Manaaki Whenua
Landcare Research

Valuing the Benefits of Permanent Forests

and 1 Billion Trees

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Landscape Policy and Governance

LINK Seminar 06/07/18

Main Presentation based on report done for MPI

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Prepared for Elizabeth Heeg,
Ministry for Primary Industries

Explore the impacts of afforestation on *marginal* lands.

ROTORUA DAILY POST

Forestry bad to best thanks to steep slope innovations

23 Dec, 2015 11:10am

2 minutes to read

Rotorua Daily Post

New Zealand forestry has gone from a bad performer to being one of the best, and one man says it is because of the new innovations in steep slope harvesting.

In recent years, New Zealand forestry has faced massive hurdles in safety, especially on steep slopes. Too many accidents occurred because workers were facing too many risks in

Assumptions/Limitations

<1 year timeframe

- Original study – time and funding limitations

Ownership of land

- Assume the lands identified could be converted
- Given marginal nature, there could be incentives or policies to convert *many* of these areas.

Dynamics

- Assumptions on transition from baseline to policy
- Two analyses

- Smaller assumptions as we go along

Policy analyses

National analysis

Assuming **scenario is fully implemented**

Rougher analysis, no transition path

Case Study – Manawatu

Include additional ecosystem service categories

Explore impacts over **50 years** as we move to implementation

- Roughly constant changes across time…

Start with GIS

- non-economics outputs from Norman and David.

Then, *the Economics.*

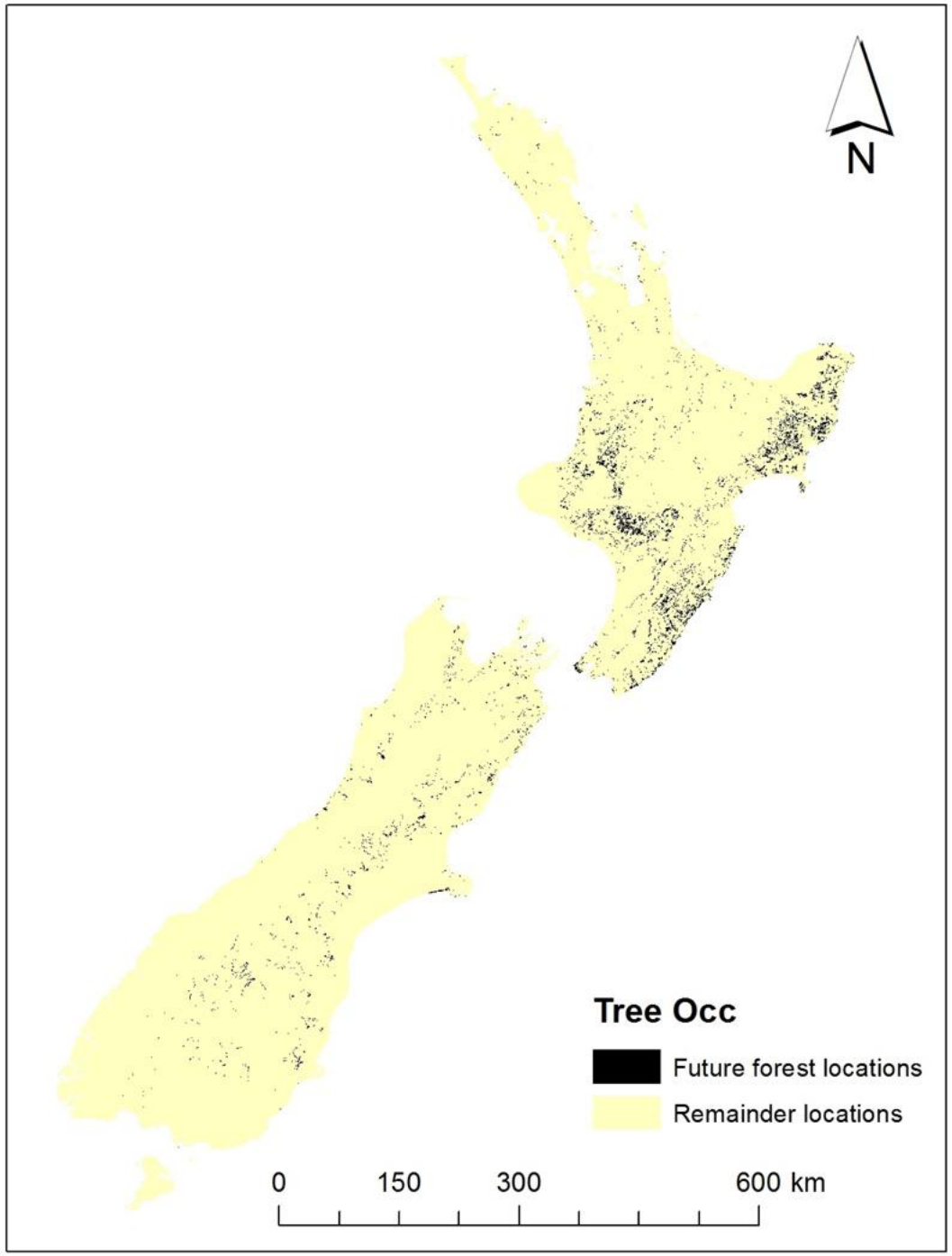
- National Impacts
- Manawatu Case Study

Step 1 Identify Marginal Lands

Watt et al. (2011) – Land Use Classes 5-8 **suitable for forest**.

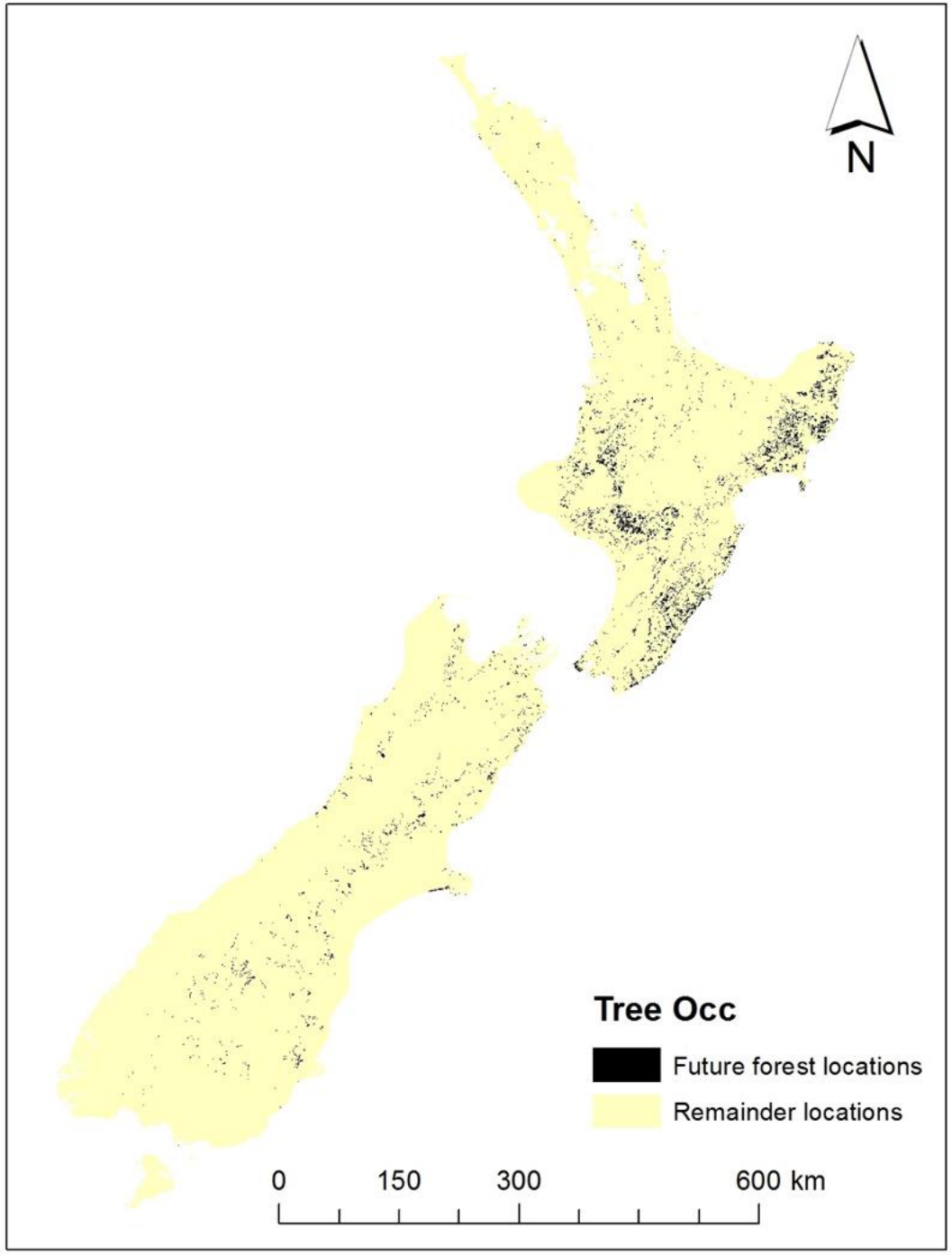
Use their most conservative scenario – land less likely to face competition from higher value agricultural uses.

