high proportion of old growth forest (81.2% of total native forest) that makes property-wide cost allocation less favourable for carbon scenarios.

The cost allocation methodology reveals important strategic considerations for integrated forest management. Properties with small regenerating forest areas relative to other forest types face challenges when property-wide pest management costs are attributed to carbon scenarios. Cases Four and Five, with regenerating forest comprising only 6.1% and 9.8% of native forest, respectively, achieve more favourable ungulate control costs when management is restricted to fenced regenerating forest blocks. This suggests that project economics may favour targeted approaches in properties with diverse forest compositions.

### *ETS Registration and FMA Plotting Costs*

This study reveals that carbon market compliance costs represent a relatively minor component of total project expenses, accounting for only 0.2% to 6.5% of total costs across scenarios. This finding suggests that regulatory streamlining efforts focused on reducing carbon market compliance costs would have minimal impact on overall biodiversity conservation viability, indicating that other cost reduction strategies should be prioritized. The comparison between FMA plot requirements (Scenarios 1, 2, and 3) and assumed lookup table approaches (Scenarios 4, 5, and 6) demonstrates that measurement protocol optimization offers limited economic benefits. The minimal cost differences between these approaches suggest that efforts to improve carbon project economics should focus on infrastructure and pest management costs rather than monitoring and verification protocols.

However, the low relative cost of carbon market compliance should not obscure its potential barrier effects for small-scale projects. While representing a small percentage of total costs, the absolute compliance costs may still create participation barriers for landowners with limited capital resources or small regenerating forest areas. The analysis suggests that policy frameworks supporting regenerating forest carbon projects should maintain current cost structures while focusing on addressing the fundamental infrastructure cost challenges.

### *Carbon Stock Additionality*

The conservative 10.0% carbon additionality assumption reflects significant uncertainty about the carbon sequestration benefits of pest management in regenerating forests. The resulting income-to-cost ratios – ranging from 0.2% to 4.9% for the most expensive scenarios and 10.6% to 19.2% for the least expensive – demonstrate the fundamental mismatch between carbon revenue potential and management costs under current market conditions.

The limited carbon additionality available under study assumptions partly reflects the relatively mature age of regenerating forests in the case studies, which constrains both the investment horizon length and total carbon accumulation potential. Younger regenerating forests might offer greater additionality potential but would require longer management commitments and higher cumulative costs, creating complex optimization challenges for landowners. The relationship between investment horizon and additionality highlights temporal trade-offs in regenerating forest projects. Case Two's 26-year investment horizon provides the highest total carbon income ($12,427) but also incurs the highest cumulative costs, while other properties with 15-year horizons face lower total costs but significantly reduced carbon income potential.

This temporal relationship suggests that project timing and forest age selection are critical factors in project development.

The sensitivity analysis provides crucial insights into the market conditions required for regenerating forest carbon project viability. The finding that doubled additionality (20.0%) combined with increased carbon prices ($80 per unit) only achieves positive NPVs for unfenced scenarios suggests that carbon prices would need to reach $150 to $200 per unit to make forest management economically viable. Such price levels are substantially above current market rates and historic highs.

### *Financial Feasibility of Carbon Additionality Scenarios*

The uniformly negative NPVs across all carbon additionality scenarios under base conditions demonstrate that the regenerating forest carbon additionality scenarios are not financially viable under current market conditions. The magnitude of negative returns – ranging from -$5,528 to -$1,607,407 – indicates that substantial changes in either cost structures or revenue mechanisms are required to achieve project viability. The scenario ranking consistency across properties (Scenarios 3 and 6 consistently achieving the best, though still negative, NPVs) suggests that management approach selection is more important than site-specific optimization for most properties. The superior performance of unfenced scenarios reflects the overwhelming impact of infrastructure costs on project economics, indicating that pest management approaches minimizing capital investment offer the best prospects for economic viability.

The sensitivity analysis reveals that even under favourable conditions – 20.0% carbon additionality and $80 per unit carbon pricing – only unfenced scenarios achieve positive NPVs. This finding reinforces the critical importance of infrastructure costs and suggests that regenerating forest carbon scenarios may be inherently constrained by the relationship between modest carbon accumulation potential and substantial management requirements. The per ha NPV analysis provides additional insights into project scaling relationships. The wide variation in per ha costs ($140 to $55,489 per ha across scenarios and properties) demonstrates that simple scaling assumptions may not apply to regenerating forest carbon projects. Site-specific factors such as accessibility and forest type proportions appear more important than forest area in determining project economics.

### Cost of Biodiversity Additionality of Old Growth Forests

The biodiversity additionality analysis provides a contrasting framework for forest conservation economics, where costs are designed to be covered by biodiversity credit values rather than requiring positive investment returns. This fundamental difference in economic structure transforms conservation from a profit-generation challenge to a cost-coverage requirement, potentially making forest protection more achievable through biodiversity markets than carbon markets.

The total costs for biodiversity scenarios ($188,473 to $2,415,809) establish the scale of biodiversity credit values required to sustain old growth forest conservation. These costs are comparable to the carbon scenario costs but operate under different economic assumptions that may prove more viable for forest conservation financing. The cost-coverage approach eliminates the need for positive investment returns while providing a framework for valuing conservation activities based on actual management costs.

### *Biodiversity Scenario Cost Patterns*

The cost hierarchy among biodiversity scenarios mirrors that observed in carbon scenarios, with property boundary fencing (Scenario 7) proving most expensive and unfenced approaches (Scenario 9) least expensive for most properties. However, the economic implications differ significantly, as biodiversity credit values can be adjusted annually to reflect actual conservation costs rather than requiring predetermined returns.

The per ha cost analysis ($4,475 to $64,506 per ha) reveals substantial variation in biodiversity credit requirements across properties and scenarios. Case One demonstrates the extreme end of this range, with Scenario 7 requiring $64,506/ha due to extensive property boundaries (13.6 km) protecting relatively small old growth forest areas (12.3 ha). This 1.1:1 ratio of fence length to protected area illustrates how property configuration can create prohibitive infrastructure requirements even under cost-coverage frameworks.

The exceptions to the typical cost hierarchy provide insights into the optimization challenges facing biodiversity conservation projects. Case Three's higher costs for Scenario 8 versus Scenario 7 reflect the accessibility challenges that drive per metre fencing costs from $35 per metre to $100 per metre. Similarly, Case Four's higher total costs for forest block fencing result from longer perimeters (3.2 km additional) that offset the benefits of targeting specific conservation areas.

### *Annual Cost Variability and Financing Implications*

The annual cost analysis reveals important patterns in biodiversity conservation financing requirements. The concentration of maximum costs in Year 0 ($1,434 to $40,196 per ha) indicates that biodiversity credit systems must accommodate substantial upfront payments or provide financing mechanisms for infrastructure development. This front-loading of costs creates cash flow challenges similar to those facing carbon projects but potentially more manageable under cost-coverage frameworks.

The minimum annual costs ($33 to $323 per ha) represent baseline payment levels required to maintain conservation management in the absence of major infrastructure investments. These minimum costs provide insights into the ongoing biodiversity credit values needed to sustain old growth forest protection over extended periods, suggesting that biodiversity markets must provide consistent annual payments rather than one-time conservation incentives. The mean annual costs ($88 to $1,265 per ha) establish benchmarks for biodiversity credit pricing that could sustain forest conservation across different property types and management approaches. The substantial variation in mean costs across properties reflects site-specific conservation challenges and suggests that biodiversity credit values may need to reflect local conditions rather than uniform national pricing. The extreme variation between minimum and maximum annual costs highlights the need for flexible biodiversity credit systems that can accommodate both regular maintenance activities and periodic infrastructure investments. The 2-to-121-fold differences between minimum and maximum costs across scenarios suggest that successful biodiversity markets may need to provide mechanisms for smoothing cost variations over time while maintaining adequate funding for conservation activities.

### *Biodiversity Credit Market Requirements*

The biodiversity cost analysis implies substantial market development requirements that extend beyond current conservation financing mechanisms. The annual cost variations suggest that biodiversity credit systems must accommodate both predictable ongoing costs and irregular infrastructure investments to maintain conservation effectiveness over multi-decade timeframes.

The property-specific variation in biodiversity costs indicates that credit values may need to reflect site-specific conservation challenges rather than uniform per ha payments. The 8-fold difference in mean costs between Case Five ($88 to $172 per ha) and Case One ($301 to $1,265 per ha) suggests that biodiversity markets may require more sophisticated pricing mechanisms than carbon markets to achieve efficient conservation outcomes. The integration of biodiversity conservation with existing land management activities creates additional complexity for credit value determination. The pest management costs allocated between old growth forest biodiversity scenarios and regenerating forest carbon scenarios highlight the need for clear cost attribution methodologies in integrated conservation approaches. This allocation challenge suggests that biodiversity credit frameworks must address the interaction between different conservation objectives on the same properties. The 50-year investment horizon assumed for biodiversity scenarios creates long-term financing requirements that differ from typical commercial investment timeframes. Biodiversity credit systems must provide stable demand and reliable payment mechanisms over extended periods to sustain conservation commitments, potentially requiring different institutional structures than those supporting shorter-term commercial activities.

## Chapter Six: Conclusions

This study reveals that carbon additionality from regenerating forest management faces fundamental economic challenges that biodiversity additionality frameworks may be better positioned to address through alternative economic structures. While carbon additionality scenarios consistently generate negative returns even under favourable market conditions, biodiversity additionality scenarios operate under cost-coverage assumptions that could provide more viable pathways for forest conservation.

The dominance of infrastructure costs in both carbon and biodiversity additionality scenarios indicates that establishing policy settings that reflect the actual impacts of pest control on additionality will be required to achieve cost-effective biodiversity conservation. The substantial variation in costs across properties and scenarios demonstrates the importance landscape-scale coordination to achieve economies of scale.

This study suggests that successful forest conservation will likely require integration of multiple conservation objectives, innovative management approaches, and supportive policy frameworks that address structural cost challenges while recognizing the multiple benefits of conservation efforts. The biodiversity additionality framework provides insights into alternative economic structures that could support conservation objectives that carbon markets alone cannot justify, suggesting pathways for more comprehensive and viable forest conservation strategies.

## Chapter Seven: Recommendations

The recommendations for future research centre strongly around addressing the lack of understanding of the effects of management practices on carbon and biodiversity additionality within old growth and regenerating forests.

Field studies measuring the actual carbon and biodiversity outcomes of different management strategies could provide more accurate benefit estimates for modelling. Site-specific studies across different forest types, management intensities, pest population densities, and landscape contexts could improve the precision of both carbon additionality and biodiversity outcome predictions.

Long-term economic analysis of integrated conservation approaches should examine market evolution scenarios for both carbon and biodiversity credits, including the potential for market integration or coordination that could improve overall conservation economics. Understanding how different market structures and pricing mechanisms affect integrated project viability would inform policy and market development strategies.

Research into biodiversity credit market development and pricing mechanisms could address critical uncertainties about the market conditions required to support the conservation costs identified in this analysis. Understanding how biodiversity credit values are determined and how they might evolve could inform integrated project development strategies.

Studies of landscape-scale conservation approaches and their economic implications could reveal opportunities for cost reduction and improved environmental outcomes not available through individual property management. Analysis of catchment group models could identify more viable pathways for biodiversity conservation.

# Chapter Eight: Limitations

This study has relied upon numerous assumptions to generate results. Although care has been taken to ensure the accuracy/reality of assumptions made, modelling exercises are inherently flawed.

Ultimately, the carbon additionality scenarios modelled within this research rely upon several assumptions. While it is likely that the largest benefits of pest control will be seen in young native forests (either afforested or regenerating) and shrubland, where there is a higher proportion of vegetation available in the browse tier (Holdaway et al., 2012), this cannot be conclusively stated with the current level of knowledge. Therefore, this research echoes the call of Kirschbaum et al. (2009) to obtain growth rates from new plantings of native forests over the first several decades to help build a picture of early sequestration rates.

This study has assumed that carbon sequestration in native forests ends at year 50, which is inconsistent with literature that indicates forests will continue to sequester carbon for hundreds of years (Carswell et al., 2009). However, with a lack of accurate data relating to carbon sequestration beyond age 50, the investment horizon was limited to 50 years of age for regenerating forests. If further research could incorporate carbon sequestration beyond this age, it is likely that the financial results will be more positive than those reported within this study.

Furthermore, the pest control scenarios all assumed high levels of possums and ungulates were present, and as such, carbon additionality was able to be claimed. However, if initial pest densities do not meet the threshold for which carbon additionality can be claimed post-control (which will be defined by the science and the voluntary carbon scheme), there is a possibility that the cost will be incurred with no income able to be received. Therefore, clear guidelines around recording initial pest populations and the establishment of a threshold above which carbon sequestration is measurably being impacted, will be required to provide landowners clarity around if their pest control efforts will be financially rewarded.

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# Appendices

## Appendix A: Case Study One Discounted Cash Flows

### Appendix A1: Scenarios Seven, Eight and Nine – Part 1

| Year | Total | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Property Area (Ha) | | 293.3 | 293.3 | 293.3 | 293.3 | 293.3 | 293.3 | 293.3 | 293.3 | 293.3 | 293.3 | 293.3 | 293.3 | 293.3 | 293.3 | 293.3 | 293.3 | 293.3 | 293.3 | 293.3 | 293.3 | 293.3 | 293.3 | 293.3 | 293.3 | 293.3 | 293.3 |
| Old Growth Forest (Ha) | | 12.3 | 12.3 | 12.3 | 12.3 | 12.3 | 12.3 | 12.3 | 12.3 | 12.3 | 12.3 | 12.3 | 12.3 | 12.3 | 12.3 | 12.3 | 12.3 | 12.3 | 12.3 | 12.3 | 12.3 | 12.3 | 12.3 | 12.3 | 12.3 | 12.3 | 12.3 |
| Regenerating Forest (Ha) | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Other Forest (Ha) | | 1.38 | 1.38 | 1.38 | 1.38 | 1.38 | 1.38 | 1.38 | 1.38 | 1.38 | 1.38 | 1.38 | 1.38 | 1.38 | 1.38 | 1.38 | 1.38 | 1.38 | 1.38 | 1.38 | 1.38 | 1.38 | 1.38 | 1.38 | 1.38 | 1.38 | 1.38 |

| **Scenario Seven - Biodiversity Additionality** | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Costs*** | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Fencing | 475,615 | 475,615 | | | | | | | | | | | | | | | | | | | | | | | | | |
| Possum Control | 28,116 | 2,850 | 256 | 260 | 263 | 267 | 721 | 275 | 280 | 284 | 288 | 776 | 297 | 301 | 306 | 310 | 837 | 320 | 324 | 329 | 334 | 901 | 344 | 350 | 355 | 360 | 971 |
| Ungulate Control | 287,756 | 14,744 | 3,705 | 3,761 | 3,817 | 3,874 | 3,933 | 3,992 | 4,051 | 4,112 | 4,174 | 4,237 | 4,300 | 4,365 | 4,430 | 4,496 | 4,564 | 4,632 | 4,702 | 4,772 | 4,844 | 4,917 | 4,990 | 5,065 | 5,141 | 5,218 | 5,297 |
| **Total Cost** | **791,488** | **493,209** | **3,961** | **4,020** | **4,081** | **4,142** | **4,653** | **4,267** | **4,331** | **4,396** | **4,462** | **5,013** | **4,597** | **4,666** | **4,736** | **4,807** | **5,400** | **4,952** | **5,026** | **5,102** | **5,178** | **5,818** | **5,335** | **5,415** | **5,496** | **5,578** | **6,267** |
| **Total Cost/Ha** | **64,506** | **40,196** | **323** | **328** | **333** | **338** | **379** | **348** | **353** | **358** | **364** | **409** | **375** | **380** | **386** | **392** | **440** | **404** | **410** | **416** | **422** | **474** | **435** | **441** | **448** | **455** | **511** |

| **Scenario Eight - Biodiversity Additionality** | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Costs*** | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Fencing | 148,750 | 148,750 | | | | | | | | | | | | | | | | | | | | | | | | | |
| Possum Control | 28,116 | 2,850 | 256 | 260 | 263 | 267 | 721 | 275 | 280 | 284 | 288 | 776 | 297 | 301 | 306 | 310 | 837 | 320 | 324 | 329 | 334 | 901 | 344 | 350 | 355 | 360 | 971 |
| Ungulate Control | 11,606 | 595 | 149 | 152 | 154 | 156 | 159 | 161 | 163 | 166 | 168 | 171 | 173 | 176 | 179 | 181 | 184 | 187 | 190 | 192 | 195 | 198 | 201 | 204 | 207 | 210 | 214 |
| **Total Cost** | **188,473** | **152,195** | **405** | **411** | **417** | **424** | **879** | **436** | **443** | **450** | **456** | **947** | **470** | **477** | **484** | **492** | **1,021** | **507** | **514** | **522** | **530** | **1,099** | **546** | **554** | **562** | **571** | **1,184** |
| **Total Cost/Ha** | **15,360** | **12,404** | **33** | **34** | **34** | **35** | **72** | **36** | **36** | **37** | **37** | **77** | **38** | **39** | **39** | **40** | **83** | **41** | **42** | **43** | **43** | **90** | **44** | **45** | **46** | **47** | **97** |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Net Revenue (Pre-Tax)** | **- 188,473** | **- 152,195** | **- 405** | **- 411** | **- 417** | **- 424** | **- 879** | **- 436** | **- 443** | **- 450** | **- 456** | **- 947** | **- 470** | **- 477** | **- 484** | **- 492** | **- 1,021** | **- 507** | **- 514** | **- 522** | **- 530** | **- 1,099** | **- 546** | **- 554** | **- 562** | **- 571** | **- 1,184** |

| **Scenario Nine - Biodiversity Additionality** | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Costs*** | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Fencing | - | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Possum Control | 28,116 | 2,850 | 256 | 260 | 263 | 267 | 721 | 275 | 280 | 284 | 288 | 776 | 297 | 301 | 306 | 310 | 837 | 320 | 324 | 329 | 334 | 901 | 344 | 350 | 355 | 360 | 971 |
| Ungulate Control | 287,756 | 14,744 | 3,705 | 3,761 | 3,817 | 3,874 | 3,933 | 3,992 | 4,051 | 4,112 | 4,174 | 4,237 | 4,300 | 4,365 | 4,430 | 4,496 | 4,564 | 4,632 | 4,702 | 4,772 | 4,844 | 4,917 | 4,990 | 5,065 | 5,141 | 5,218 | 5,297 |
| **Total Cost** | **315,873** | **17,594** | **3,961** | **4,020** | **4,081** | **4,142** | **4,653** | **4,267** | **4,331** | **4,396** | **4,462** | **5,013** | **4,597** | **4,666** | **4,736** | **4,807** | **5,400** | **4,952** | **5,026** | **5,102** | **5,178** | **5,818** | **5,335** | **5,415** | **5,496** | **5,578** | **6,267** |
| **Total Cost/Ha** | **25,743** | **1,434** | **323** | **328** | **333** | **338** | **379** | **348** | **353** | **358** | **364** | **409** | **375** | **380** | **386** | **392** | **440** | **404** | **410** | **416** | **422** | **474** | **435** | **441** | **448** | **455** | **511** |

