Supporting native plantation forestry in the NZ ETS: Combining revenue from carbon, native timber, and co-benefits

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Disclaimer

All opinions are those of the author and she is responsible for any errors or omissions.

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Abstract

This paper aims to document the evidence available on benefits that a native plantation forest could provide through the emissions trading system, and beyond. The establishment of native forestry provides a wide range of benefits, a number of which have the potential to generate revenue streams. Combining these through careful multi-investor contracts could make native plantation forests an attractive option in a wider set of circumstances.

Keywords

Forestry, Emissions Trading, Climate change, Environment, New Zealand, Indigenous forestry, Native forestry, Plantation forestry

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Executive Summary

This paper aims to document the evidence available on benefits that a native plantation forest could provide through the emissions trading system, and beyond. The establishment of native forestry provides a wide range of benefits, a number of which have the potential to generate revenue streams.

To make informed land-use decisions, land owners and those with land use rights need to be able to understand and access information about the range of those income streams they can generate from the land and the process to realise those income streams.

Establishing native plantation forests not only provides monetary benefits from timber production, but also provides environmental benefits as native forests help to counteract the accumulation of carbon dioxide in our atmosphere. Landowners with forests that are 100 hectares or greater in size, who use the Field Management Approach for measuring their forest's carbon stocks, could store average carbon stocks of up to 490 (t/ha), based on research by Kimberly et al (2014).[1] Native forests also reduce erosion, improve water quality, and protect biodiversity.

This paper details:

- The processes involved with participating in the emissions trading system with a native plantation forest and how the rules work in that system for native forests;
- estimates of the cost of establishing a native plantation;
- estimates of the cost of generating revenue from different benefits; and
- the value of the different revenue streams.

This paper also discusses contractual aspects, namely:

- the risks of different revenue streams;
- how contracts involving multiple investors will need to account for these risks; and
- how investors' characteristics may impact the design of these contracts.

The New Zealand Emissions Trading Scheme (NZ ETS) offers a functioning regulatory market framework for native forestry plantations. Native forestry is eligible to be registered under the NZ ETS in the same manner as exotic forestry.

This paper sets out how to identify if a piece of land is eligible for entry into the NZ ETS, how to enter a forest in the NZ ETS, outlining the criteria for a forest under the NZ ETS, the importance of obtaining consent, how to open a registry account, how to map the forest, and how to apply to become a participant and register the forest under the NZ ETS. It is also

[1] Assuming the forest is planted on land of average quality and averaged over an 80 year period.

important to understand the obligations of forestry participants under the NZ ETS and the importance of filing emissions returns in order to facilitate the issuance of units under the NZ ETS or notify the government of important changes to the forest.

Calculation of the carbon stocks of the forest can be complex and is determined by the size of the forest, the type of forestry, the planting periods and the harvesting timetable. This paper sets out some scenarios for small forests to indicate how carbon stocks are calculated. For larger forests, participants must use a 'field management approach' that is responsive to factors such as fertility of the land, and the environmental conditions of the region. Interestingly, all of the native forest species surveyed have higher total carbon stocks in comparison to the default look-up table, suggesting that participants who are able to use the field management approach could earn significantly more carbon units.

Landowners who establish a new native plantation forest and register their forest in the NZ ETS can generate a revenue from selling "safe" New Zealand Units (NZUs). Safe NZUs are defined here as the NZUs a landowner who never deforests will never have to surrender to the crown to meet harvesting liabilities and can therefore sell without taking on price risk. A landowner who clear fells[2] a native forest that is less than 100 hectares in size has at least 40.2 safe NZUs per hectare. At an NZU price of $20 and with a real discount rate of 8% - both very conservative assumptions - this generates a present value of $804.[3]

Landowners who choose to selectively harvest their forest can increase the number of safe NZUs their forest will generate. Landowners who selectively harvest their forest, whereby they harvest and replant one hectare of their forest every year can sell units up to the level of average carbon stock. For forests that are less than 100 hectares in size, the average carbon stock is 181.8 (t/ha). At a constant NZU price of $20 this is a present value of $1,275 per hectare. Landowners with forests of different ages, or who can negotiate financial contracts with other forest owners or emitters, can also sell up to this many NZUs without facing price risk.

Landowners receive these safe NZUs in the early years of the life of a forest, therefore generating revenue that helps to supplement interim income until native timber revenue flows.

When carbon revenues are combined with timber revenues, native plantations can be more viable for landowners. There is a significant gap between the carbon value and the cost of establishing plantation natives. For planting to occur, the value of harvested wood products and co-benefits other than carbon must be high enough to cover this gap. The choice of native tree species impacts both carbon income and timber income (and also other potential benefits such as honey) so it is important to understand the market rules and values in both of these markets.

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[2] Clear fell refers to harvesting an entire forest at once.

[3] A landowner can only safely sell 40.2 NZUs per hectare, assuming that the forest owner replants after every harvest, if the landowner deforests they will need to surrender all the NZUs they have earnt, if the forest owner has sold their "40.2" NZUs, they must purchase these NZUs at prevailing market prices. This is the mechanism by which the NZ ETS incentivizes landowners to keep replanting. This also assumes that the landowner had registered their forest from the forests establishment and applies an 8% discount rate.

New Zealand's native timber is high quality and can be sold for a high price. However, there is also high uncertainty around the value of different species native timbers and high uncertainty around the costs of establishing a native forest. Estimates of cost range from $15,000 to $30,000 per hectare. As landowners increasingly choose to establish native forests, more information on the value of different timber and establishment costs will become available.

A number of co-benefits can be reaped from native forests. Some of these co-benefits can even generate an additional income for landowners under existing market structures, policies and frameworks. These include Manuka honey, erosion control and water quality improvements (income from the latter two being largely dependent on local authority funding programmes or being part of collaborative well-funded community programmes such as 'Reconnecting Northland'[4]). Other co-benefits include tourism, biodiversity, habitat improvements and improvements for recreational use. Monetising these is often challenging.

Focussing on the existing markets, Manuka Honey for example can provide a landowner with an income from years 7 to 20 of the Manuka's lifecycle. The NPV of this income can range from $3,701 (ha) to $25,173 (ha) (Manuka Farming New Zealand). In some regions payments are also available for establishing forest land to reduce erosion. For example, the erosion control funding programme in the Gisborne region, provides $1,500-$2,000 for each hectare of forest that a landowner establishes (Ministry for Primary Industries, 2017i). Such co-benefits can help alleviate the burden of the native forest's establishment costs and also provide landowners with an income during the initial years of a plantation's life cycle. This may be very attractive to landowners, considering that native forests' rotation periods are generally a minimum of 60 years, with some species requiring rotation periods in excess of 80 years.

The different sources of potential revenue streams that we have detailed all have their own risks. When looking to combine and monetise the benefits of native plantation forestry, the various markets and 'buyers' need to be identified and the risks well understood and managed through well-crafted contract. Contracts that combine multiple revenue streams from native forests will ideally account for these risks, clearly outlining who bears each risk and the rights and obligations of each contract party.

Contracts would also ideally account for investor specific characteristics. This is especially important for contracts that combine investments in native forestry, due to the potential heterogeneity of investors. These investors will have varying motivations for investing, different risk aversions, different ability to control risk and varying access to capital. The variation in risk aversion will affect what discount rate a potential investor applies when evaluating the value of a revenue stream, this in turn affects how much the investor will be willing to pay for the right to that revenue stream. Different investors will also have varying capital availability, which will

[4] Reconnecting Northland is the first large-scale ecological restoration programme in New Zealand, focusing on the wellbeing of both the people and the land. See: http://reconnectingnorthland.org.nz/.

affect how much they are able to pay for the right to a revenue stream. Contracts will need to take into account all of these issues.

A contract would ideally combine philanthropy or local government funding to pay for non-marketed benefits such as biodiversity or erosion control, with capital provided by an investor with a low discount rate to establish the forest. NGOs could possibly mobilise free labour to help with establishment. The most knowledgeable actors (or those capable of contracting for expertise), and those with the lowest risk aversion would be exposed to the risks associated with the amount and quality of timber generated, and the timber and carbon prices. This would ensure strong incentives to make good decisions on management of both the forest and the NZUs while protecting those who are more risk averse.

1 Introduction

In order to be make informed land-use decisions, land owners need to be able to understand and access information about the various income streams they can generate from their land. Native plantation forestry can deliver a range of benefits, some of which have marketable value. This paper aims to document the limited evidence available on benefits that a native plantation forest could provide, with a particular focus on accessing carbon revenue via the ETS.

"Plantation" native forestry means tree species indigenous to New Zealand that are planted with the aim of harvesting the timber. There is a range of possible modalities for establishing plantation native forestry. In some cases, the forest will resemble exotic plantation forestry, where a single species is planted at regular intervals and is harvested as a whole. In other cases, the forest may be planted and managed as a multi-species, multi-aged forest using continuous cover forestry principles (Barton 2008). Many groups, including some iwi, are interested in more "sustainable" harvesting methods and in extracting other by-products from the land (Hall 2016). Even when it is not established or managed to resemble a "natural" forest (permanent forest cover and a diverse set of tree/shrub species), the forested land can still sequester significant levels of carbon and provide important social, cultural and environmental co-benefits.

Landowners can engage with the NZ ETS and generate carbon revenue from native plantation forestry under that scheme. A level of New Zealand Units (NZUs) up to the average carbon stock of the forest can potentially be sold without incurring price risk, thus generating a revenue from carbon for over two decades.