Land characterised by moderate to severe erosion



- 695,566 ha of afforestation area identified
- Minus 26,000 in reserves
- 669,966 ha available for afforestation

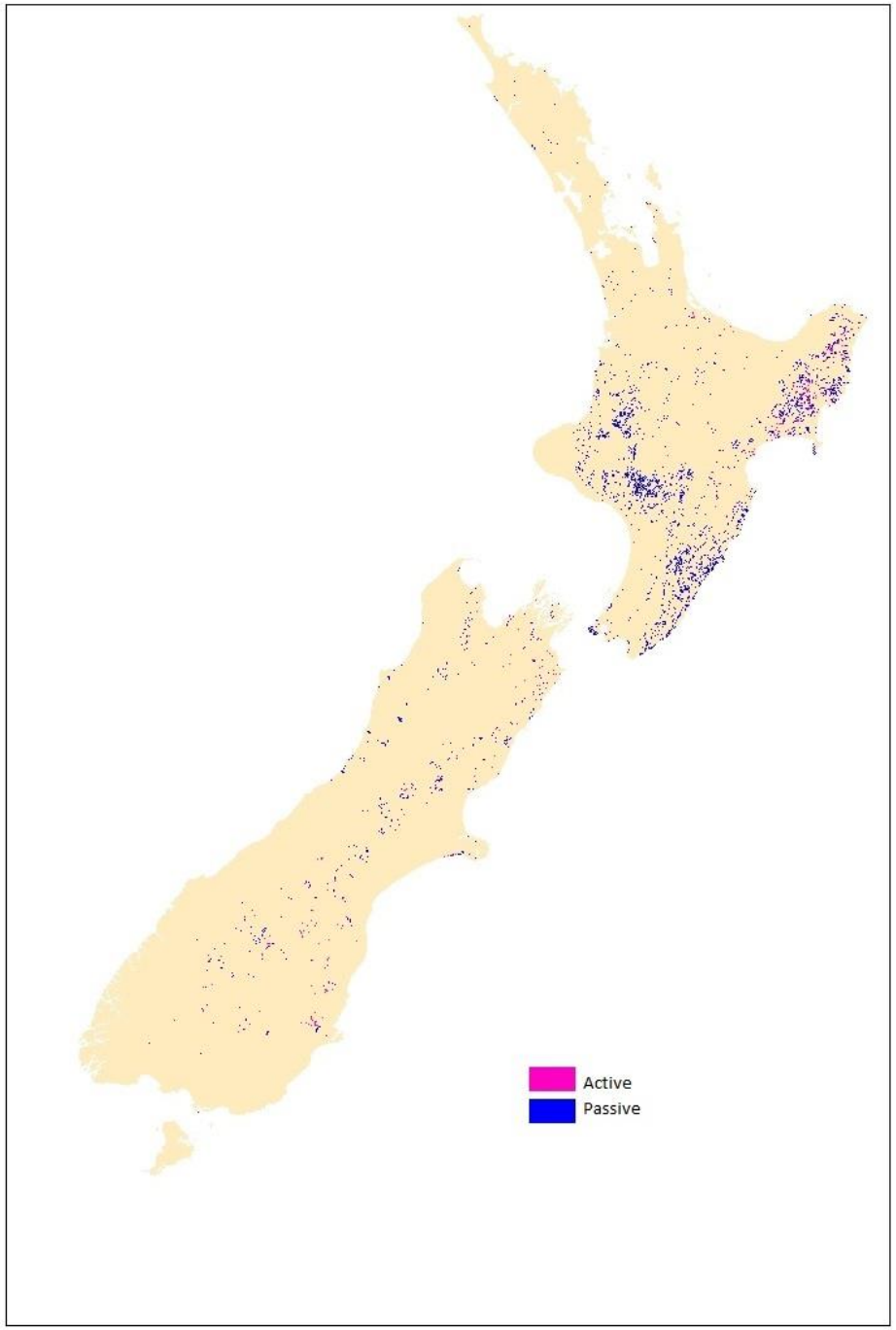
531,051 ha - North Island
138,914 ha - South Island



For Indigenous Forestry,
Active vs Passive afforestation

Some areas may not naturally revert to indigenous forest

- Ex: distance to other native forest - act as a seedbank

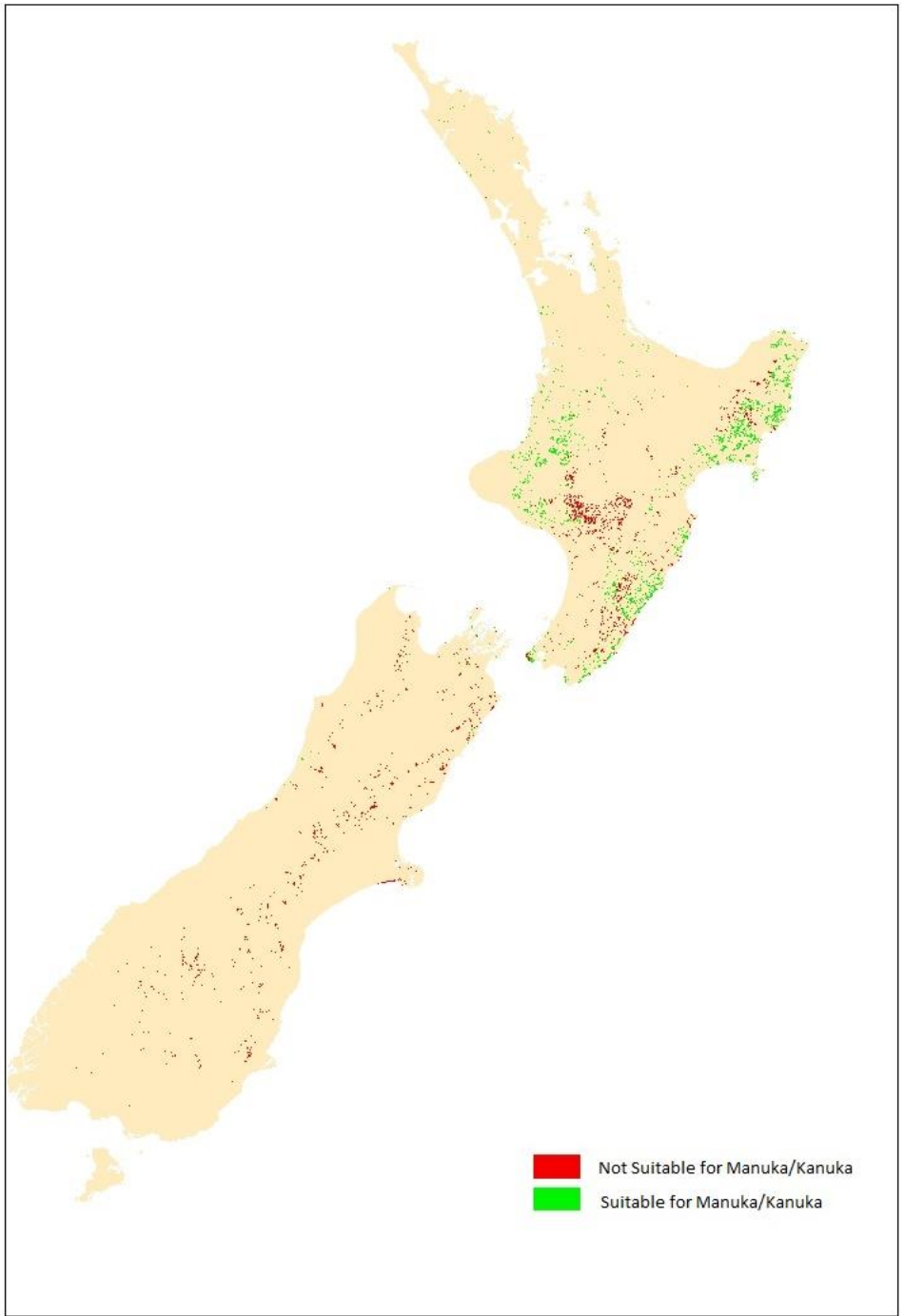


Indigenous afforestation	Total (ha)	Passive (ha)	Active (ha)
North Island	531,051	480,429	50,622
South Island	138,914	100,641	38,273
Total	669,966	581,070	88,895

Mānuka/Kānuka Predictions

Past literature – functions of temperature and precipitation

	Total new afforestation area (ha)	Area suitable for mānuka/kānuka (ha)	Percent suitable for for mānuka/kānuka
New Zealand	669,966	348,055	52
North Island	531,051	337,172	63
South Island	138,914	10,883	8



Economic Modelling and Non-market Valuation

Exotic Scenario – All afforestation land to exotic forestry operations

Indigenous Scenario – All afforestation land to indigenous forest

Indigenous Scenario with Honey - All afforestation land to indigenous forest, mānuka honey where possible

Modelling Policy change

- **Exotic Scenario**:
- New afforestation areas convert from previous use to exotic forestry.
- The land remains in productive use. Model the difference in profit (EBIT) between the two.

