FEASIBILITY OF INDIGENOUS FOREST CARBON PROJECTS IN THE WAKAPUAKA CATCHMENT, NELSON

INVESTING IN NATURE

Nature Carbon Programme

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Final Report

FEASIBILITY OF INDIGENOUS FOREST CARBON PROJECTS IN THE WAKAPUAKA CATCHMENT, NELSON

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ABOUT EKOS

A not-for-profit carbon management service provider, specialising indigenous forest carbon and zero carbon certification. We also work in environmental markets including indigenous forest carbon and sustainable land management (project development, policy and financing consulting.

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Executive Summary

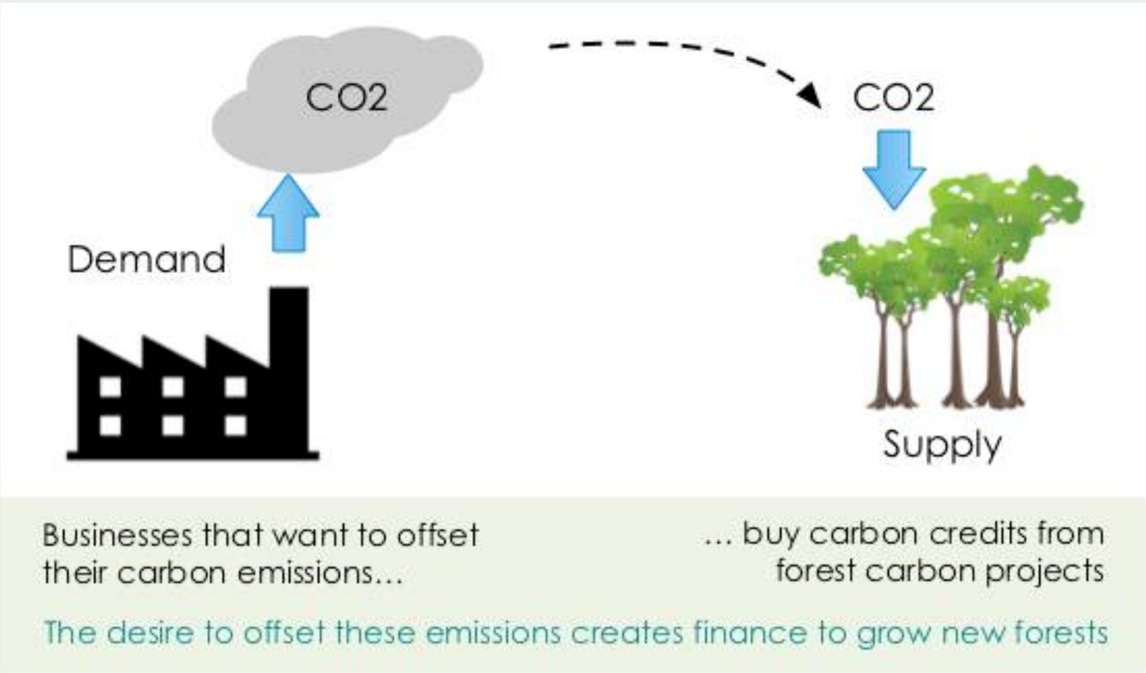
EXECUTIVE SUMMARY

Ekos was contracted by Nelson City Council to assess the commercial feasibility of carbon projects for indigenous reforestation in the Wakapuaka Catchment (north of Nelson).

Why Carbon?

One carbon credit represents one tonne of CO_2 taken out of the atmosphere by growing forests. Carbon credits provide a means of financing sustainable land management through the creation and sale of New Zealand Units (NZUs) under the New Zealand Emissions Trading Scheme (NZETS).

Demand for carbon credits comes from two situations. One is businesses who are required by the Crown to buy carbon credits to take responsibility for a proportion of their emissions. Demand also comes from businesses and individuals with no such obligations to the Crown, but who want to voluntarily take responsibility for their carbon emissions by going zero carbon.



Reforestation projects can be eligible to operate under the NZETS and be issued carbon credits from the government which they can sell for cash. For this reason, carbon credits can (in theory) be used to finance reforestation efforts for purposes of riparian revegetation, and reforesting erosion-prone lands.

This provides an opportunity for private sector markets to cover the cost of environmental protection, rather than always using rate-payer or tax-payer grants. This can enable local government entities to seed-fund carbon projects rather than funding the entire exercise. It also creates an opportunity for local government money to be provided as a financial investment that pays for itself rather than a grant, thus making rate-payer money go much further.

In addition, the discipline required under the NZETS combined with the fact that carbon credits are performance-based means that a lot of risk is taken out of the funding equation. This can enable local government to fund high priority sustainable land management by seed funding projects (e.g. this feasibility study) and providing investment capital (and benefiting from the financial returns) under a market-based conservation financing model.

The Planting Model

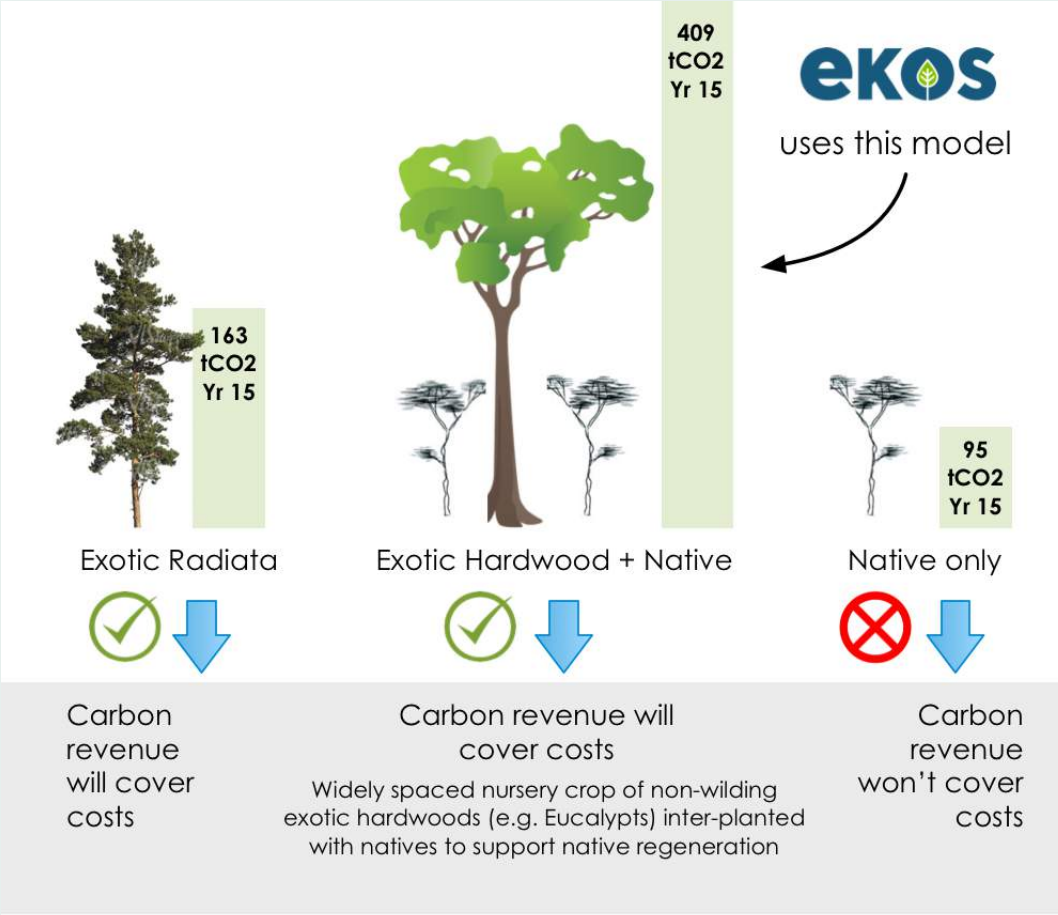
For carbon financing to work for sustainable land management, the value of carbon credits sold needs to cover the cost of the planting and management of the new forest. One key problem with indigenous reforestation using carbon finance is that the economics don't work. This is because the growth rates of indigenous trees are very slow. As a result, the number of carbon credits produced and sold annually from an indigenous forest carbon project is not enough to cover the real project costs. We know this from experience in this sector and from investment models we have developed elsewhere including at a large scale (200,000ha) [1].

