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Conversion of Production Forestry to Native Vegetation

June 2025 – NZIF Conference

Overview

- Introducing myself
- Why would we convert cutover to native afforestation?
- History of Maungataniwha
- How we transitioned
- Other considerations/examples

Introducing myself

Running two crews, this is some of the women from my female crew that I ran in my last year as a contractor, here planting Eucalyptus at Waihapua, Hawke's Bay.

Why Convert Cutover to Natives?

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Lessee, Matt Crosby, in front of his beehives at Maungataniwha Station

Why we may want to convert from production forestry:

- Economic factors
- Environmental risks such as erosion.
- Climate change and social license to operate

Furthest Flung Farms of Pāmu

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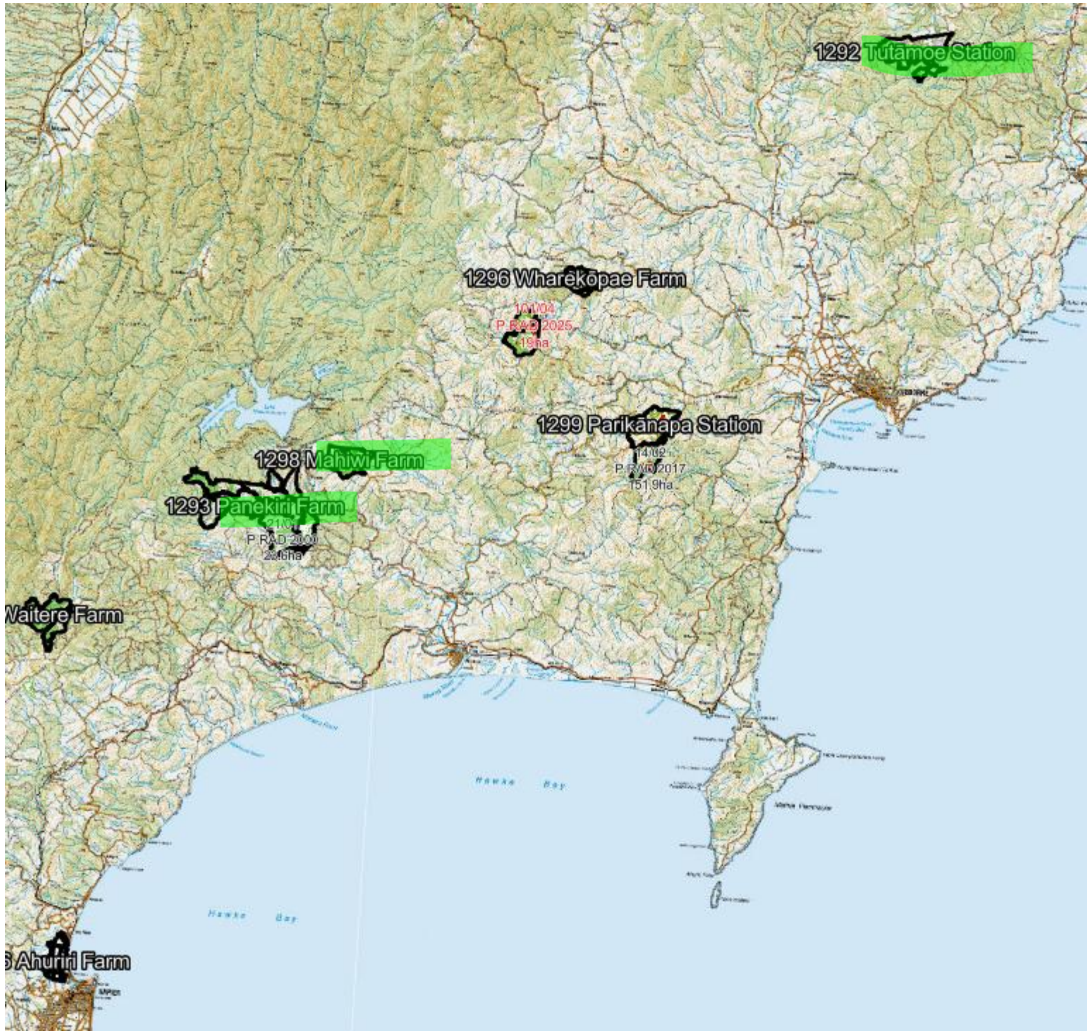

Tūtāmoe Station: 95km, but 1hr 45min from Gisborne

Mahiwi Farm: 140km to Gisborne. 153km to Napier

Panekiri Station: 143km to Gisborne 155km to Napier

Parikānapa Station

Climate Risks, Vulnerabilities and Impacts

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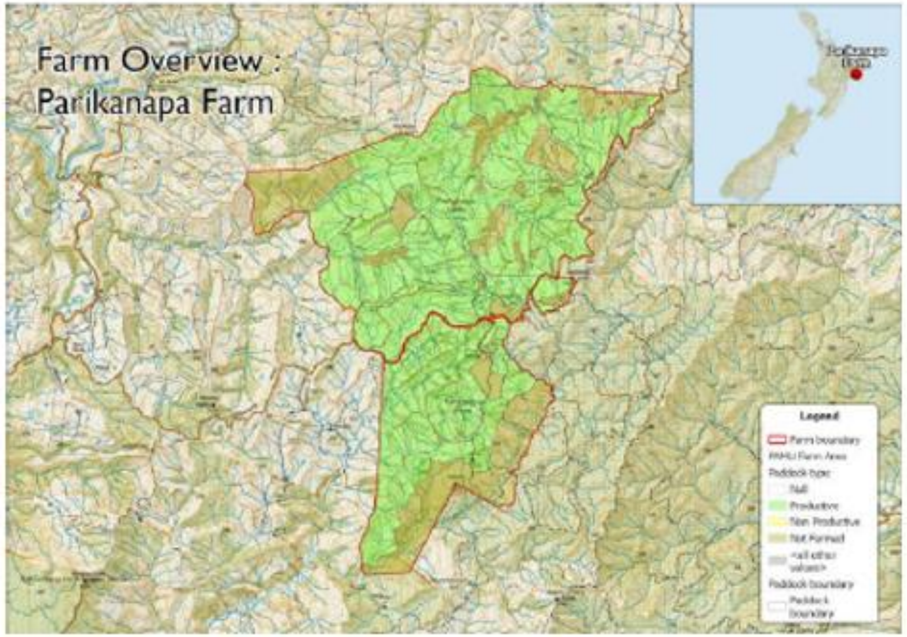
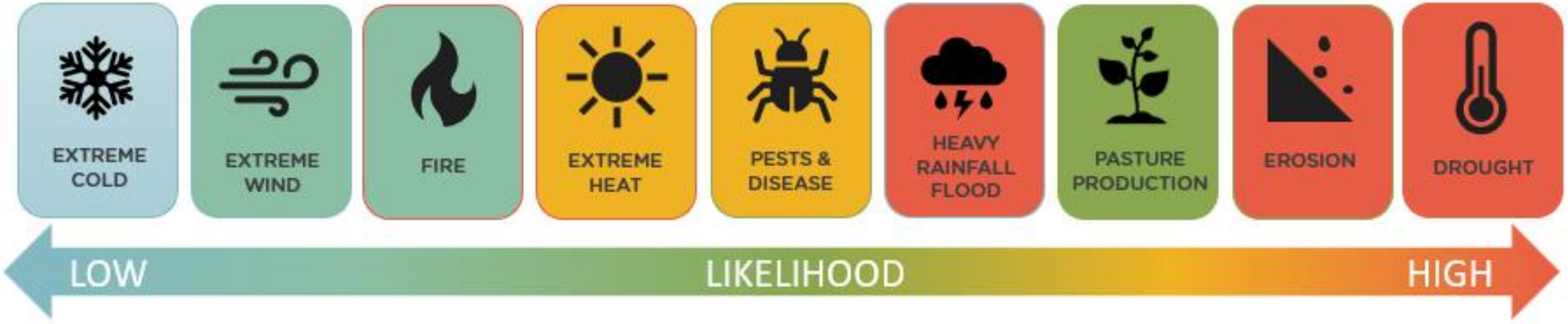
FARM OVERVIEW

- 400m-700m elevation on steep hills 25 west of Gisborne
- 2,800 productive ha
- Deep brown earth soils, mainly LUC classes 6 &7
- 25,000 stock units





2050 CLIMATE OUTLOOK

- Extreme rainfall events will be two to three times more frequent
- Baseline risk of drought is already high in this region
- Estimate a doubling of the risk of soil moisture drought events by 2050
- The risk of extreme heat stress for livestock is fairly high and will likely worsen over time
- Cold-related risks are modest and reducing

Vulnerability

- Severely erodible land in part, mitigated by land retirement
- Severe soil moisture deficits in many summers
- Area vulnerable to cyclone impacts
- Productive deep soils, often on steep slopes
- Some links between economic history and adverse events have been established
- Increasing vulnerabilities to drought, extreme heat and erosion will develop through to 2050

Overview

- Why would we convert cutover to native afforestation?
- **History of Maungataniwha**
- How we transitioned
- Other considerations/examples

Maungataniwha Station

A Brief History of Manuka Plantings

- Comprises of 6,120 hectares in northern Hawke's Bay of native bush and 4,000 hectares of ex-pine plantation.
- The owner Simon Hall ceased logging when he purchased it in 2005.
- Prolife Foods (Matt Crosby) leases over 3,500 hectares.

Preplant/Holding Sprays

How did we transition?

- The owner had sprayed out set areas of regen-pine each year that were typically between two and 15 metres tall.
- We waited at least two years before following up with a second spray over the summer.
- Then planted the following winter.