- **Indigenous Scenario** : the new afforestation areas convert from previous use to indigenous forest.
- The land is removed from production.
- Opportunity cost –
  - profit from the previous land use
  - plus the value of the converted land.*

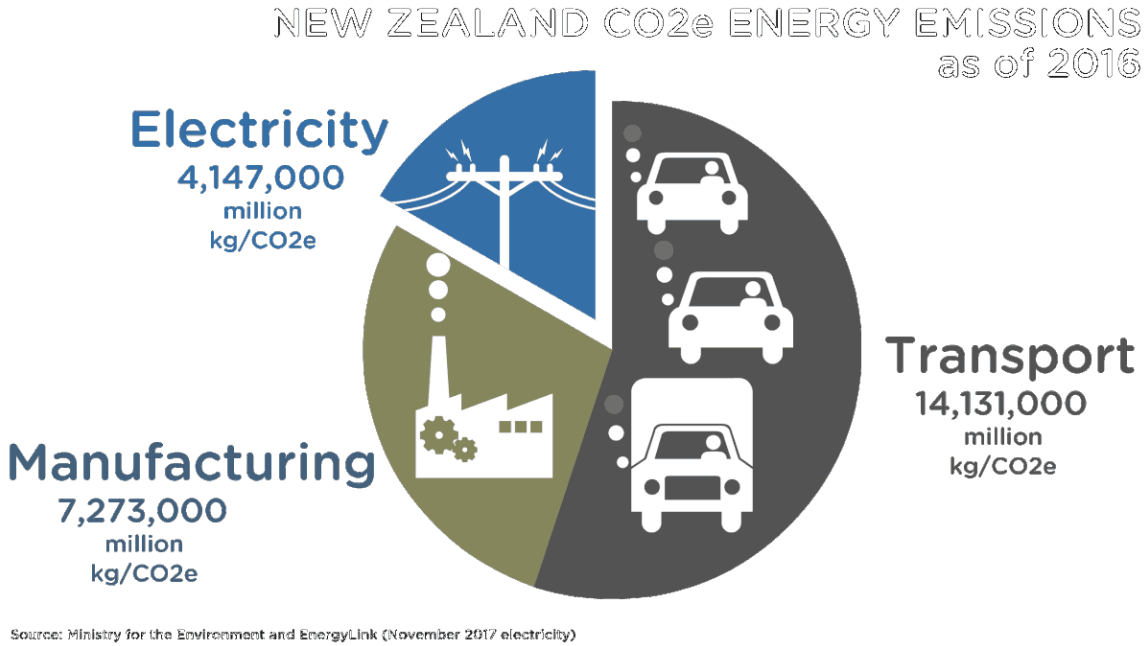
Indigenous Scenario with Honey (Mānuka):

- the new afforestation areas convert from previous use to indigenous forest
- with those areas suitable for mānuka/kānuka being used for used for productive purposes - medical or edible honey production.
- Opportunity cost
  - profit from the previous land use plus the value of the converted land.
  - Except in areas that produce honey

Also! Non-market impacts of policy

Environmental externalities/ecosystem services

- Changes in emissions and carbon sequestration
- Water quality and quantity
- Biodiversity
- Cultural values



Scenario Inputs

Afforestation area, etc.

Other mapping/modelling

Non-Market Impacts

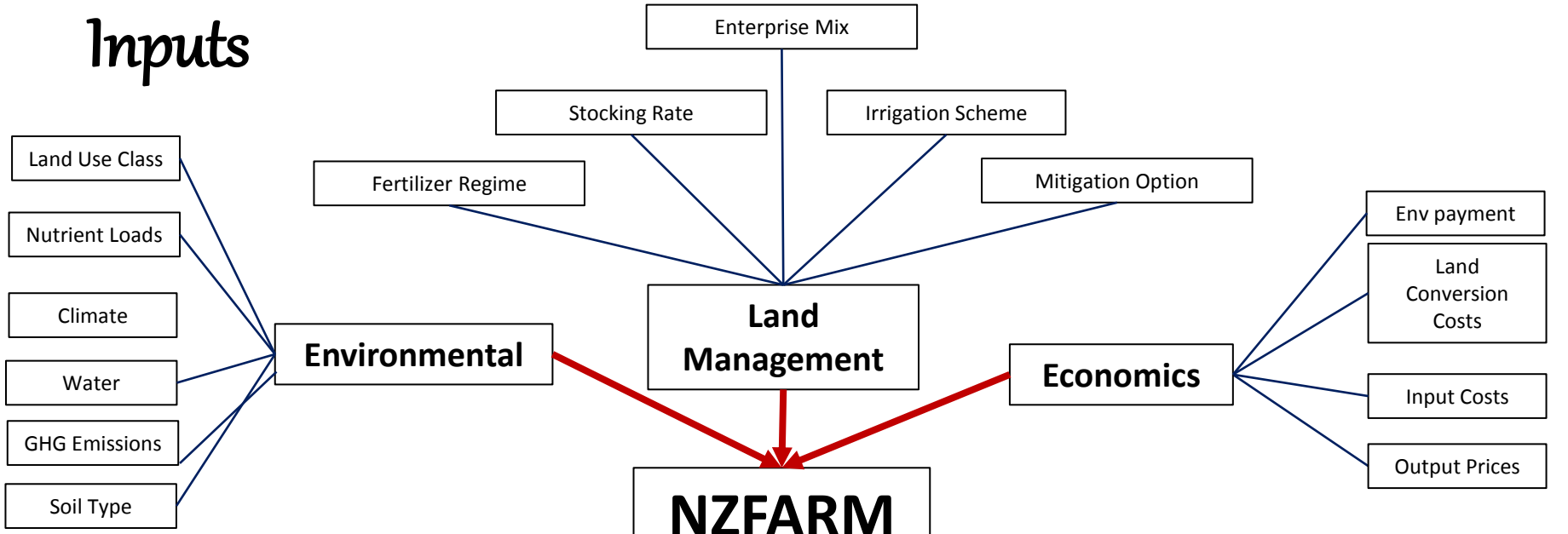
Market impacts

Monetised values

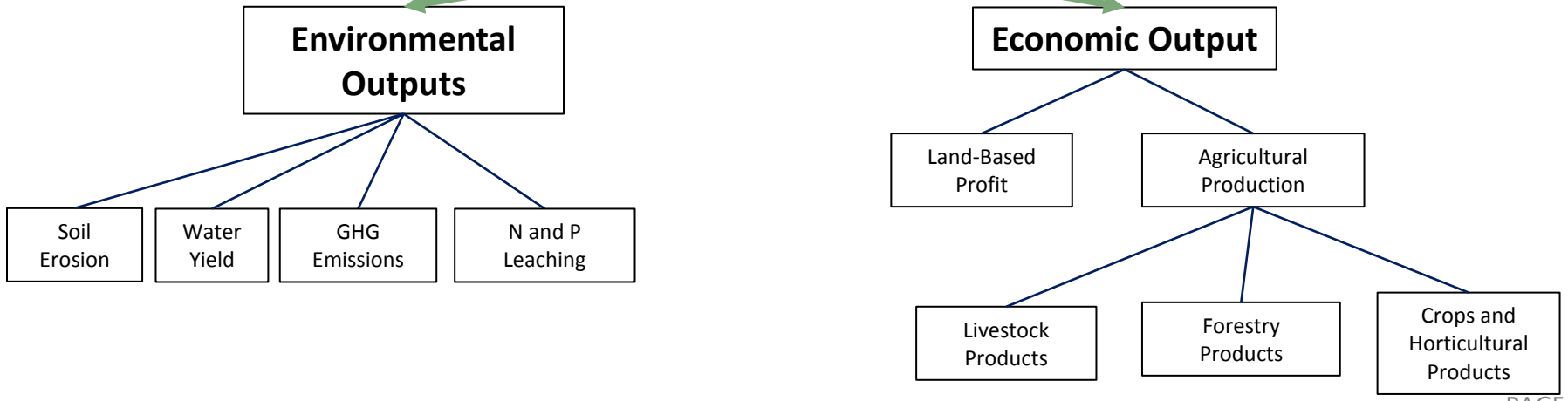
Quantified values

Descriptions of changes

Inputs



Outputs



National Analysis

Assume full implementation

Compare Annual costs and benefits

Full implementation to existing use

Market Impacts – Lost Production in Afforestation Areas

Region	Lost Profit (EBIT) ($NZ)
Auckland Region	148,726
Bay of Plenty Region	2,103,301
Canterbury Region	4,509,952
Gisborne Region	1,044,412
Hawke's Bay Region	15,999,711
Manawatū-Wanganui Region	11,029,688
Marlborough Region	2,143,932
Nelson Region	77,753
Northland Region	261,838
Otago Region	2,244,047
Southland Region	784,665
Taranaki Region	2,714,981
Tasman Region	2,078,737
Waikato Region	5,392,166
Wellington Region	7,110,840
West Coast Region	2,437,132
Total	**60,081,881**