Landowners who establish a new native plantation forest and register their forest in the ETS can generate a revenue from selling "safe" NZUs[5]. Landowners who choose to selectively harvest their forest can increase the number of safe NZUs their forest will generate. If they harvest and replant one out of each 50 ha of their forest every year, they can sell units up to the level of average carbon stock. Landowners with forests of different ages, or who can negotiate financial contracts with other forest owners or emitters, can also sell more NZUs without facing price risk. For example, for forests that are less than 100 hectares in size, the average carbon stock is 181.8 (t/ha) and the land owner can sell up to the average carbon stock. At an NZU price of $20 and with a real discount rate of 8% - both extremely conservative assumptions - this is a present value of $1,275 per hectare. Landowners with larger forests may be able to sell considerably more. Landowners receive these safe NZUs in the early years of the life of a forest, therefore generating revenue that can supplement other sources of interim income until native timber revenue flows.

[5] Safe NZUs are defined as the NZUs a landowner, who never intends to deforest, does not have to surrender to the crown to meet harvesting liabilities and can therefore sell without taking on price risk.

New Zealand's native timber is high quality and can be sold for a high price. There is, however, high uncertainty around the value of different species of native timbers and around the costs of establishing a native forest. Estimates of cost range from $15,000 to $30,000 per hectare. As well as providing timber and sequestering carbon, native forests can also provide a range of co-benefits, such as erosion and flood control, the production of Manuka honey, freshwater quality, pollination, recreational and tourism, cultural and spiritual and provision of habitat to support biodiversity. Some of these co-benefits can also generate a revenue for landowners. The erosion control funding programme in the Gisborne region, provides $1,500-$2,000 for each hectare of forest that a landowner establishes (Ministry for Primary Industries, 2017i). If Manuka is used as a nursery crop for the native plantation, Manuka Honey can provide a landowner with an income from years 7 to 20 of the Manuka's lifecycle. The NPV of this income can range from $3,701 (ha) to $25,173 (ha) (Manuka Farming New Zealand).

Due to the wide range of benefits and revenue streams that native forestry can provide, it's possible that groups of investors could come together and form multi-party contracts where each investor pays for a portion of the costs of establishing a native forest in return for the rights to different revenue streams. Multi-party contracts would help landowners to share the burden of high initial establishment costs, share the carbon and timber price risks, and possibly access expertise, while accounting for investor specific characteristics.

The paper is structured as follows. Section 2 outlines how carbon revenue can be generated from plantation native forestry under the ETS. Section 3 sets out estimated costs of establishing native plantation forestry and the potential value of a number of timber species values. Section 3 of the paper discusses a range of co-benefits that may be generated from native forestry plantations in addition to carbon sequestration. Section 4 then brings those three potential income streams together and outlines how they can be monetised (or at least valued by some investors), outlining risks, investor types, counterparty risks and key contract design considerations.

2 Forest Carbon Revenue: Generating income from native plantation forestry under the ETS

This section briefly outlines the historical context and current state of native forestry in the ETS. It then outlines how native plantation forestry can enter the ETS and how emission units / carbon credits are calculated for native forestry under the ETS rules.

2.1 Historical context and native forestry in the ETS

The ETS was introduced in 2008 as a part of the country's efforts to meet its Kyoto Protocol obligations[6]. The only unit of trade in the ETS is the New Zealand Unit (NZU). One NZU represents one tonne of carbon dioxide. The Government issues NZUs for increases in carbon stock in certain forests. NZUs may be held or bought and sold within New Zealand only. NZUs are held in the New Zealand Emission Unit Register (NZEUR).

The ETS aims to incentivise the planting of 'additional' forests, i.e. planting that would not have occurred in the absence of the ETS. New Zealand is the first, and still the only, country to include forest landowners as full participants in its ETS. This recognises the significant role the sector can play in helping the nation achieve its emission mitigation targets.

Forests, and particularly afforestation, can act as a "carbon sink", sequestering carbon and therefore counteracting the accumulation of carbon dioxide (CO2) in the atmosphere, which is the main cause of climate change. Forestry can also face liabilities under the ETS for reductions in carbon stocks on forestry land, either from harvesting (of post-1989 forests that have been registered in the ETS) or deforestation (mandatory for most pre-1990 exotic forests). Harvesting is distinct from deforestation, in that deforestation is a conversion of forested land to another land use, while harvesting is the "removal of biomass from a site followed by reforestation (replanting or natural regeneration)" (Ministry for the Environment 2015b).

The Afforestation Grant Scheme (AGS) and the Permanent Forest Sink Initiative (PFSI) are two other closely related policies that landowners can use to obtain finance and NZUs for afforestation efforts. This paper does not outline these in detail.[7] However, it is worth noting that in 2017 the NPV of the first 10 years of carbon credits from planted native forests was much less than the $1,300 payment from the AGS. It thus could make sense to utilise this.

Broadly speaking, the forestry component of the ETS provides incentives to promote carbon sequestration and storage by 1) Discouraging deforestation of pre-1990 exotic forests[8]; and encouraging: 2) Planting of new post-1989 forests; 3) Replanting of post-1989 forests; and 4) Extending harvest rotations of post-1989 forests, and increasing their forest carbon density.

Forests are distinguished based on their establishment date as either "pre-1990" or "post-1989". This structure frames the key rules for forestry in the ETS. This paper focusses on post-1989 forestry opportunities in native plantation forestry. Post-1989 forest landowners may voluntarily register as ETS participants but are not obliged to do so. Participating post-1989

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[6] For more information, see https://www.climatechange.govt.nz/emissions-trading-scheme and Leining (2016).
[7] The PFSI "promotes the establishment of permanent forests on private land". It enables landowners to earn carbon units for permanent forests planted after 1990 that were directly human induced. For more details see: https://mpi.govt.nz/funding-and-programmes/forestry/permanent-forest-sink-initiative/. The rewards are closely aligned with the ETS. The differences are mostly administrative. In 2017, the AGS promotes new planting by giving a $1,300/hectare grant to smaller (5-300 hectare) forests. The landowner receives the grant upon establishing the forest, and in exchange the Crown gets the NZUs for the first ten years. For more details see: https://www.mpi.govt.nz/funding-and-programmes/forestry/afforestation-grant-scheme/.
[8] Pre-1990 native forest owners **are not** required to register as mandatory participants in the NZ ETS if they deforest but may be subject to other deforestation restrictions under the Forests Act 1949.

forests are eligible to earn units for net carbon sequestered by their trees. Participants can however claim units only for the five year mandatory emissions reporting periods (MERP) in which they are registered.

Establishing new stands of native forestry (i.e. afforestation) has significant potential to help New Zealand companies meet their ETS commitments, contribute to voluntary programmes that go beyond New Zealand's target for corporate social responsibility reasons, and meet sectoral international commitments such as those under the International Civil Aviation Organization.

Three hundred thousand hectares of forest land are registered in the ETS. Of this, only 25,000 hectares are native (8%). Almost 90% of this native afforestation occurred between 1990 and 2000 so was not established in response to the ETS. An additional 12,000 hectares of forest land is registered in the AGS (and has been established since 2008) and 14,000 is registered in the PFSI. It is unclear how much of the forest in the AGS and PFSI is native as these data are not available; however, Ollie Belton (Managing Director, Carbon Forest Services) has stated that most of the PFSI forest land is native. Since 2008 only 500 hectares of native forest has been afforested and included in the ETS; this represents 1.5% of afforestation in the ETS since 2008 (Ministry for Primary Industries 2016b). Other afforestation of native forests has likely been included in the PFSI and AGS. In terms of its composition, more than 70% of native afforestation is naturally regenerating Manuka/Kanuka (Ministry for Primary Industries 2015b).

There is strong interest among a variety of stakeholders, including community groups and iwi, in planting more native trees, or regenerating native forest, for biodiversity, plantation forestry diversity, cultural and aesthetic reasons, and for erosion control. The financial returns from forestry have improved recently: the carbon price has rebounded; there is more certainty around New Zealand's global commitments with the Paris Agreement; and there are other potential payments for forestry available, as outlined in other sections of this paper.

2.2 How to enter a forest into the ETS

Land owners and those with registered forestry rights or leases over Post-1989 forests are eligible to register a forest under the ETS and become an ETS participant. The participant is the point of obligation and may be able to earn NZUs through the ETS if the land and forest meet certain criteria, and if specific obligations and processes are met. Those criteria, obligations and processes are set out in this section.

2.2.1 ETS definitions of Post-1989 Forests – is the forest on eligible land?

A forest will be classified as a Post-1989 forest if it meets at least one of the following three criteria (Ministry for Primary Industries, 2017e):

1. The forest was established on or after 1 January 1990 and the land on which the forest is established was not forested on 31 December 1989 (post-1989).

Eligible forms of evidence that an applicant can submit include forest maps showing the forest type and year of establishment, aerial or other photographs of the forest land dated around the 31st December 1989, recent aerial or other photographs of the forest area or satellite imagery if the forest has recently been established, planting contractors' invoices and consents issued under the Resource Management Act 1991. If there was forestry in the region around 1989, MPI may require aerial photography, to prove that this particular land was not also forested. Evidence is submitted to the Ministry for Primary Industries during the application process.

In cases where vegetation did exist on the land around 1989, the applicant must provide evidence that the vegetation did not meet the ETS forest definition (Ministry for Primary Industries, 2015a), namely that the vegetation was a non-tree species such as gorse or that it was juvenile trees subject to land management techniques that would have prevented them from ever reaching five metres (Belton, 2014).[9]

2. The land was deforested between 1 January 1990 and 31 December 2007 and the new forest was established on or after 1 January 2008.