## Appendix A2: Scenarios Seven, Eight and Nine – Part 2

| | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 371 | 377 | 382 | 388 | 1,046 | 400 | 406 | 412 | 418 | 1,127 | 431 | 437 | 444 | 450 | 1,214 | 464 | 471 | 478 | 485 | 1,308 | 500 | 507 | 515 | 522 | 1,409 |
| 5,376 | 5,457 | 5,539 | 5,622 | 5,706 | 5,792 | 5,878 | 5,967 | 6,056 | 6,147 | 6,239 | 6,333 | 6,428 | 6,524 | 6,622 | 6,721 | 6,822 | 6,925 | 7,028 | 7,134 | 7,241 | 7,349 | 7,460 | 7,572 | 7,685 |
| **5,747** | **5,833** | **5,921** | **6,010** | **6,752** | **6,191** | **6,284** | **6,378** | **6,474** | **7,274** | **6,670** | **6,770** | **6,871** | **6,974** | **7,836** | **7,185** | **7,293** | **7,402** | **7,513** | **8,441** | **7,740** | **7,857** | **7,974** | **8,094** | **9,094** |
| **468** | **475** | **483** | **490** | **550** | **505** | **512** | **520** | **528** | **593** | **544** | **552** | **560** | **568** | **639** | **586** | **594** | **603** | **612** | **688** | **631** | **640** | **650** | **660** | **741** |

| | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 371 | 377 | 382 | 388 | 1,046 | 400 | 406 | 412 | 418 | 1,127 | 431 | 437 | 444 | 450 | 1,214 | 464 | 471 | 478 | 485 | 1,308 | 500 | 507 | 515 | 522 | 1,409 |
| 217 | 220 | 223 | 227 | 230 | 234 | 237 | 241 | 244 | 248 | 252 | 255 | 259 | 263 | 267 | 271 | 275 | 279 | 283 | 288 | 292 | 296 | 301 | 305 | 310 |
| **588** | **597** | **606** | **615** | **1,276** | **633** | **643** | **652** | **662** | **1,375** | **682** | **692** | **703** | **713** | **1,481** | **735** | **746** | **757** | **768** | **1,595** | **792** | **804** | **816** | **828** | **1,719** |
| **48** | **49** | **49** | **50** | **104** | **52** | **52** | **53** | **54** | **112** | **56** | **56** | **57** | **58** | **121** | **60** | **61** | **62** | **63** | **130** | **65** | **65** | **66** | **67** | **140** |

| | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 371 | 377 | 382 | 388 | 1,046 | 400 | 406 | 412 | 418 | 1,127 | 431 | 437 | 444 | 450 | 1,214 | 464 | 471 | 478 | 485 | 1,308 | 500 | 507 | 515 | 522 | 1,409 |
| 5,376 | 5,457 | 5,539 | 5,622 | 5,706 | 5,792 | 5,878 | 5,967 | 6,056 | 6,147 | 6,239 | 6,333 | 6,428 | 6,524 | 6,622 | 6,721 | 6,822 | 6,925 | 7,028 | 7,134 | 7,241 | 7,349 | 7,460 | 7,572 | 7,685 |
| **5,747** | **5,833** | **5,921** | **6,010** | **6,752** | **6,191** | **6,284** | **6,378** | **6,474** | **7,274** | **6,670** | **6,770** | **6,871** | **6,974** | **7,836** | **7,185** | **7,293** | **7,402** | **7,513** | **8,441** | **7,740** | **7,857** | **7,974** | **8,094** | **9,094** |
| **468** | **475** | **483** | **490** | **550** | **505** | **512** | **520** | **528** | **593** | **544** | **552** | **560** | **568** | **639** | **586** | **594** | **603** | **612** | **688** | **631** | **640** | **650** | **660** | **741** |

# Appendix B: Case Study Two Discounted Cash Flows

## Appendix B1: Scenarios One, Two and Three

| Year | Total | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Property Area (Ha) | | 369.8 | 369.8 | 369.8 | 369.8 | 369.8 | 369.8 | 369.8 | 369.8 | 369.8 | 369.8 | 369.8 | 369.8 | 369.8 | 369.8 | 369.8 | 369.8 | 369.8 | 369.8 | 369.8 | 369.8 | 369.8 | 369.8 | 369.8 | 369.8 | 369.8 | 369.8 | 369.8 |
| Old Growth Forest (Ha) | | 68.0 | 68.0 | 68.0 | 68.0 | 68.0 | 68.0 | 68.0 | 68.0 | 68.0 | 68.0 | 68.0 | 68.0 | 68.0 | 68.0 | 68.0 | 68.0 | 68.0 | 68.0 | 68.0 | 68.0 | 68.0 | 68.0 | 68.0 | 68.0 | 68.0 | 68.0 | 68.0 |
| Regenerating Forest (Ha) | | 15.7 | 15.7 | 15.7 | 15.7 | 15.7 | 15.7 | 15.7 | 15.7 | 15.7 | 15.7 | 15.7 | 15.7 | 15.7 | 15.7 | 15.7 | 15.7 | 15.7 | 15.7 | 15.7 | 15.7 | 15.7 | 15.7 | 15.7 | 15.7 | 15.7 | 15.7 | 15.7 |
| Other Forest (Ha) | | 0.33 | 0.33 | 0.33 | 0.33 | 0.33 | 0.33 | 0.33 | 0.33 | 0.33 | 0.33 | 0.33 | 0.33 | 0.33 | 0.33 | 0.33 | 0.33 | 0.33 | 0.33 | 0.33 | 0.33 | 0.33 | 0.33 | 0.33 | 0.33 | 0.33 | 0.33 | 0.33 |

| Scenario One - Carbon Additionality | Total | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Costs*** | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Fencing | 482,853 | 482,853 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Possum Control | 17,053 | 3,299 | 329 | 334 | 339 | 344 | 928 | 355 | 360 | 365 | 371 | 1,000 | 382 | 388 | 394 | 400 | 1,077 | 412 | 418 | 424 | 430 | 1,161 | 443 | 450 | 457 | 464 | 1,250 | 478 |
| Ungulate Control | 31,304 | 3,510 | 882 | 895 | 909 | 922 | 936 | 950 | 964 | 979 | 994 | 1,008 | 1,024 | 1,039 | 1,055 | 1,070 | 1,086 | 1,103 | 1,119 | 1,136 | 1,153 | 1,170 | 1,188 | 1,206 | 1,224 | 1,242 | 1,261 | 1,280 |
| ETS Registration / Annual Fee | 8,129 | 2,087 | 192 | 195 | 198 | 200 | 203 | 207 | 210 | 213 | 216 | 219 | 222 | 226 | 229 | 233 | 236 | 240 | 243 | 247 | 251 | 254 | 258 | 262 | 266 | 270 | 274 | 278 |
| FMA Plots | 8,905 | | | | | | 1,526 | | | | | 1,644 | | | | | 1,771 | | | | | 1,908 | | | | | 2,055 | |
| **Total Cost** | **- 548,243** | **- 491,748** | **- 1,403** | **- 1,424** | **- 1,445** | **- 1,467** | **- 3,594** | **- 1,511** | **- 1,534** | **- 1,557** | **- 1,580** | **- 3,872** | **- 1,628** | **- 1,653** | **- 1,677** | **- 1,703** | **- 4,171** | **- 1,754** | **- 1,780** | **- 1,807** | **- 1,834** | **- 4,493** | **- 1,890** | **- 1,918** | **- 1,947** | **- 1,976** | **- 4,841** | **- 2,036** |
| **Total Cost/Ha** | **8,062** | **7,232** | **21** | **21** | **21** | **22** | **53** | **22** | **23** | **23** | **23** | **57** | **24** | **24** | **25** | **25** | **61** | **26** | **26** | **27** | **27** | **66** | **28** | **28** | **29** | **29** | **71** | **30** |
| ***Revenue*** | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Baseline CO2 Eq. (t/ha) | | 204.7 | 215.0 | 224.6 | 233.7 | 242.2 | 250.1 | 257.5 | 264.3 | 270.6 | 276.3 | 281.6 | 286.5 | 290.9 | 295 | 298.7 | 302 | 305.1 | 307.8 | 310.4 | 312.6 | 314.7 | 316.5 | 318.2 | 319.7 | 321.1 | 322.3 | 323.4 |
| Managed CO2 Eq. (t/ha) | | 225.2 | 236.5 | 247.1 | 257.1 | 266.4 | 275.1 | 283.3 | 290.7 | 297.7 | 303.9 | 309.8 | 315.2 | 320.0 | 324.5 | 328.6 | 332.2 | 335.6 | 338.6 | 341.4 | 343.9 | 346.2 | 348.2 | 350.0 | 351.7 | 353.2 | 354.5 | 355.7 |
| Additional Annual CO2 Seq. (t/ha) | 11.87 | | 1.0 | 1.0 | 0.9 | 0.9 | 0.8 | 0.7 | 0.7 | 0.6 | 0.6 | 0.5 | 0.5 | 0.4 | 0.4 | 0.4 | 0.3 | 0.3 | 0.3 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 |
| NZU Price | | | 58.77 | 59.66 | 60.55 | 61.46 | 62.38 | 63.32 | 64.27 | 65.23 | 66.21 | 67.20 | 68.21 | 69.23 | 70.27 | 71.33 | 72.40 | 73.48 | 74.58 | 75.70 | 76.84 | 77.99 | 79.16 | 80.35 | 81.55 | 82.78 | 84.02 | 85.28 |
| NZU Income | 12,427 | | 953 | 901 | 867 | 822 | 776 | 737 | 688 | 647 | 594 | 561 | 526 | 479 | 453 | 415 | 376 | 359 | 317 | 310 | 266 | 258 | 224 | 215 | 193 | 182 | 159 | 148 |
| **Total Income** | **12,427** | **-** | **953** | **901** | **867** | **822** | **776** | **737** | **688** | **647** | **594** | **561** | **526** | **479** | **453** | **415** | **376** | **359** | **317** | **310** | **266** | **258** | **224** | **215** | **193** | **182** | **159** | **148** |
| **Net Revenue (Pre-Tax)** | **- 535,817** | **- 491,748** | **- 450** | **- 523** | **- 578** | **- 645** | **- 2,818** | **- 774** | **- 846** | **- 910** | **- 986** | **- 3,311** | **- 1,102** | **- 1,173** | **- 1,224** | **- 1,287** | **- 3,795** | **- 1,395** | **- 1,463** | **- 1,497** | **- 1,568** | **- 4,235** | **- 1,665** | **- 1,703** | **- 1,754** | **- 1,794** | **- 4,682** | **- 1,888** |

| Scenario Two - Carbon Additionality | Total | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Costs*** | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Fencing | 167,650 | 167,650 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Possum Control | 17,053 | 3,299 | 329 | 334 | 339 | 344 | 928 | 355 | 360 | 365 | 371 | 1,000 | 382 | 388 | 394 | 400 | 1,077 | 412 | 418 | 424 | 430 | 1,161 | 443 | 450 | 457 | 464 | 1,250 | 478 |
| Ungulate Control | 6,805 | 763 | 192 | 195 | 198 | 200 | 203 | 207 | 210 | 213 | 216 | 219 | 222 | 226 | 229 | 233 | 236 | 240 | 243 | 247 | 251 | 254 | 258 | 262 | 266 | 270 | 274 | 278 |
| ETS Registration / Annual Fee | 8,129 | 2,087 | 192 | 195 | 198 | 200 | 203 | 207 | 210 | 213 | 216 | 219 | 222 | 226 | 229 | 233 | 236 | 240 | 243 | 247 | 251 | 254 | 258 | 262 | 266 | 270 | 274 | 278 |
| FMA Plots | 8,905 | | | | | | 1,526 | | | | | 1,644 | | | | | 1,771 | | | | | 1,908 | | | | | 2,055 | |
| **Total Cost** | **- 208,541** | **- 173,799** | **- 713** | **- 723** | **- 734** | **- 745** | **- 2,861** | **- 768** | **- 779** | **- 791** | **- 803** | **- 3,082** | **- 827** | **- 840** | **- 852** | **- 865** | **- 3,321** | **- 891** | **- 904** | **- 918** | **- 932** | **- 3,577** | **- 960** | **- 974** | **- 989** | **- 1,004** | **- 3,854** | **- 1,034** |
| **Total Cost/Ha** | **3,067** | **2,556** | **10** | **11** | **11** | **11** | **42** | **11** | **11** | **12** | **12** | **45** | **12** | **12** | **13** | **13** | **49** | **13** | **13** | **13** | **14** | **53** | **14** | **14** | **15** | **15** | **57** | **15** |
| ***Revenue*** | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Baseline CO2 Eq. (t/ha) | | 204.7 | 215 | 224.6 | 233.7 | 242.2 | 250.1 | 257.5 | 264.3 | 270.6 | 276.3 | 281.6 | 286.5 | 290.9 | 295 | 298.7 | 302 | 305.1 | 307.8 | 310.4 | 312.6 | 314.7 | 316.5 | 318.2 | 319.7 | 321.1 | 322.3 | 323.4 |
| Managed CO2 Eq. (t/ha) | | 225.2 | 236.5 | 247.06 | 257.07 | 266.42 | 275.11 | 283.25 | 290.73 | 297.66 | 303.93 | 309.76 | 315.15 | 319.99 | 324.5 | 328.57 | 332.2 | 335.61 | 338.58 | 341.44 | 343.86 | 346.17 | 348.15 | 350.02 | 351.67 | 353.21 | 354.53 | 355.74 |
| Additional Annual CO2 Seq. (t/ha) | | | 1.0 | 1.0 | 0.9 | 0.9 | 0.8 | 0.7 | 0.7 | 0.6 | 0.6 | 0.5 | 0.5 | 0.4 | 0.4 | 0.4 | 0.3 | 0.3 | 0.3 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 |
| NZU Price | | | 58.77 | 59.66 | 60.55 | 61.46 | 62.38 | 63.32 | 64.27 | 65.23 | 66.21 | 67.20 | 68.21 | 69.23 | 70.27 | 71.33 | 72.40 | 73.48 | 74.58 | 75.70 | 76.84 | 77.99 | 79.16 | 80.35 | 81.55 | 82.78 | 84.02 | 85.28 |
| NZU Income | 12,427 | | 953 | 901 | 867 | 822 | 776 | 737 | 688 | 647 | 594 | 561 | 526 | 479 | 453 | 415 | 376 | 359 | 317 | 310 | 266 | 258 | 224 | 215 | 193 | 182 | 159 | 148 |
| **Total Income** | **12,427** | **-** | **953** | **901** | **867** | **822** | **776** | **737** | **688** | **647** | **594** | **561** | **526** | **479** | **453** | **415** | **376** | **359** | **317** | **310** | **266** | **258** | **224** | **215** | **193** | **182** | **159** | **148** |
| **Net Revenue (Pre-Tax)** | **- 196,115** | **- 173,799** | **240** | **178** | **133** | **77** | **- 2,086** | **- 30** | **- 91** | **- 144** | **- 209** | **- 2,522** | **- 301** | **- 360** | **- 399** | **- 450** | **- 2,945** | **- 533** | **- 587** | **- 608** | **- 666** | **- 3,320** | **- 736** | **- 759** | **- 796** | **- 821** | **- 3,695** | **- 886** |

| Scenario Three - Carbon Additionality | Total | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Costs*** | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Fencing | - | - | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Possum Control | 17,053 | 3,299 | 329 | 334 | 339 | 344 | 928 | 355 | 360 | 365 | 371 | 1,000 | 382 | 388 | 394 | 400 | 1,077 | 412 | 418 | 424 | 430 | 1,161 | 443 | 450 | 457 | 464 | 1,250 | 478 |
| Ungulate Control | 31,304 | 3,510 | 882 | 895 | 909 | 922 | 936 | 950 | 964 | 979 | 994 | 1,008 | 1,024 | 1,039 | 1,055 | 1,070 | 1,086 | 1,103 | 1,119 | 1,136 | 1,153 | 1,170 | 1,188 | 1,206 | 1,224 | 1,242 | 1,261 | 1,280 |
| ETS Registration / Annual Fee | 8,129 | 2,087 | 192 | 195 | 198 | 200 | 203 | 207 | 210 | 213 | 216 | 219 | 222 | 226 | 229 | 233 | 236 | 240 | 243 | 247 | 251 | 254 | 258 | 262 | 266 | 270 | 274 | 278 |
| FMA Plots | 8,905 | | | | | | 1,526 | | | | | 1,644 | | | | | 1,771 | | | | | 1,908 | | | | | 2,055 | |
| **Total Cost** | **- 65,391** | **- 8,896** | **- 1,403** | **- 1,424** | **- 1,445** | **- 1,467** | **- 3,594** | **- 1,511** | **- 1,534** | **- 1,557** | **- 1,580** | **- 3,872** | **- 1,628** | **- 1,653** | **- 1,677** | **- 1,703** | **- 4,171** | **- 1,754** | **- 1,780** | **- 1,807** | **- 1,834** | **- 4,493** | **- 1,890** | **- 1,918** | **- 1,947** | **- 1,976** | **- 4,841** | **- 2,036** |
| **Total Cost/Ha** | **962** | **131** | **21** | **21** | **21** | **22** | **53** | **22** | **23** | **23** | **23** | **57** | **24** | **24** | **25** | **25** | **61** | **26** | **26** | **27** | **27** | **66** | **28** | **28** | **29** | **29** | **71** | **30** |
| ***Revenue*** | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Baseline CO2 Eq. (t/ha) | | 204.7 | 215 | 224.6 | 233.7 | 242.2 | 250.1 | 257.5 | 264.3 | 270.6 | 276.3 | 281.6 | 286.5 | 290.9 | 295 | 298.7 | 302 | 305.1 | 307.8 | 310.4 | 312.6 | 314.7 | 316.5 | 318.2 | 319.7 | 321.1 | 322.3 | 323.4 |
| Managed CO2 Eq. (t/ha) | | 225.2 | 236.5 | 247.06 | 257.07 | 266.42 | 275.11 | 283.25 | 290.73 | 297.66 | 303.93 | 309.76 | 315.15 | 319.99 | 324.5 | 328.57 | 332.2 | 335.61 | 338.58 | 341.44 | 343.86 | 346.17 | 348.15 | 350.02 | 351.67 | 353.21 | 354.53 | 355.74 |
| Additional Annual CO2 Seq. (t/ha) | | | 1.0 | 1.0 | 0.9 | 0.9 | 0.8 | 0.7 | 0.7 | 0.6 | 0.6 | 0.5 | 0.5 | 0.4 | 0.4 | 0.4 | 0.3 | 0.3 | 0.3 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 |
| NZU Price | | | 58.77 | 59.66 | 60.55 | 61.46 | 62.38 | 63.32 | 64.27 | 65.23 | 66.21 | 67.20 | 68.21 | 69.23 | 70.27 | 71.33 | 72.40 | 73.48 | 74.58 | 75.70 | 76.84 | 77.99 | 79.16 | 80.35 | 81.55 | 82.78 | 84.02 | 85.28 |
| NZU Income | 12,427 | | 953 | 901 | 867 | 822 | 776 | 737 | 688 | 647 | 594 | 561 | 526 | 479 | 453 | 415 | 376 | 359 | 317 | 310 | 266 | 258 | 224 | 215 | 193 | 182 | 159 | 148 |
| **Total Income** | **12,427** | **-** | **953** | **901** | **867** | **822** | **776** | **737** | **688** | **647** | **594** | **561** | **526** | **479** | **453** | **415** | **376** | **359** | **317** | **310** | **266** | **258** | **224** | **215** | **193** | **182** | **159** | **148** |
| **Net Revenue (Pre-Tax)** | **- 52,964** | **- 8,896** | **- 450** | **- 523** | **- 578** | **- 645** | **- 2,818** | **- 774** | **- 846** | **- 910** | **- 986** | **- 3,311** | **- 1,102** | **- 1,173** | **- 1,224** | **- 1,287** | **- 3,795** | **- 1,395** | **- 1,463** | **- 1,497** | **- 1,568** | **- 4,235** | **- 1,665** | **- 1,703** | **- 1,754** | **- 1,794** | **- 4,682** | **- 1,888** |