Market Impacts – Exotic Scenario

Region	**Lost** Profit (EBIT) ($NZ)	Gains from timber ($NZ)
Auckland Region	148,726	1,037,278
Bay of Plenty Region	2,103,301	3,333,665
Canterbury Region	4,509,952	19,178,675
Gisborne Region	1,044,412	61,909,180
Hawke's Bay Region	15,999,711	33,980,225
Manawatū-Wanganui Region	11,029,688	100,972,455
Marlborough Region	2,143,932	5,546,250
Nelson Region	77,753	364,031
Northland Region	261,838	3,448,134
Otago Region	2,244,047	7,638,856
Southland Region	784,665	1,411,443
Taranaki Region	2,714,981	14,220,458
Tasman Region	2,078,737	3,394,194
Waikato Region	5,392,166	18,434,312
Wellington Region	7,110,840	24,800,276
West Coast Region	2,437,132	2,892,839
Total	**-60,081,881**	**302,562,270**

Indigenous Scenario

Region	**Lost** agricultural EBIT ($NZ)	**Lost** value of converted land
Auckland Region	148,726	3,568,367
Bay of Plenty Region	2,103,301	37,541,507
Canterbury Region	4,509,952	73,185,872
Gisborne Region	1,044,412	148,737,670
Hawke's Bay Region	15,999,711	67,652,921
Manawatū-Wanganui Region	11,029,688	100,661,686
Marlborough Region	2,143,932	16,500,500
Nelson Region	77,753	1,451,508
Northland Region	261,838	4,338,391
Otago Region	2,244,047	38,717,878
Southland Region	784,665	7,686,860
Taranaki Region	2,714,981	24,996,834
Tasman Region	2,078,737	12,683,781
Waikato Region	5,392,166	63,053,003
Wellington Region	7,110,840	30,164,709
West Coast Region	2,437,132	5,209,318
Total	**-60,081,881**	**-636,150,805**

Indigenous Scenario with Honey

Region	**Lost** agricultural EBIT ($NZ)	**Lost** value of converted land
Auckland Region	148,726	152,689
Bay of Plenty Region	2,103,301	5,722,285
Canterbury Region	4,509,952	72,081,232
Gisborne Region	1,044,412	33,377,089
Hawke's Bay Region	15,999,711	26,048,800
Manawatū-Wanganui Region	11,029,688	59,031,742
Marlborough Region	2,143,932	11,683,279
Nelson Region	77,753	545,750
Northland Region	261,838	108,156
Otago Region	2,244,047	38,717,878
Southland Region	784,665	7,686,860
Taranaki Region	2,714,981	1,035,058
Tasman Region	2,078,737	10,011,865
Waikato Region	5,392,166	10,380,983
Wellington Region	7,110,840	14,226,323
West Coast Region	2,437,132	4,047,616
Total	**-60,081,881**	**-294,857,604**

Ecosystem Services

Exotic Scenario Carbon (Annual Figures)

- From NZFARM:

Land use	GHG avoided (tons CO_2e)	Carbon sequestration (tons CO_2e)	Total GHG avoided and carbon sequestered (tons CO_2e)
Arable	62	429	491
Dairy	10,969	61,004	71,973
Deer	879	59,604	60,483
Forestry	0	0	0
Fruit	41	808	849
Native	0	0	0
Other	0	212,653	212,653
Other pasture	17,550	231,451	249,001
Pig	18	86	104
Sheep & beef	120,006	5,750,587	5,870,593
Vegetables	31	1,266	1,297
Grapes	1,313	21,993	23,306
Total	150,869	6,339,881	6,490,750

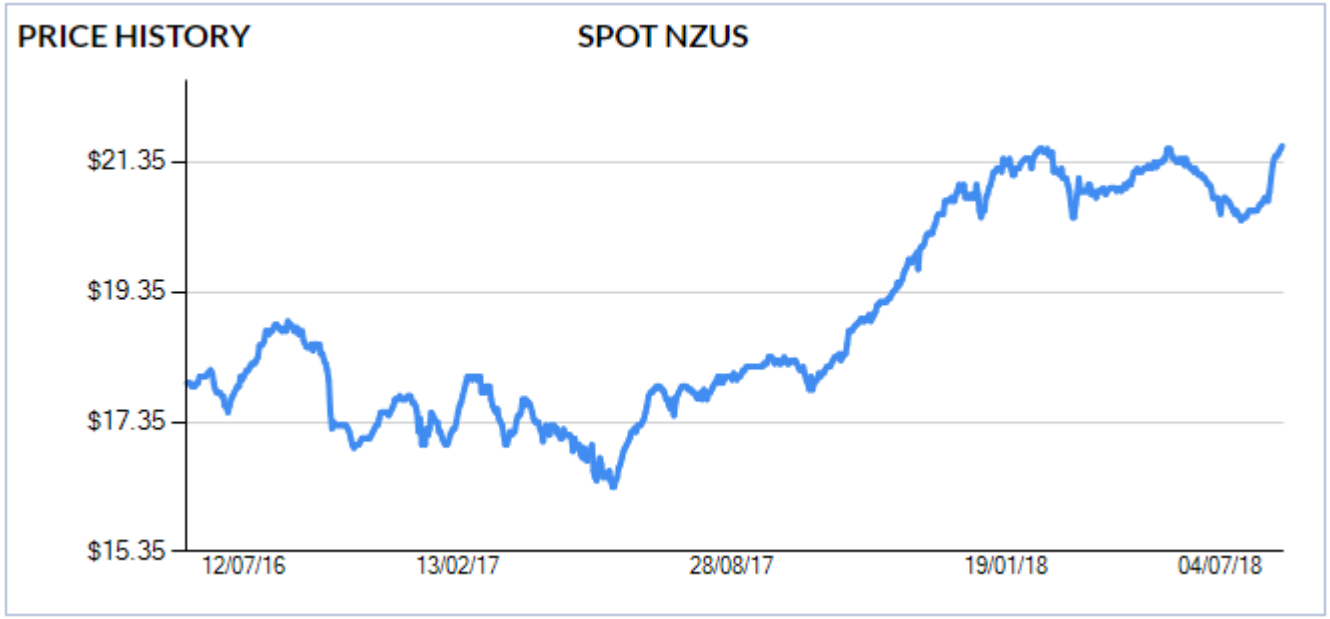
Indigenous Scenarios (Annual Figures)

Land use	GHG avoided (tons CO_2e)	Carbon sequestration (tons CO_2e)	Total GHG avoided and carbon sequestered (tons CO_2e)
Arable	62	22	84
Dairy	10,969	3,195	14,164
Deer	879	3,122	4,001
Forestry	0	0	0
Fruit	41	42	83
Native	0	0	0
Other	0	11,138	11,138
Other pasture	17,550	12,123	29,673
Pig	18	4	23
Sheep & beef	120,006	301,195	421,201
Vegetables	31	66	97
Grapes	1,313	1,152	2,465
Total	150,869	332,061	482,929

Valuing Carbon

What value to use?

Simplest value – NZ ETS Price



Alternative – Social Cost of Carbon

US, EU, Britain, etc. – Cost of damages incurred by carbon dioxide

Alternatively, value of damages avoided for a small emission reduction (i.e., the benefit of a CO_2 reduction).

US EPA Social Cost of Carbon*

	Discount Rate and Statistic			
Year	**5% Average**	**3% Average**	**2.5% Average**	**High Impact (95th pct at 3%)**
2015	$11	**$36**	$56	$105
2020	$12	**$42**	$62	$123
2025	$14	**$46**	$68	$138
2030	$16	**$50**	$73	$152
2035	$18	**$55**	$78	$168
2040	$21	**$60**	$84	$183
2045	$23	**$64**	$89	$197
2050	$26	**$69**	$95	$212

Valuing Carbon

Side note – SCC estimates recently axed (wait, “updated”) by the Trump administration

“There was a consensus that **the social cost of carbon was in need of updating**,” says Michael Greenstone, who served on Mr Obama’s Council of Economic Advisers. “But we should be updating it so that all the advances in our understanding are included. Instead, **the Trump administration is ignoring science, and trying to find the dials to turn down regulation, with no analytical evidence.**”

Only US domestic damages now included – approximately divide by 7.