The applicant can use one or more of the above forms of evidence to prove that the new native forest was established on or after 1 January 2008. The applicant must also provide evidence that that the previous forest was deforested between 1 January 1990 and 31 December 2007. The NZ ETS defines deforestation as clearing a forest and converting to another land use, or clearing and not replanting within 4 years (Ministry for Primary Industries, 2017d). Eligible forms of evidence may therefore include satellite imagery or photography of the land at two points in time (four or more years apart), that show the land was clear or in an alternative land use prior to 1 January 2008.

3. The land was forested with an exotic forest species on 1 January 1990 (A Pre-1990 forest), but was deforested after 1 January 2008 and the landowner has paid the deforestation liability (by surrendering units) to the crown for the carbon stocks that have been released into the atmosphere when their land was deforested.

Once this liability has been paid, the new forest can be classified as Post-1989 forestry and is eligible to earn NZUs for any increases in the forest’s carbon stocks. The applicant can use one or more of the above forms of evidence to prove the new forest was established on or after 1 January 2008. An applicant should include multiple forms of evidence in their application, to ensure that it is clear that the forest can be classified as Post-1989 forestry.

[9] Generally Belton (2014) states that generally the evidence must be farming or planting records from around 1990 (Belton, 2014).

If an applicant is uncertain about whether their forest is eligible, or about the evidence required, they should contact MPI early in the registration process to discuss the rules surrounding eligibility.

2.2.2 Forest criteria – is the native plantation a 'forest'?

The ETS defines a 'forest' as a grouping of trees at least one hectare in size with an average width of at least 30 meters, which must have a stocking density that results (or will result) in a tree crown cover of more than 30% in each hectare. The forest species must reach at least 5 metres in height at maturity (Ministry for Primary Industries, 2015f). MPI usually assumes that the forest does or will meet these criteria unless it has evidence otherwise.

Forested land that is not eligible under the ETS, is grassland, species grown primarily for fruit and nuts, gorse or broom (where there is not a sufficient stock of forest species also present that meet the forest land criteria), narrow shelterbelts and scattered forest species that are unlikely to ever reach 30 percent crown cover under existing management.

2.2.3 Mapping of the forest

An applicant must submit to MPI a forest land map that clearly defines the forest's boundaries in the form of an electronic shapefile. This map can be created using either a Geographic Information System, existing digital maps or the MPI online mapping tool (accessed through the ETS transaction system).[10]

Images that can be used for the mapping can be either satellite images or aerial photography. Satellite images are available from a range of sources online, however some land may not be clearly detailed. If an applicant is unable to locate sufficient satellite images and up to date aerial photography is unavailable, the applicant will need to pay for aerial photos to be taken.

Forest land maps must meet the requirements set out in the *Geospatial Mapping Information Standard* available on MPI's website.

2.3 Eligibility of an applicant to register a forest in the ETS

To be eligible to register a forest in the ETS and become the participant, an applicant must be the landowner/s or have a registered forestry right or lease for the land. The participant will be the point of obligation, receiving NZUs that are earned and required to surrender NZUs to meet harvesting and deforestation liabilities.

The applicant is required to submit information to prove their eligibility to register the forest, including the certificate of title (copies of which can be requested from Land Information New Zealand) or Māori Land Court reference(s) which detail the names of the landowners.

[10] The NZ ETS online transaction system allows an applicant to submit part of the application information online.

If multiple parties have a registered interest in the land, such as when a registered forestry right or lease is held, then copies of the forestry right or lease will be required in addition to the certificate of title. If the proposed participant is a landowner and there is a registered forestry right or registered lease over the forest land, then written consent from holders of the registered forestry right or registered lease is required. If, alternatively, the proposed participant is the holder of registered forestry right or registered lease, then written consent from the landowner is required. Written consent must be provided using the form prescribed by MPI (Ministry for Primary Industries, 2017e).[11]

In cases where multiple individuals, incorporated or unincorporated trusts, are applying to register a forest, a representative must be selected. The representative will receive NZ ETS notices regarding the status of the forest.

For those who are unsure about whether a forest has been previously registered, they can check the land title notices on the certificates of title, which record whether a Post-1989 forest has been registered (Ministry for Primary Industries, 2017d).

2.3.1 Open a holding account with New Zealand Emissions Trading Register

A participant needs to open and maintain a 'holding account' in the New Zealand Emissions Trading Register (NZETR) in order to be able to receive NZUs transferred for increases in the carbon stock in the participant's forest as it grows (or to pay units to the Crown if there is a decrease in the forest's carbon stock). A holding account is also necessary in order to sell or purchase NZUs. A holding account can be opened at the NZETR website,[12] and is required to be stated on the application form for any applicant wishing to register a forest under the NZ ETS.

2.4 Fees and Process

Once all the supporting information has been gathered by the applicant and the application form is completed, this material can be submitted to MPI.

The time taken for MPI to approve or decline an application varies.[13] Ollie Belton (Carbon Forest Services, Managing Director) estimates that most applications will be approved or declined within 6 to 7 months after the application has been submitted.

The fee for submitting an application is $562.22 (including GST), covering 4.25 hours of processing time.[14] In cases where more time is required, the applicant will be charged an additional $132.88 per hour (Ministry for Primary Industries, n.d.).[15] Ollie Belton who works as a consultant helping landowners navigate the process of registering a forest, states that in his experiences, MPI rarely charges for additional hours of processing time.

[11] https://mpi.govt.nz/growing-and-harvesting/forestry/forestry-in-the-emissions-trading-scheme/registering-post-1989-forest-land/
[12] For the NZEUR website see: https://www.eur.govt.nz/Common/Guidance.aspx
[13] In some cases other documentation may also be required.
[14] Fees stated were accurate as at February 2018.
[15] Other costs may vary also.

2.5 Emissions Returns

Once a forest is registered in the NZ ETS, the participant for that forest must regularly submit emissions returns that detail any change in the carbon stock of the forest. These emissions returns determine how many NZUs a participant will earn or will be required to surrender to the crown. For each tonne increase in the carbon stock of a forest, the participant earns one NZU and for each tonne decrease they must surrender one NZU to the crown.[16]

2.5.1 Submission of emissions returns

Emissions returns must be filed at the end of every 5-year mandatory emissions reporting period (MERP),[17] with the first period commencing on 1 January 2008 and ending on 1 December 2012. The second MERP operated from 1 January 2013 to 31 December 2017 and a new MERP commenced on 1 January 2018 (ending on 31 December 2022). Participants can also choose to submit annual emissions returns (Ministry for Primary Industries, 2017b).[18]

If a participant deforests, they must submit an emissions return. In addition, if a participant deregisters a forest, grants a forestry lease or right (transfer of participation), sells the land to another party or when there is a change in more than 40% of the members of an unincorporated body such as a Trust, the participant must also file an emissions return (Ministry for Primary Industries, 2015b).

2.5.2 Measuring the carbon stock of a forest

MPI provides carbon stock look-up tables that detail the carbon stock of a hectare of forest at each age. [19] These can be used to determine the change in carbon stock of a forest over an emissions return period. MPI provides example calculations on how to calculate the changes in carbon stocks in both small and larger forests.

Participants with small forests (less than 100 hectares in size), must use the default carbon stock look-up tables provided online by the Ministry for Primary Industries (Ministry for Primary Industries, 2017b). Using the carbon stock numbers set out in these tables, the change in carbon stocks can be calculated by deducting the carbon stock present in the first year of the emissions reporting period and from the carbon stock in the fifth year.

The default carbon stock look-up tables stop at 50 years of growth, so the carbon stock of the native forests in these scenarios will level out at 323.4 (t/ha) from years 50 to 70. This is despite that the growth cycles and rotation periods of native forest species are generally

[16] The Ministry for Primary Industries provides examples on how to calculate a forest's change in carbon stock on their website. Also see Appendix 8.1 for a selection of examples of calculating change in a native forest's carbon stock.
[17] Submitted in the year following the end of the MERP, between the 1st January and March 31st.
[18] Once registered, native forestry participants follow the same processes for recording changes in carbon stocks, as Post-1989 exotic forestry participants.
[19]https://www.mpi.govt.nz/dmsdocument/4762-a-guide-to-look-up-tables-for-forestry-in-the-emissions-trading-scheme.

considered to range from 60 to 80+ years. The tables may be extended as forests in the ETS get closer to this age.

Participants with larger forests (100 hectares or more in size), must use participant specific carbon stock look-up tables that are generated using the Field Management Approach (FMA). To generate participant specific look-up tables, participants must collect information from their forest at the end of every emission reporting period and submit this information to MPI who in turn will use this information to generate the participant specific look-up tables (Ministry for Primary Industries, 2017c). Section 2.7 below outlines further how the FMA operates in practice and what information is required together with current challenges of this approach.

2.5.3 Transfer of NZUs

Once a participant submits an emissions return, MPI processes it and issues the appropriate number of NZUs into the participant's holding account. This account acts like a bank account and can be used to receive NZUs from the government or other sellers, and to transfer NZUs to the government or buyers.

If a participant is liable to surrender NZUs, this must be effected within 20 days of submitting the emissions return. Surrender of NZUs is effected from the holding account also.

2.5.4 Compliance regarding emission returns

Participants who fail to submit an emissions return by the due date, are late surrendering NZUs that are owed, or have incorrectly calculated the unit balance may face additional penalties, fines or conviction (Ministry for Primary Industries, 2017b).