Desiccation Plan – 2019 example

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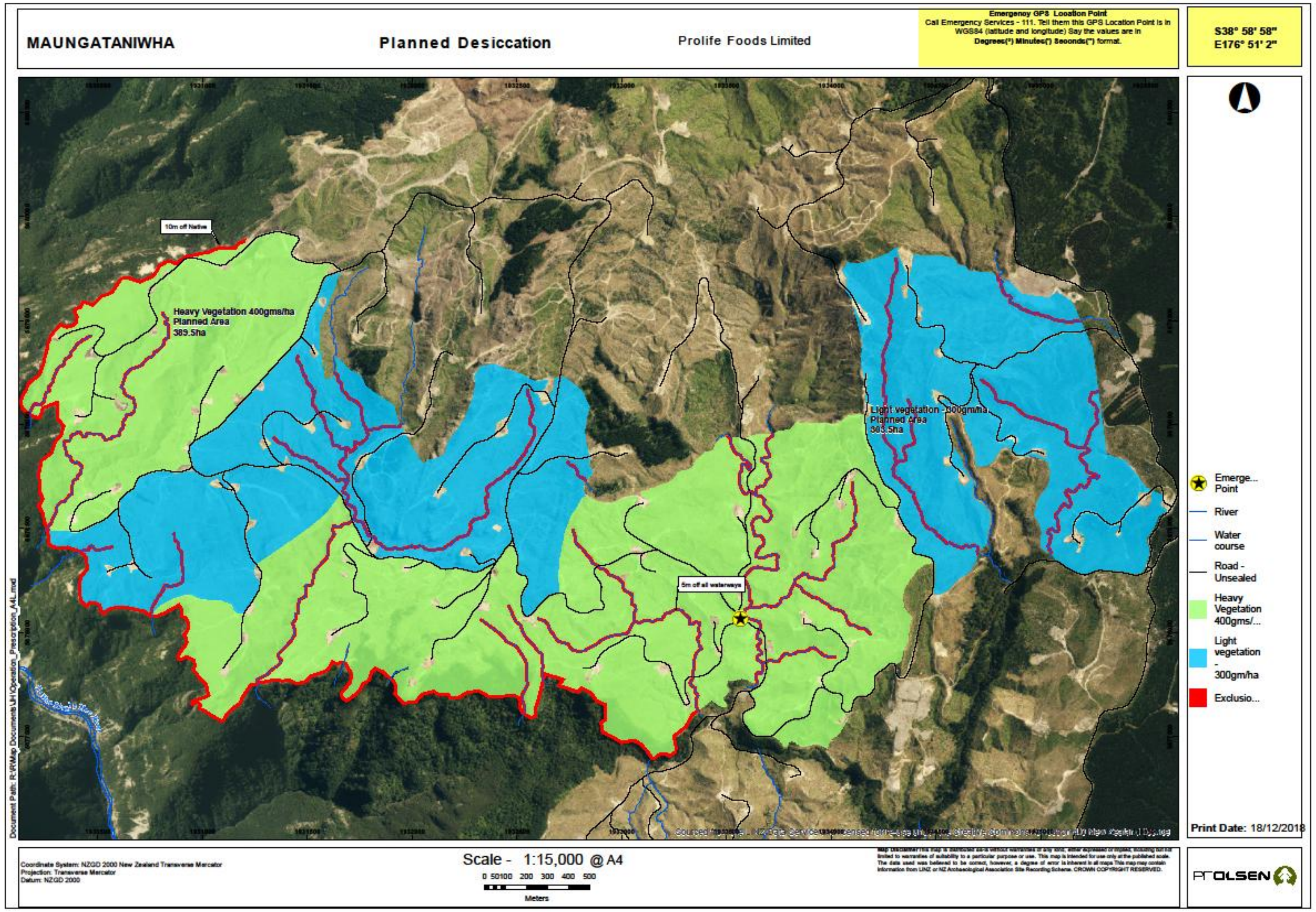
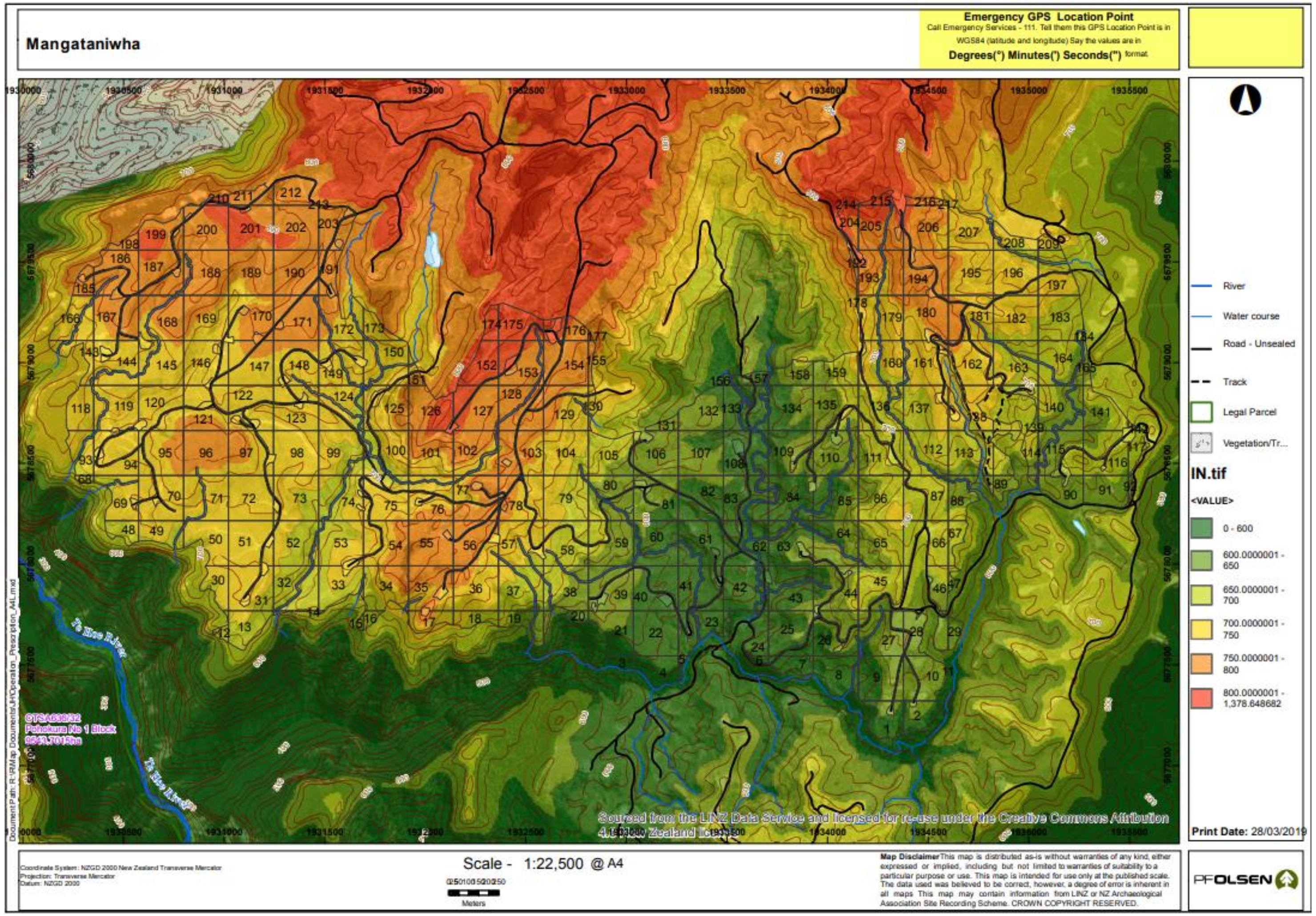
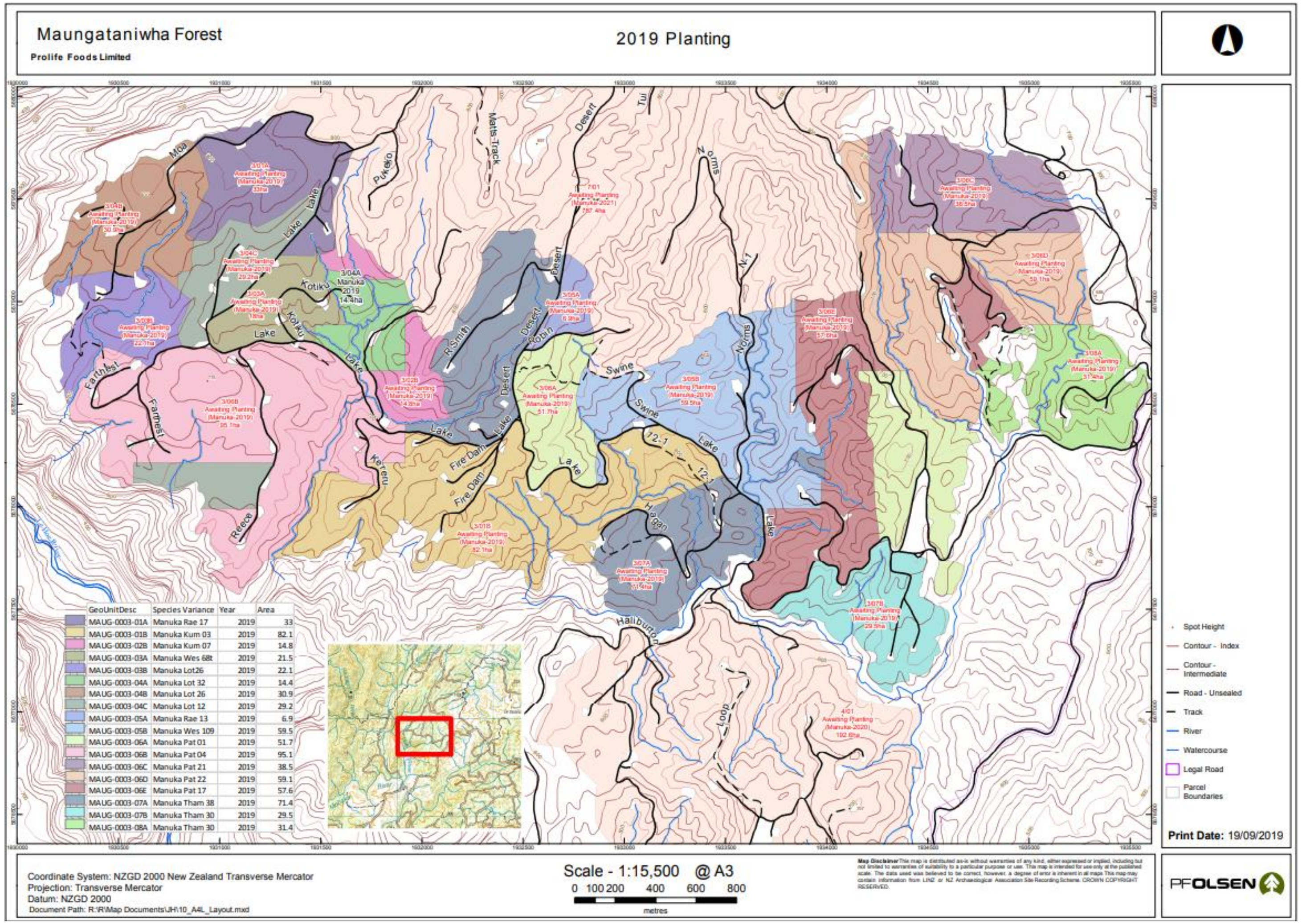


- Areas of lighter regen, pampas were treated with 300gm/ha of meturon, glyphosate and a sticker.
- Heavy infestations of weeds were treated with 400gm/ha of meturon.
- Total of 718ha treated in 2019.

Planting Planning



Planning the Different Genetic Variations of Manuka



Planting…

Planting continued…

Planting continued...

Pickup Sticks

One of the clearer areas where we were able to still plant after a windstorm blew the dead regen pine down.

Releasing after planting

Pest Control

- Regularly counted 80 – 120 deer per day, up to 15 pigs in animal counts.
- The property manager herded the deer away from the plantings.
- Manuka tended not to be touched by deer but was dug up by pigs at times.
- The hoof marks in this photo are of deer playing on the edges of roads in the pumice–seems to be a favourite pastime.

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Overview

- Why would we convert cutover to native afforestation?
- History of Maungataniwha
- How we transitioned
- **Other considerations/examples**

Other considerations/next steps

Why are we converting from radiata?

What problem are we trying to solve?