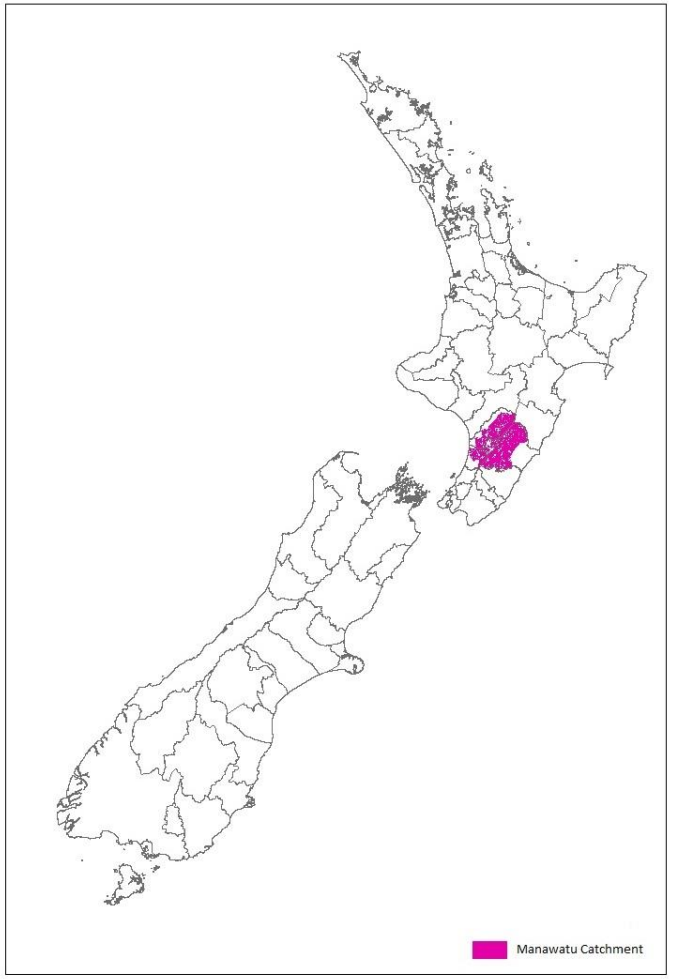
This research developed before/during the SCC changes, so we use original estimates

	2020 SCC US$/tonne (2007 $US)	NZ$/tonne (2017)	Scenario E (2017 $NZ)	Scenario I (2017 $NZ)
Reduction in GHG emissions (tonnes CO_2e)				
	-	-	6,490,750	482,929
Value of reductions in net GHG emissions				
Current NZ emissions price	-	$17	$110,342,748	$8,209,797
US SCC 5% average	$12	$19.94	$129,404,783	$9,628,063
US SCC 3% average	$42	$69.78	$452,916,739	$33,698,221
US SCC 2.5% average	$62	$103.01	$668,591,376	$49,744,994

Manawatu Catchment Case Study

50 year timeline

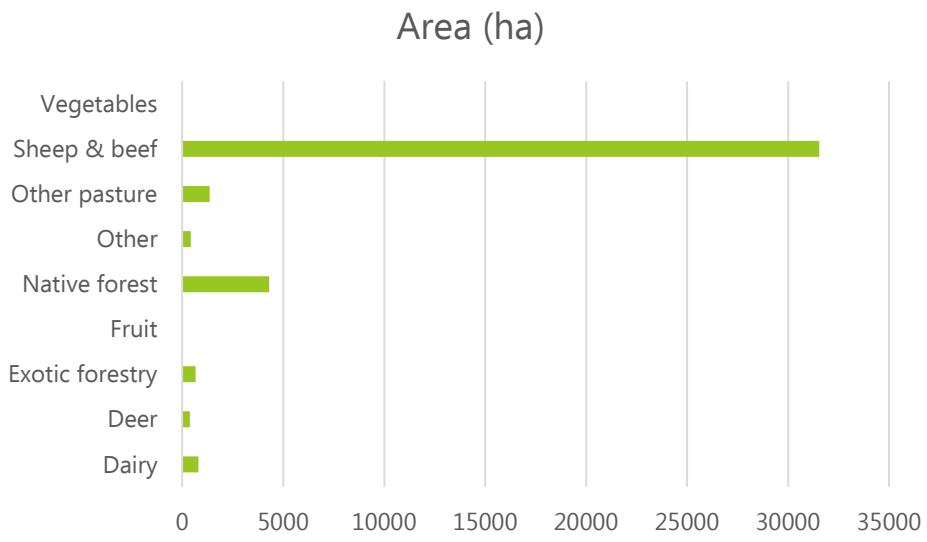
- Scale things across this horizon and use NPV/discount rates



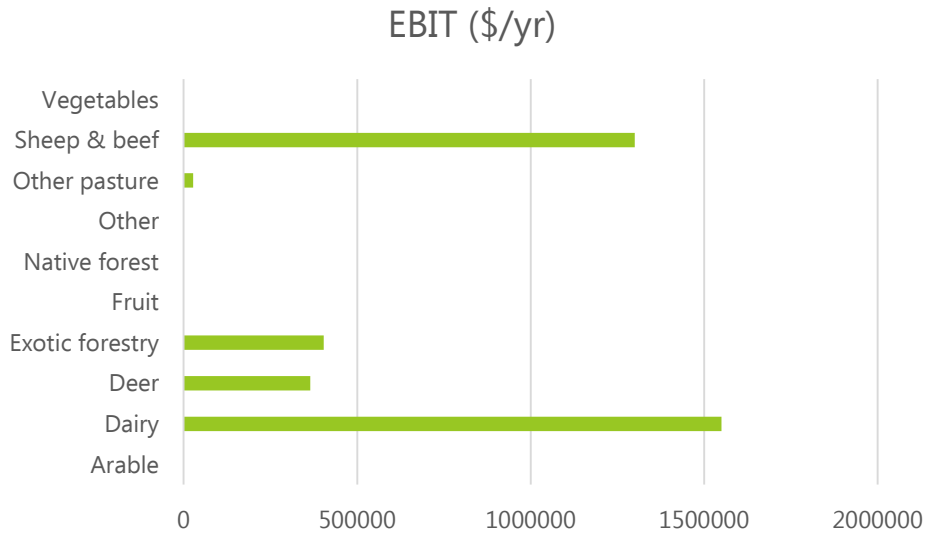
Market Impacts

Territorial Authority	EBIT ($) from exotic afforestation	**Lost** EBIT ($) from existing land use[a]	Difference
Central Hawke's Bay District	220,618	61,920	158,698
Horowhenua District	349,148	51,851	297,298
Manawatū District	3,142,778	1,324,465	1,818,313
Masterton District	6,043	0	6,043
Palmerston North City	363,589	69,693	293,896
Tararua District	17,072,045	2,138,689	14,933,356
Total annual EBIT	**21,154,221**	**-3,646,617**	**17,507,604**
Total EBIT over 50 years (8% discount rate)	**279,493,023**	**-46,858,483**	**231,313,325**

Previous Land Distribution



Previous Land Distribution



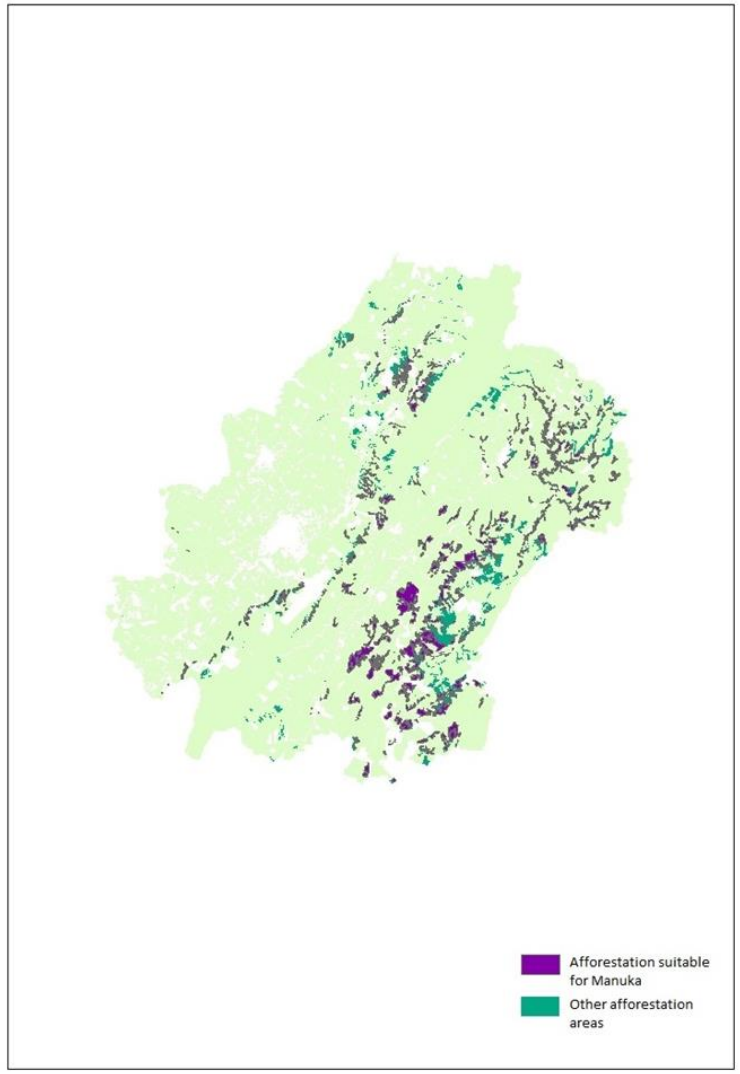
	Lost Value of land Indigenous Scenario	**Lost** Profits + **Lost** Land Indigenous Scenario
Central Hawke's Bay	223,062	282,274
Horowhenua	299,046	327,995
Manawatū	3,380,893	4,649,180
Masterton	5,638	5,638
Palmerston North City	367,483	410,649
Tararua	16,670,522	18,514,210
Total annual values	**-20,946,644**	**-24,189,946**
Total value over 50 years (using 8% discount rate)	**-276,750,447**	**-319,601,526**

	Lost Value of land Indigenous + Honey	Lost Profits + Lost Land Indigenous + Honey
Central Hawke's Bay	164,913	224,126
Horowhenua	159,939	188,888
Manawatū	2,232,817	3,501,105
Masterton	2,891	2,891
Palmerston North City	195,845	239,011
Tararua	5,560,100	7,403,788
Total annual values	**-8,316,505**	**-11,559,808**
Total value over 50 years (using 8% discount rate)	**-109,879,029**	**-152,730,078**

Honey Production

Based on recent MWLR farmer interactions/surveys regarding potential costs and profits.