In financial speak, indigenous forest carbon projects do not generate a positive Internal Rate of Return (IRR) (i.e. do not recoup the investment with or without interest) and do not deliver a positive Net Present Value (NPV) (i.e. perform much worse than money invested elsewhere). In short, money invested will not be paid back and an investment in an indigenous forest carbon project will essentially be a grant. So why are some indigenous carbon projects happening in some parts of the country? Usually because the landowner does not need the money to cover the full cost of reforestation.

To enable the carbon finance engine to work for sustainable land management, we need to "fuel" it with other species. Some have argued that we need to use pine trees (exotic softwoods). Others say that we need to artificially inflate the carbon price for indigenous carbon projects. Ekos uses a middle path approach by means of a planting model that combines indigenous trees and exotic hardwoods (leafy trees such as eucalyptus).

Widely spaced exotic hardwoods planted at 50 stems per ha, and inter-planted with indigenous tree species at 1,200 stems per ha is a planting model that does work commercially (in principle). This is because exotic hardwoods accumulate carbon much faster than both indigenous forests and pine trees. For example, after 15 years indigenous forest will have accumulated 95 tonnes of CO_2, pines will have accumulated 163 tonnes, whereas exotic leafy trees (hardwoods) will have accumulated over 400 tonnes of CO_2. For this reason, exotic hardwoods that don't create a wilding problem are the "jet fuel" we are looking for to drive the sustainable land management carbon engine (see below).

[1] Ekos developed an investment model for establishing indigenous forest on 200,000 ha of erosion-prone lands in the Hawke's Bay for Hawke's Bay Regional Council in 2017. This model tested the economics of both indigenous-only and indigenous plus exotic hardwoods in the planting model.



The Results

The results of this Ekos study showed that a carbon project for indigenous riparian reforestation and reforesting erosion-prone lands using exotic hardwood nursery crop in the Wakapuaka catchment is commercially viable provided there is available investment.

The test sites were of such a small scale that it made it difficult to generate any economies of scale. Each site was tested for financial feasibility based on a rule that to be viable the following conditions had to apply: Positive IRR, positive NPV, payback period <50 years.

As expected the indigenous-only planting model did not work - it produced a 0% IRR.

The planting model combining indigenous species and exotic hardwoods did work, delivering an IRR range from 4% to 9.8% depending on the scenario.

The 'Carbon Only' scenario delivered reforestation at least cost (~$5k/ha investment required), but with the lowest returns (at or just below 5%).

The combination of Carbon and Timber or Carbon and Manuka Honey provided the highest returns (7-9.8% but came at a much higher capital cost (~$170k/ha investment required).

Main Report

INTRODUCTION

Ekos was contracted by Nelson City Council to undertake a feasibility study to examine the potential for indigenous reforestation activities in the Wakapuaka Catchment to be financed through carbon credits. We tested the financial feasibility of different scenarios using the Ekos Nature Carbon Investment Model for carbon-financed indigenous reforestation.

CARBON CREDITS

One carbon credit represents one tonne of CO2 taken out of the atmosphere by growing forests. Carbon credits provide a means of financing sustainable land management through the creation and sale of New Zealand Units (NZUs) (carbon credits) under the New Zealand Emissions Trading Scheme (NZETS).

Demand

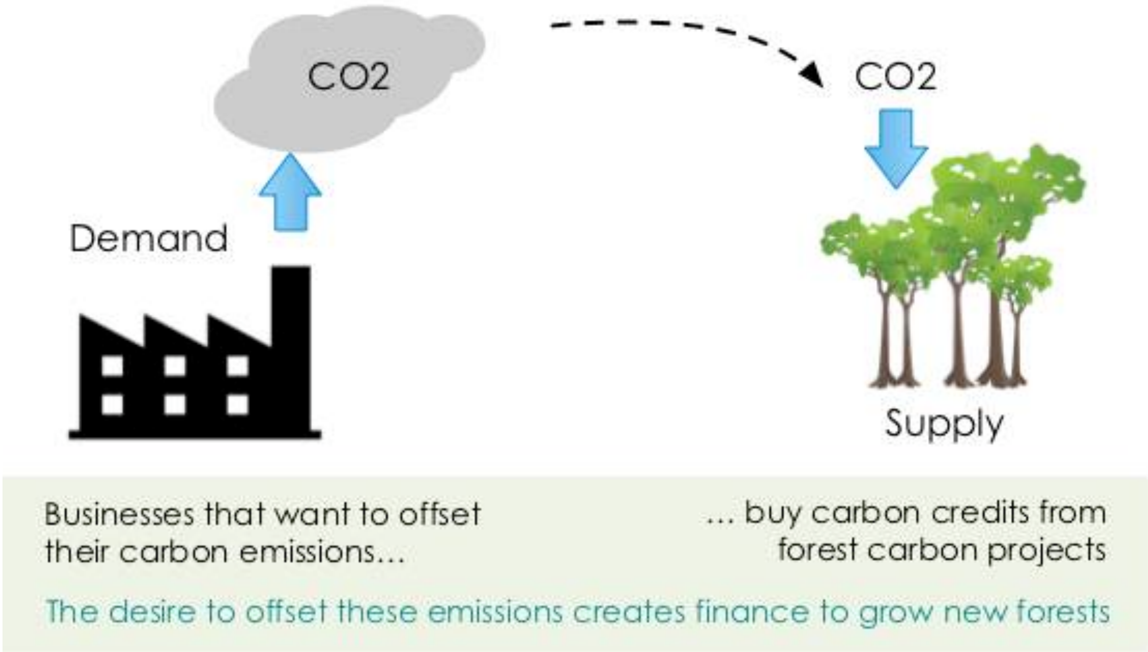
Demand for carbon credits comes from two situations. One is businesses who are required by the Crown to buy carbon credits to take responsibility for a proportion of their emissions. These are called 'points of obligation' under the NZETS and referred to as 'compliance demand'. Points of obligation include upstream entities in the energy, transport, and industrial processing sectors as well as entities that manage municipal landfills. These points of obligation are required by law to acquire (and then surrender to the Crown) carbon credits to match a certain proportion of their total greenhouse gas emissions. Points of obligation are required to acquire (e.g. produce or purchase) particular carbon credit types, including (but not always restricted to) NZUs produced in the New Zealand forest sector.