2.5.5 Cost of submitting Emissions Returns

The fee for submitting an emissions return is $102.22 (including GST) for the first 45 minutes of MPI staff processing time, and $132.88 (including GST) per hour thereafter.[20] (Ministry for Primary Industries, 2016a) If an applicant hires a consultant to prepare and submit their emissions return this is an additional cost. Ollie Belton estimates that the cost of hiring a consultant is approximately $150 + GST.

[20] Fees stated were accurate as at February 2018 and may be subject to change.

2.6 Small Forests: Managing price risk, and challenges with the default look up tables

2.6.1 Managing price risk

If a participant wishes to avoid price risk, they can choose to only sell the "safe" NZUs, namely the NZUs that a participant has left over once future harvesting liabilities are accounted for. The number of safe NZUs a participant earns depends on:

1. how the forest harvesting schedule is managed as this determines by how much the forest carbon stocks fall after harvest; and
2. when in the forest growth cycle, the forest is registered under the NZ ETS.

The participant can decide to either clear fell the forest[21] or selectively harvest. Each scenario is set out in more detail in this section. In summary, where a participant intends to clear fell a small native forest at 70 years, the participant can confidently sell the first 40.2 NZUs per hectare, being those considered as safe. At a fixed NZU price of $20 and an 8% discount rate (both of which are conservative), this represents is a present value of $804 per hectare.[22]

Alternatively, participants choose to only selectively harvest the forest, thereby increasing the number of safe NZUs generated by the forest. Participants who replant one hectare of their forest every year can sell units up to the level of average carbon stock. For small forests, the average carbon stock is 181.8 (t/ha) (assuming continual replanting post-harvest). At a conservative NZU price of $20 and an 8% discount rate, this represents a present value of $1,275 per hectare.

Carbon leasing / rental is also an option for landowners enabling them to sell safe levels of NZUs up to the average carbon stock. The parties could enter forward contracts with landowners with forests of different ages or NZ ETS emitters, enabling them to smooth their NZU liability cycles.

2.6.2 Clear fell

The forest carbon stock increases as the forest grows and then declines after harvesting. The forest carbon stock in 2078 is 323.4 (t/ha), based on the default carbon stock look-up tables (Ministry for Primary Industries, 2017h), and the participant has earned 323.4 (NZUs/ha) for these carbon stocks. After the forest is harvested by clear felling in 2078, 44% of the forest's carbon stocks are immediately released into the atmosphere. The remaining residual carbon stocks are released at 10% per year over the following ten years as the residual trunks and roots decay. The carbon stocks do not fall to zero because the new rotation that was replanted begins

[21] Clear fell refers to harvesting an entire forest at once.
[22] A landowner can only safely sell 40.2 NZUs per hectare, assuming that the forest owner replants after every harvest, if the landowner deforests they will need to surrender all the NZUs they have earnt, if the forest owner has sold their "40.2" NZUs, they must purchase these NZUs at prevailing market prices. This is the mechanism by which the NZ ETS incentivizes landowners to keep replanting. This also assumes that the landowner had registered their forest from the forests establishment and applies an 8% discount rate.

to store carbon dioxide, described by the orange line in **Error! Reference source not found.**. Therefore, the carbon stock only falls by 283 (t/ha), to its lowest point of 40.2 (t/ha).

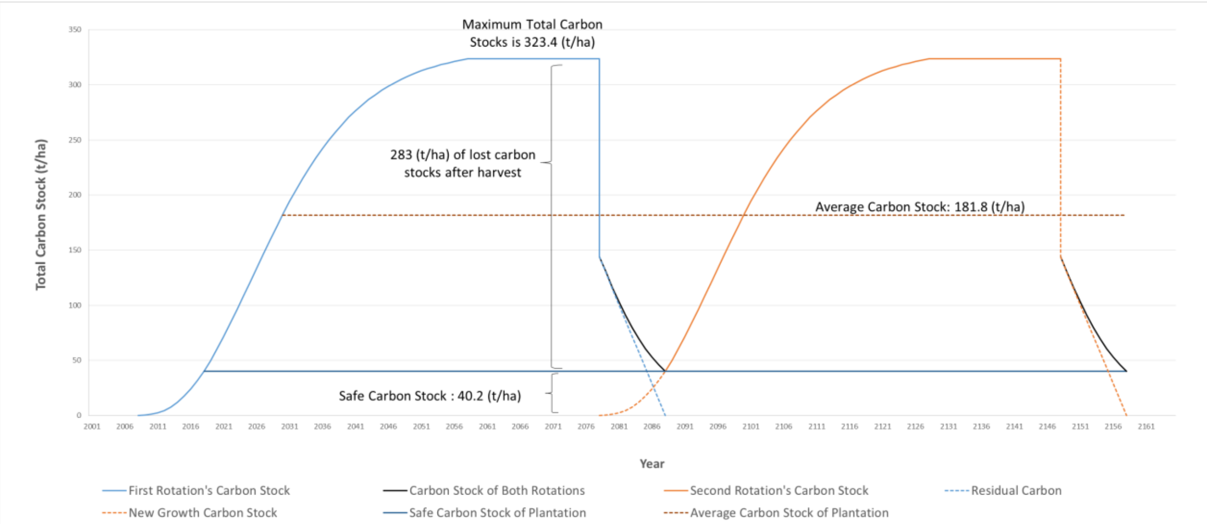
Since the carbon stock decreases by 283 (t/ha), the participant must surrender 283 NZUs to the crown. If the participant has banked (leaves in their holding account) 283 of the NZUs earned over rotation 1, they can surrender these NZUs when they harvest and the participant avoids having to purchase NZUs at prevailing market prices and therefore avoids price risk.

The emission return they submit for the mandatory reporting period from 2078 to 2082 will detail part of the decrease in the carbon stocks. The carbon stock of the forest in 2078 (and until harvest) will be 323.4 (t/ha). The residual carbon stock of 144 t/ha after harvest is assumed to decay linearly over 10 years. If the forest is clear felled in 2080, for example, in 2082 it has been two years since harvesting. The carbon stocks of the harvested trees at the end of the reporting period is therefore:

$$Carbon\ Stock_{2082} = \frac{144(10-2)}{10} = 115.2\ (t/ha)$$

For this mandatory emission reporting period the participant must surrender 323.4 - 115.2 (t/ha), or 205.9 (t/ha).

Figure 1: Total Annual Carbon Stocks of a Native Forest Plantation (t/ha)



Data source: (Ministry for Primary Industries, 2017h)

2.6.3 Delayed Replanting and Deforestation

If a participant delays replanting, the carbon stocks of the forest will fall below 40.2 (t/ha). For example, if the participant waits two years and replants in 2082 instead of in 2080 as soon as the forest is harvested, the carbon stocks of the forest will fall to 24 (t/ha). Therefore, the participant will only have 24 safe NZUs to sell. If a participant deforests, does not replant at all (or allow forest to naturally regenerate), then all of the carbon stocks are lost and the participant must surrender **all** of the NZUs they have earned.[23]

Note that all plantations that are not registered in the first ten years of growth of the **first** rotation established on the land, will not earn any safe NZUs.[24]

2.6.4 Selective harvesting of a native plantation forest

Harvesting only a portion of a forest (referred to as selective harvesting) is common in New Zealand for native forestry (Jon Dronfield, Sustainable CCF Beech Logging). Many landowners are selectively harvesting with the intent of maintaining continuous canopy cover, ensuring that the forest values and canopy at one or more levels is maintained.[25] To maintain continuous canopy cover, a landowner may only harvest a few hectares of their forest every couple of years.

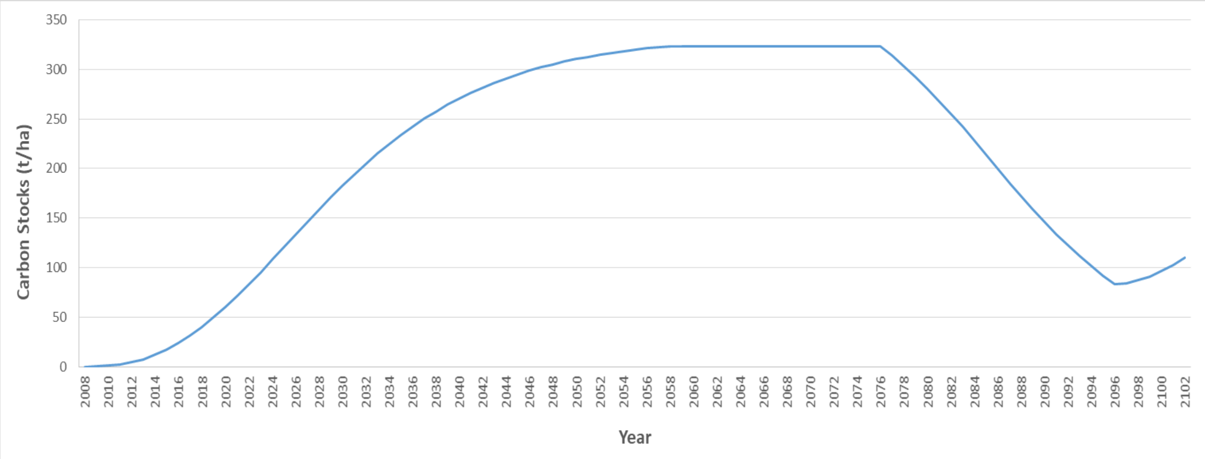
Selective harvesting can increase the amount of available safe NZUs. In the scenario below, **Error! Reference source not found.**, a native forest has been planted in 2008 and registered in the NZ ETS from 2008 but selectively harvested at a rate of 5% per year for 20 years from 2078. As the forest is harvested, it is immediately replanted.