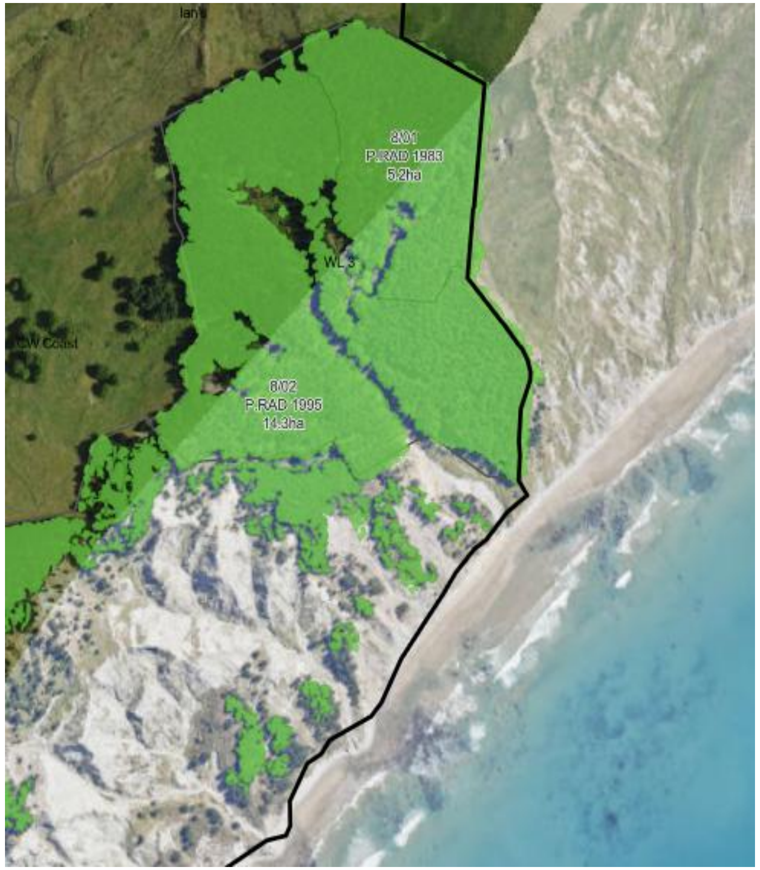
Then take into account the different considerations:

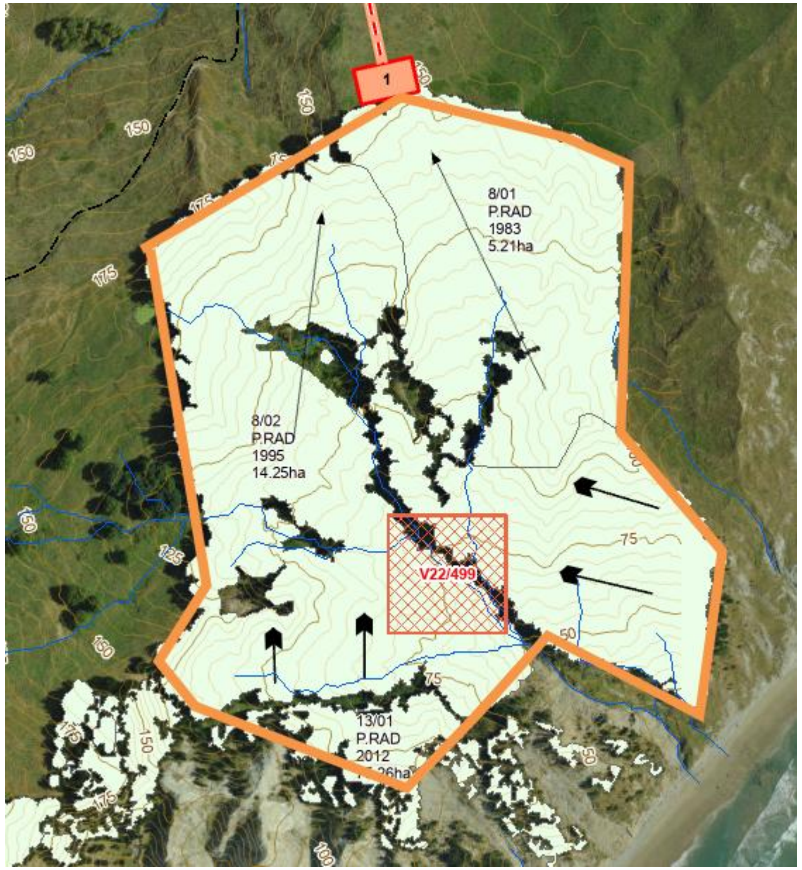
- LUC, high-risk areas incl. connectivity to waterways.
- Arch sites, soil types, pest control.
- Releasing options, living slash traps, ETS liabilities, use of coppicing varieties, and longer rotations.
- Selective harvesting, higher value crops, and cover crops.

Coastal Bluffs of Te Apiti Station – Hawke's Bay

Te Āpiti Harvest

- A highly erodible site toppling into the sea.
- Currently in P. radiata and ready to be harvested.
- Will replant with willow in wet and incised guts.
- Manuka as a nurse/cover crop along with Ngaio.
- Seed islands of Pohutukawa and Coprosma.
- Replant P. radiata at the top of the slope.
- Pest control for the goats.





Conclusion

Planning: The most important step in the process is taking into account all of the factors of your unique site. Make sure you have a plan before you start planting to solve each of your particular challenges.

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Penny Baker – bakerp@landcorp.co.nz

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Transitioning Exotic Forest to Native

Presented by Meg Graeme
June 2025
NZIF conference – Napier

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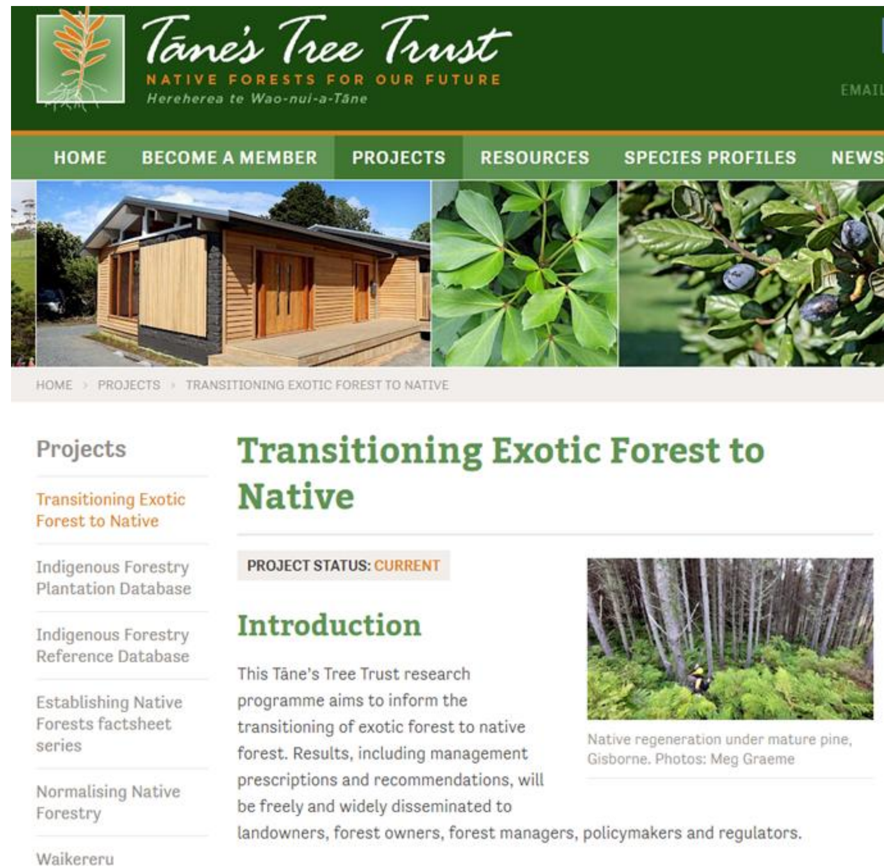
The transitional forestry project

- Focus - transitioning standing radiata-pine to native forest on highly erodible steeplands.
- Funded by MPI's SFFF (Sustainable Food & Fibre Futures) fund.
- Sits within TTT's wider R&D programme *https://www.tanestrees.org.nz/projects/*
- Outputs from this project will be made freely available via the TTT website - https://www.tanestrees.org.nz/resources/



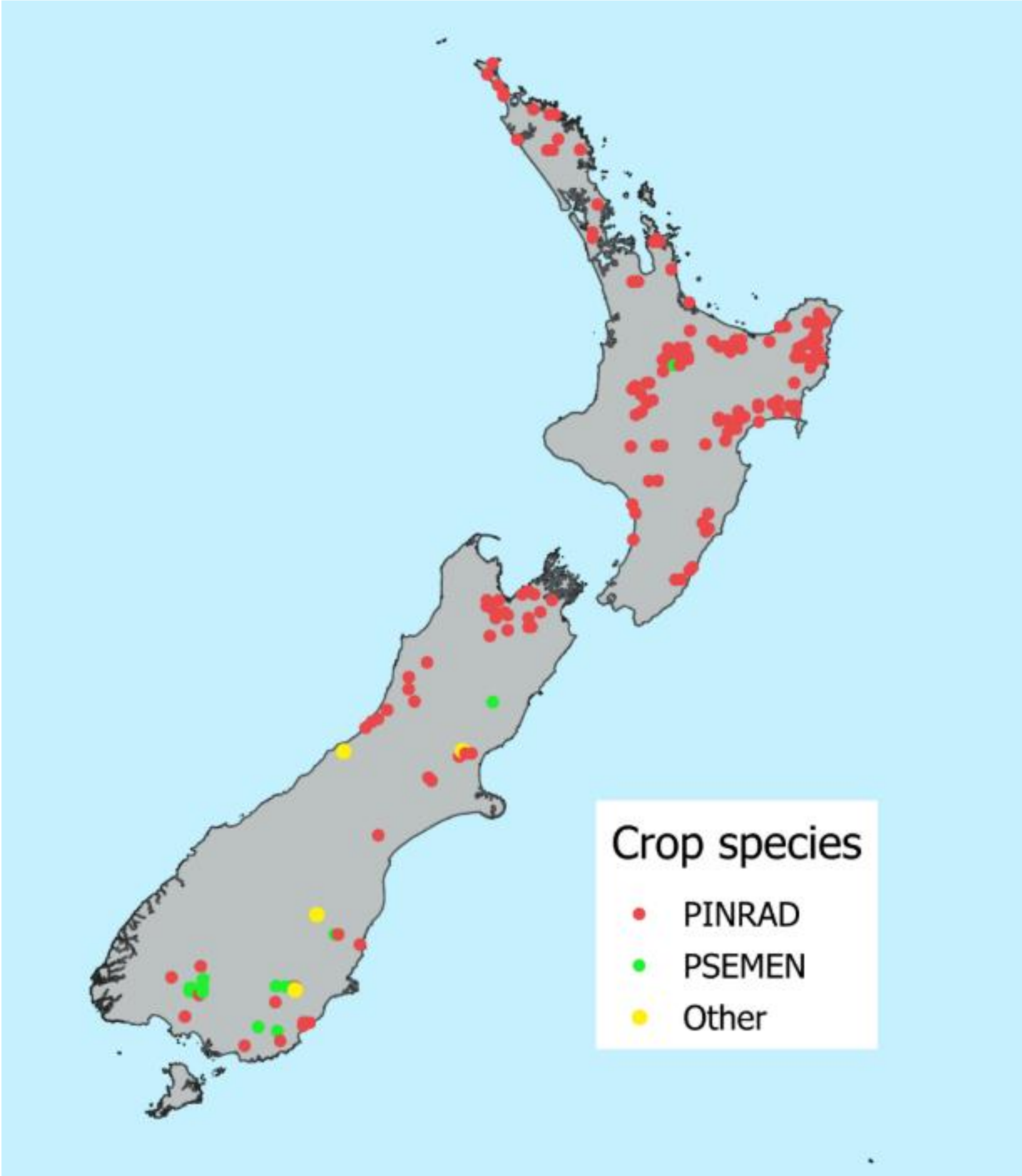
Project workstreams

- Workstream 1: LUCAS plots data analysis
- Workstream 2: Tairawhiti surveys
- Workstream 3: Bioclimatic surveys
- Workstream 4: Forest trials
- Workstream 5: Modelling
- Workstream 6: Guidelines

Project manager - Meg Graeme
Key project members - Mark Kimberley
- Adam Forbes
- Michael Bergin
- Paul Quinlan
- David Bergin

LUCAS plot analysis

- 197 LUCAS grid locations
- 90% radiata pine
- 473 plot measurements



LUCAS Analysis Results

- Radiata-pine forests more diverse understory than Douglas-fir forests
- Most radiata pine plots were Kyoto non-compliant
- Variable native understory density/diversity throughout NZ.
- Key understorey species in terms of carbon were - mahoe, wineberry, tree ferns, kanuka, putaputawētā, tutu, tree fuchsia, patē, manuka, karamū and tōtara (the only one true canopy tree species).
- Key exotic species in terms of carbon were - Radiata pine, gorse, Douglas-fir, Contorta pine, blackwood, poplar.