Demand also comes from businesses and individuals with no such obligations to the Crown, but who want to voluntarily take responsibility for their carbon emissions by going zero carbon. This is 'voluntary demand' and focuses on 'corporate social responsibility' and 'social license to operate'.

Voluntary carbon neutrality or zero carbon involves arriving at a position of net carbon neutrality. This involves measuring all greenhouse gas emissions (analogous to costs), and all greenhouse gas removals (carbon sequestered by forests) (analogous to income). When emissions (e.g. 1,000 tCO2e p.a.) match offsets (e.g. 1,000 tCO2e) we have a zero carbon outcome. Because most businesses and individuals do not have forests of their own to remove CO2 from the atmosphere[2], the only way that they can include CO2 removals in their carbon balance is to purchase carbon credits from projects that produce them.

[2] Carbon accounting is more complicated than this, but this explanation will suffice for our purposes in this report. In fact, carbon credits can and are also produced from activities that avoid and/or reduce emissions against an emissions baseline, but this does not apply to the carbon credit supply chain referred to in this report.

Figure 1. Carbon credit supply and demand.



Supply

The supply side of the New Zealand carbon market involves the production of either:

- NZUs from reforestation under the NZETS supply rules and issued by the NZETS.
- Verified Emission Reduction units (VERs)[3] issued by an international voluntary carbon market registry (e.g. Markit Environmental Registry in New York) produced either:
    - in NZ from forest carbon management activities not covered by the NZETS (e.g. pre-1990 indigenous forest carbon management or soil carbon management),
    - in other (usually developing) countries (e.g. from rainforest protection or reforestation carbon projects in the Pacific Islands).

Ekos has both types of project in its carbon offset supply chain.

[3] VERs are not able to be used by points of obligation under the NZETS and are only available to voluntary offset buyers. There are also other unit types in the voluntary carbon market including VCUs (Verified Carbon Units) but VERs are the ones that Ekos uses and produces in its projects in NZ and the Pacific Islands.

CARBON & SUSTAINABLE LAND MANAGEMENT

Reforestation projects can be eligible to operate under the NZETS and be issued carbon credits annually from the government which they can sell for cash. For this reason, carbon credits can (in theory) be used to finance reforestation efforts for purposes of riparian revegetation, and reforesting erosion-prone lands.

This provides an opportunity for private sector markets to cover the cost of environmental protection, rather than always using rate-payer or tax-payer grants. This can enable local government entities to seed-fund carbon projects rather than funding the entire exercise. It also creates an opportunity for local government money to be provided as a financial investment that pays for itself rather than a grant, thus making rate-payer money go much further.

In addition, the discipline required under the NZETS combined with the fact that carbon credits are performance-based means that a lot of risk is taken out of the funding equation. This can enable local government to fund high priority sustainable land management by seed funding projects (e.g. this feasibility study) and providing investment capital (and benefiting from the financial returns) under a market-based conservation financing model.

Carbon Financing Sustainable Land Management

The purpose of producing and selling carbon credits in New Zealand is to access a commercial source of revenue for forestry activities that would not be possible or be much more difficult financially without revenue from the sale of carbon credits. Nationally this is designed to incentivize increasing the size of the national forest estate. Locally this can be used for commercial forestry activities for conservation and sustainable land management purposes.

The purpose of creating and selling carbon credits in this sustainable land management setting is to generate carbon revenue to cover the costs of indigenous reforestation along waterways and on steep lands unsuitable for pastoral farming. Such reforestation encompasses an environmental management service involving the establishment and enhancement of “ecological infrastructure” sufficient to cause improvements in the following “ecosystem services”:

- River habitat and biodiversity.
- Flood protection and stream bank stability.
- Water quality and reduced stream sedimentation.

There are two main costs associated with reforestation for sustainable land management:

1. Forest establishment and management costs (including seedlings, planting, fencing, weeding).
2. Opportunity costs (lost farming income on lands reforested).

Carbon revenue from the sale of carbon credits in a sustainable land management setting is designed to cover (or at least significantly co-finance) these costs. In this way, the delivery of publicly beneficial environmental services on private land (e.g. waterways protection, biodiversity enhancement and erosion control) can be financed predominantly by the private sector, rather than the tax payer or rate payer.

This is particularly relevant to significant national strategic challenges such as climate resilience.

In practice, carbon projects need to be commercially viable in a particular land management context. The purpose of this study therefore, was to test the commercial viability of carbon-financed indigenous reforestation and sustainable land management on three properties in the Wakapuaka catchment near Nelson.

Indigenous Reforestation Carbon Projects

For carbon financing to work for sustainable land management, the value of carbon credits sold needs to cover the cost of the planting and management of the new forest. One key problem with indigenous-only reforestation using carbon finance is that the economics don't work. This is because the growth rates of indigenous trees are very slow. As a result, the number of carbon credits produced and sold annually from an indigenous forest carbon project is not enough to cover the real project costs. We know this from experience in this sector and from investment models we have developed elsewhere including at a large scale (200,000ha) [4].

Ekos tested this at scale in a study it undertook in late 2017 for the Hawke's Bay Regional Council (HBRC). HBRC asked Ekos to develop a preliminary investment plan for indigenous reforestation of 200,000 ha of erosion-prone lands in the Hawke's Bay region (i.e. a planting scale sufficient to generate economies of scale). Results showed that even at a large scale, indigenous forest carbon projects do not generate a positive Internal Rate of Return (IRR) (i.e. do not recoup the investment with or without interest) and deliver a deeply negative Net Present Value (NPV).

We concluded that indigenous reforestation can be carbon financed only if:

1. Forest establishment is funded by grant or not funded at all.
   or
2. The carbon credit buyer is willing to pay a carbon price that is significantly higher than the market rate.
   or
3. The planting involves the inclusion of exotic tree species.

In the absence of conditions 1. and 2., option 3 is required.

[4] Weaver, S.A. 2017. Hawke's Bay Climate Resilience Programme. A framework for the climate change component of the Hawke's Bay Long-Term Plan. Consulting report to the Hawke's Bay Regional Council. Ekos Consulting Reports 2017/008. This model tested the economics of both indigenous-only and indigenous plus exotic hardwoods in the planting model.

So why are some indigenous carbon projects happening in some parts of the country? Usually because the landowner does not need the money to cover the full cost of reforestation, or because there were no planting costs (i.e. because the land was left to regenerate naturally).