Territorial Authority	EBIT ($)
Central Hawke's Bay District	23,580
Horowhenua District	186,853
Manawatū District	484,053
Masterton District	1,730
Palmerston North City	79,116
Tararua District	4,920,116
Total annual EBIT	5,695,448
Total over 50 years (8% discount rate)	75,249,196



Non-Market Impacts

Water Quality

Increased afforestation affects several important **regulating ecosystem services**, such as water quality and water quantity

Focus here on water quality

Also quantity effects

- Less water from additional trees
- Irrigation and other implications
- Discuss in report

Nitrate levels in New Zealand rivers

Too much nitrogen-nitrate in river water can be **toxic to aquatic life**.

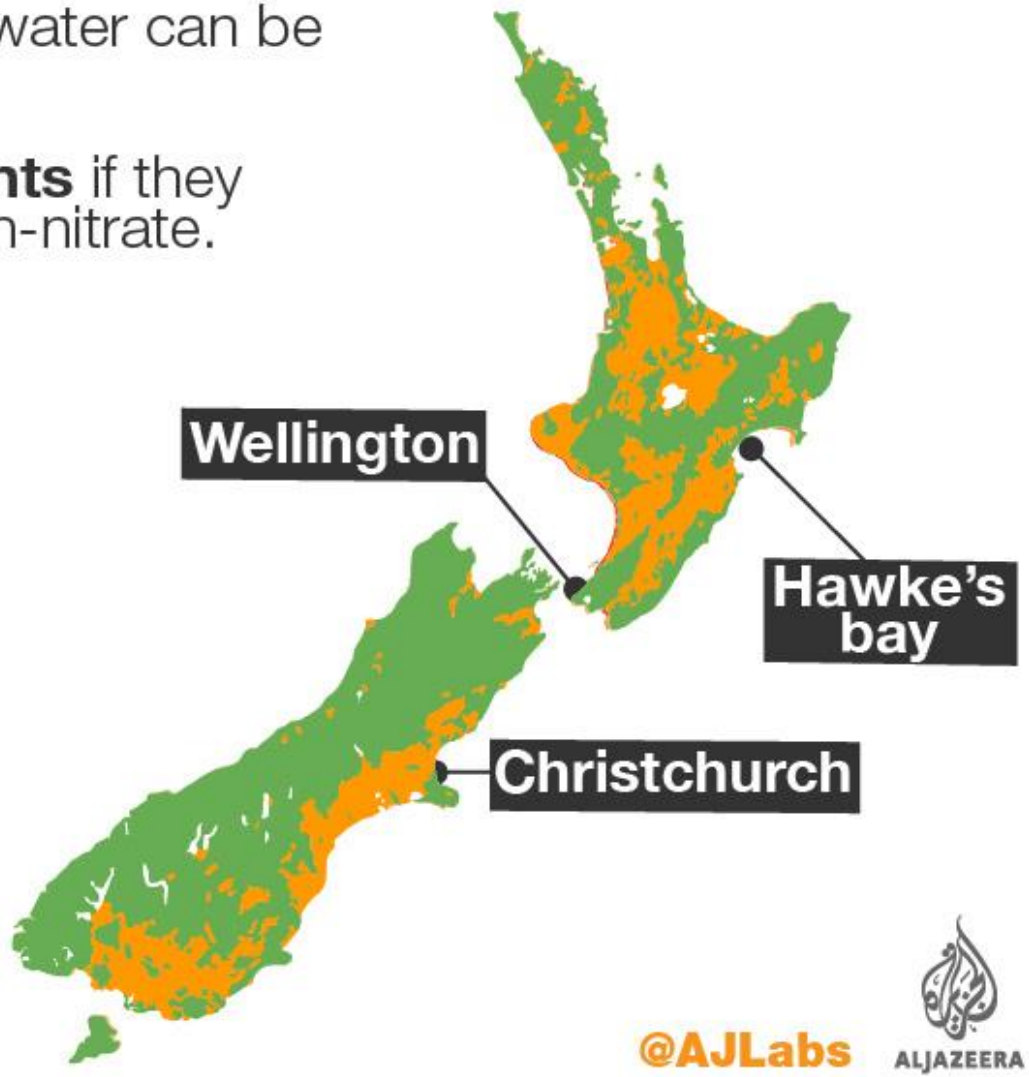
It can also be **dangerous to infants** if they drink water with too much nitrogen-nitrate.

Nitrate-nitrogen river water (mg/m^3)

- 3-13
- 13-22
- 22-53
- 53-302
- 302-1,450
- 1,450-7,882

Nitrate-nitrogen limits

- Exceeds legal limit
- Within legal limit



SOURCE
New Zealand Ministry for the Environment

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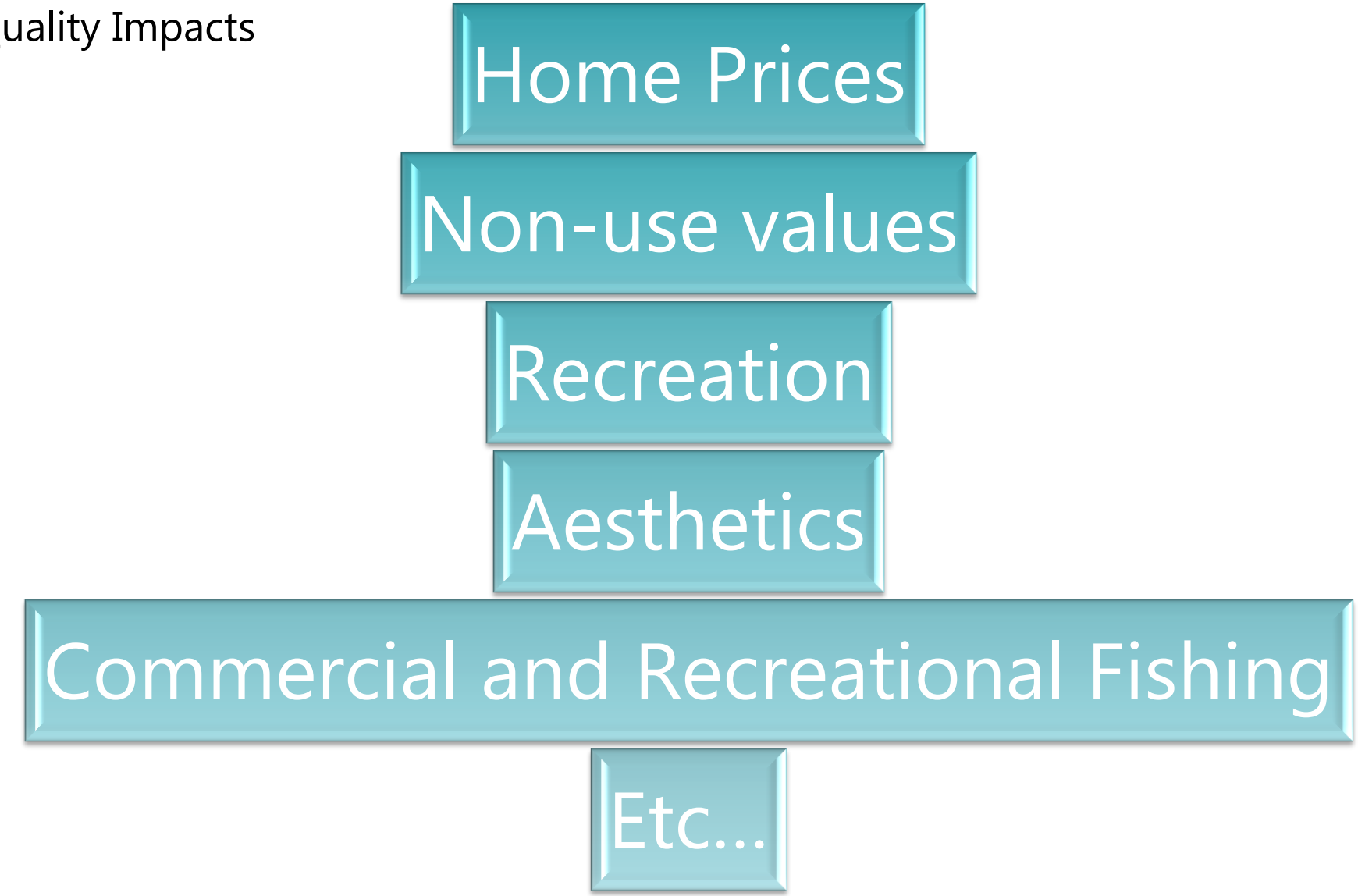
Water Quality Impacts