[23] The NZ ETS defines deforestation as clearing and converting the land to another land use or failing to replant within four years after harvesting.

[24] The earlier in the first ten years the forest is registered the more safe NZUs a participant will earn. Participants using the field management approach may have carbon stock tables that go past 50 years.

[25] The landowner aims for an annual or periodic cut that does not exceed the annual or periodic incremental growth of the forest (David Bergin, Environmental Restoration Ltd). The number of trees that can be harvested to maintain continuous forestry cover will vary between forest species and the size of the forest. For larger forests it may be possible to do an annual cut, for smaller blocks, harvesting is likely to be done every few years.

Figure 2: Total Carbon Stock of a selectively harvested native forest (t/ha)



Source: (Ministry for Primary Industries, 2017h)

If the participant harvested and replanted only 1/70 of his forest each year the participant could safely sell NZUs up to the maximum average carbon stock of the forest which is 181.8 (t/ha).

If the participant decides at any point not to harvest, but to leave the forest permanently, they could sell NZUs up to the maximum carbon stock.

2.6.5 Challenges with current Default Carbon Stock Look-Up Tables

The current default carbon stock look-up table applies to all native species across all regions. The tables also only extend to 50 years, whereas many native species have growth cycles and rotation periods ranging from 60 to 80+ years, underestimating the true total carbon stocks of native forestry. For example, Table 1 details the age, region and carbon stocks of Kauri trees that were surveyed by Tāne's Tree Trust. Table 2 details the results for all the species that were surveyed.

Table 1 Tāne's Tree Trust, Kauri Survey Results (t/ha)

Species and Region	Age	CO_2 (t/ha)
Kauri		
Taranaki, Fred Cowling Reserve	38	412
	51	614
	69	1306
Taranaki, Brooklands Park	50	663
	71	1027
	83	1116
Hawkes Bay	48	966
Northland	36	393

Source: (Kimberly, Bergin, & Beets, 2014)

Tāne's Tree Trust's research shows significant variation for surveyed trees of the same species, which are planted in different regions. A 48-year-old Kauri surveyed in Hawkes Bay had estimated carbon stocks of 966 (t/ha), almost three times as high, in comparison to 36-year-old Kauri in Northland, which had estimated carbon stocks of 393 (t/ha). There is also significant variation for the Kauri at different ages. Kauri are storing significant amounts of carbon after 50 years of growth. The 71-year-old Kauri trees' carbon stocks were estimated to be 47% higher, in comparison to the 51-year-old Kauri trees in the same location.[26]

Updating the default carbon stock tables and providing overlays for different species and regions would more accurately reflect the carbon stocks of native forests. Look-up tables for natives also need to be extended to 60 to 80+ years, dependent on the species.

2.7 Larger Forests: Using the Field Management Approach, new evidence and estimates to help manage price risk

2.7.1 Application of the Field Management Approach

Participants with larger forests are not permitted to use the default carbon stock look-up tables to calculate their carbon stocks; they are required to use the Field Management Approach (FMA) to generate 'participant specific' carbon stock look-up tables, allowing for variations in species and region to be incorporated into the tables, by directly measuring the growth of trees in the participant's forest (Ministry for Primary Industries, 2017c).

[26] Trees growth cycles, generally follow an S shape. The current default look-up table, is designed for a native species that reaches the end of its growth cycle (maturity), after around 50 years of growth. However, the growth cycle of native plantation tree species, is generally much longer than 50 years. The implication, is that the default look-up table, may overstate the carbon stocks, for plantation forests, during the initial 20 years of growth, and understate the carbon stocks, from year 20 onwards.

Information that must be collected by participants in accordance with the Field Management Approach includes:

- Tree species;
- Tree diameters and heights;
- Shrub type, and crown cover and height information (if collecting shrub information);
- Past and planned silvicultural activities for trees (pruning, thinning);
- Adverse events (such as fire, wind or disease); and
- Photographs.

MPI determines sample plots of the forest from which the participant must collect and provide the above information. The number of sample plots that are assigned is based on the size of the forest (Climate Change (Forestry Sector) Regulations 2008):

- 100 hectares: 15 sample plots;
- 100 and 10,000 hectares: determined based on a sliding scale between 15 and 100 plots; and
- 10,000 hectares or more: 100 plots.

Ollie Belton, Managing Director of Carbon Forest Services estimates that the cost of collecting information from a forest's sample plots will range from $350 to $550 per sample plot for a planted native forest with the cost of collecting information from a naturally regenerated native forest likely to cost around $550 per sample plot. An applicant may hire a consultant to help them with collecting the information for the FMA. Ollie Belton also estimates that the cost of hiring a consultant ranges from $1,000 to $4,000.

More information on the potential carbon stocks of different native species across regions is becoming available, giving prospective participants a greater indication of what expected carbon stocks may be. The following section outlines new evidence provided by Tāne's Tree Trust on the carbon stocks of a selection of native species.

2.7.2 New evidence: Estimates of the total potential carbon stocks and average carbon stocks for selected native species

For a selection of plantation native tree species in large forests, Tāne's Tree Trust (Kimberly et al, 2014) has estimated the total carbon stocks (assuming the land is of average quality) from the first year of planting out to year 80 (see the left-hand side of Table 2 below). From this information, the annual change in those stocks and the annual averages can also be calculated (represented in the right-hand side of the table).

Table 2 Tāne's Tree Trust: Native Species Carbon Stock

	Total Carbon Stock (t/ha)					**Mean Annual Increment (t/ha)**				
	Yr 0-20	**Yr 20-40**	**Yr 40-60**	**Yr 60-80**	**Total**	**Yr 0-20**	**Yr 20-40**	**Yr 40-60**	**Yr 60-80**	**Average**
Pūriri	67	348	920	1165	1165	3.35	14.05	28.6	12.25	14.56
Kauri	101	508	757	929	929	5.05	20.35	12.45	8.6	11.61
Tōtara	93	437	577	712	712	4.65	17.2	7	6.75	8.9
Black Beech	120	670			670	6	27.5			8.37
Red Beech	113	624	631		631	5.65	25.5	0.35		7.88
Rimu	68	329			329	3.4	13.05			4.11

Source: (Kimberly, Bergin, & Beets, 2014)

Pūriri has the highest total estimated carbon stocks of 1165 (t/ha) and stores around 70% of these carbon stocks, over years 40 to 80 of growth.

Kauri has the second highest total carbon stock, the third fastest carbon storage rate during years 0 to 40 and the second highest carbon storage rate during years 40 to 80.

Tōtara's maximum carbon stock is close to the beech species and Tōtara's rate of carbon storage shows less variation over the life cycle in comparison to the other species. The beech species have lower maximum carbon stocks but the fastest initial rates of carbon storage.

All 6 species have slower rates of carbon dioxide storage in the initial 20 years of growth, in comparison to the default carbon stock look-up table, however all 6 species have higher maximum carbon stocks. Some species such as Pūriri, Kauri and Tōtara could potentially store more than twice the carbon dioxide in comparison to the default carbon stock tables, suggesting that participants who use the FMA could expect to earn a significantly higher number of NZUs.

2.7.3 New evidence: Estimates to help manage price risks

The same provisions outlined above regarding small forests and how price risk can be managed by the sale of safe NZUs apply in relation to large forests also. As with small forests, landowners may choose to selectively harvest their forest to increase the number of safe NZUs it will generate.

Table 2 illustrates the total carbon stocks. Some species could potentially be harvested earlier than 80 years, depending on the species, fertility of the land and the forest management techniques that are employed by the landowner.

Table 3 below details the long-term average carbon stocks, and the safe carbon stocks of Pūriri, Kauri, Red and Black Beech, and Rimu on a plantation after clear felling, where the native species have 80-year rotation periods.[27] If a participant chooses to selectively harvest their

[27] The native species' annual carbon stocks are interpolated from Tāne's Tree Trust's estimates, by applying the same growth cycle of natives in the default look-up table. The residual carbon stock of the native forests, is assumed to be 44% of the carbon stock at harvest following the proportion used in the default look-up tables.

forest, they can sell NZUs up to this long-term average level of carbon stock. Therefore, the safe level of carbon stocks are estimates of the lower bound level of carbon stocks a participant could expect to be able to sell NZUs for and the long-term average carbon stocks, the upper bound.

Table 3 Safe and average carbon stocks for native stocks

Species	Safe Carbon Stocks (t/ha)	Long-term Average Carbon Stocks (t/ha)
Pūriri	30	509
Kauri	45	480
Black Beech	54	463
Red Beech	50	434
Tōtara	41	383
Rimu	30	229

Source: ((Kimberly M, 2014) & (Ministry for Primary Industries, 2017h))

The Native species have much longer rotation periods and therefore much higher average carbon stocks (excluding Rimu), due to the native species' storage of large amounts of carbon dioxide for longer periods of time. The higher a forest's average carbon stocks, the greater the environmental benefit reaped from planting the forest.

2.7.4 Challenges with the current Field Management Approach

For native plantation forestry that resembles exotic plantation forestry (monoculture, single-age, planted at regular intervals), the FMA is relatively easy to comply with. However, for those seeking to establish multi-species, multi-age, continuous cover native forestry, this will prove more difficult. It could even be as hard as naturally regenerating native forest land in some cases. The cost of collecting the information required for the FMA every 5 years is a heavy burden for small land owners.