Exotic Hardwood Nursery Crop

The ecological restoration community in New Zealand has long recognized that some exotic species can facilitate indigenous reforestation. A notable example is gorse. If left alone for around 20-30 years, gorse will eventually succeed to native forest in many parts of NZ.

Gorse (*Ulex europaeus*) is an exotic flowering plant - an 'exotic hardwood' shrub. In forestry parlance, the word 'hardwood' refers to a flowering tree. 'Softwoods' on the other hand refer to conifers such as *Pinus radiata*.

A reforestation project involving exotic tree species can generate carbon credit revenues sufficient to cover forest establishment costs. This is because exotic trees tend to grow a lot faster than indigenous species. The NZETS carbon credit allocations for forest projects illustrates this very well, as seen in Table 1 below.

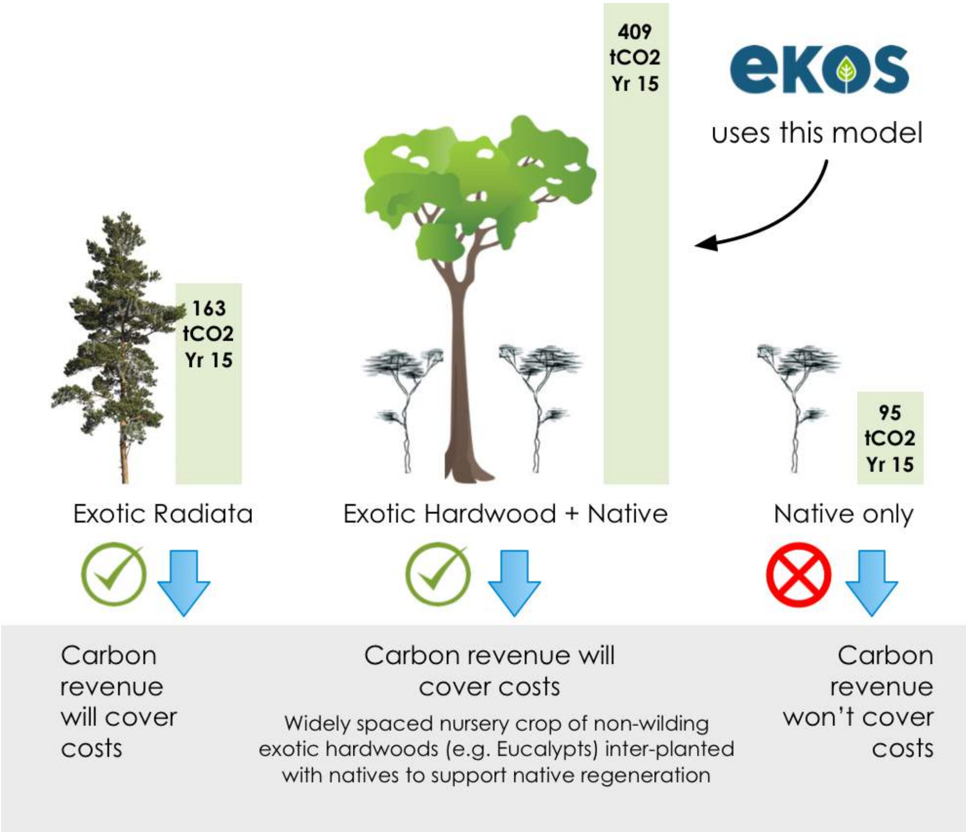
Table 1. NZETS 'Look Up Tables' for different forest types: Carbon stock per ha for Douglas-fir, exotic softwoods, exotic hardwoods, and indigenous forest (expressed as tCO2 per hectare)

Age (yrs)	Douglas-fir	Exotic softwoods	Exotic hardwoods	Indigenous forest
0	0	0	0	0
1	0.1	0.2	0.1	0.6
2	0.1	1	3	1.2
3	0.4	3	13	2.5
4	1	12	34	4.6
5	2	26	63	7.8
6	4	45	98	12.1
7	7	63	137	17.5
8	20	77	176	24.0
9	33	87	214	31.6
10	50	95	251	40.2
11	69	106	286	49.8
12	90	118	320	60.3
13	113	132	351	71.5
14	138	147	381	83.3
15	165	163	409	95.5

As shown in the bottom line of Table 1 above, carbon accumulation after 15 years for indigenous species is 95.5 tCO2e/ha, whereas exotic hardwoods accumulate 409 tCO2e/ha in the same timeframe. Exotic softwoods (e.g. *Pinus radiata*) perform better than indigenous (163 tCO2e/ha) but not as well as exotic hardwoods (e.g. *Eucalyptus sp.)*.

To enable the carbon finance engine to work for sustainable land management and indigenous reforestation, we need to "fuel" it with other species. Some have argued that we need to use pine trees (exotic softwoods). Others say that we need to artificially inflate the carbon price for indigenous carbon projects. Ekos uses a middle path approach by means of a planting model that combines indigenous trees and exotic hardwoods (leafy trees such as eucalyptus).

Figure 2. Carbon accumulation rates of different forest types



Widely spaced exotic hardwoods[5] inter-planted with indigenous tree species is a planting model that does work commercially (in principle). This is because exotic hardwoods accumulate carbon much faster than both indigenous forests and pine trees. For example, after 15 years indigenous forest will have accumulated 95 tonnes of CO_2, pines will have accumulated 163 tonnes, whereas exotic leafy trees (hardwoods) will have accumulated over 400 tonnes of CO_2. For this reason, exotic hardwoods that don't create a wilding problem are the "jet fuel" we are looking for to drive the sustainable land management carbon engine.

[5] Revenue from timber harvesting of exotic hardwoods remains an option in some situations - perhaps for some single tree extraction and on lands that are not erosion-prone.

By the time these exotic hardwood trees die naturally (e.g. in years 60+), the indigenous trees will have grown sufficiently to take over the site. Furthermore, it is possible that in many parts of New Zealand, indigenous tree growth rates will be higher under a nursery crop canopy than without. This is due to the micro-environment created by the exotic hardwood nursery crop (i.e. a larger and longer-term version of gorse succession to native forest).

When Ekos compared the carbon economics of indigenous-only plantings with indigenous + exotic hardwoods (never harvested) at scale it found that the former approach did not cover forest establishment costs, whereas the latter approach did (Table 3).

Table 3. Exotic Hardwood & Indigenous Reforestation Investment Analysis (Hawke's Bay)

	Indigenous only	Indigenous + exotic hardwoods
Area reforested:	200,000 ha	200,000 ha
Forest establishment period:	2018-2030	2018-2030
Capital required:	$620m	$400m
Internal Rate of Return (IRR):	0%	13%
Net Present Value (NPV):	-$217m	$136m

Riparian Reforestation

Riparian (riverside) reforestation focuses on replanting stream banks in indigenous forest in order to provide greater protection to streams, improve stream habitats for biodiversity, and contribute to improvements in water quality. Local government entities around the country have allocated significant funds to such plantings by community organizations and private landowners.