LUCAS Analysis Results

Key trends for radiata pine plantations have emerged (reinforcing other earlier research) including:

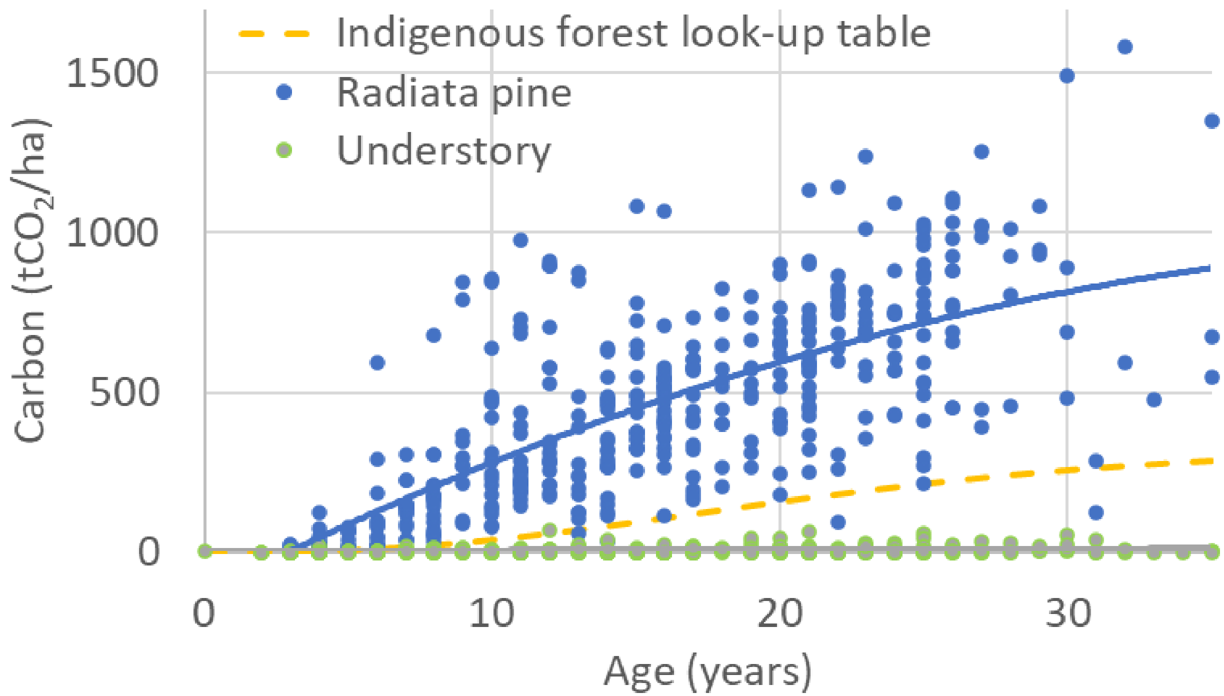
- Native understory plant density and diversity increases with stand age and decreasing stand density (≤ 250 stems/ha).

- Naturally regenerating radiata pine is absent in 1st rotation stands but present in young 2nd or later rotation stands - however becomes an increasingly minor component with stand age.

LUCAS Analysis Results

Key trends continued ….:

- Carbon in the understory was only a small fraction of the carbon stored in the crop trees



Bioclimatic surveys

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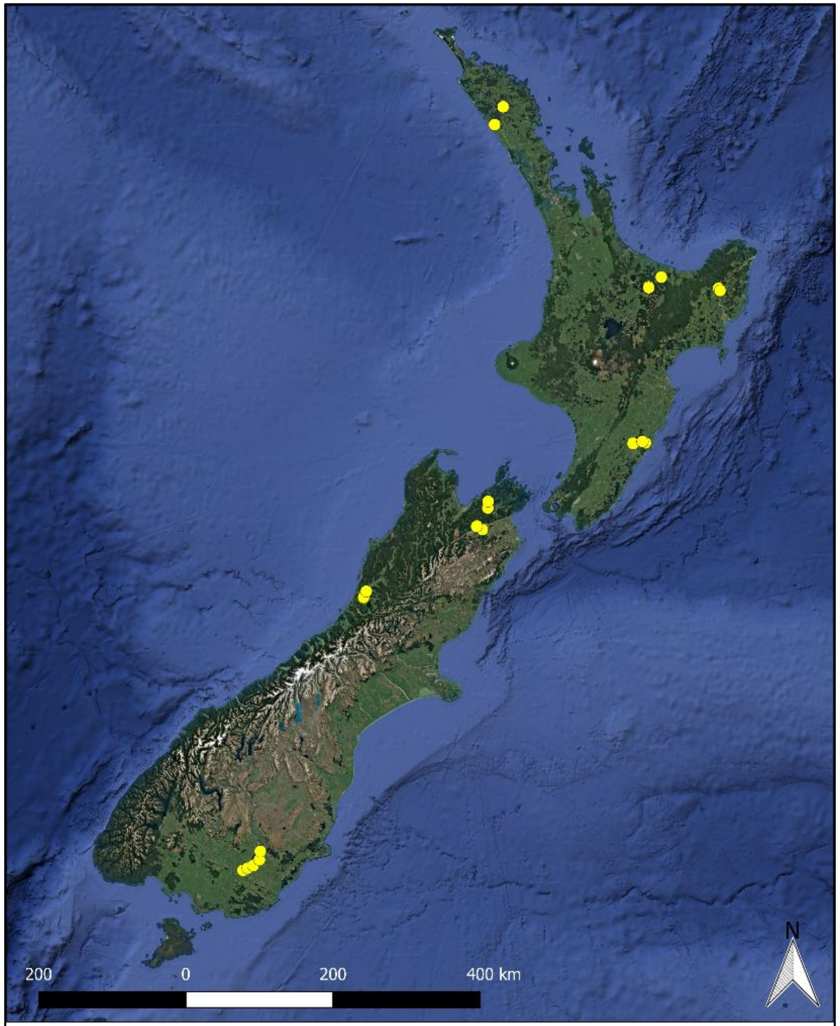
- 80 plots surveyed around the country:
  - Northland (4 plots)
  - Gisborne (7 plots)
  - Waikato (25 plots)
  - Bay of Plenty (6 plots)
  - Wellington (10 plots)
  - Marlborough (12 plots)
  - West Coast (6 plots)
  - Otago (10 plots)



Bioclimatic survey sites

1:8,000,000 at A4
Date Created: 06-05-2025
Created by: M. Graeme
Coordinate System: NZGD2000 / New Zealand Transverse Mercator 2000
Service layer credits: Google Satellite

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Bioclimatic results

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Key findings:

Native understorey varied with:

- Climate
- Elevation and aspect
- Plantation top height
- Nearby indigenous forest
- level of browsing.

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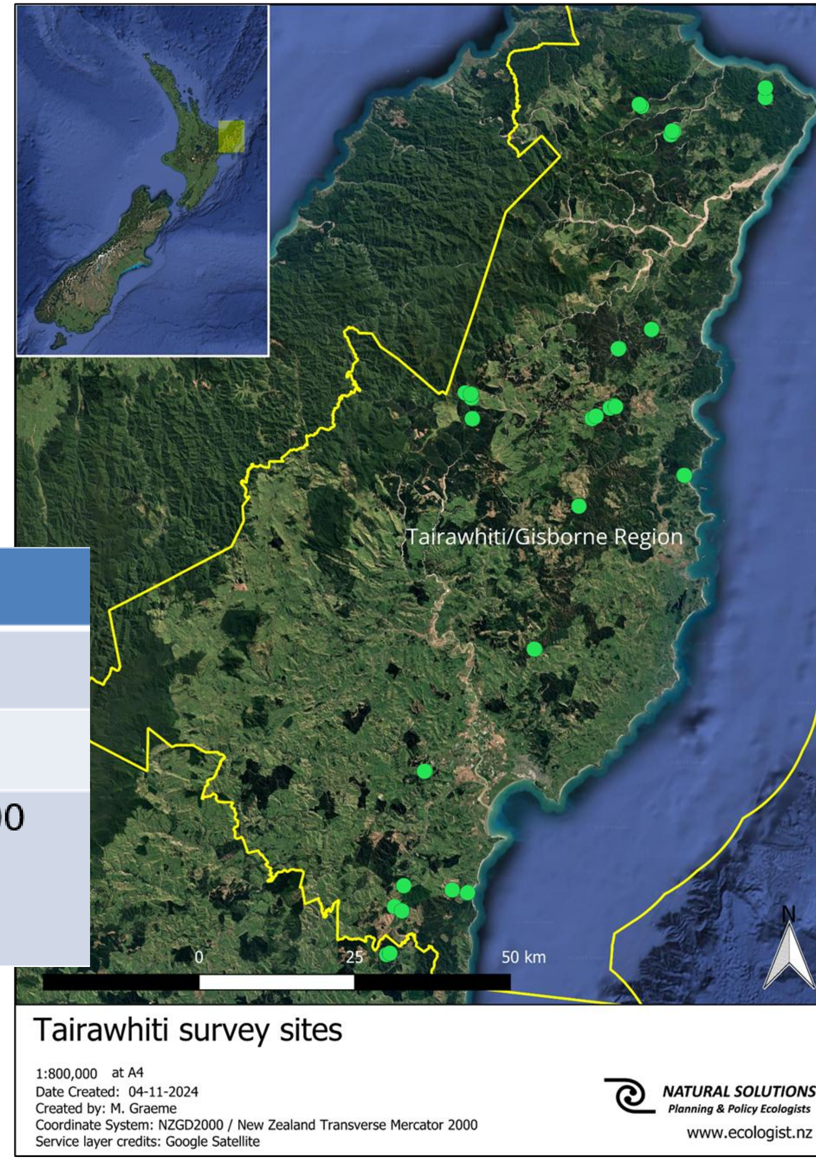
Tairawhiti surveys

- 24 sites, 45 plots
- 0.06ha PSP plot with $100m^2$ sub-plot

Variable	Mean ± Std. dev	Range
Stand age (years)	37.1 ± 7.5	21 - 63
Elevation (m)	378 ± 237	73 - 983
Distance to native seed source (m)	633 ± 511	65 - 1,900