## Appendix B2: Scenarios Four, Five and Six

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Scenario Four - Carbon Additionality** | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ***Costs*** | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Fencing | 482,853 | 482,853 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Possum Control | 17,053 | 3,299 | 329 | 334 | 339 | 344 | 928 | 355 | 360 | 365 | 371 | 1,000 | 382 | 388 | 394 | 400 | 1,077 | 412 | 418 | 424 | 430 | 1,161 | 443 | 450 | 457 | 464 | 1,250 | 478 |
| Ungulate Control | 31,304 | 3,510 | 882 | 895 | 909 | 922 | 936 | 950 | 964 | 979 | 994 | 1,008 | 1,024 | 1,039 | 1,055 | 1,070 | 1,086 | 1,103 | 1,119 | 1,136 | 1,153 | 1,170 | 1,188 | 1,206 | 1,224 | 1,242 | 1,261 | 1,280 |
| ETS Registration / Annual Fee | 8,129 | 2,087 | 192 | 195 | 198 | 200 | 203 | 207 | 210 | 213 | 216 | 219 | 222 | 226 | 229 | 233 | 236 | 240 | 243 | 247 | 251 | 254 | 258 | 262 | 266 | 270 | 274 | 278 |
| FMA Plots | - | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Total Cost** | **-539,339** | **-491,748** | **-1,403** | **-1,424** | **-1,445** | **-1,467** | **-2,068** | **-1,511** | **-1,534** | **-1,557** | **-1,580** | **-2,228** | **-1,628** | **-1,653** | **-1,677** | **-1,703** | **-2,400** | **-1,754** | **-1,780** | **-1,807** | **-1,834** | **-2,585** | **-1,890** | **-1,918** | **-1,947** | **-1,976** | **-2,785** | **-2,036** |
| **Total Cost/Ha** | **7,931** | **7,232** | **21** | **21** | **21** | **22** | **30** | **22** | **23** | **23** | **23** | **33** | **24** | **24** | **25** | **25** | **35** | **26** | **26** | **27** | **27** | **38** | **28** | **28** | **29** | **29** | **41** | **30** |
| ***Revenue*** | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Baseline CO2 Eq. (t/ha) | | 204.7 | 215 | 224.6 | 233.7 | 242.2 | 250.1 | 257.5 | 264.3 | 270.6 | 276.3 | 281.6 | 286.5 | 290.9 | 295 | 298.7 | 302 | 305.1 | 307.8 | 310.4 | 312.6 | 314.7 | 316.5 | 318.2 | 319.7 | 321.1 | 322.3 | 323.4 |
| Managed CO2 Eq. (t/ha) | | 225.2 | 236.5 | 247.06 | 257.07 | 266.42 | 275.11 | 283.25 | 290.73 | 297.66 | 303.93 | 309.76 | 315.15 | 319.99 | 324.5 | 328.57 | 332.2 | 335.61 | 338.58 | 341.44 | 343.86 | 346.17 | 348.15 | 350.02 | 351.67 | 353.21 | 354.53 | 355.74 |
| Additional Annual CO2 Seq. (t/ha) | | | 1.0 | 1.0 | 0.9 | 0.9 | 0.8 | 0.7 | 0.7 | 0.6 | 0.6 | 0.5 | 0.5 | 0.4 | 0.4 | 0.4 | 0.3 | 0.3 | 0.3 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 |
| NZU Price | | | 58.77 | 59.66 | 60.55 | 61.46 | 62.38 | 63.32 | 64.27 | 65.23 | 66.21 | 67.20 | 68.21 | 69.23 | 70.27 | 71.33 | 72.40 | 73.48 | 74.58 | 75.70 | 76.84 | 77.99 | 79.16 | 80.35 | 81.55 | 82.78 | 84.02 | 85.28 |
| NZU Income | 12,427 | | 953 | 901 | 867 | 822 | 776 | 737 | 688 | 647 | 594 | 561 | 526 | 479 | 453 | 415 | 376 | 359 | 317 | 310 | 266 | 258 | 224 | 215 | 193 | 182 | 159 | 148 |
| **Total Income** | **12,427** | **-** | **953** | **901** | **867** | **822** | **776** | **737** | **688** | **647** | **594** | **561** | **526** | **479** | **453** | **415** | **376** | **359** | **317** | **310** | **266** | **258** | **224** | **215** | **193** | **182** | **159** | **148** |
| **Net Revenue (Pre-Tax)** | **-526,912** | **-491,748** | **-450** | **-523** | **-578** | **-645** | **-1,292** | **-774** | **-846** | **-910** | **-986** | **-1,667** | **-1,102** | **-1,173** | **-1,224** | **-1,287** | **-2,024** | **-1,395** | **-1,463** | **-1,497** | **-1,568** | **-2,328** | **-1,665** | **-1,703** | **-1,754** | **-1,794** | **-2,626** | **-1,888** |

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Scenario Five - Carbon Additionality** | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ***Costs*** | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Fencing | 167,650 | 167,650 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Possum Control | 17,053 | 3,299 | 329 | 334 | 339 | 344 | 928 | 355 | 360 | 365 | 371 | 1,000 | 382 | 388 | 394 | 400 | 1,077 | 412 | 418 | 424 | 430 | 1,161 | 443 | 450 | 457 | 464 | 1,250 | 478 |
| Ungulate Control | 6,805 | 763 | 192 | 195 | 198 | 200 | 203 | 207 | 210 | 213 | 216 | 219 | 222 | 226 | 229 | 233 | 236 | 240 | 243 | 247 | 251 | 254 | 258 | 262 | 266 | 270 | 274 | 278 |
| ETS Registration / Annual Fee | 8,129 | 2,087 | 192 | 195 | 198 | 200 | 203 | 207 | 210 | 213 | 216 | 219 | 222 | 226 | 229 | 233 | 236 | 240 | 243 | 247 | 251 | 254 | 258 | 262 | 266 | 270 | 274 | 278 |
| FMA Plots | - | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Total Cost** | **-199,637** | **-173,799** | **-713** | **-723** | **-734** | **-745** | **-1,335** | **-768** | **-779** | **-791** | **-803** | **-1,438** | **-827** | **-840** | **-852** | **-865** | **-1,550** | **-891** | **-904** | **-918** | **-932** | **-1,669** | **-960** | **-974** | **-989** | **-1,004** | **-1,798** | **-1,034** |
| **Total Cost/Ha** | **2,936** | **2,556** | **10** | **11** | **11** | **11** | **20** | **11** | **11** | **12** | **12** | **21** | **12** | **12** | **13** | **13** | **23** | **13** | **13** | **13** | **14** | **25** | **14** | **14** | **15** | **15** | **26** | **15** |
| ***Revenue*** | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Baseline CO2 Eq. (t/ha) | | 204.7 | 215 | 224.6 | 233.7 | 242.2 | 250.1 | 257.5 | 264.3 | 270.6 | 276.3 | 281.6 | 286.5 | 290.9 | 295 | 298.7 | 302 | 305.1 | 307.8 | 310.4 | 312.6 | 314.7 | 316.5 | 318.2 | 319.7 | 321.1 | 322.3 | 323.4 |
| Managed CO2 Eq. (t/ha) | | 225.2 | 236.5 | 247.06 | 257.07 | 266.42 | 275.11 | 283.25 | 290.73 | 297.66 | 303.93 | 309.76 | 315.15 | 319.99 | 324.5 | 328.57 | 332.2 | 335.61 | 338.58 | 341.44 | 343.86 | 346.17 | 348.15 | 350.02 | 351.67 | 353.21 | 354.53 | 355.74 |
| Additional Annual CO2 Seq. (t/ha) | | | 1.0 | 1.0 | 0.9 | 0.9 | 0.8 | 0.7 | 0.7 | 0.6 | 0.6 | 0.5 | 0.5 | 0.4 | 0.4 | 0.4 | 0.3 | 0.3 | 0.3 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 |
| NZU Price | | | 58.77 | 59.66 | 60.55 | 61.46 | 62.38 | 63.32 | 64.27 | 65.23 | 66.21 | 67.20 | 68.21 | 69.23 | 70.27 | 71.33 | 72.40 | 73.48 | 74.58 | 75.70 | 76.84 | 77.99 | 79.16 | 80.35 | 81.55 | 82.78 | 84.02 | 85.28 |
| NZU Income | 12,427 | | 953 | 901 | 867 | 822 | 776 | 737 | 688 | 647 | 594 | 561 | 526 | 479 | 453 | 415 | 376 | 359 | 317 | 310 | 266 | 258 | 224 | 215 | 193 | 182 | 159 | 148 |
| **Total Income** | **12,427** | **-** | **953** | **901** | **867** | **822** | **776** | **737** | **688** | **647** | **594** | **561** | **526** | **479** | **453** | **415** | **376** | **359** | **317** | **310** | **266** | **258** | **224** | **215** | **193** | **182** | **159** | **148** |
| **Net Revenue (Pre-Tax)** | **-187,210** | **-173,799** | **240** | **178** | **133** | **77** | **-560** | **-30** | **-91** | **-144** | **-209** | **-878** | **-301** | **-360** | **-399** | **-450** | **-1,174** | **-533** | **-587** | **-608** | **-666** | **-1,412** | **-736** | **-759** | **-796** | **-821** | **-1,640** | **-886** |

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Scenario Six - Carbon Additionality** | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ***Costs*** | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Fencing | - | - | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Possum Control | 17,053 | 3,299 | 329 | 334 | 339 | 344 | 928 | 355 | 360 | 365 | 371 | 1,000 | 382 | 388 | 394 | 400 | 1,077 | 412 | 418 | 424 | 430 | 1,161 | 443 | 450 | 457 | 464 | 1,250 | 478 |
| Ungulate Control | 39,388 | 3,510 | 882 | 895 | 909 | 922 | 936 | 950 | 964 | 979 | 994 | 1,008 | 1,024 | 1,039 | 1,055 | 1,070 | 1,086 | 1,103 | 1,119 | 1,136 | 1,153 | 1,170 | 1,188 | 1,206 | 1,224 | 1,242 | 1,261 | 1,280 |
| ETS Registration / Annual Fee | 8,129 | 2,087 | 192 | 195 | 198 | 200 | 203 | 207 | 210 | 213 | 216 | 219 | 222 | 226 | 229 | 233 | 236 | 240 | 243 | 247 | 251 | 254 | 258 | 262 | 266 | 270 | 274 | 278 |
| FMA Plots | - | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Total Cost** | **-64,571** | **-8,896** | **-1,403** | **-1,424** | **-1,445** | **-1,467** | **-2,068** | **-1,511** | **-1,534** | **-1,557** | **-1,580** | **-2,228** | **-1,628** | **-1,653** | **-1,677** | **-1,703** | **-2,400** | **-1,754** | **-1,780** | **-1,807** | **-1,834** | **-2,585** | **-1,890** | **-1,918** | **-1,947** | **-1,976** | **-2,785** | **-2,036** |
| **Total Cost/Ha** | **950** | **131** | **21** | **21** | **21** | **22** | **30** | **22** | **23** | **23** | **23** | **33** | **24** | **24** | **25** | **25** | **35** | **26** | **26** | **27** | **27** | **38** | **28** | **28** | **29** | **29** | **41** | **30** |
| ***Revenue*** | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Baseline CO2 Eq. (t/ha) | | 204.7 | 215 | 224.6 | 233.7 | 242.2 | 250.1 | 257.5 | 264.3 | 270.6 | 276.3 | 281.6 | 286.5 | 290.9 | 295 | 298.7 | 302 | 305.1 | 307.8 | 310.4 | 312.6 | 314.7 | 316.5 | 318.2 | 319.7 | 321.1 | 322.3 | 323.4 |
| Managed CO2 Eq. (t/ha) | | 225.2 | 236.5 | 247.06 | 257.07 | 266.42 | 275.11 | 283.25 | 290.73 | 297.66 | 303.93 | 309.76 | 315.15 | 319.99 | 324.5 | 328.57 | 332.2 | 335.61 | 338.58 | 341.44 | 343.86 | 346.17 | 348.15 | 350.02 | 351.67 | 353.21 | 354.53 | 355.74 |
| Additional Annual CO2 Seq. (t/ha) | | | 1.0 | 1.0 | 0.9 | 0.9 | 0.8 | 0.7 | 0.7 | 0.6 | 0.6 | 0.5 | 0.5 | 0.4 | 0.4 | 0.4 | 0.3 | 0.3 | 0.3 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 |
| NZU Price | | | 58.77 | 59.66 | 60.55 | 61.46 | 62.38 | 63.32 | 64.27 | 65.23 | 66.21 | 67.20 | 68.21 | 69.23 | 70.27 | 71.33 | 72.40 | 73.48 | 74.58 | 75.70 | 76.84 | 77.99 | 79.16 | 80.35 | 81.55 | 82.78 | 84.02 | 85.28 |
| NZU Income | 12,427 | | 953 | 901 | 867 | 822 | 776 | 737 | 688 | 647 | 594 | 561 | 526 | 479 | 453 | 415 | 376 | 359 | 317 | 310 | 266 | 258 | 224 | 215 | 193 | 182 | 159 | 148 |
| **Total Income** | **12,427** | **-** | **953** | **901** | **867** | **822** | **776** | **737** | **688** | **647** | **594** | **561** | **526** | **479** | **453** | **415** | **376** | **359** | **317** | **310** | **266** | **258** | **224** | **215** | **193** | **182** | **159** | **148** |
| **Net Revenue (Pre-Tax)** | **-52,144** | **-8,896** | **-450** | **-523** | **-578** | **-645** | **-1,292** | **-774** | **-846** | **-910** | **-986** | **-1,667** | **-1,102** | **-1,173** | **-1,224** | **-1,287** | **-2,024** | **-1,395** | **-1,463** | **-1,497** | **-1,568** | **-2,328** | **-1,665** | **-1,703** | **-1,754** | **-1,794** | **-2,626** | **-1,888** |

## Appendix B3: Scenarios Seven, Eight and Nine

| Scenario Seven - Biodiversity Additionality | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Costs*** | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Fencing | 482,853 | 482,853 | | | | | | | | | | | | | | | | | | | | | | | | | |
| Possum Control | 180,599 | 14,253 | 1,683 | 1,709 | 1,734 | 1,760 | 4,745 | 1,813 | 1,841 | 1,868 | 1,896 | 5,112 | 1,954 | 1,983 | 2,013 | 2,043 | 5,507 | 2,105 | 2,136 | 2,168 | 2,201 | 5,933 | 2,267 | 2,301 | 2,336 | 2,371 | 6,391 |
| Ungulate Control | 336,058 | 17,219 | 4,327 | 4,392 | 4,458 | 4,525 | 4,593 | 4,662 | 4,732 | 4,803 | 4,875 | 4,948 | 5,022 | 5,097 | 5,174 | 5,251 | 5,330 | 5,410 | 5,491 | 5,573 | 5,657 | 5,742 | 5,828 | 5,916 | 6,004 | 6,094 | 6,186 |
| Biodiversity Plan Development/Auditing | 21,000 | 5,000 | | | | | 2,000 | | | | | 2,000 | | | | | 2,000 | | | | | | | | 2,000 | | |
| **Total Cost** | **1,020,510** | **519,324** | **6,011** | **6,101** | **6,192** | **6,285** | **11,338** | **6,475** | **6,572** | **6,671** | **6,771** | **12,060** | **6,975** | **7,080** | **7,186** | **7,294** | **12,837** | **7,515** | **7,627** | **7,742** | **7,858** | **11,675** | **8,095** | **8,217** | **10,340** | **8,465** | **12,577** |
| **Total Cost/Ha** | **15,007** | **7,637** | **88** | **90** | **91** | **92** | **167** | **95** | **97** | **98** | **100** | **177** | **103** | **104** | **106** | **107** | **189** | **111** | **112** | **114** | **116** | **172** | **119** | **121** | **152** | **124** | **185** |

| | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Possum Control | 2,442 | 2,479 | 2,516 | 2,554 | 6,885 | 2,631 | 2,671 | 2,711 | 2,751 | 7,418 | 2,835 | 2,877 | 2,920 | 2,964 | 7,991 | 3,054 | 3,099 | 3,146 | 3,193 | 8,608 | 3,290 | 3,339 | 3,389 | 3,440 | 9,274 |
| Ungulate Control | 6,279 | 6,373 | 6,468 | 6,565 | 6,664 | 6,764 | 6,865 | 6,968 | 7,073 | 7,179 | 7,286 | 7,396 | 7,507 | 7,619 | 7,734 | 7,850 | 7,967 | 8,087 | 8,208 | 8,331 | 8,456 | 8,583 | 8,712 | 8,843 | 8,975 |
| Biodiversity Plan Development/Auditing | | | 2,000 | | | | | 2,000 | | | | | | | | 2,000 | | | | | 2,000 | | | | |
| **Total Cost** | **8,721** | **8,852** | **10,985** | **9,119** | **13,549** | **9,395** | **9,536** | **11,679** | **9,824** | **14,596** | **10,121** | **10,273** | **10,427** | **10,583** | **15,724** | **12,903** | **11,067** | **11,233** | **11,401** | **16,940** | **13,746** | **11,922** | **12,101** | **12,282** | **18,249** |
| **Total Cost/Ha** | **128** | **130** | **162** | **134** | **199** | **138** | **140** | **172** | **144** | **215** | **149** | **151** | **153** | **156** | **231** | **190** | **163** | **165** | **168** | **249** | **202** | **175** | **178** | **181** | **268** |

| Scenario Eight - Biodiversity Additionality | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Costs*** | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Fencing | 634,120 | 634,120 | | | | | | | | | | | | | | | | | | | | | | | | | |
| Possum Control | 180,599 | 14,253 | 1,683 | 1,709 | 1,734 | 1,760 | 4,745 | 1,813 | 1,841 | 1,868 | 1,896 | 5,112 | 1,954 | 1,983 | 2,013 | 2,043 | 5,507 | 2,105 | 2,136 | 2,168 | 2,201 | 5,933 | 2,267 | 2,301 | 2,336 | 2,371 | 6,391 |
| Ungulate Control | 64,323 | 3,296 | 828 | 841 | 853 | 866 | 879 | 892 | 906 | 919 | 933 | 947 | 961 | 976 | 990 | 1,005 | 1,020 | 1,035 | 1,051 | 1,067 | 1,083 | 1,099 | 1,116 | 1,132 | 1,149 | 1,166 | 1,184 |
| Biodiversity Plan Development/Auditing | 21,000 | 5,000 | | | | | 2,000 | | | | | 2,000 | | | | | 2,000 | | | | | | | | 2,000 | | |
| **Total Cost** | **900,042** | **656,669** | **2,512** | **2,549** | **2,587** | **2,626** | **7,625** | **2,706** | **2,746** | **2,787** | **2,829** | **8,059** | **2,915** | **2,958** | **3,003** | **3,048** | **8,527** | **3,140** | **3,187** | **3,235** | **3,283** | **7,032** | **3,383** | **3,433** | **5,485** | **3,537** | **7,575** |
| **Total Cost/Ha** | **13,236** | **9,657** | **37** | **37** | **38** | **39** | **112** | **40** | **40** | **41** | **42** | **119** | **43** | **44** | **44** | **45** | **125** | **46** | **47** | **48** | **48** | **103** | **50** | **50** | **81** | **52** | **111** |

| | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Possum Control | 2,442 | 2,479 | 2,516 | 2,554 | 6,885 | 2,631 | 2,671 | 2,711 | 2,751 | 7,418 | 2,835 | 2,877 | 2,920 | 2,964 | 7,991 | 3,054 | 3,099 | 3,146 | 3,193 | 8,608 | 3,290 | 3,339 | 3,389 | 3,440 | 9,274 |
| Ungulate Control | 1,202 | 1,220 | 1,238 | 1,257 | 1,275 | 1,295 | 1,314 | 1,334 | 1,354 | 1,374 | 1,395 | 1,416 | 1,437 | 1,458 | 1,480 | 1,502 | 1,525 | 1,548 | 1,571 | 1,595 | 1,619 | 1,643 | 1,667 | 1,692 | 1,718 |
| Biodiversity Plan Development/Auditing | | | 2,000 | | | | | 2,000 | | | | | | | | 2,000 | | | | | 2,000 | | | | |
| **Total Cost** | **3,644** | **3,699** | **5,754** | **3,811** | **8,161** | **3,926** | **3,985** | **6,044** | **4,105** | **8,792** | **4,229** | **4,293** | **4,357** | **4,422** | **9,471** | **6,556** | **4,624** | **4,694** | **4,764** | **10,203** | **6,908** | **4,982** | **5,056** | **5,132** | **10,991** |
| **Total Cost/Ha** | **54** | **54** | **85** | **56** | **120** | **58** | **59** | **89** | **60** | **129** | **62** | **63** | **64** | **65** | **139** | **96** | **68** | **69** | **70** | **150** | **102** | **73** | **74** | **75** | **162** |

| Scenario Nine - Biodiversity Additionality | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Costs*** | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Fencing | - | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Possum Control | 180,599 | 14,253 | 1,683 | 1,709 | 1,734 | 1,760 | 4,745 | 1,813 | 1,841 | 1,868 | 1,896 | 5,112 | 1,954 | 1,983 | 2,013 | 2,043 | 5,507 | 2,105 | 2,136 | 2,168 | 2,201 | 5,933 | 2,267 | 2,301 | 2,336 | 2,371 | 6,391 |
| Ungulate Control | 336,058 | 17,219 | 4,327 | 4,392 | 4,458 | 4,525 | 4,593 | 4,662 | 4,732 | 4,803 | 4,875 | 4,948 | 5,022 | 5,097 | 5,174 | 5,251 | 5,330 | 5,410 | 5,491 | 5,573 | 5,657 | 5,742 | 5,828 | 5,916 | 6,004 | 6,094 | 6,186 |
| Biodiversity Plan Development/Auditing | 21,000 | 5,000 | | | | | 2,000 | | | | | 2,000 | | | | | 2,000 | | | | | | | | 2,000 | | |
| **Total Cost** | **537,657** | **36,472** | **6,011** | **6,101** | **6,192** | **6,285** | **11,338** | **6,475** | **6,572** | **6,671** | **6,771** | **12,060** | **6,975** | **7,080** | **7,186** | **7,294** | **12,837** | **7,515** | **7,627** | **7,742** | **7,858** | **11,675** | **8,095** | **8,217** | **10,340** | **8,465** | **12,577** |
| **Total Cost/Ha** | **7,907** | **536** | **88** | **90** | **91** | **92** | **167** | **95** | **97** | **98** | **100** | **177** | **103** | **104** | **106** | **107** | **189** | **111** | **112** | **114** | **116** | **172** | **119** | **121** | **152** | **124** | **185** |

| | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Possum Control | 2,442 | 2,479 | 2,516 | 2,554 | 6,885 | 2,631 | 2,671 | 2,711 | 2,751 | 7,418 | 2,835 | 2,877 | 2,920 | 2,964 | 7,991 | 3,054 | 3,099 | 3,146 | 3,193 | 8,608 | 3,290 | 3,339 | 3,389 | 3,440 | 9,274 |
| Ungulate Control | 6,279 | 6,373 | 6,468 | 6,565 | 6,664 | 6,764 | 6,865 | 6,968 | 7,073 | 7,179 | 7,286 | 7,396 | 7,507 | 7,619 | 7,734 | 7,850 | 7,967 | 8,087 | 8,208 | 8,331 | 8,456 | 8,583 | 8,712 | 8,843 | 8,975 |
| Biodiversity Plan Development/Auditing | | | 2,000 | | | | | 2,000 | | | | | | | | 2,000 | | | | | 2,000 | | | | |
| **Total Cost** | **8,721** | **8,852** | **10,985** | **9,119** | **13,549** | **9,395** | **9,536** | **11,679** | **9,824** | **14,596** | **10,121** | **10,273** | **10,427** | **10,583** | **15,724** | **12,903** | **11,067** | **11,233** | **11,401** | **16,940** | **13,746** | **11,922** | **12,101** | **12,282** | **18,249** |
| **Total Cost/Ha** | **128** | **130** | **162** | **134** | **199** | **138** | **140** | **172** | **144** | **215** | **149** | **151** | **153** | **156** | **231** | **190** | **163** | **165** | **168** | **249** | **202** | **175** | **178** | **181** | **268** |

## Appendix C: Case Study Three Discounted Cash Flows

## Appendix C1: Scenarios One, Two and Three

| Year | Total | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Property Area (Ha) | | 356.6 | 356.6 | 356.6 | 356.6 | 356.6 | 356.6 | 356.6 | 356.6 | 356.6 | 356.6 | 356.6 | 356.6 | 356.6 | 356.6 | 356.6 | 356.6 |
| Old Growth Forest (Ha) | | 30.7 | 30.7 | 30.7 | 30.7 | 30.7 | 30.7 | 30.7 | 30.7 | 30.7 | 30.7 | 30.7 | 30.7 | 30.7 | 30.7 | 30.7 | 30.7 |
| Regenerating Forest (Ha) | | 128.5 | 128.5 | 128.5 | 128.5 | 128.5 | 128.5 | 128.5 | 128.5 | 128.5 | 128.5 | 128.5 | 128.5 | 128.5 | 128.5 | 128.5 | 128.5 |
| Other Forest (Ha) | | 18.94 | 18.94 | 18.94 | 18.94 | 18.94 | 18.94 | 18.94 | 18.94 | 18.94 | 18.94 | 18.94 | 18.94 | 18.94 | 18.94 | 18.94 | 18.94 |
| **Scenario One - Carbon Additionality** | | | | | | | | | | | | | | | | | |
| ***Costs*** | | | | | | | | | | | | | | | | | |
| Fencing | 355,880 | 355,880 | | | | | | | | | | | | | | | |
| Possum Control | 97,045 | 30,017 | 2,996 | 3,041 | 3,086 | 3,133 | 8,446 | 3,227 | 3,276 | 3,325 | 3,375 | 9,099 | 3,477 | 3,529 | 3,582 | 3,636 | 9,802 |
| Ungulate Control | 94,714 | 18,241 | 4,584 | 4,653 | 4,723 | 4,793 | 4,865 | 4,938 | 5,012 | 5,088 | 5,164 | 5,241 | 5,320 | 5,400 | 5,481 | 5,563 | 5,646 |
| ETS Registration / Annual Fee | 29,142 | 3,036 | 1,565 | 1,588 | 1,612 | 1,636 | 1,661 | 1,686 | 1,711 | 1,737 | 1,763 | 1,789 | 1,816 | 1,843 | 1,871 | 1,899 | 1,928 |
| FMA Plots | 40,333 | | | | | | 12,457 | | | | | 13,420 | | | | | 14,457 |
| **Total Cost** | **-617,114** | **-407,174** | **-9,145** | **-9,282** | **-9,421** | **-9,563** | **-27,429** | **-9,852** | **-9,999** | **-10,149** | **-10,302** | **-29,549** | **-10,613** | **-10,772** | **-10,934** | **-11,098** | **-31,832** |
| **Total Cost/Ha** | **20,134** | **13,285** | **298** | **303** | **307** | **312** | **895** | **321** | **326** | **331** | **336** | **964** | **346** | **351** | **357** | **362** | **1,039** |
| ***Revenue*** | | | | | | | | | | | | | | | | | |
| Baseline CO2 Eq. (t/ha) | | 286.5 | 290.9 | 295 | 298.7 | 302 | 305.1 | 307.8 | 310.4 | 312.6 | 314.7 | 316.5 | 318.2 | 319.7 | 321.1 | 322.3 | 323.4 |
| Managed CO2 Eq. (t/ha) | | 315.2 | 320.0 | 324.5 | 328.6 | 332.2 | 335.6 | 338.6 | 341.4 | 343.9 | 346.2 | 348.2 | 350.0 | 351.7 | 353.2 | 354.5 | 355.7 |
| Additional Annual CO2 Seq. (t/ha) | 3.69 | | 0.4 | 0.4 | 0.4 | 0.3 | 0.3 | 0.3 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 |
| NZU Price | | | 58.77 | 59.66 | 60.55 | 61.46 | 62.38 | 63.32 | 64.27 | 65.23 | 66.21 | 67.20 | 68.21 | 69.23 | 70.27 | 71.33 | 72.40 |
| NZU Income | 30,172 | | 3,323 | 3,142 | 2,878 | 2,606 | 2,485 | 2,196 | 2,147 | 1,844 | 1,786 | 1,554 | 1,490 | 1,334 | 1,264 | 1,100 | 1,023 |
| **Total Income** | **30,172** | **-** | **3,323** | **3,142** | **2,878** | **2,606** | **2,485** | **2,196** | **2,147** | **1,844** | **1,786** | **1,554** | **1,490** | **1,334** | **1,264** | **1,100** | **1,023** |
| **Net Revenue (Pre-Tax)** | **-586,942** | **-407,174** | **-5,822** | **-6,140** | **-6,543** | **-6,957** | **-24,944** | **-7,655** | **-7,853** | **-8,306** | **-8,515** | **-27,995** | **-9,123** | **-9,438** | **-9,670** | **-9,998** | **-30,809** |
| **Scenario Two - Carbon Additionality** | | | | | | | | | | | | | | | | | |
| ***Costs*** | | | | | | | | | | | | | | | | | |
| Fencing | 1,501,875 | 1,501,875 | | | | | | | | | | | | | | | |
| Possum Control | 97,045 | 30,017 | 2,996 | 3,041 | 3,086 | 3,133 | 8,446 | 3,227 | 3,276 | 3,325 | 3,375 | 9,099 | 3,477 | 3,529 | 3,582 | 3,636 | 9,802 |
| Ungulate Control | 32,333 | 6,227 | 1,565 | 1,588 | 1,612 | 1,636 | 1,661 | 1,686 | 1,711 | 1,737 | 1,763 | 1,789 | 1,816 | 1,843 | 1,871 | 1,899 | 1,928 |
| ETS Registration / Annual Fee | 29,142 | 3,036 | 1,565 | 1,588 | 1,612 | 1,636 | 1,661 | 1,686 | 1,711 | 1,737 | 1,763 | 1,789 | 1,816 | 1,843 | 1,871 | 1,899 | 1,928 |
| FMA Plots | 40,333 | | | | | | 12,457 | | | | | 13,420 | | | | | 14,457 |
| **Total Cost** | **-1,700,728** | **-1,541,155** | **-6,126** | **-6,218** | **-6,311** | **-6,405** | **-24,224** | **-6,599** | **-6,698** | **-6,799** | **-6,901** | **-26,097** | **-7,109** | **-7,216** | **-7,324** | **-7,434** | **-28,113** |
| **Total Cost/Ha** | **55,489** | **50,282** | **200** | **203** | **206** | **209** | **790** | **215** | **219** | **222** | **225** | **851** | **232** | **235** | **239** | **243** | **917** |
| ***Revenue*** | | | | | | | | | | | | | | | | | |
| Baseline CO2 Eq. (t/ha) | | 286.5 | 290.9 | 295 | 298.7 | 302 | 305.1 | 307.8 | 310.4 | 312.6 | 314.7 | 316.5 | 318.2 | 319.7 | 321.1 | 322.3 | 323.4 |
| Managed CO2 Eq. (t/ha) | | 315.2 | 319.99 | 324.5 | 328.57 | 332.2 | 335.61 | 338.58 | 341.44 | 343.86 | 346.17 | 348.15 | 350.02 | 351.67 | 353.21 | 354.53 | 355.74 |
| Additional Annual CO2 Seq. (t/ha) | | | 0.4 | 0.4 | 0.4 | 0.3 | 0.3 | 0.3 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 |
| NZU Price | | | 58.77 | 59.66 | 60.55 | 61.46 | 62.38 | 63.32 | 64.27 | 65.23 | 66.21 | 67.20 | 68.21 | 69.23 | 70.27 | 71.33 | 72.40 |
| NZU Income | 30,172 | | 3,323 | 3,142 | 2,878 | 2,606 | 2,485 | 2,196 | 2,147 | 1,844 | 1,786 | 1,554 | 1,490 | 1,334 | 1,264 | 1,100 | 1,023 |
| **Total Income** | **30,172** | **-** | **3,323** | **3,142** | **2,878** | **2,606** | **2,485** | **2,196** | **2,147** | **1,844** | **1,786** | **1,554** | **1,490** | **1,334** | **1,264** | **1,100** | **1,023** |
| **Net Revenue (Pre-Tax)** | **-1,670,556** | **-1,541,155** | **-2,803** | **-3,075** | **-3,432** | **-3,800** | **-21,740** | **-4,403** | **-4,551** | **-4,955** | **-5,114** | **-24,542** | **-5,619** | **-5,881** | **-6,060** | **-6,334** | **-27,090** |
| **Scenario Three - Carbon Additionality** | | | | | | | | | | | | | | | | | |
| ***Costs*** | | | | | | | | | | | | | | | | | |
| Fencing | - | - | | | | | | | | | | | | | | | |
| Possum Control | 97,045 | 30,017 | 2,996 | 3,041 | 3,086 | 3,133 | 8,446 | 3,227 | 3,276 | 3,325 | 3,375 | 9,099 | 3,477 | 3,529 | 3,582 | 3,636 | 9,802 |
| Ungulate Control | 94,714 | 18,241 | 4,584 | 4,653 | 4,723 | 4,793 | 4,865 | 4,938 | 5,012 | 5,088 | 5,164 | 5,241 | 5,320 | 5,400 | 5,481 | 5,563 | 5,646 |
| ETS Registration / Annual Fee | 29,142 | 3,036 | 1,565 | 1,588 | 1,612 | 1,636 | 1,661 | 1,686 | 1,711 | 1,737 | 1,763 | 1,789 | 1,816 | 1,843 | 1,871 | 1,899 | 1,928 |
| FMA Plots | 40,333 | | | | | | 12,457 | | | | | 13,420 | | | | | 14,457 |
| **Total Cost** | **-261,234** | **-51,294** | **-9,145** | **-9,282** | **-9,421** | **-9,563** | **-27,429** | **-9,852** | **-9,999** | **-10,149** | **-10,302** | **-29,549** | **-10,613** | **-10,772** | **-10,934** | **-11,098** | **-31,832** |
| **Total Cost/Ha** | **8,523** | **1,674** | **298** | **303** | **307** | **312** | **895** | **321** | **326** | **331** | **336** | **964** | **346** | **351** | **357** | **362** | **1,039** |
| ***Revenue*** | | | | | | | | | | | | | | | | | |
| Baseline CO2 Eq. (t/ha) | | 286.5 | 290.9 | 295 | 298.7 | 302 | 305.1 | 307.8 | 310.4 | 312.6 | 314.7 | 316.5 | 318.2 | 319.7 | 321.1 | 322.3 | 323.4 |
| Managed CO2 Eq. (t/ha) | | 315.2 | 319.99 | 324.5 | 328.57 | 332.2 | 335.61 | 338.58 | 341.44 | 343.86 | 346.17 | 348.15 | 350.02 | 351.67 | 353.21 | 354.53 | 355.74 |
| Additional Annual CO2 Seq. (t/ha) | | | 0.4 | 0.4 | 0.4 | 0.3 | 0.3 | 0.3 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 |
| NZU Price | | | 58.77 | 59.66 | 60.55 | 61.46 | 62.38 | 63.32 | 64.27 | 65.23 | 66.21 | 67.20 | 68.21 | 69.23 | 70.27 | 71.33 | 72.40 |
| NZU Income | 30,172 | | 3,323 | 3,142 | 2,878 | 2,606 | 2,485 | 2,196 | 2,147 | 1,844 | 1,786 | 1,554 | 1,490 | 1,334 | 1,264 | 1,100 | 1,023 |
| **Total Income** | **30,172** | **-** | **3,323** | **3,142** | **2,878** | **2,606** | **2,485** | **2,196** | **2,147** | **1,844** | **1,786** | **1,554** | **1,490** | **1,334** | **1,264** | **1,100** | **1,023** |
| **Net Revenue (Pre-Tax)** | **-231,062** | **-51,294** | **-5,822** | **-6,140** | **-6,543** | **-6,957** | **-24,944** | **-7,655** | **-7,853** | **-8,306** | **-8,515** | **-27,995** | **-9,123** | **-9,438** | **-9,670** | **-9,998** | **-30,809** |