If riparian reforestation could be financed through carbon credits it would enable local government to significantly increase the impact per rate payer dollar spent, because the bulk of funds for forest establishment and management could come from the private sector. This would enable local government to focus on:

- Start-up funding for forest carbon projects and programmes rather than covering the main project costs.
- Providing impact investment capital and gaining a financial return on their investment.
- Fully funding indigenous reforestation of biodiversity or water quality hotspots that require special attention over and above what can be commercially financed elsewhere.

Challenges

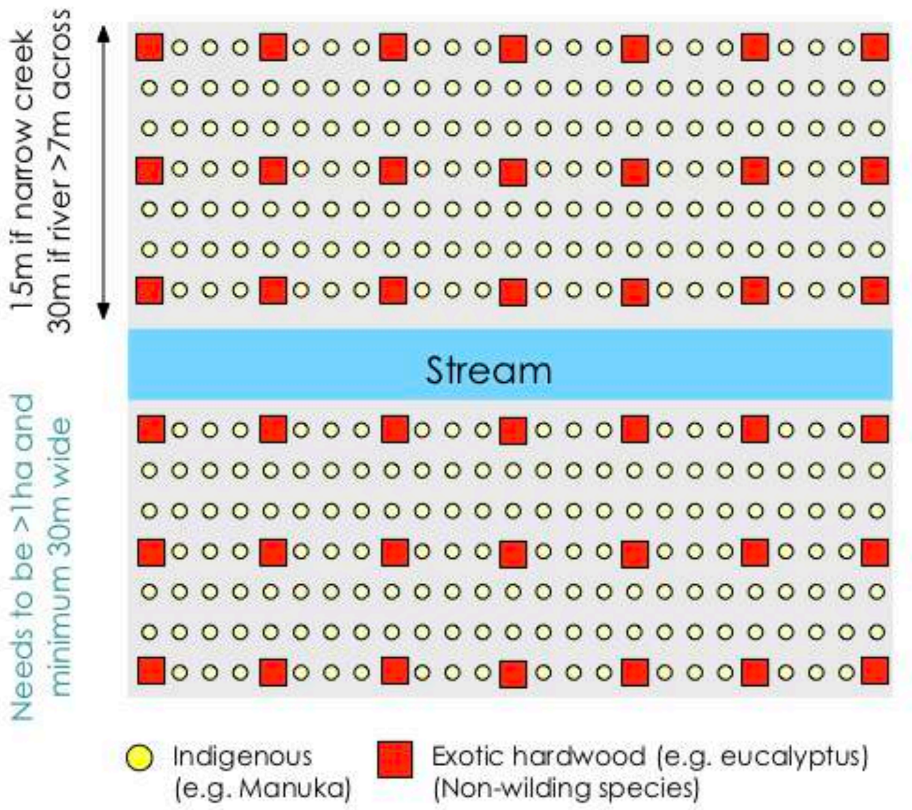
Riparian reforestation projects are difficult to carbon finance because:

a) They often do not meet the NZETS eligibility requirements of a minimum width of 30m, a minimum of 1ha in area, with a tree canopy cover of greater than 30% for each hectare, and with trees that can reach at least 5m in height in situ.
b) They are often planted in indigenous species only and the carbon economics don't work (as shown above).
c) They are often so small in total area (long and thin) that they cannot generate any economies of scale.

d) They have high fencing costs per ha (because they are long and thin) and fencing costs are a significant contributor to total project costs.

In principle, the exotic hardwood + indigenous planting model described above mitigates strongly against these challenges by significantly increasing the annual carbon revenues per ha. In practice, this needed to be tested using a case study, and the current study does this using the planting model shown in Figure 3.

Figure 3. Exotic hardwood + indigenous riparian reforestation planting model



FEASIBILITY STUDY - WAKAPUAKA CATCHMENT

The current feasibility study involved an investment analysis of carbon financed indigenous reforestation at three sites in the Wakapuaka catchment, north of Nelson. The study involved consultation with landowners in this catchment, a mapping exercise and the development of an investment plan outlining the costs and benefits, IRR and NPV, and allows sensitivity analysis including:

Income	Expenses
Carbon accumulation	Seedling cost
Carbon pricing	Weed control
Wood sales (where relevant)	Fencing
Non-wood forest products	Proportion of trees lost after planting

We tested the feasibility using the Ekos 'Nature Carbon Investment Model' for carbon-financed indigenous reforestation. This included testing the following scenarios:

With Fencing Costs	Without Fencing Costs
Indigenous Only Carbon Only	Indigenous Only Carbon Only
Indigenous & Exotic Hardwoods Carbon Only	Indigenous & Exotic Hardwoods Carbon Only
Indigenous & Exotic Hardwoods Carbon + Timber	Indigenous & Exotic Hardwoods Carbon + Timber
Indigenous & Exotic Hardwoods Carbon + Timber + Manuka Honey	Indigenous & Exotic Hardwoods Carbon + Timber + Manuka Honey

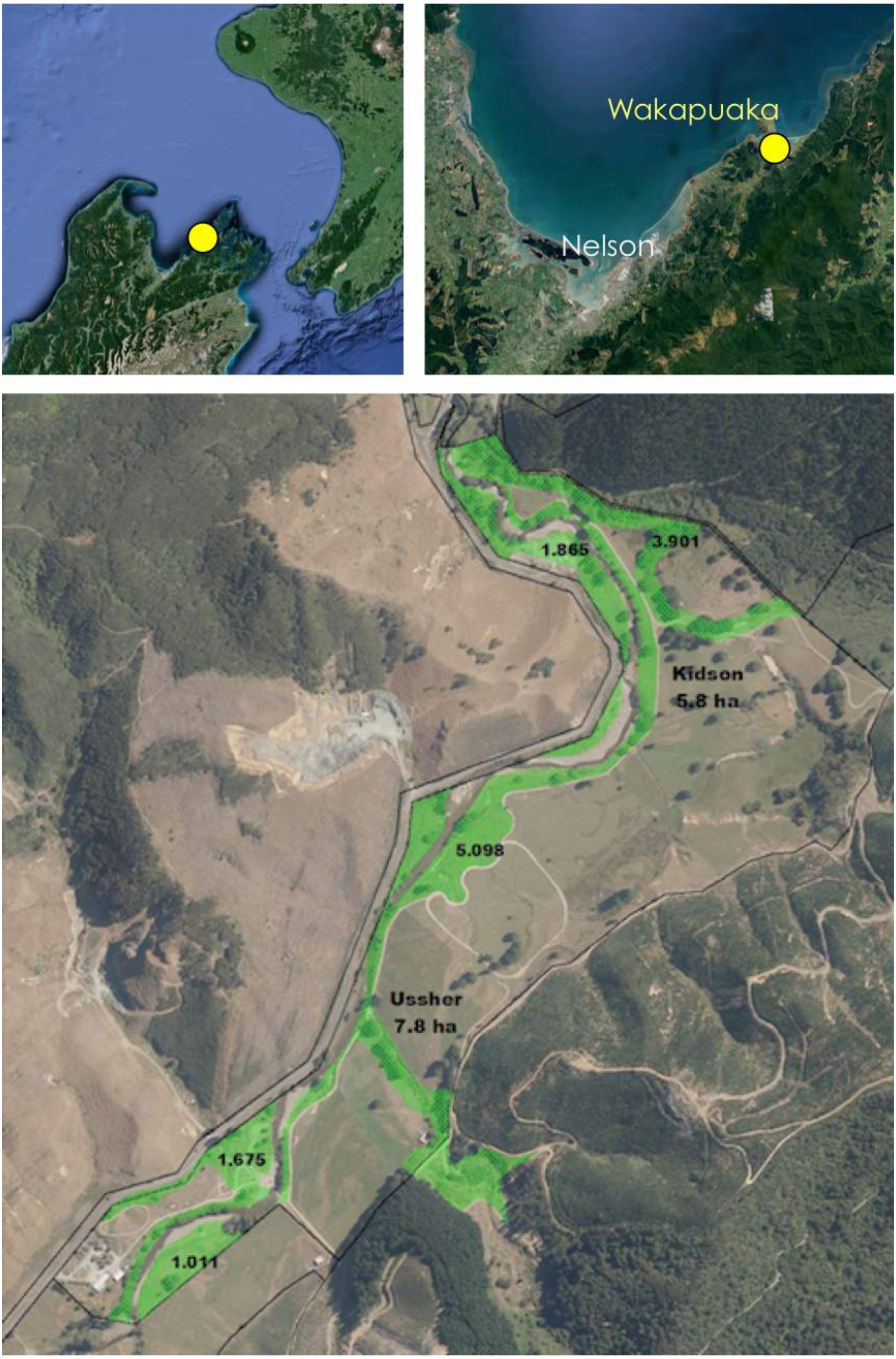
Any timber extraction would involve removal of the widely-spaced exotic hardwoods only and harvested in year 45. By this time the inter-planted indigenous forest would be well established, and could take advantage of the light gaps from exotic tree removal.