3 Timber revenue: Generating income from native plantation timber

References to "plantation" native forestry refer to tree species indigenous to New Zealand that are planted with the aim of harvesting the timber. New Zealand's unique environmental conditions have resulted in a range of native tree species that provide timber that is strong, durable and has high aesthetic value. The value of wood from these native species is generally very high but can vary, as do establishment costs. This section outlines estimates for the main costs of establishing a native plantation and the potential value of native timber for a selection of native species' timber values.

3.1 Establishing and maintaining a native plantation

The estimates provided are generalised across plantations, actual costs will vary between plantations, based on land quality, location of the plantation, stocking density and planting techniques. Table 4 provides estimates for planting a native plantation.

Table 4 Cost of establishing a Native Plantation

Cost	Lower Bound	Middle	Upper Bound
Total per hectare	$5,000	$30,000	$60,000

Sources: (Bergin & Gea, Native Trees, 2007)

The total cost of establishing a plantation is estimated to lie between $5,000-$60,000, with the lower bound estimate of $5,000 a very optimistic estimate and the upper bound of $60,000 a worst-case estimate (Bergin & Gea, Native Trees, 2007). David Bergin estimates that $20,000 per hectare is the most reliable estimate. Included in the cost of establishing a plantation is the cost of labour, seeds and weed control.

3.2 Establishing yield and the value of native timber

This section sets out estimates of the yield of sapwood and the value of native timber. Actual yield will vary between plantations, based on land quality, location of the plantation, stocking density and planting techniques. Prices will vary by species and over time and will depend on the quality of timber from a specific plantation. Harvesting costs are also a critical part of the financial calculus. These will be considerably higher than the equivalent costs for exotic forests if the native trees are not clear felled so economies of scale cannot be realised. Table 5 provides summary estimates for the properties of a selection of native species.

3.2.1 Rotation Periods

Growth of native tree species varies significantly between regions and opinions on the optimal rotation periods are far from in agreement. Common estimates place rotation periods between 60-100 years, 60 years is often considered the minimum (Steward et al. 2014).

3.2.2 Sapwood vs Heartwood

Native species require significant rotation periods to produce usable quantities of heartwood. Native species can however produce good yields of sapwood over shorter rotation periods.

3.2.3 Kauri

A study by Steward and McKinley (2004), looked at the properties of natural old growth, natural second growth and plantation kauri, the results are detailed in Table 6.

Table 5 Comparison of Native Species properties

Species	**Location**	**Rotation Periods for Sapwood**	**Basic Density (kg/m³)**	**Yield (preferably yield per tree not in hectares)**	**Height (m)**	**Diameter[28] (m)**	**Stiffness (MOE) (Gpa)**	**Radial Shrinkage (%)**	**Tangential Shrinkage (%)**	**Rotation periods for Heartwood**
Kauri	Natural stands found in upper North Island, but plantations can be planted outside of this area.	70	451	85% of total stand volume[29]			13.6	2.9	4.1	
Red Beech	Foothills and inland river valleys	60-80	630	1.5m³/ha –forever beech.		0.6	11.6	2.4	7.6	75
Black Beech	Foothills of North Island, Taranaki, Wanganui, north west of the South Island		650-720		30	1		4	6	
Tōtara	Distributed throughout New Zealand	60-80[30]	480		30-40	0.6	6.4	2.0	4.0	75
Rimu[5]	Distributed throughout New Zealand		591				9.65	2.5	4.4	

Sources: (Steward & McKinley, 2004), (NZ WOOD, 2017b), (NZ WOOD, 2017a), (NZ WOOD, 2017c), (NZWOOD, 2017d)

[28] At breast height.
[29] Used in the New Zealand forestry handbook 2005
[30] Dr Bergin and Dr Steward, estimate that with fertile sites, fertiliser applications, good releasing and seedling shelter a tree rotation of 60 years was predicted to provide an average volume of 470 cubic metres a hectare. See: http://www.nzherald.co.nz/bay-of-plenty-times/news/article.cfm?c_id=1503343&objectid=10914202.

Table 6 Comparison of Kauri Properties

	Age	Basic Density	Stiffness (MOE) (Gpa)	Radial Shrinkage (%)	Tangential Shrinkage (%)
Natural old growth	>150	520 kg/m^3	13.0	2.3	4.1
Natural second growth	120 - 150	472 kg/m^3	10.8	2.6	3.9
Plantation	68	451 kg/m^3	13.6	2.9	4.1

Source: (Steward & McKinley, 2004)

Timber from natural second growth stands of 120 – 150 years had similar properties to plantation growth sapwood stands at 68-years-old. However, the shorter rotation periods of 70 to 100 years for plantation native forestry is expected to yield timber with lower proportions of heartwood and higher proportions of sapwood, in comparison to old growth. [31] While sapwood will not be as valuable as heartwood, sapwood is still likely to sell for more than exotic species timber.

3.2.4 Red and Black Beech

Beech trees have a functioning timber market. Rotation periods are between 60 and 80 years. There is a substantial potential volume available from red beech. The beech species are well suited to sustainable management by restocking from natural regeneration. In optimal conditions high quality timber can be produced in 60-80 years from forests that will then be managed on a continuing basis. (NZ WOOD, 2017b).

3.2.5 Tōtara

Second growth stands less than 100 years in age have a high proportion of sapwood. (Steward & McKinley, 2004). On steep hill slopes tōtara with a nearby seed source, can develop into small stands of saplings within 20 years if the area is protected from predators. (NZ WOOD, 2017a).

It is a long time before a plantation owner will receive cash inflows from timber sales from a new native plantation (minimum 50 years). Therefore, combining an investment in a native plantation with carbon credits and co-benefit payments which have cash inflows that occur earlier in a rotation period may be a very attractive option for landowners.

[31] Studies by Barton and Horgan 1980 and Steward and Kimberly 2002 found that the formation of heartwood in kauri and Tōtara stands was slow and the timber was predominantly sapwood.

4 Other co-benefits that could generate economic returns

Native forestry is established in New Zealand for a wide range of reasons and by a diverse set of actors. This section outlines a number of the co-benefits that can be reaped from establishing native forests. These could provide a revenue stream for a landowner in the initial years of a native forest rotation, supplementing interim income until native timber revenue flows.

4.1 Manuka Honey

The potential of New Zealand Manuka honey sales in international markets is still largely untapped, with the Ministry for Primary Industries setting an export goal of $1.2 billion per year by 2028.[32] This can present an attractive investment opportunity for those who are establishing native plantations in the next few years to also plant Manuka as a nursery shrub.[33]

Manuka Farming New Zealand estimates that the cost of establishing Manuka hives (the forest and the hives) is $2,539 (ha), with ongoing costs at $62 (ha) from years 3-6 and $47 (ha) from year 7 to 20 of growth (Manuka Farming New Zealand).[34]

Manuka hives produce most of their honey from years 7 to 20 of growth, with honey production estimated to be 40kg per hive per year, with 32kg estimated to be Manuka honey (Manuka Farming New Zealand). If 1.5 hives are able to be support per hectare of Manuka forest, that's an annual supply of 48kg of Manuka honey per hectare. Peter Adams (Manuka honey bee keeper) believes that 40kg of Manuka honey produced per hive each year is a reasonable estimate and that some hives may produce even more in years with good weather.

The value of this Manuka honey will vary between grades. Table 7 provides estimates for the gate prices for different grades and an estimate of the net present value of the honey production at each price.

Table 7 Gate prices and NPV of different Manuka Honey Grades per hectare

Manuka Honey	Gate Price	NPV
Manuka UMF 5	$21	$4,220
Manuka UMF 10	$37	$8,124
Manuka UMF 15	$72	$15,809
Manuka UMF 20	$130	$28,153

Source: (Manuka Farming New Zealand)[35]

[32] In August 2017, new requirements regarding the testing of the authenticity of New Zealand Manuka are expected to come into effect. This provides landowners who wish to establish Manuka for honey exports with government authentication of their product.
[33] For more information on Manuka Honey see: https://www.mpi.govt.nz/growing-and-producing/bees-and-other-insects/manuka-honey/
[34] A total cost of $3336 per hectare.
[35] NPV assumes a discount rate of 8%.

4.2 Erosion Control

Forests help create a range of ecosystem services related to erosion control: land stability, soil conservation, reduced erosion, and, as a result, improvements in water quality (primarily sediment) and protection of downstream infrastructure.

In some regions payments are available for establishing forest land to reduce erosion. For example, the erosion control funding programme (ECFP) in the Gisborne region, provides $1,500-$2,000 per hectare of forest land (Ministry for Primary Industries, 2017i). This payment can support landowners with the high upfront costs of establishing a native forest plantation.

4.3 Water Quality

The degradation of New Zealand's rivers and lakes from nutrient run-off has become a major problem for human health, fisheries, recreational users and the tourism sector.

Establishment of native forestry can help reduce the contamination of water bodies by blocking sediments and absorbing nutrients that would otherwise enter bodies of water (Parliamentary Commissioner for the Environment, 2009). Planting forestry on land that was previously in pasture can improve the quality of water from the land within 5-6 years (Scion, 2016). Forests could play a significant role in addressing this issue in many catchments (Daigneault et al. 2016; Shepherd et al. 2017).