Ideally – original study for each category

- Overlaps…

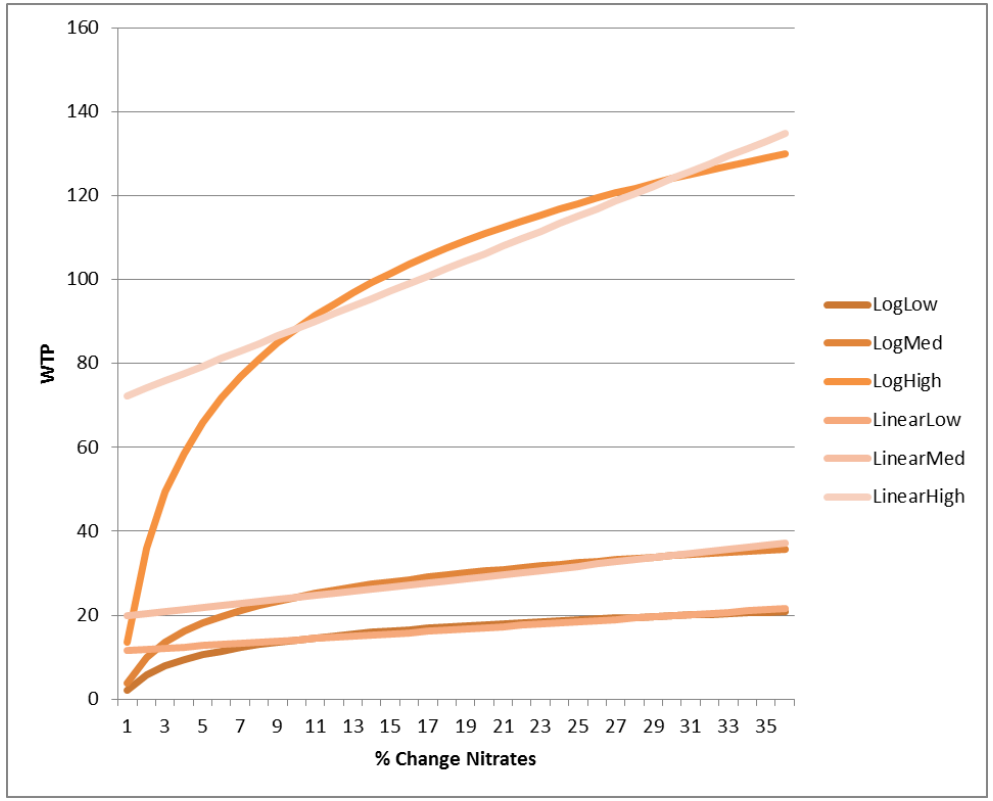
Time, funding constraints – Benefit Transfer

NZ-Based literature is slim

Best study for transfer - Baskaran et al. 2009 -

- ask respondents about their WTP for either a 10% or 30% reduction in nitrate leaching.
- Estimate different values for different income levels.

Value (WTP) Approximation Functions



Changes in Nitrogen

	N Leaching (kg)			Estimated % Change		Annual % Change	
Territorial Authority	Current	Exotic	Indig.	Exotic	Indig.	Exotic	Indig.
Central Hawke's Bay	5,251	789	473	0.850	0.910	0.028	0.018
Horowhenua	5,929	1,390	834	0.766	0.859	0.026	0.017
Manawatū	69,776	12,479	7,488	0.821	0.893	0.027	0.018
Masterton	128	40	24	0.686	0.812	0.023	0.016
Palmerston North City	6,516	1,507	904	0.769	0.861	0.026	0.017
Tararua	370,242	62,701	37,621	0.831	0.898	0.028	0.018

Total WTP for water quality benefits in the Manawatū catchment over 50 years (NZ$a)

	Exotic 3%	Exotic 8%	Indigenous 3%	Indigenous 8%
Central Hawke's Bay District	1,413,481	799,167	1,335,079	611,987
Horowhenua District	1,916,060	1,076,445	1,864,398	841,829
Manawatū District	3,061,206	1,697,848	3,032,572	1,327,608
Masterton District	2,364,891	1,320,119	2,391,795	1,063,530
Palmerston North City	7,716,217	4,348,821	7,454,413	3,391,467
Tararua District	1,749,103	1,001,482	1,614,293	762,041
Total WTP over 50 years	**18,220,958**	**10,243,883**	**17,692,549**	**7,998,462**

Carbon Benefits – Manawatu Catchment

50 year analysis

2015 New Zealand Ministry for Primary Industries ETS lookup tables

Exotic – one harvest
- Account for residual carbon

Ministry for Primary Industries
Manatū Ahu Matua

Carbon Benefits for Exotic Scenario over **50 years**

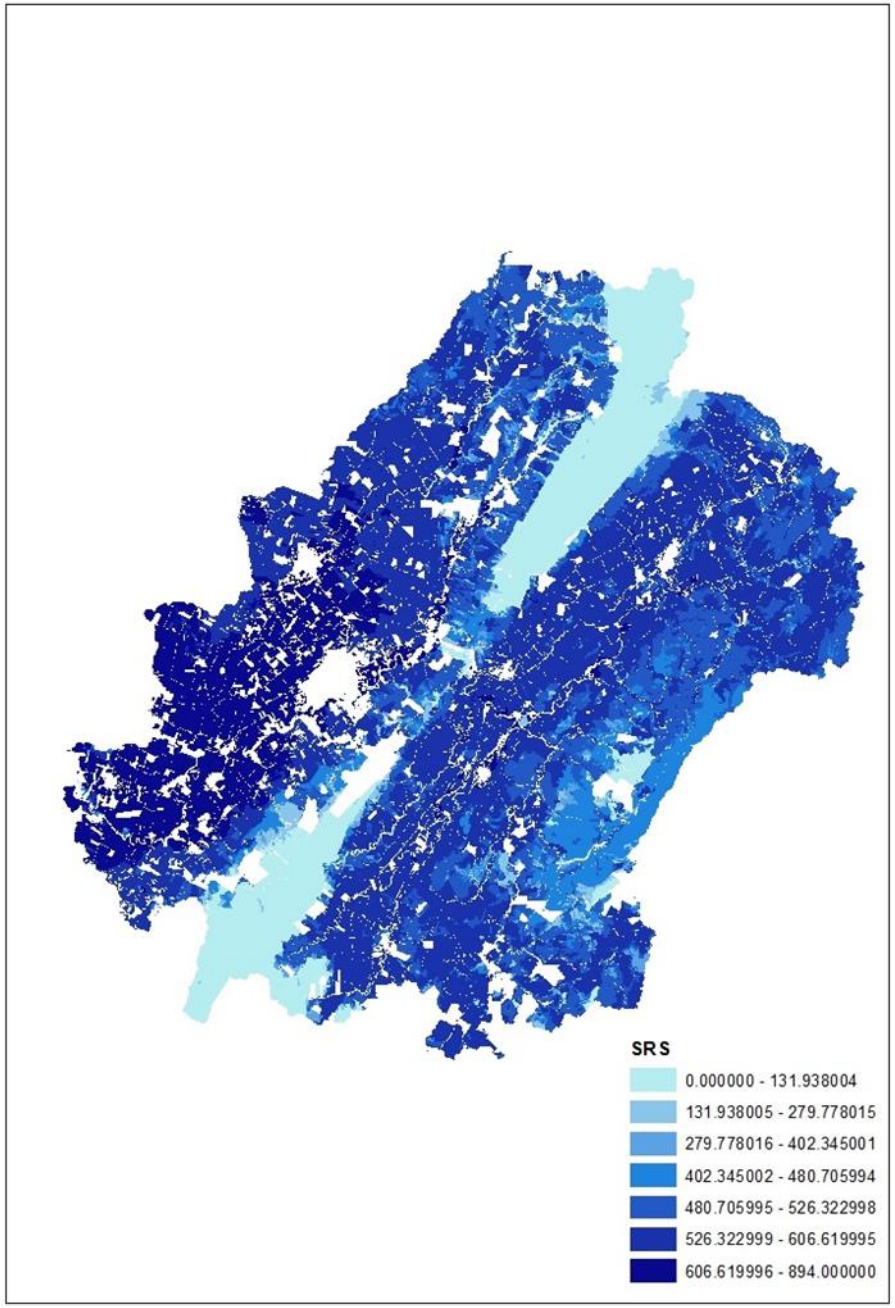
	NZETS 3%	NZETS 8%	SCC 3%
Central Hawke's Bay District	1,732,879	1,046,857	7,071,811
Horowhenua District	3,052,358	1,843,973	12,291,778
Manawatū District	27,410,838	16,559,281	110,382,821
Masterton District	88,109	53,228	354,811
Palmerston North City	3,310,675	2,000,027	13,332,014
Tararua District	137,724,026	83,201,060	554,611,514
Total	**173,318,885**	**104,704,425**	**698,044,750**

Carbon benefits for Indigenous Scenarios over 50 years

	NZETS 3%	NZETS 8%	SCC 3%
Central Hawke's Bay District	1,182,273	521,915	5,367,236
Horowhenua District	2,082,500	919,321	9,393,804
Manawatū District	18,701,300	8,255,702	84,358,394
Masterton District	60,113	26,537	271,159
Palmerston North City	2,258,739	997,122	10,188,790
Tararua District	93,963,502	41,480,252	423,853,425
Total	**118,248,428**	**52,200,848**	**533,432,808**

Biodiversity – Related Impacts

- SRS Score - the full potential of indigenous biotic and abiotic factors, and natural processes, functioning in sustainable communities, habitats, and landscapes.
- The **darker the blue** indicates a higher SRS score, indicating that **more biodiversity** could be gained from allowing those areas to revert to indigenous forest



Exotic Afforestation – Once stand is at full height.