This feasibility study looked at three properties and presents different scenarios depending on how the project is structured. Key variables include whether the exotic hardwoods are harvested at some stage to create timber revenue.

The three properties considered were:

- Ussher (7.784 ha)
- Kidson (5.766 ha)
- Kelly (10 ha) (not riparian, but on erosion-prone steep land)

Figure 4. Study Site Location



Method

Ekos undertook a site visit to interview landowners and undertake project mapping. Ekos then prepared an investment analysis spreadsheet to test the economic variables in question.

The resulting analysis presents different investment outcomes depending on different input variables relating to: Area planted; species planted; timber revenue (or not); manuka honey revenue (or not); fencing costs excluded (either not relevant or covered by farmer or grant).

Assumptions

Current carbon price:	\$21/tCO2e rising at \$1 p.a. assuming no sudden price shocks
Maximum carbon price:	\$50/tCO2e
Percentage carbon credits sold:	75% (25% held in a buffer reserve as self-insurance against reversals (e.g. fire, flood damage)).
Manuka rental/ha/yr:	\$200
Log value as dry sawn:	\$950
Discount rate:	5%[6]
Inflation rate:	1%
Exotic hardwood stocking rate:	51 stems/ha
Tree lucern[7] stocking rate:	612 stems/ha
Indigenous stocking rate:	612 stems/ha
Project Period:	FY2018-2066

Results

The investment analysis presented below is broken into two parts. Part 1 involves testing the project feasibility when fencing costs are covered by carbon credit revenues; Part 2 tests the project feasibility assuming that any fencing costs are funded externally to the carbon project (e.g. covered by the farmer or grant).

Revenue included: carbon credits and timber for Ussher and Kidson properties, and carbon credits only for the Kelly property. Manuka honey revenue was included but the small-scale planting area may make it difficult to secure a manuka honey rental. Manuka honey would be more relevant for the Kelly property which comprises a 10ha block of reforestation.

[6] The 5% discount rate was used as a benchmark for an alternative investment at 5% elsewhere.

[7] Tree lucern (*Cytisus proliferus*) is included in the planting model to provide an additional beneficial (nitrogen fixing) nursery crop attractive to native birds under which indigenous tree species can establish naturally.

Outputs: Carbon Only

Landowner:	Ussher	Kidson	Kelly	Total
Area:	7.784ha	5.766ha	10ha	23.544ha
Including Fencing Costs (Fencing costs covered by carbon revenues)				
IRR Indigenous only:	0%	0%	0%	0%
NPV Indigenous only:	($90,604)	($66,042)	($72,462)	($148,108)
Capital required Ind only:	$80,205	$55,066	$60,070	$195,341
Capital required / ha Ind only:	$10,304	$9,550	$6,007	$8.296
Payback period Ind only:	Never	Never	Never	Never
IRR Hardwood/Indigenous:	1.3%	1.1%	4.4%	2.4%
NPV Hardwood/Indigenous:	($38,513)	($27,531)	($5,361)	($71,405)
Capital required Hw/Ind:	$75,343	$51,464	$53,823	$180,630
Capital required / ha Hw/Ind:	$9,701	$8,925	$5,382	$7,672
Payback period Hw/Ind:	33 years	34 years	19 years	27 years
Excluding Fencing Costs (Fencing costs covered by grant or by farmer)				
IRR Indigenous only:	0%	0%	0%	0%
NPV Indigenous only:	($59,918)	($28,494)	($72,462)	($160,974)
Capital required Ind only:	$42,450	$32,093	$53,823	$128,366
Capital required / ha Ind only:	$5,453	$5,566	$5,382	$5,452
Payback period Ind only:	Never	Never	Never	Never
IRR Hardwood/Indigenous:	4.0%	3.2%	4.4%	3.9%
NPV Hardwood/Indigenous:	($7,745)	($9,915)	($5,361)	($23,021)
Capital required Hw/Ind:	$42,450	$32,093	$53,823	$128,366
Capital required / ha Hw/Ind:	$5,453	$5,566	$5,382	$5,452
Payback period Hw/Ind:	20 years	23 years	19 years	15 years

Analysis: Carbon Only

Commercially viable?	Indigenous Only (fencing or no fencing):	No
	Hardwood/Indigenous + Fencing:	Yes (marginal)
	Hardwood/Indigenous No Fencing:	Yes
Indigenous-only IRR:	The 0% IRR in both fencing and no-fencing scenarios means that there is no return on investment and as such the project will not cover its costs or provide interest on invested money.	
Indigenous-only NPV:	The deeply negative NPV in both fencing and no-fencing scenarios means that the project financing would need to be grant funded with minor cost recovery from carbon credit sales, and where carbon revenues would never recoup the investment.	
Hardwood & indigenous IRR:	The positive IRR in both fencing and no fencing scenarios means that there is a positive return on investment and as such the project will cover its costs and provide interest on invested money at the rate shown for each. None of the scenarios delivers an IRR above 5%, which means that the investment will generate a return but will perform worse than an alternative investment at 5% elsewhere.	