Tairawhiti Survey Results

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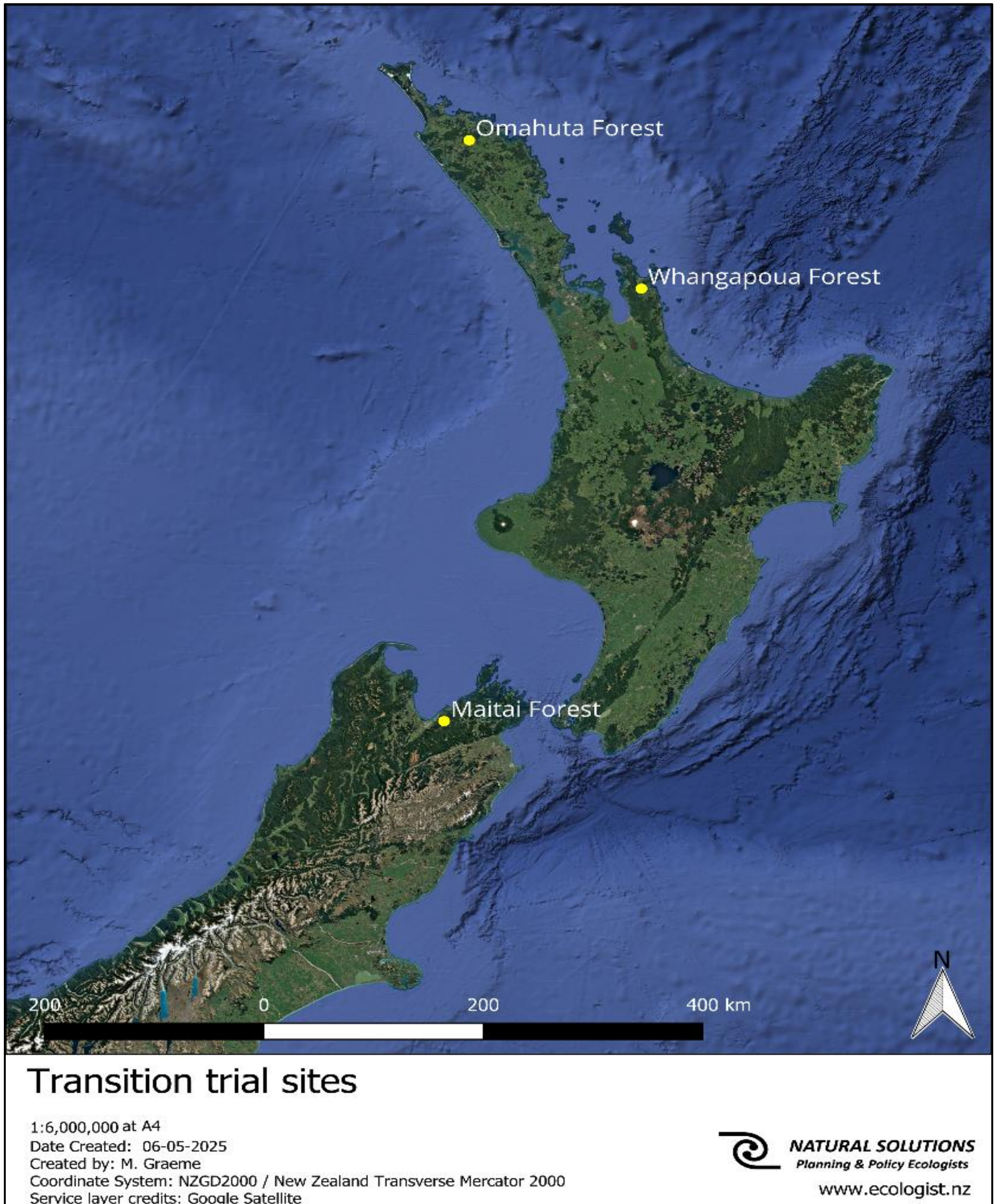
Results indicate:

- Widespread browse
- Predominantly native 98.2%
- Tairāwhiti understory stem density, carbon and species diversity ranked higher than national LUCAS metrics

Tairawhiti Survey Results

- Plot veg mainly shrub species (76%) and subcanopy species (21%)
- But carbon mainly in the subcanopy and tree ferns.
- Tall canopy species make up 1.8% of stems but contribute 8% of carbon.
- Number and density of species, as well as carbon, increases with plantation age.



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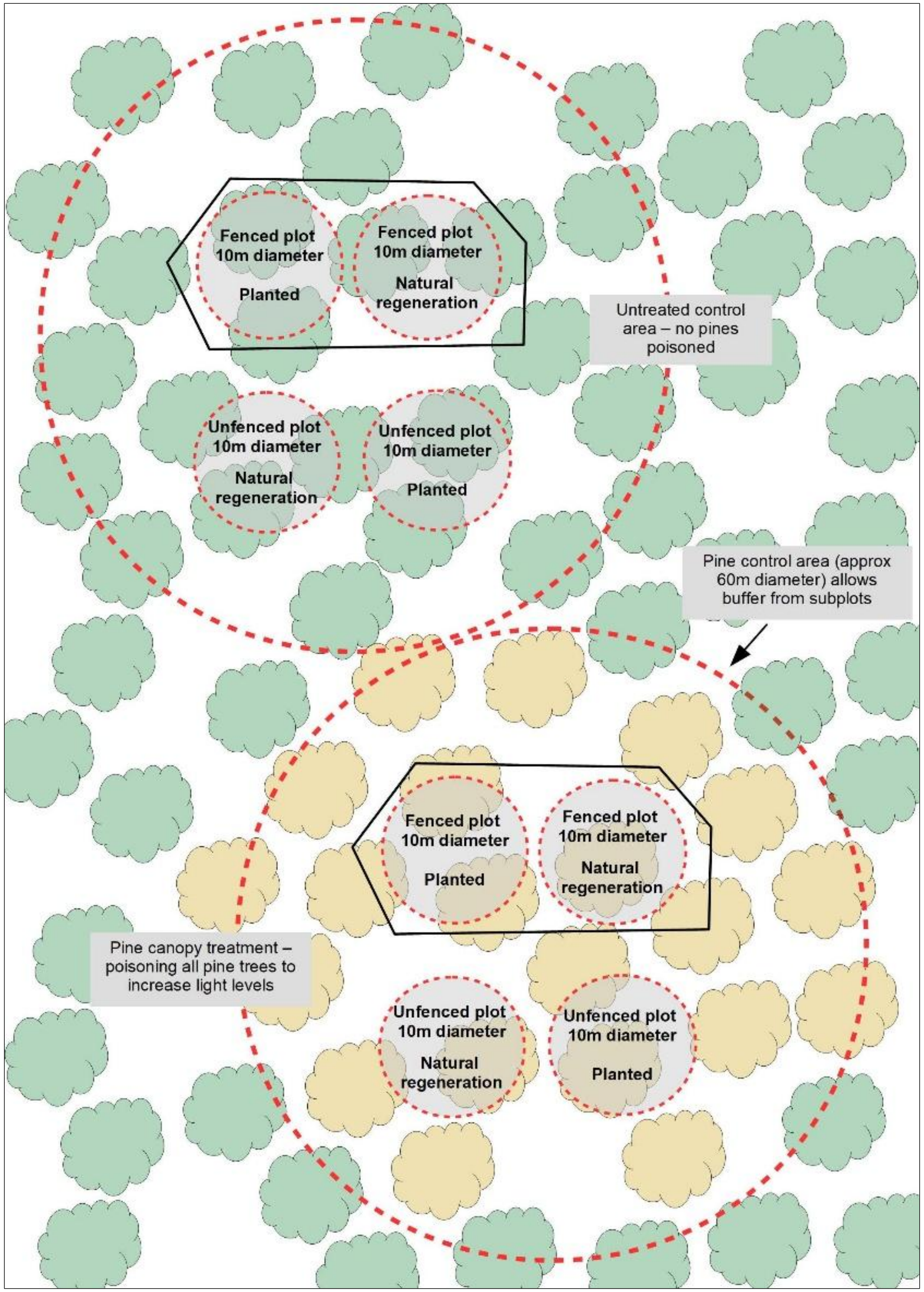
Forest trials

3 main replicated trials with canopy manipulations, together with other associated sites.

Forest trials



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Forest trials - fencing

Whangapoua est. 2023, Omahuta and Maitai est. late June 2024

Forest trials - planting

Whangapoua	Omahuta	Maitai
Agathis australis (kauri)	*Ackama rosifolia* (makamaka)	*Carpodetus serratus* (putaputawētā)
Beilschmiedia tarairi (taraire)	*Beilschmiedia tarairi* (taraire)	*Dacrycarpus dacrydioides* (kahikatea)
Dacrycarpus dacrydioides (kahikatea)	*Didymocheton spectabile* (kohekohe)	*Dodonaea viscosa* (akeake)
Didymocheton spectabile (kohekohe)	*Hoheria populnea* (houhere)	*Fuscospora truncata* (hard beech)
Knightia excelsa (rewarewa)	*Knightia excelsa* (rewarewa)	*Kunzea ericoides* (kānuka)
Podocarpus tōtara (tōtara)	*Pectinopitys ferruginea* (miro)	*Pittosporum eugenioides* (tarata)
	Podocarpus tōtara (tōtara)	*Pittosporum tenuifolium* (kōhūhū)
	Vitex lucens (puriri)	*Podocarpus laetus* (Hall's tōtara)
		Podocarpus tōtara (tōtara)

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Forest trials – canopy manipulation

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Forest trials – pressures

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Forest trials - browse

Outside fence | Inside fence

Forest trials – browse






Natural regeneration
- Maitai

Upcoming work

- Carbon and biodiversity modelling

- Development of preliminary guidelines covering key findings from workstreams.

Outstanding questions

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- Density of understory stems required?
- Density of tall canopy tree species required if sustainable mature native forest end goal?
- Time or manipulation needed?

Thanks go to our funding partner MPI & our forestry/agency partners who shared LUCAS data, provided trial sites, helped with advice, field surveys etc.

Kia ora!

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Landscape features as indicators of past and potential slope instability; the ‘key’ to identifying and managing ‘risk’.

Mike Marden – Research Associate with Manaaki Whenua Landcare Research

Manaaki Whenua
Landcare Research

Context

Since the release of the Ministerial Report on Land Use in Tairawhiti and Wairoa District (2023), pressure is on land owners to mitigate both the on-and off-site impacts of sediment and woody debris, the key to which is the ability to identify parts of the landscape likely at greatest/least ‘risk’ to future storms.

While parts of the landscape effected by recent storms are in plain sight, signs of the impacts of past storms, as an indicator of ‘high’ risk to future storms, seemingly go unnoticed.

An appreciation of how landscapes form, and an ability to recognise the significance of ‘relict’ features as indicators of both past instability and potential vulnerability can inform decisions on the future management of ‘at risk’ sites.

Scope

The focus of this presentation is:

- To draw attention to the presence of ‘relict’ landscape features useful in understanding the processes involved in the development of landscapes.