Payments for water quality are possible in some regions where schemes are in place for river/lake catchments that put a price on nutrient run-off. One such scheme is the nitrogen cap and trade and buy-back scheme introduced by the Waikato Regional Council to reduce the level of nitrogen run-off into Lake Taupō (Waikato Regional Council 2016; Duhon, McDonald, and Kerr 2015).

Funds have also been made available by the Ministry for the Environment (MfE) and Fonterra for planting to improve water quality (Hall 2016).

4.4 Tourism

The tourism industry is the second largest contributor to New Zealand's Gross Domestic Product. The tourism industry is fuelled by New Zealand's "clean green image", an image that is reliant on the maintenance of New Zealand's native forests and reputation as an eco-friendly nation.

Establishment of more native forests would support the aesthetic appeal of New Zealand for tourists and our eco-friendly reputation. There is currently no systematic regulatory, policy or commercial pathway to monetise this investment efficiently from a tourism perspective.

4.5 Recreational Use

Native forests provide recreational value to tourists and also to local people. Some groups (e.g. local councils) may be willing to make payment/s for native forests that will be publicly accessible. These payments could help with the high establishment costs or provide annual payments for the plantation owner for the duration of the agreement.[36]

4.6 Biodiversity and forest habitat

Establishing native forestry increases biodiversity, delivering services such as endangered species protection and healthy forests. Some groups of investors may be willing to make payments for increased biodiversity.

It could be possible for the Department of Conservation and local authorities to co-ordinate, in order to provide information for prospective plantation owners on what areas are in the greatest need for increased biodiversity and what native tree species should be established. These initiatives could be partnered with organisations whose activities have a biodiversity impact that, under the Resource Management Act 1991, they are required to mitigate (the Resource Management Act requires that adverse effects be avoided, remedied or mitigated). The Department of Conservation has issued some guidance on biodiversity offsetting.

4.7 A potential model for the future

The collaborative work being carried out in the Reconnecting Northland programme[37] offers a potential model to be explored in other regions wishing to create large-scale change for the benefit of both the natural environment, as well as the region's people.

This programme, funded by the Tindall Foundation and the HSBC Water programme, and managed by the New Zealand branch of the WWF, is exploring the role of co-benefits as a framework to both generate income for their landowners and improve the water quality, biodiversity, physical resilience, and health of the Northland landscape. A lot of work has been done within this programme on understanding Payment for Ecosystem Services models, understanding how one or more programmes could be established, and scoping, analysing and assessing viable options including identifying potential buyers, sellers and incentives.

[36] The Longbush Eco sanctuary which is a naturally regenerated native forest allows public access.
[37] http://reconnectingnorthland.org.nz/

5 Combining and monetising the benefits of native plantation forestry

Anticipated revenue streams from the sale of carbon credits, native timber and co-benefits payments can be combined into group investments with bespoke contracts that allocate obligations and the rights to different revenue streams among investors.

The value investors will attribute to these revenue streams depends on the amount of the cash flows, the timing of the cash flows that stem from the benefits and the unmanageable risks associated with them, and investor specific characteristics.

Contracts that combine cash flows from different benefits will ideally account for these factors when allocating rights to revenue flows among investors and defining the obligations and investments required by those who will receive those rights. Contracts would also need to account for some of the counter–party risks within the group of investors.

Previous sections have discussed the amount and timing of cash flows, the following sections will discuss the risks of these cash flows, investor characteristics and how to combine investments in different benefits into contractual arrangements.

5.1 Risks of cash flows

Table 8 below outlines some of the risks associated with different benefit flows. Some of these risks can be mitigated through careful management by people with appropriate expertise. The greater the remaining risk, the higher the return an investor will require.

Table 8 Risks associated with benefit flows

Investment	Risks
Plantation	Timber price risk
	Natural disaster
	Government policy changes regarding harvesting
	Wood quality uncertainty
NZUs	NZU price risk
	Changes in stringency and hence price
	ETS policy changes that are adverse to forestry
	Institutional risk
Manuka Honey	Manuka honey price risk
	Natural disaster
	Loss of hives
	Quality of honey
Water Quality	Counter-party risk, that the plantation owner deforests
	Government policy change risks
Erosion Control	Counter-party risk, that the plantation owner deforests
	Government policy change risks

5.2 Investor Types

An investor's characteristics will affect how much they value an investment, and therefore how much they are willing to pay for the rights to different revenue flows.

There is a wide range of investors willing to invest in native plantation forestry; foresters or institutional investors who wish to diversify their portfolio, commercial entities with compliance obligations under the ETS, farmers with water quality obligations, commercial entities willing to invest in native forestry for social corporate responsibility reasons and private citizens, usually through NGOs etc. The heterogeneity of investors results in a wide range of abilities to contribute capital, skill and labour; risk tolerances; perceptions of future prices and risks; and investment objectives.

Table 9 describes the main types of investors that may be interested, and what their motivations for investing, their capital availability and risk aversion may be. The actual characteristics will depend on the specific people and institutions.

Table 9: Investors and their possible motivations, capital availability and willingness to bear risk

<table>
<tr><th colspan="2">Landowners (not farmers)</th></tr>
<tr><td>Primary Motivations</td><td>Profit:
Profit from selling timber and by-products
Diversification of timber portfolio if they are foresters
Amenity values (e.g. birds, attractive land use) – if they live on the land or believe potential purchasers will value them.</td></tr>
<tr><td>Capital availability</td><td>May be high if land is owned outright and it is possible to borrow against it.</td></tr>
<tr><td>Ability and willingness to bear risk</td><td>Low to Medium: Landowners whose land is currently in pasture may have little experience in forestry and be nervous about native plantations; more positively, forests may increase the diversity of their activities reducing overall risk.</td></tr>
<tr><th colspan="2">Farmers</th></tr>
<tr><td>Likely Motivations</td><td>Profit:
Revenue stream from low productivity land.
Profit from selling timber and by-products.
Diversification of investments.</td></tr>
<tr><td>Capital availability</td><td>Medium: In good times farmers generally have strong cash-flow and access to capital. However, they may tend to be highly leveraged.</td></tr>
<tr><td>Ability and willingness to bear risk</td><td>Low to Medium: The farm may be their only asset and home and they may not be willing to risk it on an unfamiliar activity. Not generally experienced in forestry.</td></tr>
<tr><th colspan="2">Foresters</th></tr>
<tr><td>Primary Motivations</td><td>Profit:
Profit from selling timber and by-products.
Diversification of timber portfolio.</td></tr>
<tr><td>Capital availability</td><td>High: If they are a forestry company</td></tr>
<tr><td>Ability and willingness to bear risk</td><td>Medium to high: High level of expertise and are familiar with plantation investment risks.</td></tr>
</table>

Commercial entities – not foresters	
Likely Motivations	**Profit:** • Profit from selling timber and by-products. **Environmental:** • Earn NZUs to surrender for emissions liabilities or use for Corporate Social Responsibility reasons. **Public Relations:** • Branding benefits of engaging in native afforestation and supporting local regions in economic development and environmental improvement.
Capital availability	**High:** Larger portfolios of investments, in comparison to other interested parties resulting in easier access to capital.
Ability and willingness to bear risk	**Medium:** Low risk aversion for small investments (if part of a large portfolio) but have little knowledge about forestry. May be able to effectively contract for this skill. Not their core business

Iwi	
Likely Motivations	**Economic:** • Harvesting of timber and by products for profit. • Employment for local iwi members **Environmental:** • Increased biodiversity • Carbon storage • Water quality protection • Erosion control. **Cultural:** • Kaitiakitanga and use of wood.
Capital availability	**Low to High:** This varies between Iwi. Discount rates may be low.
Ability and willingness to bear risk	**Medium to high:** Varies between Iwi, dependent on the size of Iwi portfolios. Iwi investment decisions tend to have a strong emphasis on returns for future generations (50-yearōōō business plans) so intertemporal risk aversion is lower (lower aversion to long rotation periods). Some Iwi have extensive experience with forestry and knowledge of land management. Iwi's multiple reasons for interest in native forests may reduce their concern about risks associated with any one benefit such as timber.

Local government	
Likely Motivations	**Environmental:** • Local environmental aims (e.g., nutrient run-off, erosion control). **Social Utility:** • Local recreation/social benefits/tourism (e.g., using forest as public space).
Capital availability	**Medium:** Some ability to give grants and financial incentives.
Ability and willingness to bear risk	**Low:** Are publicly accountable for how they use rates income. Few currently have strong experience in native plantation management.
NGOs and philanthropists	
Likely Motivations	**Environmental:** • Promote biodiversity • Water quality • Carbon sequestration • Erosion control
Capital availability	**Low:** There are a few large donors, but most NGOs have limited funding.
Ability and willingness to bear risk	**Low:** With no profit making objective NGOs are likely to have lower risk aversion. They are however accountable to their supporters. They may have access to scientific support that can help with effective forest management, thereby lowering risks.
Researchers	
Likely Motivations	**Scientific:** • Provide better understanding of native forestry and its benefits for other stakeholders.
Capital availability	**Low:** Funding is limited to test sites at most.
Ability to control risks	May be able to provide useful advice to reduce the risks associated with native plantations.

5.3 Counter-party risks

Different investors may have conflicting incentives when investors have control over different assets in an agreement. These conflicting incentives lead to counter-party risks such as a landowner deforesting and converting to another land use; default on payments to other investors by NZU and co-benefit investors; and transfer of unit balance liabilities to a landowner at the expiration of a forestry right or lease. All parties that are required or able to take actions that affect the revenue stream for other actors could impose counter-party risk on other investors.