Hardwood & indigenous NPV:	The negative NPV for each scenario means that compared with an alternative investment at 5% the project would be viable but make a lower return (i.e. lower by the amount stated as a negative) compared with a 5% investment elsewhere. This also means that the individual project with a negative NPV would not cover the full cost of capital based on a commercial investment alternative that earned 5%. This would amount to an opportunity cost to the capital provider, who by definition would need to be an impact investor (i.e. an investor more interested in causing beneficial impact than causing a commercial return on money invested).
Capital required:	The average capital cost of viable options is $5,452-$7,672/ha. This set of 'carbon only' scenarios has the lowest capital requirement of any scenario in this study (i.e. compared with the other scenarios presented below). This means that this 'carbon only' approach delivers reforestation at 'least cost' but with the lowest returns (lowest IRR compared with other scenarios presented below).
Hardwood & indigenous Investment:	IRR has not yet been allocated between stakeholders, but two competing interests will want a stake (farmer and capital provider). The low IRR means that a private sector capital provider would likely negotiate strongly for all of it. An impact investor or public-sector capital provider may be willing to receive a lower return in exchange for impact delivery under a funding scenario that is significantly out-performs a grant because this scenario pays back.
Hardwood & indigenous Risk:	Risks include: • Carbon price rises at a rate lower than the $1 p.a. modelled, or suddenly falling due to policy change (e.g. government allowing import of cheap foreign credits into the NZETS) • Significant increases in seedling prices above rate of inflation. • Reversals from events such as illegal forest removal, fire, storm and flood damage.

Outputs: Carbon & Timber

Landowner:	Ussher	Kidson	Kelly	Total
Area:	7.784ha	5.766ha	10ha	23.544ha
Including Fencing Costs (Fencing costs covered by carbon revenues)				
IRR Hardwood/Indigenous:	6.4%	6.5%	8.2%	7.1%
NPV Hardwood/Indigenous:	$52,051	$39,465	$111,083	$202,599
Capital required Hw/Ind:	$1,379,371	$1,018,305	$1,728,123	$4,125,799
Capital required / ha Hw/Ind:	$177,206	$176,605	$172,812	$175,237
Payback period Hw/Ind:	34 years	35 years	20 years	28 years
Excluding Fencing Costs (Fencing costs covered by grant or by farmer)				
IRR Hardwood/Indigenous:	8.7%	7.7%	8.2%	8.2%
NPV Hardwood/Indigenous:	$102,232	$57,081	$111,083	$270.396
Capital required Hw/Ind:	$1,346,479	$998,934	$1,728,123	$4,073,536
Capital required / ha Hw/Ind:	$172,980	$173,246	$172,812	$173,018
Payback period Hw/Ind:	19 years	24 years	20 years	22 years

Analysis

Commercially viable?	Indigenous Only (fencing or no fencing):	Not applicable
	Hardwood/Indigenous + Fencing:	Yes (marginal)
	Hardwood/Indigenous No Fencing:	Yes
IRR:	The positive IRR for each scenario and the aggregated project (3 properties combined into one investment) is higher in each case than an alternative base case investment at 5%. The scenario excluding fencing costs has the highest IRR.	
NPV:	The NPV for each scenario shows that the project is financially better off than an alternative investment at 5% by the amount stated in today's terms. This means that the project (either as individual farm or aggregated across all three properties) presents a moderate commercial or impact investment.	
Capital required:	An average of ~$173,000-$175,000/ha most of which services the timber extraction effort. Highest capital requirement scenario to reforest these lands coupled with the second highest returns.	
Investment:	The high capital investment required coupled with a long timeframe for returns moves this scenario into a significantly different investment space compared with the carbon only scenario. The main cash flows are delivered at the time of timber harvest in year 45 which means this is a long-term investment.	
Risk:	Risks include: • Carbon price rises at a rate lower than the $1 p.a. modelled, or suddenly falling due to policy change (e.g. government allowing import of cheap foreign credits into the NZETS) • Significant increases in seedling prices above rate of inflation. • Reversals from events such as illegal forest removal, fire, storm and flood damage. • Timber pricing lower than modelled at time of harvest. • Timber harvesting may not be appropriate for the Kelly property due to erosion risk at harvest.	

Outputs: Carbon, Timber, Manuka Honey

Landowner:	Ussher	Kidson	Kelly	Total
Area:	7.784ha	5.766ha	10ha	23.544ha
Including Fencing Costs (Fencing costs covered by carbon revenues)				
IRR Hardwood/Indigenous:	7.0%	7.1%	8.9%	7.7%
NPV Hardwood/Indigenous:	$71,464	$53,845	$136,023	$261,332
Capital required Hw/Ind:	$1,379,371	$1,018,305	$1,728,123	$4,125,799
Capital required / ha Hw/Ind:	$177,206	$176,605	$172,812	$175,237
Payback period Hw/Ind:	24 years	24 years	17 years	19 years
Excluding Fencing Costs (Fencing costs covered by grant or by farmer)				
IRR Hardwood/Indigenous:	8.7%	8.4%	8.9%	8.7%
NPV Hardwood/Indigenous:	$102,232	$71,461	$136,023	$309,716
Capital required Hw/Ind:	$1,346,479	$998,934	$1,728,123	$4,073,536
Capital required / ha Hw/Ind:	$172,980	$173,246	$172,812	$173,018
Payback period Hw/Ind:	19 years	19 years	17 years	19 years

Analysis

Commercially viable?	Indigenous Only (fencing or no fencing):	Not applicable
	Hardwood/Indigenous + Fencing:	Yes
	Hardwood/Indigenous No Fencing:	Yes
IRR:	The positive IRR for each scenario and the aggregated project (3 properties combined into one investment) is higher in each case than an alternative base case investment at 5%. The scenario excluding fencing costs has the highest IRR.	
NPV:	The NPV for each show that the project is financially better off than an alternative investment at 5% by the amount stated in today's terms. This means that the project (either as individual farm or aggregated across all three properties) presents a moderate commercial or impact investment.	
Capital required:	An average of ~$173,000-$175,000/ha most of which services the timber extraction effort. Highest capital requirement scenario to reforest these lands coupled with the second highest returns. Highest capital requirement scenario to reforest these lands coupled with the highest returns.	
Investment:	Similar to results for Carbon + Timber, but because of the manuka honey rental, the main cash flows are not delayed until the time of timber harvest in year 45, although the biggest cash flows are in years 45-47. This is a long-term investment but with stronger cash flows through time due to manuka honey rentals. Also, IRR split between farmer and capital provider has not been allocated but the returns will need to be proportionate to investment made and subject to negotiation. A split that allocates the bulk of manuka honey returns to the farmer and the bulk of timber revenues to the capital provider seems the most likely.	
Risk:	Same as for Carbon + Timber scenario above. • Manuka honey pricing lower than modelled. • Timber harvesting may not be appropriate for the Kelly property due to erosion risk at harvest.	