## Appendix C2: Scenarios Four, Five and Six

| Scenario Four - Carbon Additionality | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Costs*** | | | | | | | | | | | | | | | | | |
| Fencing | 355,880 | 355,880 | | | | | | | | | | | | | | | |
| Possum Control | 97,045 | 30,017 | 2,996 | 3,041 | 3,086 | 3,133 | 8,446 | 3,227 | 3,276 | 3,325 | 3,375 | 9,099 | 3,477 | 3,529 | 3,582 | 3,636 | 9,802 |
| Ungulate Control | 94,714 | 18,241 | 4,584 | 4,653 | 4,723 | 4,793 | 4,865 | 4,938 | 5,012 | 5,088 | 5,164 | 5,241 | 5,320 | 5,400 | 5,481 | 5,563 | 5,646 |
| ETS Registration / Annual Fee | 29,142 | 3,036 | 1,565 | 1,588 | 1,612 | 1,636 | 1,661 | 1,686 | 1,711 | 1,737 | 1,763 | 1,789 | 1,816 | 1,843 | 1,871 | 1,899 | 1,928 |
| FMA Plots | - | | | | | | | | | | | | | | | | |
| **Total Cost** | **- 576,781** | **- 407,174** | **- 9,145** | **- 9,282** | **- 9,421** | **- 9,563** | **- 14,972** | **- 9,852** | **- 9,999** | **- 10,149** | **- 10,302** | **- 16,129** | **- 10,613** | **- 10,772** | **- 10,934** | **- 11,098** | **- 17,376** |
| **Total Cost/Ha** | **18,818** | **13,285** | **298** | **303** | **307** | **312** | **488** | **321** | **326** | **331** | **336** | **526** | **346** | **351** | **357** | **362** | **567** |
| ***Revenue*** | | | | | | | | | | | | | | | | | |
| Baseline CO2 Eq. (t/ha) | | 286.5 | 290.9 | 295 | 298.7 | 302 | 305.1 | 307.8 | 310.4 | 312.6 | 314.7 | 316.5 | 318.2 | 319.7 | 321.1 | 322.3 | 323.4 |
| Managed CO2 Eq. (t/ha) | | 315.2 | 319.99 | 324.5 | 328.57 | 332.2 | 335.61 | 338.58 | 341.44 | 343.86 | 346.17 | 348.15 | 350.02 | 351.67 | 353.21 | 354.53 | 355.74 |
| Additional Annual CO2 Seq. (t/ha) | | | 0.4 | 0.4 | 0.4 | 0.3 | 0.3 | 0.3 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 |
| NZU Price | | | 58.77 | 59.66 | 60.55 | 61.46 | 62.38 | 63.32 | 64.27 | 65.23 | 66.21 | 67.20 | 68.21 | 69.23 | 70.27 | 71.33 | 72.40 |
| NZU Income | 30,172 | | 3,323 | 3,142 | 2,878 | 2,606 | 2,485 | 2,196 | 2,147 | 1,844 | 1,786 | 1,554 | 1,490 | 1,334 | 1,264 | 1,100 | 1,023 |
| **Total Income** | **30,172** | **-** | **3,323** | **3,142** | **2,878** | **2,606** | **2,485** | **2,196** | **2,147** | **1,844** | **1,786** | **1,554** | **1,490** | **1,334** | **1,264** | **1,100** | **1,023** |
| **Net Revenue (Pre-Tax)** | **- 546,609** | **- 407,174** | **- 5,822** | **- 6,140** | **- 6,543** | **- 6,957** | **- 12,488** | **- 7,655** | **- 7,853** | **- 8,306** | **- 8,515** | **- 14,575** | **- 9,123** | **- 9,438** | **- 9,670** | **- 9,998** | **- 16,353** |

| Scenario Five - Carbon Additionality | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Costs*** | | | | | | | | | | | | | | | | | |
| Fencing | 1,501,875 | 1,501,875 | | | | | | | | | | | | | | | |
| Possum Control | 97,045 | 30,017 | 2,996 | 3,041 | 3,086 | 3,133 | 8,446 | 3,227 | 3,276 | 3,325 | 3,375 | 9,099 | 3,477 | 3,529 | 3,582 | 3,636 | 9,802 |
| Ungulate Control | 32,333 | 6,227 | 1,565 | 1,588 | 1,612 | 1,636 | 1,661 | 1,686 | 1,711 | 1,737 | 1,763 | 1,789 | 1,816 | 1,843 | 1,871 | 1,899 | 1,928 |
| ETS Registration / Annual Fee | 29,142 | 3,036 | 1,565 | 1,588 | 1,612 | 1,636 | 1,661 | 1,686 | 1,711 | 1,737 | 1,763 | 1,789 | 1,816 | 1,843 | 1,871 | 1,899 | 1,928 |
| FMA Plots | - | | | | | | | | | | | | | | | | |
| **Total Cost** | **- 1,660,395** | **- 1,541,155** | **- 6,126** | **- 6,218** | **- 6,311** | **- 6,405** | **- 11,768** | **- 6,599** | **- 6,698** | **- 6,799** | **- 6,901** | **- 12,677** | **- 7,109** | **- 7,216** | **- 7,324** | **- 7,434** | **- 13,657** |
| **Total Cost/Ha** | **54,173** | **50,282** | **200** | **203** | **206** | **209** | **384** | **215** | **219** | **222** | **225** | **414** | **232** | **235** | **239** | **243** | **446** |
| ***Revenue*** | | | | | | | | | | | | | | | | | |
| Baseline CO2 Eq. (t/ha) | | 286.5 | 290.9 | 295 | 298.7 | 302 | 305.1 | 307.8 | 310.4 | 312.6 | 314.7 | 316.5 | 318.2 | 319.7 | 321.1 | 322.3 | 323.4 |
| Managed CO2 Eq. (t/ha) | | 315.2 | 319.99 | 324.5 | 328.57 | 332.2 | 335.61 | 338.58 | 341.44 | 343.86 | 346.17 | 348.15 | 350.02 | 351.67 | 353.21 | 354.53 | 355.74 |
| Additional Annual CO2 Seq. (t/ha) | | | 0.4 | 0.4 | 0.4 | 0.3 | 0.3 | 0.3 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 |
| NZU Price | | | 58.77 | 59.66 | 60.55 | 61.46 | 62.38 | 63.32 | 64.27 | 65.23 | 66.21 | 67.20 | 68.21 | 69.23 | 70.27 | 71.33 | 72.40 |
| NZU Income | 30,172 | | 3,323 | 3,142 | 2,878 | 2,606 | 2,485 | 2,196 | 2,147 | 1,844 | 1,786 | 1,554 | 1,490 | 1,334 | 1,264 | 1,100 | 1,023 |
| **Total Income** | **30,172** | **-** | **3,323** | **3,142** | **2,878** | **2,606** | **2,485** | **2,196** | **2,147** | **1,844** | **1,786** | **1,554** | **1,490** | **1,334** | **1,264** | **1,100** | **1,023** |
| **Net Revenue (Pre-Tax)** | **- 1,630,222** | **- 1,541,155** | **- 2,803** | **- 3,075** | **- 3,432** | **- 3,800** | **- 9,283** | **- 4,403** | **- 4,551** | **- 4,955** | **- 5,114** | **- 11,123** | **- 5,619** | **- 5,881** | **- 6,060** | **- 6,334** | **- 12,634** |

| Scenario Six - Carbon Additionality | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Costs*** | | | | | | | | | | | | | | | | | |
| Fencing | - | - | | | | | | | | | | | | | | | |
| Possum Control | 97,045 | 30,017 | 2,996 | 3,041 | 3,086 | 3,133 | 8,446 | 3,227 | 3,276 | 3,325 | 3,375 | 9,099 | 3,477 | 3,529 | 3,582 | 3,636 | 9,802 |
| Ungulate Control | 94,714 | 18,241 | 4,584 | 4,653 | 4,723 | 4,793 | 4,865 | 4,938 | 5,012 | 5,088 | 5,164 | 5,241 | 5,320 | 5,400 | 5,481 | 5,563 | 5,646 |
| ETS Registration / Annual Fee | 29,142 | 3,036 | 1,565 | 1,588 | 1,612 | 1,636 | 1,661 | 1,686 | 1,711 | 1,737 | 1,763 | 1,789 | 1,816 | 1,843 | 1,871 | 1,899 | 1,928 |
| FMA Plots | - | | | | | | | | | | | | | | | | |
| **Total Cost** | **- 220,901** | **- 51,294** | **- 9,145** | **- 9,282** | **- 9,421** | **- 9,563** | **- 14,972** | **- 9,852** | **- 9,999** | **- 10,149** | **- 10,302** | **- 16,129** | **- 10,613** | **- 10,772** | **- 10,934** | **- 11,098** | **- 17,376** |
| **Total Cost/Ha** | **7,207** | **1,674** | **298** | **303** | **307** | **312** | **488** | **321** | **326** | **331** | **336** | **526** | **346** | **351** | **357** | **362** | **567** |
| ***Revenue*** | | | | | | | | | | | | | | | | | |
| Baseline CO2 Eq. (t/ha) | | 286.5 | 290.9 | 295 | 298.7 | 302 | 305.1 | 307.8 | 310.4 | 312.6 | 314.7 | 316.5 | 318.2 | 319.7 | 321.1 | 322.3 | 323.4 |
| Managed CO2 Eq. (t/ha) | | 315.2 | 319.99 | 324.5 | 328.57 | 332.2 | 335.61 | 338.58 | 341.44 | 343.86 | 346.17 | 348.15 | 350.02 | 351.67 | 353.21 | 354.53 | 355.74 |
| Additional Annual CO2 Seq. (t/ha) | | | 0.4 | 0.4 | 0.4 | 0.3 | 0.3 | 0.3 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 |
| NZU Price | | | 58.77 | 59.66 | 60.55 | 61.46 | 62.38 | 63.32 | 64.27 | 65.23 | 66.21 | 67.20 | 68.21 | 69.23 | 70.27 | 71.33 | 72.40 |
| NZU Income | 30,172 | | 3,323 | 3,142 | 2,878 | 2,606 | 2,485 | 2,196 | 2,147 | 1,844 | 1,786 | 1,554 | 1,490 | 1,334 | 1,264 | 1,100 | 1,023 |
| **Total Income** | **30,172** | **-** | **3,323** | **3,142** | **2,878** | **2,606** | **2,485** | **2,196** | **2,147** | **1,844** | **1,786** | **1,554** | **1,490** | **1,334** | **1,264** | **1,100** | **1,023** |
| **Net Revenue (Pre-Tax)** | **- 190,729** | **- 51,294** | **- 5,822** | **- 6,140** | **- 6,543** | **- 6,957** | **- 12,488** | **- 7,655** | **- 7,853** | **- 8,306** | **- 8,515** | **- 14,575** | **- 9,123** | **- 9,438** | **- 9,670** | **- 9,998** | **- 16,353** |

## Appendix C3: Scenarios Seven, Eight and Nine

| Scenario Seven - Biodiversity Additionality | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Costs*** | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Fencing | 355,880 | 355,880 | | | | | | | | | | | | | | | | | | | | | | | | | |
| Possum Control | 121,234 | 7,161 | 1,154 | 1,172 | 1,189 | 1,207 | 3,254 | 1,244 | 1,262 | 1,281 | 1,300 | 3,506 | 1,340 | 1,360 | 1,380 | 1,401 | 3,777 | 1,443 | 1,465 | 1,487 | 1,509 | 4,069 | 1,555 | 1,578 | 1,602 | 1,626 | 4,383 |
| Ungulate Control | 67,105 | 3,438 | 864 | 877 | 890 | 904 | 917 | 931 | 945 | 959 | 973 | 988 | 1,003 | 1,018 | 1,033 | 1,049 | 1,064 | 1,080 | 1,096 | 1,113 | 1,130 | 1,147 | 1,164 | 1,181 | 1,199 | 1,217 | 1,235 |
| Biodiversity Plan Development/Auditing | 21,000 | 5,000 | | | | | 2,000 | | | | | 2,000 | | | | | 2,000 | | | | | | | | 2,000 | | |
| **Total Cost** | **565,219** | **371,479** | **2,018** | **2,049** | **2,079** | **2,111** | **6,171** | **2,174** | **2,207** | **2,240** | **2,274** | **6,494** | **2,342** | **2,378** | **2,413** | **2,449** | **6,841** | **2,523** | **2,561** | **2,600** | **2,639** | **5,215** | **2,719** | **2,759** | **4,801** | **2,843** | **5,618** |
| **Total Cost/Ha** | **18,441** | **12,120** | **66** | **67** | **68** | **69** | **201** | **71** | **72** | **73** | **74** | **212** | **76** | **78** | **79** | **80** | **223** | **82** | **84** | **85** | **86** | **170** | **89** | **90** | **157** | **93** | **183** |

| | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1,675 | 1,700 | 1,726 | 1,751 | 4,722 | 1,804 | 1,831 | 1,859 | 1,887 | 5,087 | 1,944 | 1,973 | 2,003 | 2,033 | 5,480 | 2,094 | 2,125 | 2,157 | 2,190 | 5,903 | 2,256 | 2,290 | 2,324 | 2,359 | 6,359 |
| 1,254 | 1,273 | 1,292 | 1,311 | 1,331 | 1,351 | 1,371 | 1,391 | 1,412 | 1,433 | 1,455 | 1,477 | 1,499 | 1,521 | 1,544 | 1,567 | 1,591 | 1,615 | 1,639 | 1,664 | 1,689 | 1,714 | 1,740 | 1,766 | 1,792 |
| | | 2,000 | | | | | 2,000 | | | | | | | | 2,000 | | | | | 2,000 | | | | |
| **2,929** | **2,973** | **5,017** | **3,062** | **6,052** | **3,155** | **3,202** | **5,250** | **3,299** | **6,520** | **3,399** | **3,450** | **3,502** | **3,554** | **7,024** | **5,661** | **3,716** | **3,772** | **3,829** | **7,567** | **5,944** | **4,004** | **4,064** | **4,125** | **8,152** |
| **96** | **97** | **164** | **100** | **197** | **103** | **104** | **171** | **108** | **213** | **111** | **113** | **114** | **116** | **229** | **185** | **121** | **123** | **125** | **247** | **194** | **131** | **133** | **135** | **266** |

| Scenario Eight - Biodiversity Additionality | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Costs*** | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Fencing | 1,053,000 | 1,053,000 | | | | | | | | | | | | | | | | | | | | | | | | | |
| Possum Control | 121,234 | 7,161 | 1,154 | 1,172 | 1,189 | 1,207 | 3,254 | 1,244 | 1,262 | 1,281 | 1,300 | 3,506 | 1,340 | 1,360 | 1,380 | 1,401 | 3,777 | 1,443 | 1,465 | 1,487 | 1,509 | 4,069 | 1,555 | 1,578 | 1,602 | 1,626 | 4,383 |
| Ungulate Control | 28,993 | 1,486 | 373 | 379 | 385 | 390 | 396 | 402 | 408 | 414 | 421 | 427 | 433 | 440 | 446 | 453 | 460 | 467 | 474 | 481 | 488 | 495 | 503 | 510 | 518 | 526 | 534 |
| Biodiversity Plan Development/Auditing | 21,000 | 5,000 | | | | | 2,000 | | | | | 2,000 | | | | | 2,000 | | | | | | | | 2,000 | | |
| **Total Cost** | **1,224,227** | **1,066,646** | **1,528** | **1,551** | **1,574** | **1,597** | **5,650** | **1,646** | **1,670** | **1,695** | **1,721** | **5,933** | **1,773** | **1,800** | **1,827** | **1,854** | **6,237** | **1,910** | **1,939** | **1,968** | **1,997** | **4,564** | **2,058** | **2,088** | **4,120** | **2,152** | **4,917** |
| **Total Cost/Ha** | **39,942** | **34,801** | **50** | **51** | **51** | **52** | **184** | **54** | **54** | **55** | **56** | **194** | **58** | **59** | **60** | **60** | **203** | **62** | **63** | **64** | **65** | **149** | **67** | **68** | **134** | **70** | **160** |

| | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1,675 | 1,700 | 1,726 | 1,751 | 4,722 | 1,804 | 1,831 | 1,859 | 1,887 | 5,087 | 1,944 | 1,973 | 2,003 | 2,033 | 5,480 | 2,094 | 2,125 | 2,157 | 2,190 | 5,903 | 2,256 | 2,290 | 2,324 | 2,359 | 6,359 |
| 542 | 550 | 558 | 566 | 575 | 584 | 592 | 601 | 610 | 619 | 629 | 638 | 648 | 657 | 667 | 677 | 687 | 698 | 708 | 719 | 730 | 740 | 752 | 763 | 774 |
| | | 2,000 | | | | | 2,000 | | | | | | | | 2,000 | | | | | 2,000 | | | | |
| **2,217** | **2,250** | **4,284** | **2,318** | **5,297** | **2,388** | **2,424** | **4,460** | **2,497** | **5,706** | **2,572** | **2,611** | **2,650** | **2,690** | **6,147** | **4,771** | **2,813** | **2,855** | **2,898** | **6,622** | **4,985** | **3,030** | **3,076** | **3,122** | **7,134** |
| **72** | **73** | **140** | **76** | **173** | **78** | **79** | **146** | **81** | **186** | **84** | **85** | **86** | **88** | **201** | **156** | **92** | **93** | **95** | **216** | **163** | **99** | **100** | **102** | **233** |

| Scenario Nine - Biodiversity Additionality | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Costs*** | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Fencing | - | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Possum Control | 121,234 | 7,161 | 1,154 | 1,172 | 1,189 | 1,207 | 3,254 | 1,244 | 1,262 | 1,281 | 1,300 | 3,506 | 1,340 | 1,360 | 1,380 | 1,401 | 3,777 | 1,443 | 1,465 | 1,487 | 1,509 | 4,069 | 1,555 | 1,578 | 1,602 | 1,626 | 4,383 |
| Ungulate Control | 67,105 | 3,438 | 864 | 877 | 890 | 904 | 917 | 931 | 945 | 959 | 973 | 988 | 1,003 | 1,018 | 1,033 | 1,049 | 1,064 | 1,080 | 1,096 | 1,113 | 1,130 | 1,147 | 1,164 | 1,181 | 1,199 | 1,217 | 1,235 |
| Biodiversity Plan Development/Auditing | 21,000 | 5,000 | | | | | 2,000 | | | | | 2,000 | | | | | 2,000 | | | | | | | | 2,000 | | |
| **Total Cost** | **209,339** | **15,599** | **2,018** | **2,049** | **2,079** | **2,111** | **6,171** | **2,174** | **2,207** | **2,240** | **2,274** | **6,494** | **2,342** | **2,378** | **2,413** | **2,449** | **6,841** | **2,523** | **2,561** | **2,600** | **2,639** | **5,215** | **2,719** | **2,759** | **4,801** | **2,843** | **5,618** |
| **Total Cost/Ha** | **6,830** | **509** | **66** | **67** | **68** | **69** | **201** | **71** | **72** | **73** | **74** | **212** | **76** | **78** | **79** | **80** | **223** | **82** | **84** | **85** | **86** | **170** | **89** | **90** | **157** | **93** | **183** |

| | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1,675 | 1,700 | 1,726 | 1,751 | 4,722 | 1,804 | 1,831 | 1,859 | 1,887 | 5,087 | 1,944 | 1,973 | 2,003 | 2,033 | 5,480 | 2,094 | 2,125 | 2,157 | 2,190 | 5,903 | 2,256 | 2,290 | 2,324 | 2,359 | 6,359 |
| 1,254 | 1,273 | 1,292 | 1,311 | 1,331 | 1,351 | 1,371 | 1,391 | 1,412 | 1,433 | 1,455 | 1,477 | 1,499 | 1,521 | 1,544 | 1,567 | 1,591 | 1,615 | 1,639 | 1,664 | 1,689 | 1,714 | 1,740 | 1,766 | 1,792 |
| | | 2,000 | | | | | 2,000 | | | | | | | | 2,000 | | | | | 2,000 | | | | |
| **2,929** | **2,973** | **5,017** | **3,062** | **6,052** | **3,155** | **3,202** | **5,250** | **3,299** | **6,520** | **3,399** | **3,450** | **3,502** | **3,554** | **7,024** | **5,661** | **3,716** | **3,772** | **3,829** | **7,567** | **5,944** | **4,004** | **4,064** | **4,125** | **8,152** |
| **96** | **97** | **164** | **100** | **197** | **103** | **104** | **171** | **108** | **213** | **111** | **113** | **114** | **116** | **229** | **185** | **121** | **123** | **125** | **247** | **194** | **131** | **133** | **135** | **266** |