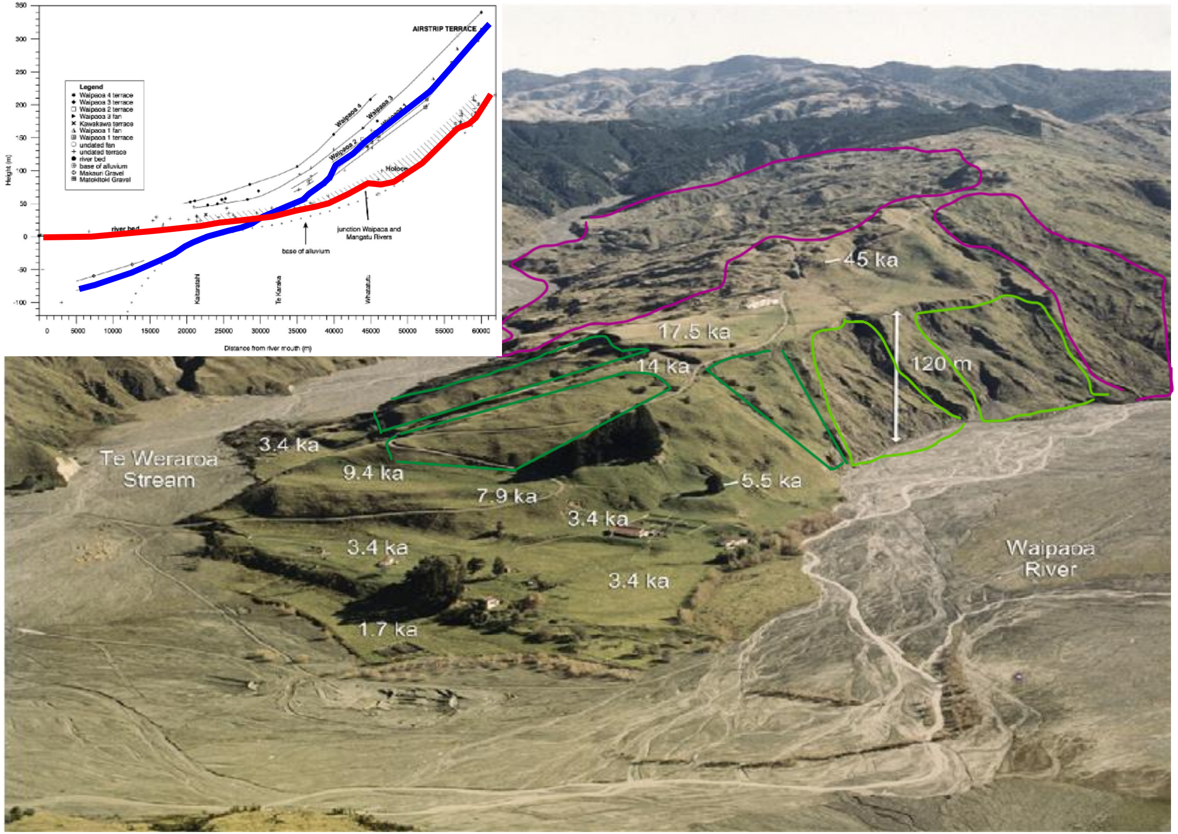
- To demonstrate how these features can be used to identify areas of varying ‘risk’(susceptibility) of generating and delivering sediment and woody debris to streams (connectivity).

- To present examples of the impact ‘natural’ erosion processes have had, and will continue to have, on the sustainability of ‘high risk’ areas irrespective of land use.

Landscape features of significance in the identification of areas of varying 'risk' of generating and delivering sediment and woody debris to streams.

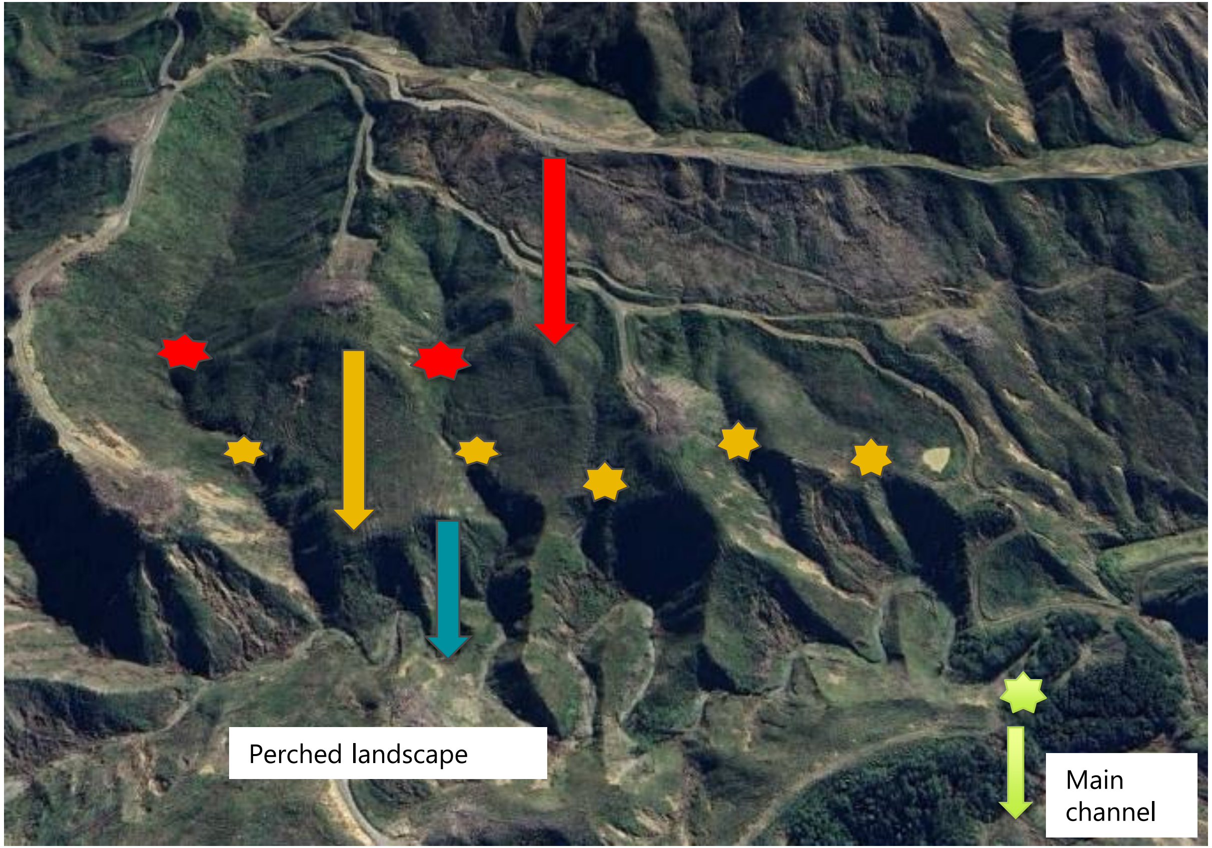
Alluvial terraces as indicators of landscape development.

- Alluvial terraces are remnants of former riverbeds abandoned as channels incise in response to multiple episodes of tectonic uplift.
- As channel incision increases, slopes readjust to a lowering base level by slumping which tends to be episodic: older slumps (dark green outlines with smooth surface texture), more recent slumps (light green outlines), and by earthflows (purple outlines) where displacement over time scales of 1000’s of years is near continuous.
- Rates of river incision are based on the age and elevation difference between successive terrace levels
- Terrace age (ka=1000 years) is based on the presence of volcanic ash.
- The white arrow indicates that coincident with climate change ~15 ka BP, this river incised 120m+into the structurally fractured and weak lithologies of Cretaceous age.

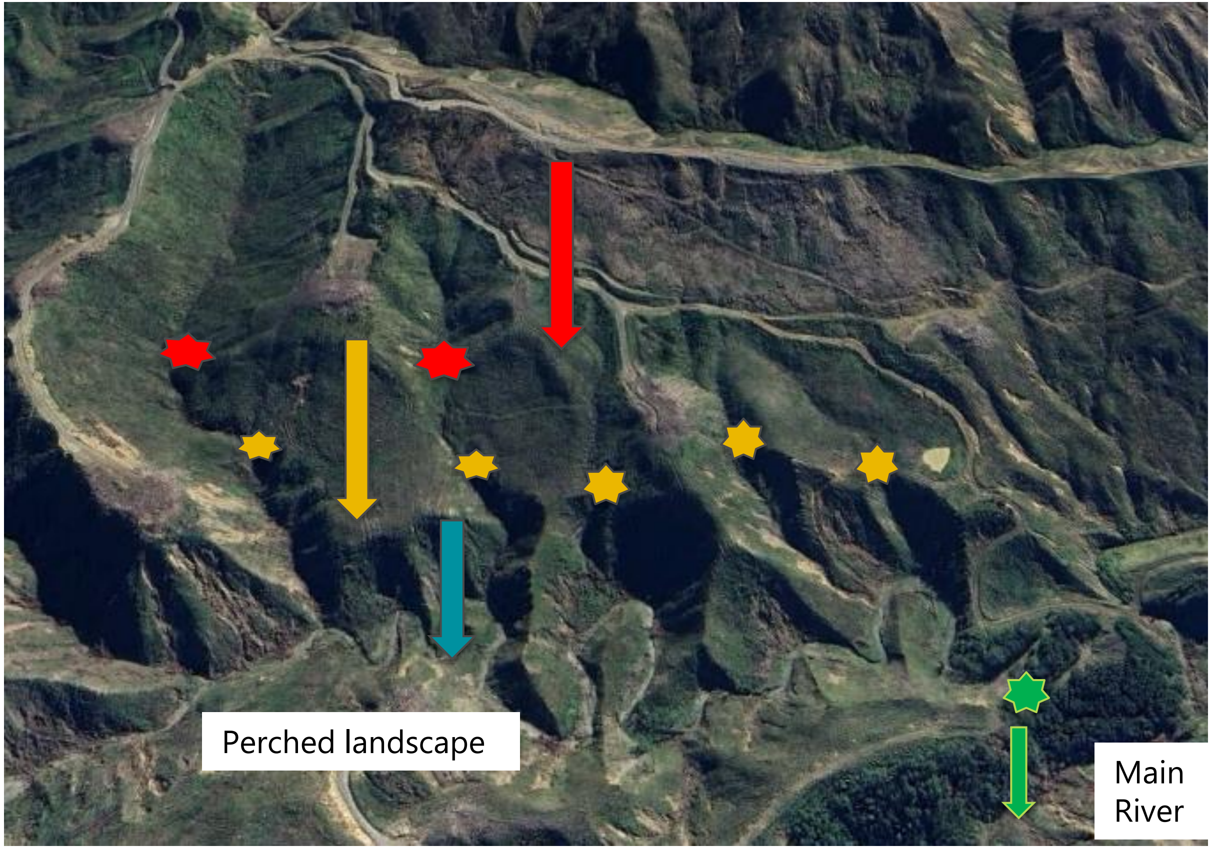


- In other landscapes where the underlying lithologies are of younger (Tertiary-age) and less deformed, 'nick' points can be used to construct the same sequence of landscape development.
- Nick points mark an abrupt change in the profile of a stream due to a change in the rate of tectonic uplift.
- Red arrow represents the earliest of 4 phases of river incision.
- Red stars indicate end of this period of incision when tectonic uplift rates slowed or ceased.
- This part of the landscape currently has **high erosion susceptibility but low connectivity to the main river.**