Enterprise Class	Minimum SRS	25th Percentile SRS	Mean SRS	Max SRS	Std Dev. SRS
Scrub	0.0	192.1055	204.9	291.6	44.9
Deer	51.7	179.3309	205.1	285.1	51.0
Native	0.0	196.2252	209.3	321.8	55.0
SNB	0.0	203.0922	211.0	333.3	46.9
Other	0.0	214.2	218.3	337.9	47.7
Forest	0.0	212.9668	223.8	294.8	39.7
Dairy	0.0	215.7257	223.9	294.8	44.7
Other pasture	0.0	217.7437	228.0	294.8	31.4

Indigenous Afforestation

Enterprise Class	Minimum SRS	25th Percentile SRS	Mean SRS	Max SRS	Std Dev. SRS
Scrub	0.0	426.901	455.3	647.9	99.8
Deer	114.9	398.513	455.7	633.7	113.3
Native	0.0	436.056	465.0	715.0	122.3
SNB	0.0	451.316	468.8	740.6	104.2
Other	0.0	473.2595	485.1	750.8	106.1
Forest	0.0	479.3905	497.3	655.0	88.2
Dairy	0.0	483.875	497.6	655.0	99.3
Other pasture	0.0	485.231	506.7	655.0	69.8

Bringing Things Together

Ecosystem Services Summary Table

Emphasize non-monetised benefits

Qualitative description

Category	Ecosystem Service	Effect of Afforestation Scenario	Quantified	Monetized	Methods/ Notes
Provisioning	Crops	Reduced production	X	X	NZFARM was used to examine agricultural impacts
	Livestock: milk	Reduced production	X	X	NZFARM was used to examine agricultural impacts
	Livestock: meat	Reduced production	X	X	NZFARM was used to examine agricultural impacts
	Capture fisheries	Likely improvement			Fish habitat is expected to improve as water quality improves and with additional stream shading expected with the afforestation scenarios. Decreased stream flows associated with afforestation, however, may have some negative impacts on fish habitat. Improved fish habitat is likely to enhance commercial fishery harvest for freshwater species such as eel or recreational trout catch. To estimate the full effects would require hydrological and fish modelling which is beyond the scope of this project. Any impacts on the ocean fishery are unknown.
	Freshwater	Improvement in quality/decrease in quantity			Water quality is expected to improve due to decreases in nutrient inputs and other forms of farm runoff associated with pasture land, and thereby improving drinking and stock water quality. In addition, freshwater contact recreation should be improved, yielding human health impacts. Water yield, however, is expected to decrease with greater areas of forested land. This may affect irrigation in the area. Hydrological modelling is required to determine the spatial and temporal impacts on water flows.
	Wildfoods	Likely increase			Wildfood harvests should increase, particularly in indigenous afforestation scenarios (Scenario I). Trout and eel habitat should improve with better water quality leading to greater fish abundance and catch. Honey will increase particularly in Scenario Ib).
	Timber & wood	Increase in Scenario E	X	X	NZFARM was used to examine forestry impacts.
	Fibres & resins	Potential Increase			Afforestation may yield products in addition to timber.
	Biomass fuel	Potential increase			Forestry by-products could be used for biomass fuel.
	Ornamental resources	Potential increase			With indigenous forest (Scenario I) we expect greater availability of ornamental resources such as flax.
	Biochemical, natural medicines and pharmaceuticals	Potential increase			High-grade mānuka honey, among other products, has several medical applications. Mānuka is one of the first successional species that is anticipated after reversion from pastoral farming to indigenous vegetation. Rongoā is also likely to increase in Scenario I.
Regulating	Air quality and climate regulation	Improvement	X	X	NZFARM outputs and ETS materials are used to quantify and value changes in carbon, in particular the carbon sequestration potential of forests. Forests also improve air quality in terms of reduced particulates. Pine pollen, however, could be an issue in some areas.

	Water regulation	Mixed			The afforestation scenarios will likely decrease water yield in the area as runoff from erosion-prone and pastoral areas is reduced. Alternatively, improvements in water quality will reduce water treatment costs for drinking and agriculture water.
	Erosion control	Improvement			Afforestation will improve erosion control.
	Water quality or purification	Improvement	X	X	NZFARM nutrient outputs are used for a benefit transfer of stated preference WTP values to monetise the value of improved water quality.
	Pollination	Potential improvement			We expect an increase in native pollinators with indigenous forest (Scenario I); the extent, however, will depend on the availability of floral resources. There is also an increase in honey production (from honey bees) under Scenario I that will likely have additional indirect pollination benefits.
	Natural hazard regulation	Improvement			A reduction in water yield should reduce stormwater impacts, such as stream scouring, and potentially reduce peak flooding flows
Cultural	Recreation and Ecotourism	May increase			Increased afforestation may induce greater local recreation, particularly in areas with greater public accessibility. This could be hiking, biking or similar recreation. Improvements in water quality should improve the swimability of streams and also improve the recreational experience and the health of the recreational fishery (e.g. trout). There is some evidence of aesthetic preferences for indigenous species over exotic species (Brown et al. 2012), which may mean greater recreation and ecotourism services are provided by indigenous forest (Scenario I).
	Ethical and spiritual	Expected improvement			With indigenous forest (Scenario I) there is an expected increase in the spiritual values associated with the landscape, especially when native species increase (e.g. taonga species).
	Aesthetic values	Expected improvement			Views will be changed, particularly when afforested areas are elevated. The local value of changing viewscapes depends on the local population and the particular scenario. In a farmer workshop on ecosystem services in the Manawatū in 2015, the farming community noted the importance of the aesthetic value of their catchment and how these attracted international visitors.
	Cultural heritage values	Expected improvement			Indigenous afforestation scenarios (Scenario I) may promote the return of indigenous species with particular cultural values. Water quality improvements in culturally important waterbodies should provide additional benefits.

	Social relations	Mixed		There is likely to be a change in the rural population with afforestation. With less farm labour required there is likely to be an initial reduction of people in the catchment. However, over time different people are expected to move into the area, but with different employment preferences. Anecdotally, this is what happened in the Taupō catchment when a portion of the land was afforested leading to an initial decrease in social relations/cohesion followed by an increase when new people moved into the catchment (Mike Barton, Farmer Lake Taupō, March 2016).
	Sense of place	Mixed		The 'look' of the catchment will change with a move from pastoral land to forested land in the marginal areas. Therefore, the sense of place may be altered (and potentially reduced), especially for those who grew up surrounded by pastoral land. However, older generations may feel a greater sense of place with a reversion to forest.
	Cultural diversity	Unclear		The expected initial reduction in the rural population is likely to decrease cultural diversity. However, as noted above this will likely change over time as new people are expected to move into the catchment.
Supporting	Habitat Provision	Increase	X	The habitat for native species is expected to increase, particularly in the indigenous scenario (Scenario Ia and Ib).

Summary Table at 8%

	Exotic	Indigenous	Indigenous Honey
Opportunity Costs			
Lost EBIT	42,851,048	42,851,048	42,851,048
Converted value of land		276,750,447	109,879,029
Total opportunity cost	42,851,048	316,660,879	152,730,078
Increases in EBIT			
Forestry	279,493,023		
Honey			75,249,196

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Water quality	10,243,883	7,998,462	7,998,462
Carbon Benefits			
Carbon valuation (Current NZ ETS price)	104,704,425	118,248,428	118,248,428

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Total monetized benefits	394,441,331	126,246,890	201,496,086
Overall NPV	351,590,283	-190,413,989	48,766,008
Benefit-cost ratio	9.2	0.40	1.3

Sensitivity Analysis

Costs driven by opportunity cost of land.

Assume here that the full value of land is lost.
Use average values for agricultural land.

Policies - covenant, incentives, ETS variations

Summary Table at 8%

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Sensitivity Analysis			
Overall NPV – Lost EBIT only	351,590,283	83,395,842	158,645,038
Benefit-cost ratio – Lost EBIT only	9.2	3.0	3.7

Concluding thoughts

Several scenarios - afforestation of marginal land could yield significant *monetised* net benefits

Consideration of non-monetised benefits – cultural impacts, biodiversity and endemic species, recreation, etc… could make these scenarios even more attractive.

Concluding thoughts

Drivers –

- Opportunity cost of land
- Carbon benefits

Both strongly influenced by policy

Assumptions underlying each

- Significant room for improvement – better tailor results to impacts
- Only LUC 5-8
- Lumpy costs and benefits and discounting
- Average per ha profits for agriculture
  - Steep slopes

Omitted categories

- Erosion, landslips, among others

Bounds

Ongoing work

Across Manaaki Whenua Landcare Research, insights to be applied to future work

- Dynamic version of NZFARM
- Non-market survey of values on Erosion, Water Quality, Sediment
  - Collaborations with Lincoln University Environmental Perceptions survey
  - Plan to assess values every few years – Stability

- MBIE proposal on targeting sediment control currently under review
- Plantation forest post-harvest erosion and sediment
  - Part of Scion program

- Invasive species
- Wilding Conifers
- Cultural values – Deep South Seminar by Shaun Awatere