# Appendix D: Case Study Four Discounted Cash Flows

## Appendix D1: Scenarios One, Two and Three

| Year | Total | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Property Area (Ha) | | 104.2 | 104.2 | 104.2 | 104.2 | 104.2 | 104.2 | 104.2 | 104.2 | 104.2 | 104.2 | 104.2 | 104.2 | 104.2 | 104.2 | 104.2 | 104.2 |
| Old Growth Forest (Ha) | | 56.4 | 56.4 | 56.4 | 56.4 | 56.4 | 56.4 | 56.4 | 56.4 | 56.4 | 56.4 | 56.4 | 56.4 | 56.4 | 56.4 | 56.4 | 56.4 |
| Regenerating Forest (Ha) | | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 |
| Other Forest (Ha) | | 44.09 | 44.09 | 44.09 | 44.09 | 44.09 | 44.09 | 44.09 | 44.09 | 44.09 | 44.09 | 44.09 | 44.09 | 44.09 | 44.09 | 44.09 | 44.09 |

| Scenario One - Carbon Additionality | Total | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Costs*** | | | | | | | | | | | | | | | | | |
| Fencing | 466,000 | 466,000 | | | | | | | | | | | | | | | |
| Possum Control | 4,283 | 1,325 | 132 | 134 | 136 | 138 | 373 | 142 | 145 | 147 | 149 | 402 | 153 | 156 | 158 | 160 | 433 |
| Ungulate Control | 977 | 188 | 47 | 48 | 49 | 49 | 50 | 51 | 52 | 52 | 53 | 54 | 55 | 56 | 57 | 57 | 58 |
| ETS Registration / Annual Fee | 2,831 | 2,087 | 45 | 45 | 46 | 47 | 47 | 48 | 49 | 49 | 50 | 51 | 52 | 53 | 53 | 54 | 55 |
| FMA Plots | 1,149 | | | | | | 355 | | | | | 382 | | | | | 412 |
| **Total Cost** | **- 475,240** | **- 469,600** | **- 224** | **- 227** | **- 231** | **- 234** | **- 825** | **- 241** | **- 245** | **- 249** | **- 252** | **- 889** | **- 260** | **- 264** | **- 268** | **- 272** | **- 958** |
| **Total Cost/Ha** | **8,422** | **8,322** | **4** | **4** | **4** | **4** | **15** | **4** | **4** | **4** | **4** | **16** | **5** | **5** | **5** | **5** | **17** |
| ***Revenue*** | | | | | | | | | | | | | | | | | |
| Baseline CO2 Eq. (t/ha) | | 286.5 | 290.9 | 295 | 298.7 | 302 | 305.1 | 307.8 | 310.4 | 312.6 | 314.7 | 316.5 | 318.2 | 319.7 | 321.1 | 322.3 | 323.4 |
| Managed CO2 Eq. (t/ha) | | 315.2 | 320.0 | 324.5 | 328.6 | 332.2 | 335.6 | 338.6 | 341.4 | 343.9 | 346.2 | 348.2 | 350.0 | 351.7 | 353.2 | 354.5 | 355.7 |
| Additional Annual CO2 Seq. (t/ha) | 3.69 | | 0.4 | 0.4 | 0.4 | 0.3 | 0.3 | 0.3 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 |
| NZU Price | | | 58.77 | 59.66 | 60.55 | 61.46 | 62.38 | 63.32 | 64.27 | 65.23 | 66.21 | 67.20 | 68.21 | 69.23 | 70.27 | 71.33 | 72.40 |
| NZU Income | 860 | | 95 | 90 | 82 | 74 | 71 | 63 | 61 | 53 | 51 | 44 | 42 | 38 | 36 | 31 | 29 |
| **Total Income** | **860** | **-** | **95** | **90** | **82** | **74** | **71** | **63** | **61** | **53** | **51** | **44** | **42** | **38** | **36** | **31** | **29** |
| **Net Revenue (Pre-Tax)** | **- 474,381** | **- 469,600** | **- 129** | **- 138** | **- 149** | **- 160** | **- 754** | **- 179** | **- 184** | **- 196** | **- 202** | **- 845** | **- 218** | **- 226** | **- 232** | **- 241** | **- 928** |

| Scenario Two - Carbon Additionality | Total | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Costs*** | | | | | | | | | | | | | | | | | |
| Fencing | 119,000 | 119,000 | | | | | | | | | | | | | | | |
| Possum Control | 4,283 | 1,325 | 132 | 134 | 136 | 138 | 373 | 142 | 145 | 147 | 149 | 402 | 153 | 156 | 158 | 160 | 433 |
| Ungulate Control | 921 | 177 | 45 | 45 | 46 | 47 | 47 | 48 | 49 | 49 | 50 | 51 | 52 | 53 | 53 | 54 | 55 |
| ETS Registration / Annual Fee | 2,831 | 2,087 | 45 | 45 | 46 | 47 | 47 | 48 | 49 | 49 | 50 | 51 | 52 | 53 | 53 | 54 | 55 |
| FMA Plots | 1,149 | | | | | | 355 | | | | | 382 | | | | | 412 |
| **Total Cost** | **- 128,184** | **- 122,589** | **- 221** | **- 225** | **- 228** | **- 231** | **- 822** | **- 238** | **- 242** | **- 246** | **- 249** | **- 886** | **- 257** | **- 261** | **- 265** | **- 269** | **- 954** |
| **Total Cost/Ha** | **2,272** | **2,172** | **4** | **4** | **4** | **4** | **15** | **4** | **4** | **4** | **4** | **16** | **5** | **5** | **5** | **5** | **17** |
| ***Revenue*** | | | | | | | | | | | | | | | | | |
| Baseline CO2 Eq. (t/ha) | | 286.5 | 290.9 | 295 | 298.7 | 302 | 305.1 | 307.8 | 310.4 | 312.6 | 314.7 | 316.5 | 318.2 | 319.7 | 321.1 | 322.3 | 323.4 |
| Managed CO2 Eq. (t/ha) | | 315.2 | 319.99 | 324.5 | 328.57 | 332.2 | 335.61 | 338.58 | 341.44 | 343.86 | 346.17 | 348.15 | 350.02 | 351.67 | 353.21 | 354.53 | 355.74 |
| Additional Annual CO2 Seq. (t/ha) | | | 0.4 | 0.4 | 0.4 | 0.3 | 0.3 | 0.3 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 |
| NZU Price | | | 58.77 | 59.66 | 60.55 | 61.46 | 62.38 | 63.32 | 64.27 | 65.23 | 66.21 | 67.20 | 68.21 | 69.23 | 70.27 | 71.33 | 72.40 |
| NZU Income | 860 | | 95 | 90 | 82 | 74 | 71 | 63 | 61 | 53 | 51 | 44 | 42 | 38 | 36 | 31 | 29 |
| **Total Income** | **860** | **-** | **95** | **90** | **82** | **74** | **71** | **63** | **61** | **53** | **51** | **44** | **42** | **38** | **36** | **31** | **29** |
| **Net Revenue (Pre-Tax)** | **- 127,325** | **- 122,589** | **- 127** | **- 135** | **- 146** | **- 157** | **- 751** | **- 176** | **- 181** | **- 193** | **- 198** | **- 842** | **- 214** | **- 223** | **- 229** | **- 237** | **- 925** |

| Scenario Three - Carbon Additionality | Total | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Costs*** | | | | | | | | | | | | | | | | | |
| Fencing | - | - | | | | | | | | | | | | | | | |
| Possum Control | 4,283 | 1,325 | 132 | 134 | 136 | 138 | 373 | 142 | 145 | 147 | 149 | 402 | 153 | 156 | 158 | 160 | 433 |
| Ungulate Control | 977 | 188 | 47 | 48 | 49 | 49 | 50 | 51 | 52 | 52 | 53 | 54 | 55 | 56 | 57 | 57 | 58 |
| ETS Registration / Annual Fee | 2,831 | 2,087 | 45 | 45 | 46 | 47 | 47 | 48 | 49 | 49 | 50 | 51 | 52 | 53 | 53 | 54 | 55 |
| FMA Plots | 1,149 | | | | | | 355 | | | | | 382 | | | | | 412 |
| **Total Cost** | **- 9,240** | **- 3,600** | **- 224** | **- 227** | **- 231** | **- 234** | **- 825** | **- 241** | **- 245** | **- 249** | **- 252** | **- 889** | **- 260** | **- 264** | **- 268** | **- 272** | **- 958** |
| **Total Cost/Ha** | **164** | **64** | **4** | **4** | **4** | **4** | **15** | **4** | **4** | **4** | **4** | **16** | **5** | **5** | **5** | **5** | **17** |
| ***Revenue*** | | | | | | | | | | | | | | | | | |
| Baseline CO2 Eq. (t/ha) | | 286.5 | 290.9 | 295 | 298.7 | 302 | 305.1 | 307.8 | 310.4 | 312.6 | 314.7 | 316.5 | 318.2 | 319.7 | 321.1 | 322.3 | 323.4 |
| Managed CO2 Eq. (t/ha) | | 315.2 | 319.99 | 324.5 | 328.57 | 332.2 | 335.61 | 338.58 | 341.44 | 343.86 | 346.17 | 348.15 | 350.02 | 351.67 | 353.21 | 354.53 | 355.74 |
| Additional Annual CO2 Seq. (t/ha) | | | 0.4 | 0.4 | 0.4 | 0.3 | 0.3 | 0.3 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 |
| NZU Price | | | 58.77 | 59.66 | 60.55 | 61.46 | 62.38 | 63.32 | 64.27 | 65.23 | 66.21 | 67.20 | 68.21 | 69.23 | 70.27 | 71.33 | 72.40 |
| NZU Income | 860 | | 95 | 90 | 82 | 74 | 71 | 63 | 61 | 53 | 51 | 44 | 42 | 38 | 36 | 31 | 29 |
| **Total Income** | **860** | **-** | **95** | **90** | **82** | **74** | **71** | **63** | **61** | **53** | **51** | **44** | **42** | **38** | **36** | **31** | **29** |
| **Net Revenue (Pre-Tax)** | **- 8,381** | **- 3,600** | **- 129** | **- 138** | **- 149** | **- 160** | **- 754** | **- 179** | **- 184** | **- 196** | **- 202** | **- 845** | **- 218** | **- 226** | **- 232** | **- 241** | **- 928** |

## Appendix D2: Scenarios Four, Five and Six

| Scenario Four - Carbon Additionality | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Costs*** | | | | | | | | | | | | | | | | | |
| Fencing | 466,000 | 466,000 | | | | | | | | | | | | | | | |
| Possum Control | 4,283 | 1,325 | 132 | 134 | 136 | 138 | 373 | 142 | 145 | 147 | 149 | 402 | 153 | 156 | 158 | 160 | 433 |
| Ungulate Control | 977 | 188 | 47 | 48 | 49 | 49 | 50 | 51 | 52 | 52 | 53 | 54 | 55 | 56 | 57 | 57 | 58 |
| ETS Registration / Annual Fee | 2,831 | 2,087 | 45 | 45 | 46 | 47 | 47 | 48 | 49 | 49 | 50 | 51 | 52 | 53 | 53 | 54 | 55 |
| FMA Plots | - | | | | | | | | | | | | | | | | |
| **Total Cost** | **- 474,091** | **- 469,600** | **- 224** | **- 227** | **- 231** | **- 234** | **- 470** | **- 241** | **- 245** | **- 249** | **- 252** | **- 507** | **- 260** | **- 264** | **- 268** | **- 272** | **- 546** |
| **Total Cost/Ha** | **8,401** | **8,322** | **4** | **4** | **4** | **4** | **8** | **4** | **4** | **4** | **4** | **9** | **5** | **5** | **5** | **5** | **10** |
| ***Revenue*** | | | | | | | | | | | | | | | | | |
| Baseline CO2 Eq. (t/ha) | | 286.5 | 290.9 | 295 | 298.7 | 302 | 305.1 | 307.8 | 310.4 | 312.6 | 314.7 | 316.5 | 318.2 | 319.7 | 321.1 | 322.3 | 323.4 |
| Managed CO2 Eq. (t/ha) | | 315.2 | 319.99 | 324.5 | 328.57 | 332.2 | 335.61 | 338.58 | 341.44 | 343.86 | 346.17 | 348.15 | 350.02 | 351.67 | 353.21 | 354.53 | 355.74 |
| Additional Annual CO2 Seq. (t/ha) | | | 0.4 | 0.4 | 0.4 | 0.3 | 0.3 | 0.3 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 |
| NZU Price | | | 58.77 | 59.66 | 60.55 | 61.46 | 62.38 | 63.32 | 64.27 | 65.23 | 66.21 | 67.20 | 68.21 | 69.23 | 70.27 | 71.33 | 72.40 |
| NZU Income | 860 | | 95 | 90 | 82 | 74 | 71 | 63 | 61 | 53 | 51 | 44 | 42 | 38 | 36 | 31 | 29 |
| **Total Income** | **860** | **-** | **95** | **90** | **82** | **74** | **71** | **63** | **61** | **53** | **51** | **44** | **42** | **38** | **36** | **31** | **29** |
| **Net Revenue (Pre-Tax)** | **- 473,232** | **- 469,600** | **- 129** | **- 138** | **- 149** | **- 160** | **- 399** | **- 179** | **- 184** | **- 196** | **- 202** | **- 462** | **- 218** | **- 226** | **- 232** | **- 241** | **- 517** |

| Scenario Five - Carbon Additionality | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Costs*** | | | | | | | | | | | | | | | | | |
| Fencing | 119,000 | 119,000 | | | | | | | | | | | | | | | |
| Possum Control | 4,283 | 1,325 | 132 | 134 | 136 | 138 | 373 | 142 | 145 | 147 | 149 | 402 | 153 | 156 | 158 | 160 | 433 |
| Ungulate Control | 921 | 177 | 45 | 45 | 46 | 47 | 47 | 48 | 49 | 49 | 50 | 51 | 52 | 53 | 53 | 54 | 55 |
| ETS Registration / Annual Fee | 2,831 | 2,087 | 45 | 45 | 46 | 47 | 47 | 48 | 49 | 49 | 50 | 51 | 52 | 53 | 53 | 54 | 55 |
| FMA Plots | - | | | | | | | | | | | | | | | | |
| **Total Cost** | **- 127,035** | **- 122,589** | **- 221** | **- 225** | **- 228** | **- 231** | **- 467** | **- 238** | **- 242** | **- 246** | **- 249** | **- 504** | **- 257** | **- 261** | **- 265** | **- 269** | **- 542** |
| **Total Cost/Ha** | **2,251** | **2,172** | **4** | **4** | **4** | **4** | **8** | **4** | **4** | **4** | **4** | **9** | **5** | **5** | **5** | **5** | **10** |
| ***Revenue*** | | | | | | | | | | | | | | | | | |
| Baseline CO2 Eq. (t/ha) | | 286.5 | 290.9 | 295 | 298.7 | 302 | 305.1 | 307.8 | 310.4 | 312.6 | 314.7 | 316.5 | 318.2 | 319.7 | 321.1 | 322.3 | 323.4 |
| Managed CO2 Eq. (t/ha) | | 315.2 | 319.99 | 324.5 | 328.57 | 332.2 | 335.61 | 338.58 | 341.44 | 343.86 | 346.17 | 348.15 | 350.02 | 351.67 | 353.21 | 354.53 | 355.74 |
| Additional Annual CO2 Seq. (t/ha) | | | 0.4 | 0.4 | 0.4 | 0.3 | 0.3 | 0.3 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 |
| NZU Price | | | 58.77 | 59.66 | 60.55 | 61.46 | 62.38 | 63.32 | 64.27 | 65.23 | 66.21 | 67.20 | 68.21 | 69.23 | 70.27 | 71.33 | 72.40 |
| NZU Income | 860 | | 95 | 90 | 82 | 74 | 71 | 63 | 61 | 53 | 51 | 44 | 42 | 38 | 36 | 31 | 29 |
| **Total Income** | **860** | **-** | **95** | **90** | **82** | **74** | **71** | **63** | **61** | **53** | **51** | **44** | **42** | **38** | **36** | **31** | **29** |
| **Net Revenue (Pre-Tax)** | **- 126,176** | **- 122,589** | **- 127** | **- 135** | **- 146** | **- 157** | **- 397** | **- 176** | **- 181** | **- 193** | **- 198** | **- 459** | **- 214** | **- 223** | **- 229** | **- 237** | **- 513** |

| Scenario Six - Carbon Additionality | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Costs*** | | | | | | | | | | | | | | | | | |
| Fencing | - | - | | | | | | | | | | | | | | | |
| Possum Control | 4,283 | 1,325 | 132 | 134 | 136 | 138 | 373 | 142 | 145 | 147 | 149 | 402 | 153 | 156 | 158 | 160 | 433 |
| Ungulate Control | 977 | 188 | 47 | 48 | 49 | 49 | 50 | 51 | 52 | 52 | 53 | 54 | 55 | 56 | 57 | 57 | 58 |
| ETS Registration / Annual Fee | 2,831 | 2,087 | 45 | 45 | 46 | 47 | 47 | 48 | 49 | 49 | 50 | 51 | 52 | 53 | 53 | 54 | 55 |
| FMA Plots | - | | | | | | | | | | | | | | | | |
| **Total Cost** | **- 8,091** | **- 3,600** | **- 224** | **- 227** | **- 231** | **- 234** | **- 470** | **- 241** | **- 245** | **- 249** | **- 252** | **- 507** | **- 260** | **- 264** | **- 268** | **- 272** | **- 546** |
| **Total Cost/Ha** | **143** | **64** | **4** | **4** | **4** | **4** | **8** | **4** | **4** | **4** | **4** | **9** | **5** | **5** | **5** | **5** | **10** |
| ***Revenue*** | | | | | | | | | | | | | | | | | |
| Baseline CO2 Eq. (t/ha) | | 286.5 | 290.9 | 295 | 298.7 | 302 | 305.1 | 307.8 | 310.4 | 312.6 | 314.7 | 316.5 | 318.2 | 319.7 | 321.1 | 322.3 | 323.4 |
| Managed CO2 Eq. (t/ha) | | 315.2 | 319.99 | 324.5 | 328.57 | 332.2 | 335.61 | 338.58 | 341.44 | 343.86 | 346.17 | 348.15 | 350.02 | 351.67 | 353.21 | 354.53 | 355.74 |
| Additional Annual CO2 Seq. (t/ha) | | | 0.4 | 0.4 | 0.4 | 0.3 | 0.3 | 0.3 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 |
| NZU Price | | | 58.77 | 59.66 | 60.55 | 61.46 | 62.38 | 63.32 | 64.27 | 65.23 | 66.21 | 67.20 | 68.21 | 69.23 | 70.27 | 71.33 | 72.40 |
| NZU Income | 860 | | 95 | 90 | 82 | 74 | 71 | 63 | 61 | 53 | 51 | 44 | 42 | 38 | 36 | 31 | 29 |
| **Total Income** | **860** | **-** | **95** | **90** | **82** | **74** | **71** | **63** | **61** | **53** | **51** | **44** | **42** | **38** | **36** | **31** | **29** |
| **Net Revenue (Pre-Tax)** | **- 7,232** | **- 3,600** | **- 129** | **- 138** | **- 149** | **- 160** | **- 399** | **- 179** | **- 184** | **- 196** | **- 202** | **- 462** | **- 218** | **- 226** | **- 232** | **- 241** | **- 517** |