'Nick' (knick) points

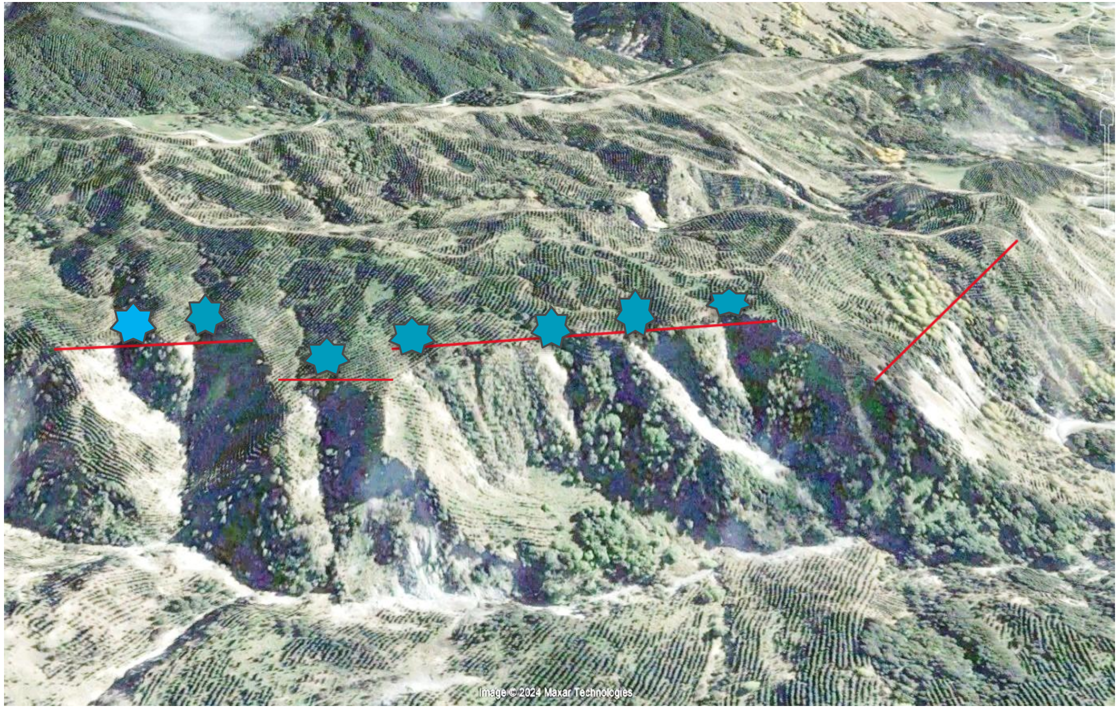


- Orange arrow represents second period of river incision **(moderate erosion susceptibility (**smooth surface texture**) and low connectivity to the main river).**
- Blue arrow indicates short period of rapid incision creating shorter and steeper slopes =**high erosion susceptibility but low connectivity to the main river.**
- Perched landscape was created during a long period when uplift rates and river incision slowed for a considerable period of time.
- Green arrow represents the latest period of incision. Very steep slopes in close proximity to streams = **high to very high erosion susceptibility and connectivity to main river.**

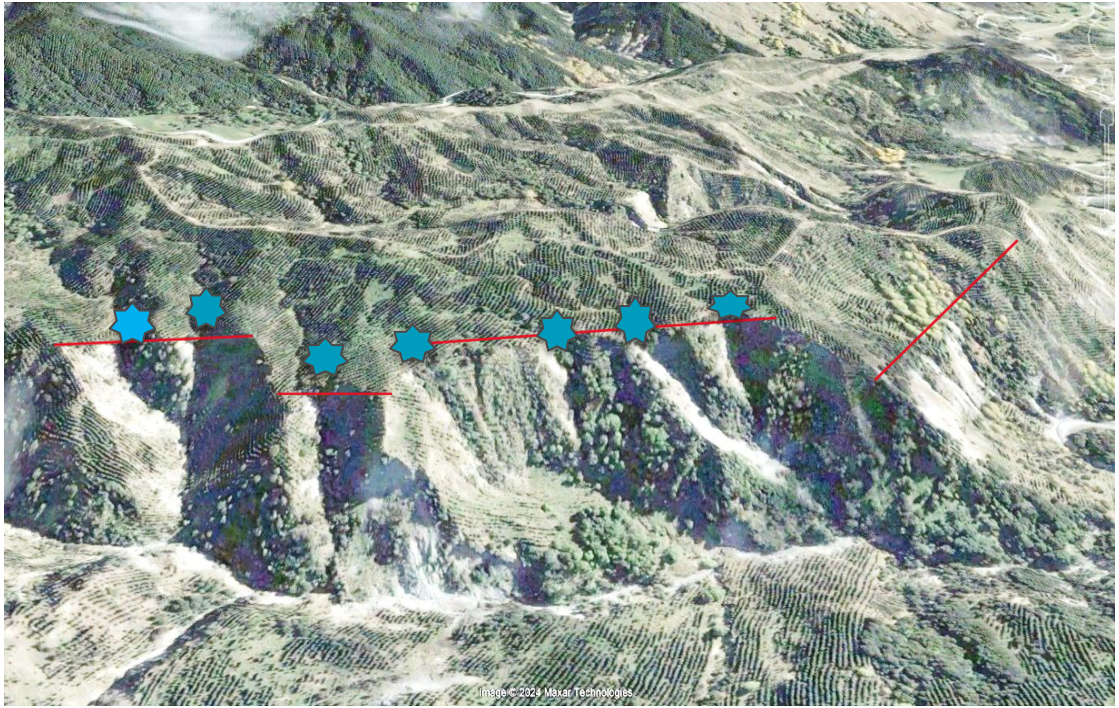


Breaks in slope steepness

- Steep-sided slopes along streams incised within Tertiary-aged bedrock.
- Subdued topography formed during a period when uplift rates were low (**low erosion susceptibility and connectivity)**
- Break in slope and increased slope steepness signal an increase in the rate of river incision.



- Resultant steep-sided slopes highly susceptible to repeat episodes of slumping, shallow landsliding and gullying (**high erosion susceptibility and connectivity).**
- Rate of nick point retreat slower under a forest regime due to reduced runoff and stream flow.



Surface texture as a indicator of slope stability/instability

- Smooth texture=stable terrain, often an indication of where sandstones are the dominant lithology (above red line) (**low erosion susceptibility and connectivity).**

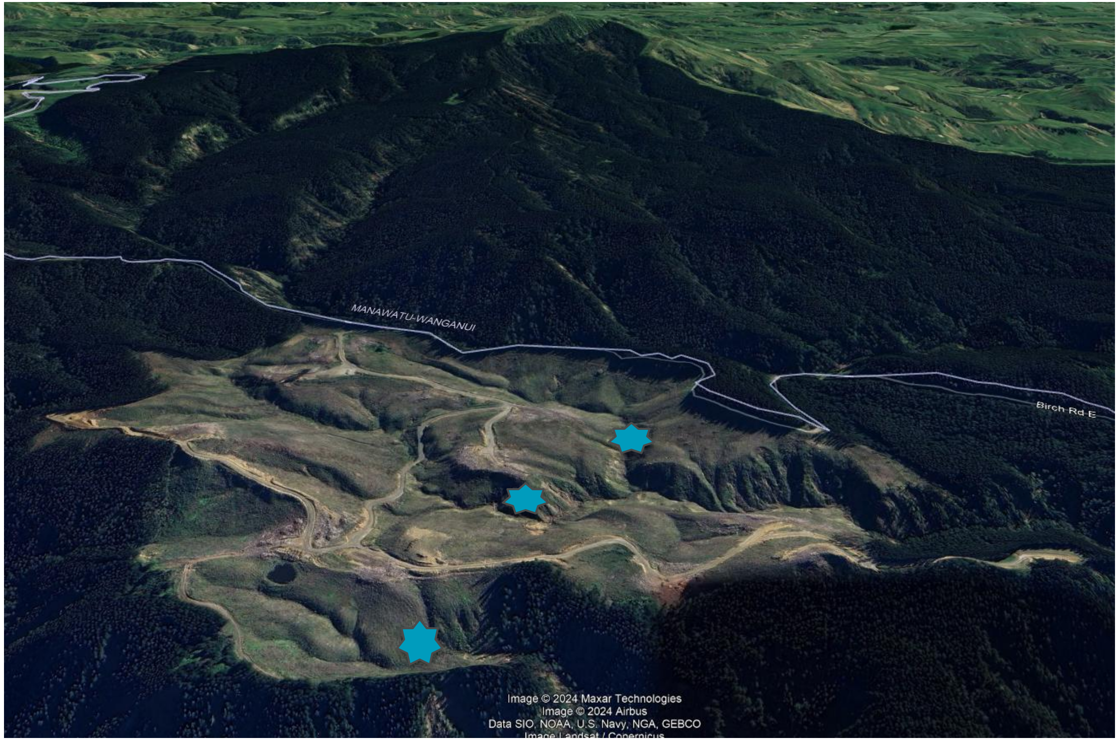
- Rough texture =sign of unstable terrain (purple polygon).
- Reflects inherent weakness of underlying bedrock often comprising fractured mudstones with greater susceptibility to slumping and earthflow displacement.
- Result is broken, hummocky surface **(moderate erosion susceptibility/low to high connectivity**
- In the absence of a tree cover, gullies (blue outline) initiated on earthflows and slumps have potential to develop quickly **(extreme erosion susceptibility and connectivity).**

Preservation of volcanic ash

- Accumulation and preservation of volcanic ash on slopes above red line and on ridge spurs (yellow polygons) indicate slopes have remained stable for thousands of years **(low erosion susceptibility and connectivity).**
- Rough surface texture (purple polygon) indicates slope displacement has occurred subsequent to the deposition of ash **(moderate erosion susceptibility and low to high connectivity).**
- Ash stripped from active gullies.

Perched watersheds

- Remnants of subdued topography located upstream of ‘nick’ points with low to moderate relief (25-35°).
- Stream channels located upstream of nick points are low gradient and therefore not deeply incised.



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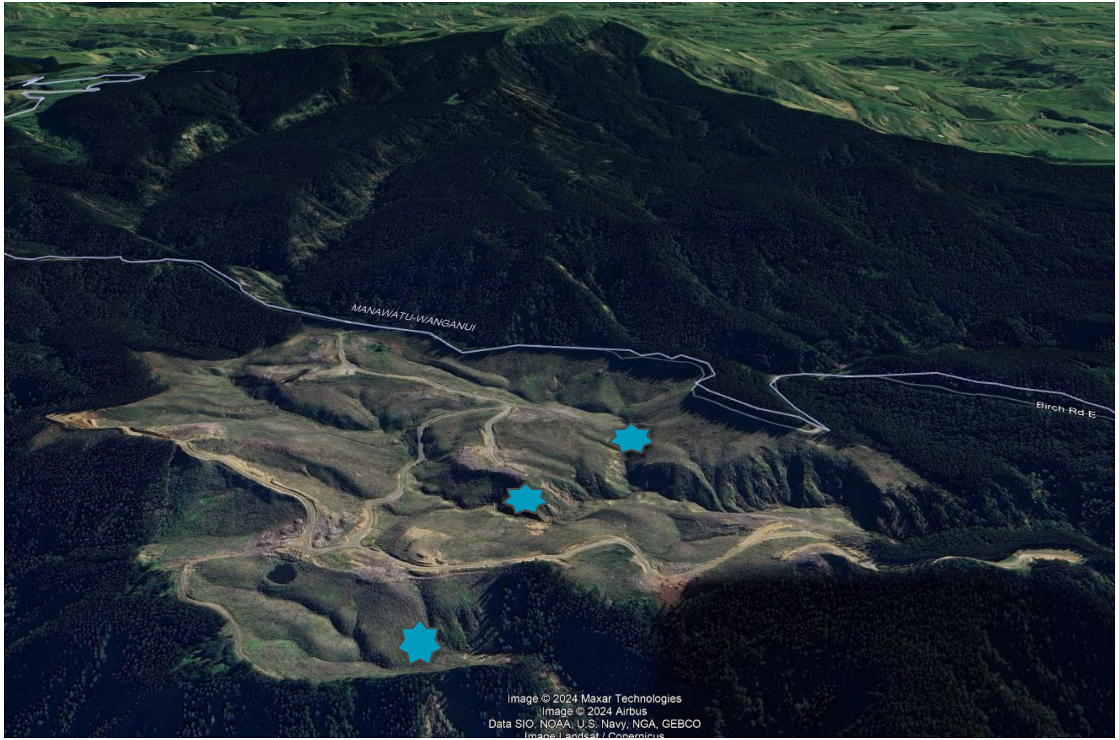
- Dominant erosion process is small scale shallow landslides and localised bank collapse **(low to moderate erosion susceptibility).**

- Streams are either ephemeral or perennial but lack sufficient flow to mobilise significant volumes of sediment or woody debris beyond nick points and into larger perennial streams/rivers **(low connectivity).**



Impact of ‘natural’ erosion on sustainability of high risk areas.