For example, if a landowner deforests an NZ ETS registered plantation, all NZUs earned must be surrendered to the government. If the landowner is the ETS participant, they will be liable to purchase equivalent NZUs in the carbon market, equivalent to the number of NZUs they sold. However, if another party has invested in order to receive the NZUs, the contract would also need to outline the landowner's obligation to pay the carbon investor for the quantity of NZUs they would have received if the land had not been deforested.

Co-benefit investors may default on payments for the biodiversity or water quality benefits. This risk is probably small as in most instances co-benefit investors would either be operating under a local regulation with its own enforcement mechanism or would invest up-front. If the forest is harvested prematurely or deforested, they would lose some of the expected co-benefits however. This possibility would need to be accounted for.

Landowners can give permission for owners of a registered forestry right or lease on the land to register the forest in the ETS and to act as the participant. When a right or lease ends, the unit balance automatically transfers to the landowner. When landowners give permission to a holder of a registered forestry right to register the forest in the NZ ETS, a contract would ideally outline the obligation of the forestry right/lease holder to ensure the unit balance is at zero before the expiration of the lease, so that the landowner is not held liable for surrendering any carbon credits.

5.4 Contract Design

The contract needs to allocate rights to different revenue streams, and define the obligations of each investor.

Translating these into legal terms requires care. Core to the contract design for any carbon / timber / co-benefit contract are the following:

- Define the benefit, e.g. NZUs, water quality improvement, either by creating a contractual definition or by linking it back to a law or regulation;
- Define the unit of measurement delivering the benefit e.g. dollars, timber in cubic metres, NZU, reduction in nitrate leaching;
- Set out how that unit is measured and verified, e.g. by way of an independent assessment or as set out in the relevant regulations;
- Identify what needs to be done to ensure the continuation of the environmental benefits once the forest is established, e.g. requiring a covenant to make the forest generating the benefits more permanent or explicitly allowing for impermanence with appropriate consequences;
- Set out the agreed applicable remedies are if a breach occurs or if the;

In the case of carbon, most of these aspects are defined through the ETS. Timber production is easily defined and measured. Co-benefits may be harder to define. For example, water quality benefits may be easily defined in a catchment with clear property specific limits on nitrates, phosphorus or sediment load enforced by local regulators but otherwise would require definition and some form of monitoring. Biodiversity is extremely difficult to define – habitat is usually used as a proxy, but few models for defining, measuring and enforcing benefit flows yet exist in New Zealand.

- State the contractual period;
- Set out payment terms; and
- Clearly articulate the performance risks and how these will be managed between the parties (e.g. payment timing, an entity taking on the risk or insurance measures).

Two contract type examples are outlined in this section.

5.4.1 Example Contract 1

There are four investors, a landowner, a carbon investor, a biodiversity investor and a Manuka honey investor.

- The carbon investor pays for the registration of the forest (the landowner is the ETS participant)[38], the collection of FMA information every 5 years (or annually), and a portion of the establishment costs.[39] In return, the carbon investor receives an agreed flow of NZUs.[40]
- The Manuka honey investor pays for the establishment of Manuka, which also acts as a nursery shrub for the plantation. The Manuka honey investor manages the hives and receives the revenue from honey sales.
- The biodiversity investor pays a portion of the establishment costs, and in return receives utility from the increased biodiversity.
- The landowner pays the rest of the establishment costs and the forest management costs, and receives revenues from native timber sale.

The landowner controls the land use and management decisions around the plantation. If the landowner harvests prematurely, they must pay the carbon investor the market value of any NZUs that are still owed under the contract and reimburse the Manuka honey investor for the costs they paid to establish the Manuka and hives plus potentially damages (i.e. loss of income from the honey, however the parties agree to apportion risk).

5.4.2 Example Contract 2

There are two investors, the landowner and a registered forestry right holder. The owner of the registered forestry right makes regular rental payments to the landowner for use of the land. The registered forestry right holder gets consent from the landowner to register the forest in the

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[38] Only landowners, owners of forestry rights or leases can be ETS participants. So the carbon credit investor's claim to carbon credits must be carefully outlined in the contract.
[39] For participants with forests 100 hectares or more in size.
[40] Depending on how the forest and ETS liabilities are managed the landowner could agree to sell only the 'safe' NZUs, or up to the average carbon stock of the forest. She might choose to bank enough NZUs to cover harvest liabilities.

ETS and to act as the participant. The registered forestry right holder bears the cost of establishing the plantation and registering the forest in the ETS and receives the revenue from timber sale and the carbon credits. When the forestry right expires, the forestry right holder is obliged to return the NZU balance to zero and address all outstanding regulatory obligations under the ETS before the land is transferred back to the landowner.

6 Driving uptake of native plantation forestry for carbon

In some locations, native plantations could be an attractive option. It was beyond the scope of this paper to estimate potential profitability. In any case, the paucity of data and the scale of spatial and species variability would make it very hard to produce useful estimates. This would best be done on a site by site basis. Native plantation forestry will be most attractive when the forest: will offer high timber values; is managed sustainably so that high levels of NZUs can be sold without bearing price risk; is easily accessed so harvesting costs are not too high; is larger than 100ha so that it can receive more NZUs than the default native carbon sequestration tables; can produce Manuka honey during the establishment phase; and can offer other co-benefits that can either be monetised (through for example grants from Regional Councils for erosion control or water quality improvements, or because the forest allows the landowner to comply with water quality regulations cost-effectively) or are of direct personal value to investors (e.g. philanthropists). If emission prices become much higher than currently – and all modelling suggests that they must if we are to meet global climate stability targets – the value of the carbon flows will also become much higher.

Within the emissions trading system, some changes could encourage more native forestry plantations for carbon. Carver and Kerr (2017) offer some ideas.

Summary	**Opportunity**
Clarify eligibility of land for NZUs	Request a definitive “line in the sand” ruling on what land is pre-1990 and what land is post-1989
Enable NZUs to receive a premium in the market.	Request that NZUs earned by native forestry be “tagged” with a native forestry certification.
	Emitters who need to purchase carbon credits to meet their liabilities, may be interested in purchasing carbon credits that have been generated from native forestry and willing to pay more.
Improve accuracy of the native look-up tables	Tables could be differentiated by forest type and location. The limited available data suggests considerable discrepancies between the carbon sequestration rates of native plantation tree species (e.g. kauri, tōtara, rimu) and the values in the native default look-up table. It also would be helpful if the length of the look-up tables were extended to 80+ years.

As the freshwater reforms progress, if Government and Regional Councils could design regulations and programmes in such a way that efforts to achieve water quality targets recognise the value from native forests, farmers will value the water quality benefits from native forests more (e.g. because they will allow them to comply at lower cost) and may more frequently be able to express the value to them in dollars. Philanthropists could convene different types of investors who can jointly benefit.

Considerable uncertainties remain about the costs of establishing and managing native plantation of different species in different locations. The quality of timber that will result is still uncertain and future timber prices will always be hard to predict. Systematic data collection would help reduce these uncertainties. The long-term emissions price will also remain uncertain though as policy stabilises it may be easier to predict in the short to medium term which is the period that matters most to investors.

Mobilising the diverse actors needed to produce a significant expansion in New Zealand's plantation native forests will be challenging but the rewards are potentially large.

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Appendix

Appendix Table 1: Nationwide native forest look-up table – 50 years

Year	Total Carbon Stored	Total Residual
0	0	0
1	0.6	0.6
2	1.2	1.2
3	2.5	2.5
4	4.6	4.6
5	7.8	8
6	12.1	12
7	17.5	18
8	24	24
9	31.6	30
10	40.2	31
11	49.8	35
12	60.3	38
13	71.5	42
14	83.3	46
15	95.5	52
16	108.1	56
17	120.8	61
18	133.6	66
19	146.3	87
20	158.7	94
21	170.9	104
22	182.6	107
23	193.9	109
24	204.7	111
25	215	114
26	224.6	116
27	233.7	122
28	242.2	124
29	250.1	125
30	257.5	127
31	264.3	129
32	270.6	130
33	276.3	131
34	281.6	132
35	286.5	134
36	290.9	135
37	295	136
38	298.7	137
39	302	141
40	305.1	142
41	307.8	142
42	310.4	143
43	312.6	143
44	314.7	143
45	316.5	144
46	318.2	144
47	319.7	144
48	321.1	144
49	322.3	145
50	323.4	145

Source: MPI look-up tables 2017

Appendix Table 2: Carbon Stocks and NZUs (Native Plantation Forest)

Year	Total Carbon Stocks (Rotation One)	Total Carbon Stocks (Rotation Two)	Total Carbon Stocks (Forest)	Total carbon credits
2008	0		0	0
		Years 1 to 50 of Rotation 1		
Beginning 2078	323.4		323.4	323.4
During 2078	**Harvest Rotation 1**	**Replant Rotation 2**		
End 2078	144	0	144	144
2079	129.6	0.6	130.2	130.2
2080	115.2	1.2	116.4	116.4
2081	100.8	2.5	103.3	103.3
2082	86.4	4.6	91	91
2083	72	7.8	79.8	79.8
2084	57.6	12.1	69.7	69.7
2085	43.2	17.5	60.7	60.7
2086	28.8	24	52.8	52.8
2087	14.4	31.6	46	46
2088	0	40.2	**40.2**	**40.2**
		Years 10 to 50 of Rotation 2		
Beginning 2148		323	323	283

Source: (Ministry for Primary Industries, 2017h)

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