## Appendix D3: Scenarios Seven, Eight and Nine

| Scenario Seven - Biodiversity Additionality | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Costs* | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Fencing | 466,000 | 466,000 | | | | | | | | | | | | | | | | | | | | | | | | | |
| Possum Control | 143,705 | 20,426 | 1,248 | 1,266 | 1,285 | 1,304 | 3,517 | 1,344 | 1,364 | 1,385 | 1,405 | 3,789 | 1,448 | 1,469 | 1,492 | 1,514 | 4,081 | 1,560 | 1,583 | 1,607 | 1,631 | 4,397 | 1,680 | 1,705 | 1,731 | 1,757 | 4,737 |
| Ungulate Control | 103,499 | 5,303 | 1,333 | 1,353 | 1,373 | 1,394 | 1,414 | 1,436 | 1,457 | 1,479 | 1,501 | 1,524 | 1,547 | 1,570 | 1,593 | 1,617 | 1,642 | 1,666 | 1,691 | 1,717 | 1,742 | 1,768 | 1,795 | 1,822 | 1,849 | 1,877 | 1,905 |
| Biodiversity Plan Development/Auditing | 21,000 | 5,000 | | | | | 2,000 | | | | | 2,000 | | | | | 2,000 | | | | | | | | 2,000 | | |
| **Total Cost** | **734,204** | **496,729** | **2,580** | **2,619** | **2,658** | **2,698** | **6,931** | **2,780** | **2,821** | **2,864** | **2,907** | **7,312** | **2,994** | **3,039** | **3,085** | **3,131** | **7,723** | **3,226** | **3,274** | **3,323** | **3,373** | **6,165** | **3,475** | **3,527** | **5,580** | **3,634** | **6,642** |
| **Total Cost/Ha** | **13,011** | **8,803** | **46** | **46** | **47** | **48** | **123** | **49** | **50** | **51** | **52** | **130** | **53** | **54** | **55** | **55** | **137** | **57** | **58** | **59** | **60** | **109** | **62** | **63** | **99** | **64** | **118** |

| | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1,810 | 1,837 | 1,865 | 1,893 | 5,103 | 1,950 | 1,979 | 2,009 | 2,039 | 5,497 | 2,101 | 2,132 | 2,164 | 2,197 | 5,922 | 2,263 | 2,297 | 2,331 | 2,366 | 6,380 | 2,438 | 2,474 | 2,512 | 2,549 | 6,873 |
| 1,934 | 1,963 | 1,992 | 2,022 | 2,052 | 2,083 | 2,114 | 2,146 | 2,178 | 2,211 | 2,244 | 2,278 | 2,312 | 2,347 | 2,382 | 2,418 | 2,454 | 2,491 | 2,528 | 2,566 | 2,604 | 2,643 | 2,683 | 2,723 | 2,764 |
| | | 2,000 | | | | | 2,000 | | | | | | | | 2,000 | | | | | 2,000 | | | | |
| **3,744** | **3,800** | **5,857** | **3,915** | **7,155** | **4,033** | **4,094** | **6,155** | **4,217** | **7,708** | **4,345** | **4,410** | **4,476** | **4,543** | **8,304** | **6,681** | **4,751** | **4,822** | **4,894** | **8,945** | **7,042** | **5,118** | **5,195** | **5,273** | **9,637** |
| **66** | **67** | **104** | **69** | **127** | **71** | **73** | **109** | **75** | **137** | **77** | **78** | **79** | **81** | **147** | **118** | **84** | **85** | **87** | **159** | **125** | **91** | **92** | **93** | **171** |

| Scenario Eight - Biodiversity Additionality | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Costs* | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Fencing | 784,000 | 784,000 | | | | | | | | | | | | | | | | | | | | | | | | | |
| Possum Control | 143,705 | 20,426 | 1,248 | 1,266 | 1,285 | 1,304 | 3,517 | 1,344 | 1,364 | 1,385 | 1,405 | 3,789 | 1,448 | 1,469 | 1,492 | 1,514 | 4,081 | 1,560 | 1,583 | 1,607 | 1,631 | 4,397 | 1,680 | 1,705 | 1,731 | 1,757 | 4,737 |
| Ungulate Control | 53,378 | 2,735 | 687 | 698 | 708 | 719 | 729 | 740 | 752 | 763 | 774 | 786 | 798 | 810 | 822 | 834 | 847 | 859 | 872 | 885 | 899 | 912 | 926 | 940 | 954 | 968 | 983 |
| Biodiversity Plan Development/Auditing | 21,000 | 5,000 | | | | | 2,000 | | | | | 2,000 | | | | | 2,000 | | | | | | | | 2,000 | | |
| **Total Cost** | **1,002,083** | **812,161** | **1,935** | **1,964** | **1,993** | **2,023** | **6,246** | **2,084** | **2,116** | **2,147** | **2,180** | **6,575** | **2,245** | **2,279** | **2,313** | **2,348** | **6,928** | **2,419** | **2,455** | **2,492** | **2,529** | **5,309** | **2,606** | **2,645** | **4,685** | **2,725** | **5,719** |
| **Total Cost/Ha** | **17,758** | **14,392** | **34** | **35** | **35** | **36** | **111** | **37** | **37** | **38** | **39** | **117** | **40** | **40** | **41** | **42** | **123** | **43** | **44** | **44** | **45** | **94** | **46** | **47** | **83** | **48** | **101** |

| | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1,810 | 1,837 | 1,865 | 1,893 | 5,103 | 1,950 | 1,979 | 2,009 | 2,039 | 5,497 | 2,101 | 2,132 | 2,164 | 2,197 | 5,922 | 2,263 | 2,297 | 2,331 | 2,366 | 6,380 | 2,438 | 2,474 | 2,512 | 2,549 | 6,873 |
| 997 | 1,012 | 1,027 | 1,043 | 1,058 | 1,074 | 1,090 | 1,107 | 1,123 | 1,140 | 1,157 | 1,175 | 1,192 | 1,210 | 1,228 | 1,247 | 1,266 | 1,284 | 1,304 | 1,323 | 1,343 | 1,363 | 1,384 | 1,405 | 1,426 |
| | | 2,000 | | | | | 2,000 | | | | | | | | 2,000 | | | | | 2,000 | | | | |
| **2,807** | **2,849** | **4,892** | **2,936** | **6,161** | **3,024** | **3,070** | **5,116** | **3,162** | **6,637** | **3,258** | **3,307** | **3,356** | **3,407** | **7,150** | **5,510** | **3,562** | **3,616** | **3,670** | **7,703** | **5,781** | **3,838** | **3,895** | **3,954** | **8,298** |
| **50** | **50** | **87** | **52** | **109** | **54** | **54** | **91** | **56** | **118** | **58** | **59** | **59** | **60** | **127** | **98** | **63** | **64** | **65** | **137** | **102** | **68** | **69** | **70** | **147** |

| Scenario Nine - Biodiversity Additionality | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Costs* | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Fencing | - | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Possum Control | 143,705 | 20,426 | 1,248 | 1,266 | 1,285 | 1,304 | 3,517 | 1,344 | 1,364 | 1,385 | 1,405 | 3,789 | 1,448 | 1,469 | 1,492 | 1,514 | 4,081 | 1,560 | 1,583 | 1,607 | 1,631 | 4,397 | 1,680 | 1,705 | 1,731 | 1,757 | 4,737 |
| Ungulate Control | 103,499 | 5,303 | 1,333 | 1,353 | 1,373 | 1,394 | 1,414 | 1,436 | 1,457 | 1,479 | 1,501 | 1,524 | 1,547 | 1,570 | 1,593 | 1,617 | 1,642 | 1,666 | 1,691 | 1,717 | 1,742 | 1,768 | 1,795 | 1,822 | 1,849 | 1,877 | 1,905 |
| Biodiversity Plan Development/Auditing | 21,000 | 5,000 | | | | | 2,000 | | | | | 2,000 | | | | | 2,000 | | | | | | | | 2,000 | | |
| **Total Cost** | **268,204** | **30,729** | **2,580** | **2,619** | **2,658** | **2,698** | **6,931** | **2,780** | **2,821** | **2,864** | **2,907** | **7,312** | **2,994** | **3,039** | **3,085** | **3,131** | **7,723** | **3,226** | **3,274** | **3,323** | **3,373** | **6,165** | **3,475** | **3,527** | **5,580** | **3,634** | **6,642** |
| **Total Cost/Ha** | **4,753** | **545** | **46** | **46** | **47** | **48** | **123** | **49** | **50** | **51** | **52** | **130** | **53** | **54** | **55** | **55** | **137** | **57** | **58** | **59** | **60** | **109** | **62** | **63** | **99** | **64** | **118** |

| | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1,810 | 1,837 | 1,865 | 1,893 | 5,103 | 1,950 | 1,979 | 2,009 | 2,039 | 5,497 | 2,101 | 2,132 | 2,164 | 2,197 | 5,922 | 2,263 | 2,297 | 2,331 | 2,366 | 6,380 | 2,438 | 2,474 | 2,512 | 2,549 | 6,873 |
| 1,934 | 1,963 | 1,992 | 2,022 | 2,052 | 2,083 | 2,114 | 2,146 | 2,178 | 2,211 | 2,244 | 2,278 | 2,312 | 2,347 | 2,382 | 2,418 | 2,454 | 2,491 | 2,528 | 2,566 | 2,604 | 2,643 | 2,683 | 2,723 | 2,764 |
| | | 2,000 | | | | | 2,000 | | | | | | | | 2,000 | | | | | 2,000 | | | | |
| **3,744** | **3,800** | **5,857** | **3,915** | **7,155** | **4,033** | **4,094** | **6,155** | **4,217** | **7,708** | **4,345** | **4,410** | **4,476** | **4,543** | **8,304** | **6,681** | **4,751** | **4,822** | **4,894** | **8,945** | **7,042** | **5,118** | **5,195** | **5,273** | **9,637** |
| **66** | **67** | **104** | **69** | **127** | **71** | **73** | **109** | **75** | **137** | **77** | **78** | **79** | **81** | **147** | **118** | **84** | **85** | **87** | **159** | **125** | **91** | **92** | **93** | **171** |

# Appendix E: Case Study Five Discounted Cash Flows

## Appendix E1: Scenarios One, Two and Three

| Year | Total | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Property Area (Ha) | | 362.4 | 362.4 | 362.4 | 362.4 | 362.4 | 362.4 | 362.4 | 362.4 | 362.4 | 362.4 | 362.4 | 362.4 | 362.4 | 362.4 | 362.4 | 362.4 |
| Old Growth Forest (Ha) | | 275.8 | 275.8 | 275.8 | 275.8 | 275.8 | 275.8 | 275.8 | 275.8 | 275.8 | 275.8 | 275.8 | 275.8 | 275.8 | 275.8 | 275.8 | 275.8 |
| Regenerating Forest (Ha) | | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 |
| Other Forest (Ha) | | 18.69 | 18.69 | 18.69 | 18.69 | 18.69 | 18.69 | 18.69 | 18.69 | 18.69 | 18.69 | 18.69 | 18.69 | 18.69 | 18.69 | 18.69 | 18.69 |
| **Scenario One - Carbon Additionality** | | | | | | | | | | | | | | | | | |
| ***Costs*** | | | | | | | | | | | | | | | | | |
| Fencing | 1,181,700 | 1,181,700 | | | | | | | | | | | | | | | |
| Possum Control | 21,367 | 6,609 | 660 | 670 | 680 | 690 | 1,860 | 711 | 721 | 732 | 743 | 2,003 | 766 | 777 | 789 | 800 | 2,158 |
| Ungulate Control | 9,176 | 1,767 | 444 | 451 | 458 | 464 | 471 | 478 | 486 | 493 | 500 | 508 | 515 | 523 | 531 | 539 | 547 |
| ETS Registration / Annual Fee | 8,148 | 2,087 | 363 | 369 | 374 | 380 | 386 | 391 | 397 | 403 | 409 | 415 | 422 | 428 | 434 | 441 | 448 |
| FMA Plots | 9,364 | | | | | | 2,892 | | | | | 3,116 | | | | | 3,356 |
| **Total Cost** | **-1,229,756** | **-1,192,163** | **-1,467** | **-1,489** | **-1,511** | **-1,534** | **-5,609** | **-1,580** | **-1,604** | **-1,628** | **-1,653** | **-6,042** | **-1,703** | **-1,728** | **-1,754** | **-1,780** | **-6,509** |
| **Total Cost/Ha** | **4,460** | **4,323** | **5** | **5** | **5** | **6** | **20** | **6** | **6** | **6** | **6** | **22** | **6** | **6** | **6** | **6** | **24** |
| ***Revenue*** | | | | | | | | | | | | | | | | | |
| Baseline CO2 Eq. (t/ha) | | 286.5 | 290.9 | 295 | 298.7 | 302 | 305.1 | 307.8 | 310.4 | 312.6 | 314.7 | 316.5 | 318.2 | 319.7 | 321.1 | 322.3 | 323.4 |
| Managed CO2 Eq. (t/ha) | | 315.2 | 320.0 | 324.5 | 328.6 | 332.2 | 335.6 | 338.6 | 341.4 | 343.9 | 346.2 | 348.2 | 350.0 | 351.7 | 353.2 | 354.5 | 355.7 |
| Additional Annual CO2 Seq. (t/ha) | 3.69 | | 0.4 | 0.4 | 0.4 | 0.3 | 0.3 | 0.3 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 |
| NZU Price | | | 58.77 | 59.66 | 60.55 | 61.46 | 62.38 | 63.32 | 64.27 | 65.23 | 66.21 | 67.20 | 68.21 | 69.23 | 70.27 | 71.33 | 72.40 |
| NZU Income | 7,005 | | 771 | 730 | 668 | 605 | 577 | 510 | 498 | 428 | 415 | 361 | 346 | 310 | 293 | 255 | 238 |
| **Total Income** | **7,005** | **-** | **771** | **730** | **668** | **605** | **577** | **510** | **498** | **428** | **415** | **361** | **346** | **310** | **293** | **255** | **238** |
| **Net Revenue (Pre-Tax)** | **-1,222,750** | **-1,192,163** | **-696** | **-759** | **-843** | **-929** | **-5,032** | **-1,070** | **-1,106** | **-1,200** | **-1,238** | **-5,681** | **-1,357** | **-1,418** | **-1,461** | **-1,525** | **-6,272** |
| **Scenario Two - Carbon Additionality** | | | | | | | | | | | | | | | | | |
| ***Costs*** | | | | | | | | | | | | | | | | | |
| Fencing | 451,000 | 451,000 | | | | | | | | | | | | | | | |
| Possum Control | 21,367 | 6,609 | 660 | 670 | 680 | 690 | 1,860 | 711 | 721 | 732 | 743 | 2,003 | 766 | 777 | 789 | 800 | 2,158 |
| Ungulate Control | 7,507 | 1,446 | 363 | 369 | 374 | 380 | 386 | 391 | 397 | 403 | 409 | 415 | 422 | 428 | 434 | 441 | 448 |
| ETS Registration / Annual Fee | 8,148 | 2,087 | 363 | 369 | 374 | 380 | 386 | 391 | 397 | 403 | 409 | 415 | 422 | 428 | 434 | 441 | 448 |
| FMA Plots | 9,364 | | | | | | 2,892 | | | | | 3,116 | | | | | 3,356 |
| **Total Cost** | **-497,386** | **-461,142** | **-1,386** | **-1,407** | **-1,428** | **-1,450** | **-5,523** | **-1,493** | **-1,516** | **-1,539** | **-1,562** | **-5,950** | **-1,609** | **-1,633** | **-1,657** | **-1,682** | **-6,410** |
| **Total Cost/Ha** | **1,804** | **1,672** | **5** | **5** | **5** | **5** | **20** | **5** | **5** | **6** | **6** | **22** | **6** | **6** | **6** | **6** | **23** |
| ***Revenue*** | | | | | | | | | | | | | | | | | |
| Baseline CO2 Eq. (t/ha) | | 286.5 | 290.9 | 295 | 298.7 | 302 | 305.1 | 307.8 | 310.4 | 312.6 | 314.7 | 316.5 | 318.2 | 319.7 | 321.1 | 322.3 | 323.4 |
| Managed CO2 Eq. (t/ha) | | 315.2 | 319.99 | 324.5 | 328.57 | 332.2 | 335.61 | 338.58 | 341.44 | 343.86 | 346.17 | 348.15 | 350.02 | 351.67 | 353.21 | 354.53 | 355.74 |
| Additional Annual CO2 Seq. (t/ha) | 3.69 | | 0.4 | 0.4 | 0.4 | 0.3 | 0.3 | 0.3 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 |
| NZU Price | | | 58.77 | 59.66 | 60.55 | 61.46 | 62.38 | 63.32 | 64.27 | 65.23 | 66.21 | 67.20 | 68.21 | 69.23 | 70.27 | 71.33 | 72.40 |
| NZU Income | 7,005 | | 771 | 730 | 668 | 605 | 577 | 510 | 498 | 428 | 415 | 361 | 346 | 310 | 293 | 255 | 238 |
| **Total Income** | **7,005** | **-** | **771** | **730** | **668** | **605** | **577** | **510** | **498** | **428** | **415** | **361** | **346** | **310** | **293** | **255** | **238** |
| **Net Revenue (Pre-Tax)** | **-490,381** | **-461,142** | **-615** | **-677** | **-760** | **-845** | **-4,946** | **-983** | **-1,017** | **-1,110** | **-1,147** | **-5,589** | **-1,263** | **-1,323** | **-1,364** | **-1,427** | **-6,172** |
| **Scenario Three - Carbon Additionality** | | | | | | | | | | | | | | | | | |
| ***Costs*** | | | | | | | | | | | | | | | | | |
| Fencing | - | - | | | | | | | | | | | | | | | |
| Possum Control | 21,367 | 6,609 | 660 | 670 | 680 | 690 | 1,860 | 711 | 721 | 732 | 743 | 2,003 | 766 | 777 | 789 | 800 | 2,158 |
| Ungulate Control | 9,176 | 1,767 | 444 | 451 | 458 | 464 | 471 | 478 | 486 | 493 | 500 | 508 | 515 | 523 | 531 | 539 | 547 |
| ETS Registration / Annual Fee | 8,148 | 2,087 | 363 | 369 | 374 | 380 | 386 | 391 | 397 | 403 | 409 | 415 | 422 | 428 | 434 | 441 | 448 |
| FMA Plots | 9,364 | | | | | | 2,892 | | | | | 3,116 | | | | | 3,356 |
| **Total Cost** | **-48,056** | **-10,463** | **-1,467** | **-1,489** | **-1,511** | **-1,534** | **-5,609** | **-1,580** | **-1,604** | **-1,628** | **-1,653** | **-6,042** | **-1,703** | **-1,728** | **-1,754** | **-1,780** | **-6,509** |
| **Total Cost/Ha** | **174** | **38** | **5** | **5** | **5** | **6** | **20** | **6** | **6** | **6** | **6** | **22** | **6** | **6** | **6** | **6** | **24** |
| ***Revenue*** | | | | | | | | | | | | | | | | | |
| Baseline CO2 Eq. (t/ha) | | 286.5 | 290.9 | 295 | 298.7 | 302 | 305.1 | 307.8 | 310.4 | 312.6 | 314.7 | 316.5 | 318.2 | 319.7 | 321.1 | 322.3 | 323.4 |
| Managed CO2 Eq. (t/ha) | | 315.2 | 319.99 | 324.5 | 328.57 | 332.2 | 335.61 | 338.58 | 341.44 | 343.86 | 346.17 | 348.15 | 350.02 | 351.67 | 353.21 | 354.53 | 355.74 |
| Additional Annual CO2 Seq. (t/ha) | | | 0.4 | 0.4 | 0.4 | 0.3 | 0.3 | 0.3 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 |
| NZU Price | | | 58.77 | 59.66 | 60.55 | 61.46 | 62.38 | 63.32 | 64.27 | 65.23 | 66.21 | 67.20 | 68.21 | 69.23 | 70.27 | 71.33 | 72.40 |
| NZU Income | 7,005 | | 771 | 730 | 668 | 605 | 577 | 510 | 498 | 428 | 415 | 361 | 346 | 310 | 293 | 255 | 238 |
| **Total Income** | **7,005** | **-** | **771** | **730** | **668** | **605** | **577** | **510** | **498** | **428** | **415** | **361** | **346** | **310** | **293** | **255** | **238** |
| **Net Revenue (Pre-Tax)** | **-41,050** | **-10,463** | **-696** | **-759** | **-843** | **-929** | **-5,032** | **-1,070** | **-1,106** | **-1,200** | **-1,238** | **-5,681** | **-1,357** | **-1,418** | **-1,461** | **-1,525** | **-6,272** |