Outputs: Carbon & Timber (Ussher/Kidson); Carbon & Manuka Honey (Kelly)

Landowner:	Ussher	Kidson	Kelly	Total
Area:	7.784ha	5.766ha	10ha	23.544ha

Including Fencing Costs (Fencing costs covered by carbon revenues)				
IRR Hardwood/Indigenous:	7.0%	7.1%	6.7%	7.0%
NPV Hardwood/Indigenous:	$71,464	$53,845	$19,578	$144,887
Capital required Hw/Ind:	$1,379,371	$1,018,305	$53,823	$2,451,499
Capital required / ha Hw/Ind:	$177,206	$176,605	$9,334	$104,124
Payback period Hw/Ind:	24 years	24 years	15 years	19 years
Excluding Fencing Costs (Fencing costs covered by grant or by farmer)				
IRR Hardwood/Indigenous:	8.7%	8.4%	6.7%	8.1%
NPV Hardwood/Indigenous:	$102,232	$71,461	$19,578	$193,271
Capital required Hw/Ind:	$1,346,479	$998,934	$53,823	$2,399,236
Capital required / ha Hw/Ind:	$172,980	$173,246	$9,334	$101,904
Payback period Hw/Ind:	19 years	19 years	15 years	17 years

Analysis

Commercially viable?	Indigenous Only (fencing or no fencing):	Not applicable
	Hardwood/Indigenous + Fencing:	Yes
	Hardwood/Indigenous No Fencing:	Yes
IRR:	The positive IRR for each project and the aggregated project (3 properties combined into one investment) is higher in each case than an alternative base case investment at 5%.	
NPV:	The NPV for each show that the project is financially better off than an alternative investment at 5% by the amount stated in today's terms. This means that the project (either as individual farm or aggregated across all three properties) presents a moderate commercial or impact investment.	
Capital required:	Lower capital requirement to reforest than Carbon/Timber and Carbon/Timber/Honey coupled with returns that are lower than both but higher than Carbon Only.	
Investment:	The investment for the Ussher and Kidson properties is the same as in Carbon + Timber. This is a long-term investment for Ussher & Kidson. For the Kelly property this scenario performs better than the Carbon Only scenario and is more realistic than scenarios involving timber harvest because the land is not particularly suitable for timber extraction.	
Risk:	Same as for Carbon + Timber scenario above. • Manuka honey pricing lower than modelled.	

DISCUSSION

This study tested the commercial feasibility of indigenous riparian reforestation and reforesting erosion-prone lands in the Wakapuaka catchment. Four investment models were tested in this feasibility study:

1. Carbon Only (indigenous only; indigenous + exotic hardwood)
2. Carbon + Timber (indigenous + exotic hardwood)
3. Carbon, Timber and Manuka Honey (indigenous + exotic hardwood)
4. Carbon & Timber (2 properties); Carbon & Manuka Honey (1 property) (indigenous + exotic hardwood).

The results showed that a carbon project at these sites using 'indigenous species only' is not commercially feasible, whereas a project using both exotic hardwoods and indigenous species is commercially feasible (in principle) provided there is available investment.

For the viable projects, carbon credit revenues will cover the cost of:

a) Reforestation and associated management,
b) Repaying the original capital investment with returns (provided an investor is willing to invest), and in some cases
c) Compensating farming opportunity cost to the landowner (e.g. loss of net beef & lamb revenue on planted lands).

The key stakeholders seeking access to cash flows, therefore, are:

1. Project Coordinator who develops the project for the farmer and needs cash flows to cover planting and management costs (mostly in the first 5 years).
2. Farmer who wants the reforestation to happen at no net cost, and who seeks to recover lost farming revenues on land given up to reforestation.
3. Capital provider who supplies investment capital (at a cost - i.e. interest) to enable the project to be developed and who recovers their principle and interest through repayments for the duration of the investment period.

The landowner and the capital provider have a competing interest in a share of the project IRR because both are interested in on-going returns for the project duration. The IRR presented in the results scenarios have not been split into farmer and investor portions. This will be subject to negotiation between these parties and likely based on financial and other capital invested by those parties.

Internal Rate of Return

Of the scenarios using a combination of indigenous and exotic hardwoods, the lowest performing viable investment model was Carbon Only (IRR 1.3%-4.4%), although it did provide the least cost option (~$5k/ha). The low IRR would make it more difficult to attract commercial investment but may be sufficient for a council investment (rate payer funds provided as a concessionary loan), or perhaps an impact investor or both.

The highest performing investment model was Carbon, Timber & Manuka Honey on the Kelly property (8.9%), with a higher capital investment required (~$173k/ha).

The most realistic high performing combination was carbon and timber for the Ussher and Kidson properties (IRR 7.0%-8.4%; capital required: ~$170k/ha), and carbon and manuka honey for the Kelly property (6.7%; capital required: ~$9k/ha). The reason for structuring this scenario in this way relates to a) the likelihood that the Ussher and Kidson projects would not be large enough to attract a manuka honey rental, b) the larger (10ha) Kelly block may do so (although this remains to be proven), and c) the Kelly property is unsuitable for timber harvesting.

The Carbon + Timber scenarios have the advantage of higher returns (up to 8.7%) coupled with the disadvantage of higher capital investment requirement (<$170k/ha). The long timeframe for returns (timber cash flows from year 45) would only be attractive to certain investor types.

Some of the ecological benefits could diminish somewhat at harvest time for scenarios using timber harvesting of the exotic hardwoods. Although by the harvest year (yr 45) the indigenous forest understory will have grown substantially and will be able to take advantage of canopy gaps afforded by felling of the widely spaced exotic hardwood crop. Timber harvests however, are not advisable on steep, erosion-prone lands due to the sedimentation risks at harvest and given that the purpose of this investment type is to cause net environmental benefits.

CONCLUSION

In general terms, a forest carbon investment of the kind described here may provide Nelson City Council with a useful strategic financing tool for the delivery of high priority sustainable land management goals. The use of Council funds as an impact investment (positive IRR) for market-based conservation represents a significant efficiency gain compared with grant funding for the same (guaranteed 0% IRR). This is because investments delivering a positive IRR will pay for themselves, enabling ratepayer funds to be recycled through time.

A variation on council investment, particularly when considering an ambitious regional or catchment-wide programme, could involve a public-private-partnership. Imagine that the capital required for a catchment-wide riparian reforestation programme was $2m and the project IRR was 8%. Then imagine that the programme investment portfolio splits this capital into two halves ($1m each). The public capital provider (e.g. NCC) could offer to supply investment capital of $1m (50% of the total) at a lower IRR than the project IRR - for example, offering money at 5% instead of 8%. This would enable the other 50% of required capital to be allocated an IRR above the 8% base project IRR - e.g. 11%. This higher IRR may then be sufficient to attract private investors to participate because the IRR is high enough to compensate for investment risk in an impact investment.

Under this kind of market-based conservation financing, the council gets a $2m outcome for $1m and shares the risk with the private sector.

On the topic of risk, a commercial conservation financing model using carbon credit cash flows operates on a performance-basis. In other words, cash does not flow until and unless the project delivers environmental benefits, measures, reports and verifies those benefits (by being issued the next batch of carbon credits). This significantly reduces non-delivery risk compared with a grant funding model. Under grant funding, a project is typically funded before any measurable environmental outcome has been delivered, which places non-delivery risk heavily on the shoulders of the grant provider.