## Appendix E2: Scenarios Four, Five and Six

| Scenario Four - Carbon Additionality | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Costs*** | | | | | | | | | | | | | | | | | |
| Fencing | 1,181,700 | 1,181,700 | | | | | | | | | | | | | | | |
| Possum Control | 21,367 | 6,609 | 660 | 670 | 680 | 690 | 1,860 | 711 | 721 | 732 | 743 | 2,003 | 766 | 777 | 789 | 800 | 2,158 |
| Ungulate Control | 9,176 | 1,767 | 444 | 451 | 458 | 464 | 471 | 478 | 486 | 493 | 500 | 508 | 515 | 523 | 531 | 539 | 547 |
| ETS Registration / Annual Fee | 8,148 | 2,087 | 363 | 369 | 374 | 380 | 386 | 391 | 397 | 403 | 409 | 415 | 422 | 428 | 434 | 441 | 448 |
| FMA Plots | - | | | | | | | | | | | | | | | | |
| **Total Cost** | **-1,220,391** | **-1,192,163** | **-1,467** | **-1,489** | **-1,511** | **-1,534** | **-2,717** | **-1,580** | **-1,604** | **-1,628** | **-1,653** | **-2,926** | **-1,703** | **-1,728** | **-1,754** | **-1,780** | **-3,153** |
| **Total Cost/Ha** | **4,426** | **4,323** | **5** | **5** | **5** | **6** | **10** | **6** | **6** | **6** | **6** | **11** | **6** | **6** | **6** | **6** | **11** |
| ***Revenue*** | | | | | | | | | | | | | | | | | |
| Baseline CO2 Eq. (t/ha) | | 286.5 | 290.9 | 295 | 298.7 | 302 | 305.1 | 307.8 | 310.4 | 312.6 | 314.7 | 316.5 | 318.2 | 319.7 | 321.1 | 322.3 | 323.4 |
| Managed CO2 Eq. (t/ha) | | 315.2 | 319.99 | 324.5 | 328.57 | 332.2 | 335.61 | 338.58 | 341.44 | 343.86 | 346.17 | 348.15 | 350.02 | 351.67 | 353.21 | 354.53 | 355.74 |
| Additional Annual CO2 Seq. (t/ha) | | | 0.4 | 0.4 | 0.4 | 0.3 | 0.3 | 0.3 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 |
| NZU Price | | | 58.77 | 59.66 | 60.55 | 61.46 | 62.38 | 63.32 | 64.27 | 65.23 | 66.21 | 67.20 | 68.21 | 69.23 | 70.27 | 71.33 | 72.40 |
| NZU Income | 7,005 | | 771 | 730 | 668 | 605 | 577 | 510 | 498 | 428 | 415 | 361 | 346 | 310 | 293 | 255 | 238 |
| **Total Income** | **7,005** | **-** | **771** | **730** | **668** | **605** | **577** | **510** | **498** | **428** | **415** | **361** | **346** | **310** | **293** | **255** | **238** |
| **Net Revenue (Pre-Tax)** | **-1,213,386** | **-1,192,163** | **-696** | **-759** | **-843** | **-929** | **-2,140** | **-1,070** | **-1,106** | **-1,200** | **-1,238** | **-2,566** | **-1,357** | **-1,418** | **-1,461** | **-1,525** | **-2,915** |

| Scenario Five - Carbon Additionality | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Costs*** | | | | | | | | | | | | | | | | | |
| Fencing | 451,000 | 451,000 | | | | | | | | | | | | | | | |
| Possum Control | 21,367 | 6,609 | 660 | 670 | 680 | 690 | 1,860 | 711 | 721 | 732 | 743 | 2,003 | 766 | 777 | 789 | 800 | 2,158 |
| Ungulate Control | 7,507 | 1,446 | 363 | 369 | 374 | 380 | 386 | 391 | 397 | 403 | 409 | 415 | 422 | 428 | 434 | 441 | 448 |
| ETS Registration / Annual Fee | 8,148 | 2,087 | 363 | 369 | 374 | 380 | 386 | 391 | 397 | 403 | 409 | 415 | 422 | 428 | 434 | 441 | 448 |
| FMA Plots | - | | | | | | | | | | | | | | | | |
| **Total Cost** | **-488,022** | **-461,142** | **-1,386** | **-1,407** | **-1,428** | **-1,450** | **-2,631** | **-1,493** | **-1,516** | **-1,539** | **-1,562** | **-2,834** | **-1,609** | **-1,633** | **-1,657** | **-1,682** | **-3,053** |
| **Total Cost/Ha** | **1,770** | **1,672** | **5** | **5** | **5** | **5** | **10** | **5** | **5** | **6** | **6** | **10** | **6** | **6** | **6** | **6** | **11** |
| ***Revenue*** | | | | | | | | | | | | | | | | | |
| Baseline CO2 Eq. (t/ha) | | 286.5 | 290.9 | 295 | 298.7 | 302 | 305.1 | 307.8 | 310.4 | 312.6 | 314.7 | 316.5 | 318.2 | 319.7 | 321.1 | 322.3 | 323.4 |
| Managed CO2 Eq. (t/ha) | | 315.2 | 319.99 | 324.5 | 328.57 | 332.2 | 335.61 | 338.58 | 341.44 | 343.86 | 346.17 | 348.15 | 350.02 | 351.67 | 353.21 | 354.53 | 355.74 |
| Additional Annual CO2 Seq. (t/ha) | | | 0.4 | 0.4 | 0.4 | 0.3 | 0.3 | 0.3 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 |
| NZU Price | | | 58.77 | 59.66 | 60.55 | 61.46 | 62.38 | 63.32 | 64.27 | 65.23 | 66.21 | 67.20 | 68.21 | 69.23 | 70.27 | 71.33 | 72.40 |
| NZU Income | 7,005 | | 771 | 730 | 668 | 605 | 577 | 510 | 498 | 428 | 415 | 361 | 346 | 310 | 293 | 255 | 238 |
| **Total Income** | **7,005** | **-** | **771** | **730** | **668** | **605** | **577** | **510** | **498** | **428** | **415** | **361** | **346** | **310** | **293** | **255** | **238** |
| **Net Revenue (Pre-Tax)** | **-481,017** | **-461,142** | **-615** | **-677** | **-760** | **-845** | **-2,054** | **-983** | **-1,017** | **-1,110** | **-1,147** | **-2,473** | **-1,263** | **-1,323** | **-1,364** | **-1,427** | **-2,816** |

| Scenario Six - Carbon Additionality | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Costs*** | | | | | | | | | | | | | | | | | |
| Fencing | - | - | | | | | | | | | | | | | | | |
| Possum Control | 21,367 | 6,609 | 660 | 670 | 680 | 690 | 1,860 | 711 | 721 | 732 | 743 | 2,003 | 766 | 777 | 789 | 800 | 2,158 |
| Ungulate Control | 9,176 | 1,767 | 444 | 451 | 458 | 464 | 471 | 478 | 486 | 493 | 500 | 508 | 515 | 523 | 531 | 539 | 547 |
| ETS Registration / Annual Fee | 8,148 | 2,087 | 363 | 369 | 374 | 380 | 386 | 391 | 397 | 403 | 409 | 415 | 422 | 428 | 434 | 441 | 448 |
| FMA Plots | - | | | | | | | | | | | | | | | | |
| **Total Cost** | **-38,691** | **-10,463** | **-1,467** | **-1,489** | **-1,511** | **-1,534** | **-2,717** | **-1,580** | **-1,604** | **-1,628** | **-1,653** | **-2,926** | **-1,703** | **-1,728** | **-1,754** | **-1,780** | **-3,153** |
| **Total Cost/Ha** | **140** | **38** | **5** | **5** | **5** | **6** | **10** | **6** | **6** | **6** | **6** | **11** | **6** | **6** | **6** | **6** | **11** |
| ***Revenue*** | | | | | | | | | | | | | | | | | |
| Baseline CO2 Eq. (t/ha) | | 286.5 | 290.9 | 295 | 298.7 | 302 | 305.1 | 307.8 | 310.4 | 312.6 | 314.7 | 316.5 | 318.2 | 319.7 | 321.1 | 322.3 | 323.4 |
| Managed CO2 Eq. (t/ha) | | 315.2 | 319.99 | 324.5 | 328.57 | 332.2 | 335.61 | 338.58 | 341.44 | 343.86 | 346.17 | 348.15 | 350.02 | 351.67 | 353.21 | 354.53 | 355.74 |
| Additional Annual CO2 Seq. (t/ha) | | | 0.4 | 0.4 | 0.4 | 0.3 | 0.3 | 0.3 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 |
| NZU Price | | | 58.77 | 59.66 | 60.55 | 61.46 | 62.38 | 63.32 | 64.27 | 65.23 | 66.21 | 67.20 | 68.21 | 69.23 | 70.27 | 71.33 | 72.40 |
| NZU Income | 7,005 | | 771 | 730 | 668 | 605 | 577 | 510 | 498 | 428 | 415 | 361 | 346 | 310 | 293 | 255 | 238 |
| **Total Income** | **7,005** | **-** | **771** | **730** | **668** | **605** | **577** | **510** | **498** | **428** | **415** | **361** | **346** | **310** | **293** | **255** | **238** |
| **Net Revenue (Pre-Tax)** | **-31,686** | **-10,463** | **-696** | **-759** | **-843** | **-929** | **-2,140** | **-1,070** | **-1,106** | **-1,200** | **-1,238** | **-2,566** | **-1,357** | **-1,418** | **-1,461** | **-1,525** | **-2,915** |

## Appendix E3: Scenarios Seven, Eight and Nine

| | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Scenario Seven - Biodiversity Additionality** | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ***Costs*** | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Fencing | 1,181,700 | 1,181,700 | | | | | | | | | | | | | | | | | | | | | | | | | |
| Possum Control | 684,350 | 61,092 | 6,307 | 6,402 | 6,498 | 6,595 | 17,780 | 6,794 | 6,896 | 7,000 | 7,105 | 19,154 | 7,320 | 7,429 | 7,541 | 7,654 | 20,634 | 7,885 | 8,003 | 8,124 | 8,245 | 22,229 | 8,495 | 8,622 | 8,751 | 8,883 | 23,947 |
| Ungulate Control | 528,759 | 27,092 | 6,808 | 6,911 | 7,014 | 7,119 | 7,226 | 7,335 | 7,445 | 7,556 | 7,670 | 7,785 | 7,901 | 8,020 | 8,140 | 8,262 | 8,386 | 8,512 | 8,640 | 8,769 | 8,901 | 9,034 | 9,170 | 9,308 | 9,447 | 9,589 | 9,733 |
| Biodiversity Plan Development/Auditing | 21,000 | 5,000 | | | | | 2,000 | | | | | 2,000 | | | | | 2,000 | | | | | | | | 2,000 | | |
| **Total Cost** | **2,415,809** | **1,274,884** | **13,115** | **13,312** | **13,512** | **13,715** | **27,006** | **14,129** | **14,341** | **14,556** | **14,774** | **28,939** | **15,221** | **15,449** | **15,681** | **15,916** | **31,021** | **16,397** | **16,643** | **16,893** | **17,146** | **31,264** | **17,665** | **17,930** | **20,199** | **18,471** | **33,680** |
| **Total Cost/Ha** | **8,761** | **4,623** | **48** | **48** | **49** | **50** | **98** | **51** | **52** | **53** | **54** | **105** | **55** | **56** | **57** | **58** | **112** | **59** | **60** | **61** | **62** | **113** | **64** | **65** | **73** | **67** | **122** |

| | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9,151 | 9,288 | 9,428 | 9,569 | 25,798 | 9,858 | 10,006 | 10,156 | 10,309 | 27,792 | 10,620 | 10,780 | 10,941 | 11,105 | 29,939 | 11,441 | 11,613 | 11,787 | 11,964 | 32,253 | 12,325 | 12,510 | 12,698 | 12,888 | 34,746 |
| 9,879 | 10,027 | 10,177 | 10,330 | 10,485 | 10,642 | 10,802 | 10,964 | 11,128 | 11,295 | 11,465 | 11,637 | 11,811 | 11,988 | 12,168 | 12,351 | 12,536 | 12,724 | 12,915 | 13,109 | 13,305 | 13,505 | 13,707 | 13,913 | 14,122 |
| | | 2,000 | | | | | 2,000 | | | | | | | | 2,000 | | | | | 2,000 | | | | |
| **19,030** | **19,315** | **21,605** | **19,899** | **36,283** | **20,500** | **20,808** | **23,120** | **21,437** | **39,087** | **22,085** | **22,416** | **22,752** | **23,094** | **42,108** | **25,792** | **24,149** | **24,511** | **24,878** | **45,362** | **27,630** | **26,015** | **26,405** | **26,801** | **48,868** |
| **69** | **70** | **78** | **72** | **132** | **74** | **75** | **84** | **78** | **142** | **80** | **81** | **83** | **84** | **153** | **94** | **88** | **89** | **90** | **165** | **100** | **94** | **96** | **97** | **177** |

| | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Scenario Eight - Biodiversity Additionality** | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ***Costs*** | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Fencing | 1,116,000 | 1,116,000 | | | | | | | | | | | | | | | | | | | | | | | | | |
| Possum Control | 684,350 | 61,092 | 6,307 | 6,402 | 6,498 | 6,595 | 17,780 | 6,794 | 6,896 | 7,000 | 7,105 | 19,154 | 7,320 | 7,429 | 7,541 | 7,654 | 20,634 | 7,885 | 8,003 | 8,124 | 8,245 | 22,229 | 8,495 | 8,622 | 8,751 | 8,883 | 23,947 |
| Ungulate Control | 260,838 | 13,365 | 3,359 | 3,409 | 3,460 | 3,512 | 3,565 | 3,618 | 3,672 | 3,728 | 3,783 | 3,840 | 3,898 | 3,956 | 4,016 | 4,076 | 4,137 | 4,199 | 4,262 | 4,326 | 4,391 | 4,457 | 4,524 | 4,591 | 4,660 | 4,730 | 4,801 |
| Biodiversity Plan Development/Auditing | 21,000 | 5,000 | | | | | 2,000 | | | | | 2,000 | | | | | 2,000 | | | | | | | | 2,000 | | |
| **Total Cost** | **2,082,189** | **1,195,457** | **9,666** | **9,811** | **9,958** | **10,107** | **23,345** | **10,413** | **10,569** | **10,727** | **10,888** | **24,994** | **11,217** | **11,386** | **11,556** | **11,730** | **26,771** | **12,084** | **12,266** | **12,450** | **12,636** | **26,686** | **13,018** | **13,213** | **15,412** | **13,613** | **28,748** |
| **Total Cost/Ha** | **7,551** | **4,335** | **35** | **36** | **36** | **37** | **85** | **38** | **38** | **39** | **39** | **91** | **41** | **41** | **42** | **43** | **97** | **44** | **44** | **45** | **46** | **97** | **47** | **48** | **56** | **49** | **104** |

| | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9,151 | 9,288 | 9,428 | 9,569 | 25,798 | 9,858 | 10,006 | 10,156 | 10,309 | 27,792 | 10,620 | 10,780 | 10,941 | 11,105 | 29,939 | 11,441 | 11,613 | 11,787 | 11,964 | 32,253 | 12,325 | 12,510 | 12,698 | 12,888 | 34,746 |
| 4,873 | 4,946 | 5,020 | 5,096 | 5,172 | 5,250 | 5,329 | 5,408 | 5,490 | 5,572 | 5,656 | 5,740 | 5,826 | 5,914 | 6,003 | 6,093 | 6,184 | 6,277 | 6,371 | 6,466 | 6,563 | 6,662 | 6,762 | 6,863 | 6,966 |
| | | 2,000 | | | | | 2,000 | | | | | | | | 2,000 | | | | | 2,000 | | | | |
| **14,024** | **14,235** | **16,448** | **14,665** | **30,970** | **15,108** | **15,335** | **17,565** | **15,798** | **33,364** | **16,276** | **16,520** | **16,768** | **17,019** | **35,942** | **19,534** | **17,797** | **18,064** | **18,335** | **38,720** | **20,889** | **19,172** | **19,460** | **19,751** | **41,712** |
| **51** | **52** | **60** | **53** | **112** | **55** | **56** | **64** | **57** | **121** | **59** | **60** | **61** | **62** | **130** | **71** | **65** | **66** | **66** | **140** | **76** | **70** | **71** | **72** | **151** |

| | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Scenario Nine - Biodiversity Additionality** | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ***Costs*** | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Fencing | - | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Possum Control | 684,350 | 61,092 | 6,307 | 6,402 | 6,498 | 6,595 | 17,780 | 6,794 | 6,896 | 7,000 | 7,105 | 19,154 | 7,320 | 7,429 | 7,541 | 7,654 | 20,634 | 7,885 | 8,003 | 8,124 | 8,245 | 22,229 | 8,495 | 8,622 | 8,751 | 8,883 | 23,947 |
| Ungulate Control | 528,759 | 27,092 | 6,808 | 6,911 | 7,014 | 7,119 | 7,226 | 7,335 | 7,445 | 7,556 | 7,670 | 7,785 | 7,901 | 8,020 | 8,140 | 8,262 | 8,386 | 8,512 | 8,640 | 8,769 | 8,901 | 9,034 | 9,170 | 9,308 | 9,447 | 9,589 | 9,733 |
| Biodiversity Plan Development/Auditing | 21,000 | 5,000 | | | | | 2,000 | | | | | 2,000 | | | | | 2,000 | | | | | | | | 2,000 | | |
| **Total Cost** | **1,234,109** | **93,184** | **13,115** | **13,312** | **13,512** | **13,715** | **27,006** | **14,129** | **14,341** | **14,556** | **14,774** | **28,939** | **15,221** | **15,449** | **15,681** | **15,916** | **31,021** | **16,397** | **16,643** | **16,893** | **17,146** | **31,264** | **17,665** | **17,930** | **20,199** | **18,471** | **33,680** |
| **Total Cost/Ha** | **4,475** | **338** | **48** | **48** | **49** | **50** | **98** | **51** | **52** | **53** | **54** | **105** | **55** | **56** | **57** | **58** | **112** | **59** | **60** | **61** | **62** | **113** | **64** | **65** | **73** | **67** | **122** |

| | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9,151 | 9,288 | 9,428 | 9,569 | 25,798 | 9,858 | 10,006 | 10,156 | 10,309 | 27,792 | 10,620 | 10,780 | 10,941 | 11,105 | 29,939 | 11,441 | 11,613 | 11,787 | 11,964 | 32,253 | 12,325 | 12,510 | 12,698 | 12,888 | 34,746 |
| 9,879 | 10,027 | 10,177 | 10,330 | 10,485 | 10,642 | 10,802 | 10,964 | 11,128 | 11,295 | 11,465 | 11,637 | 11,811 | 11,988 | 12,168 | 12,351 | 12,536 | 12,724 | 12,915 | 13,109 | 13,305 | 13,505 | 13,707 | 13,913 | 14,122 |
| | | 2,000 | | | | | 2,000 | | | | | | | | 2,000 | | | | | 2,000 | | | | |
| **19,030** | **19,315** | **21,605** | **19,899** | **36,283** | **20,500** | **20,808** | **23,120** | **21,437** | **39,087** | **22,085** | **22,416** | **22,752** | **23,094** | **42,108** | **25,792** | **24,149** | **24,511** | **24,878** | **45,362** | **27,630** | **26,015** | **26,405** | **26,801** | **48,868** |
| **69** | **70** | **78** | **72** | **132** | **74** | **75** | **84** | **78** | **142** | **80** | **81** | **83** | **84** | **153** | **94** | **88** | **89** | **90** | **165** | **100** | **94** | **96** | **97** | **177** |