Shallow landslides

- Shallow landslide occurrence typical of planar, often NE facing slopes >35°.
- Cover bed materials (soil) stripped to expose underlying bedrock.
- Slopes located downstream of ‘nick points’ (blue arrow) are longer and steeper (**high erosion susceptibility and connectivity).**
- Unplantable slopes=reduction in net stocked area.

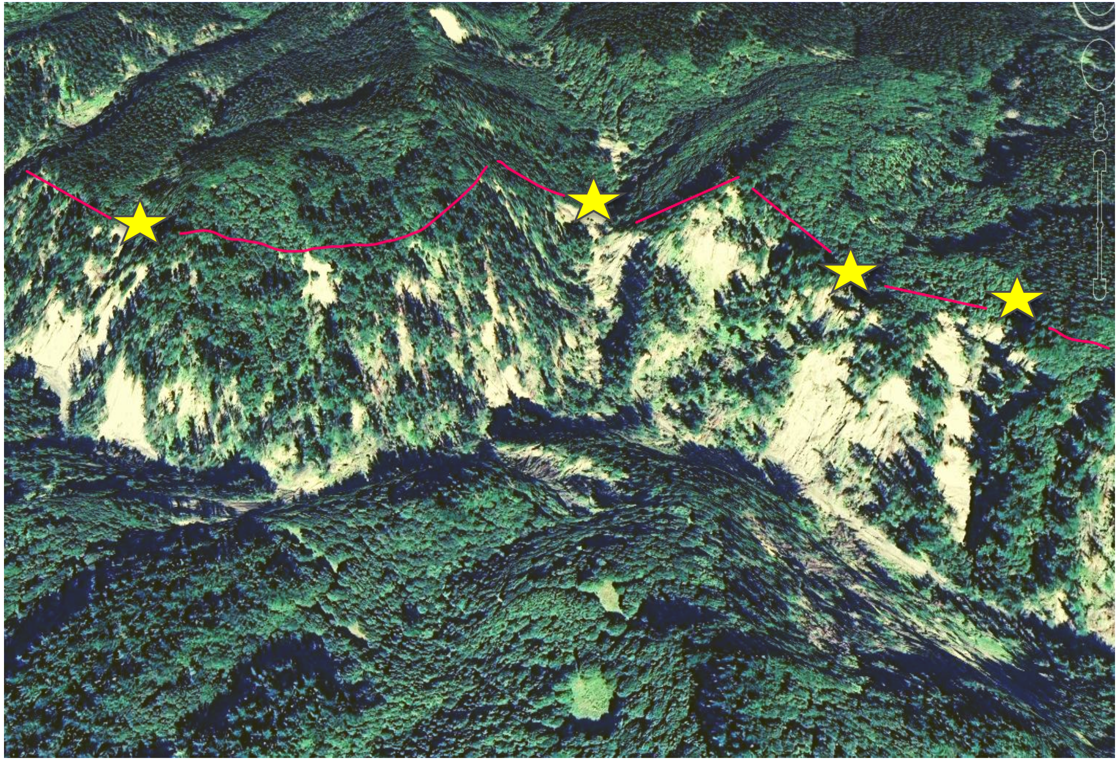
- Slopes upstream of nick point where stream is less-incised, are shorter, less steep and less prevalent to landslide occurrence (**moderate erosion susceptibility and connectivity).**
- Sufficient soil retained on and at base of slope as debris fans (green arrow) to support further rotations.
- Stream channels often ephemeral; less likely to mobilise woody debris.

Shallow soils vulnerable to saturation

- Extensive areas of exotic forest have been planted on steep slopes with minimal soil depth.
- Thin and porous soils with a high volcanic ash content readily saturate and fail.
- Tree roots unable to penetrate impervious bedrock and develop shallow ‘plate-like’ root systems.
- Insufficient root mass to support tall trees.
- Live trees slide off hillsides and into stream channels (**high susceptibility and connectivity).**
- Unplantable sites=reduction in net stocked area.

Multiple episodes of slope failure over time indicative of 'high' risk slopes

- In plain view, are slopes displaying erosion scars at different stages of vegetation recovery (below red line).
- Expansion of areas of bare ground exceeds the rate at which any form of vegetation is able to colonise and stabilise slopes (**high susceptibility and connectivity).**
- Production forestry is unlikely to be sustainable on steep slopes baring signs of multiple episodes of slope failure**.**



Tunnel gullies

- Tunnel gullies form at the interface between porous cover bed materials (volcanic ash in this instance) and impervious bedrock.
- Subsurface flow emerges at a break in slope where it triggers landslides.
- Over time, as tunnels enlarge, the roof collapses and they become open drainage channels.

Debris slides

- Example of a debris slide initiated on steep and unstable slopes flanking an actively expanding gully.
- Sub-surface flow emerges ~3m below ground level, at a break in slope, triggering a debris slide.
- Debris slides are generally of sufficient volume to calve a tract through standing forest.

- Debris slides have the potential to deliver significant volumes of sediment and woody debris to stream channels (**extreme susceptibility and connectivity).**
- Over time the headwalls retrogress further upslope often to ridge lines.
- Production forestry is not sustainable on unstable slopes flanking actively eroding and expanding gullies.

Bank undercutting

- At times of elevated stream flow, steep slopes proximal to and on outside bends of streams are prone to undercutting.
- Shallow landslides (top right) and slumping (bottom left) are common forms of slope collapse in close proximity to streams (**high susceptibility and connectivity).**

Badass gullies

- Gullies were almost non-existent before indigenous forest was cleared.
- Following removal of the forest canopy:

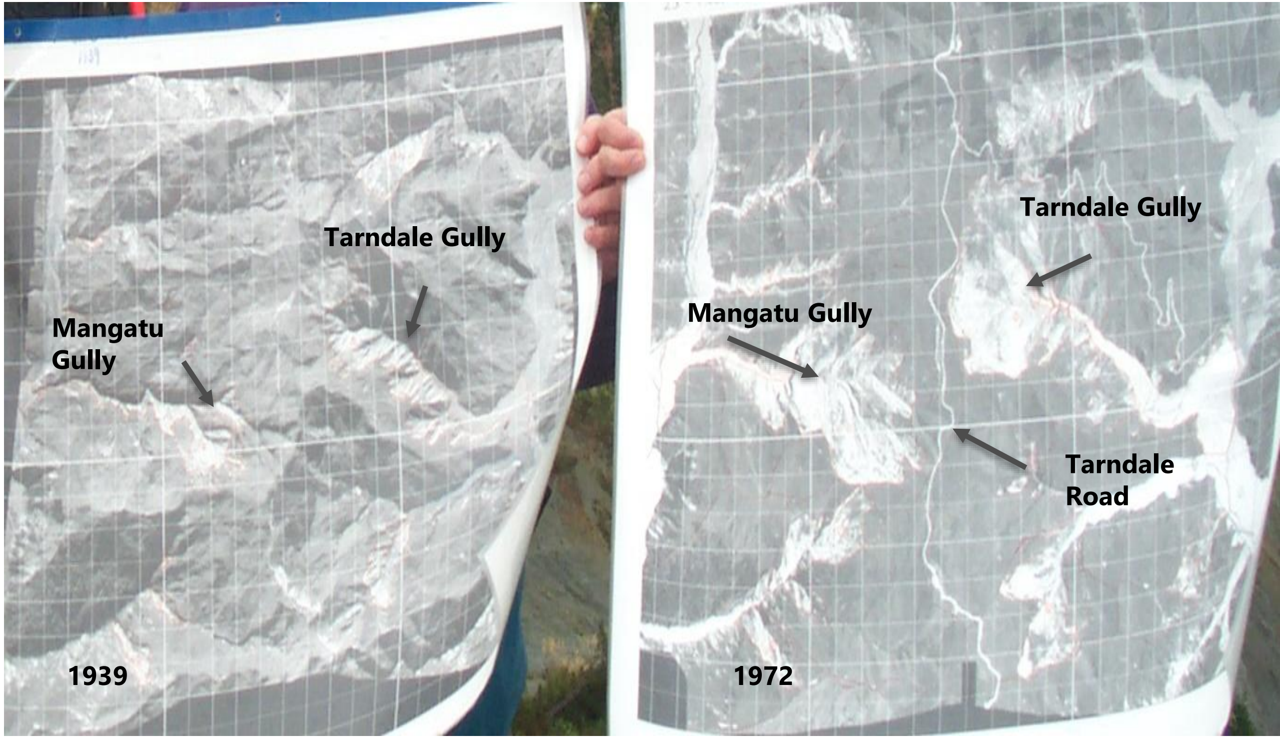
  - surface water runoff increased,

  -channels incised into weak underlying bedrock,

  - gullies widened,

  - sediment generation rates increased,

  -valley floors aggraded.



Gullies can threaten access routes

- Roads in the vicinity of rapidly eroding gullies require regular realigning, regrading and maintenance to keep them operational over a long period.
- Headward retreat eventually rendered this road impassable, severing access to a large part of this forest and farmland in the upper catchment.
- Other locations where headward retreat of gullies will take out road access before trees are of harvestable age.

Example of headwall retreat of a large gully:1939–2004

Headwall retreat

- ~100m towards the west.

Elevation change

- minus 50m at road.

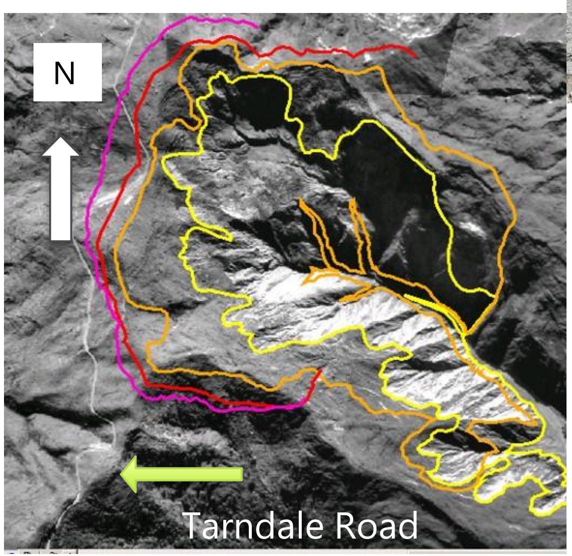
Gully expansion

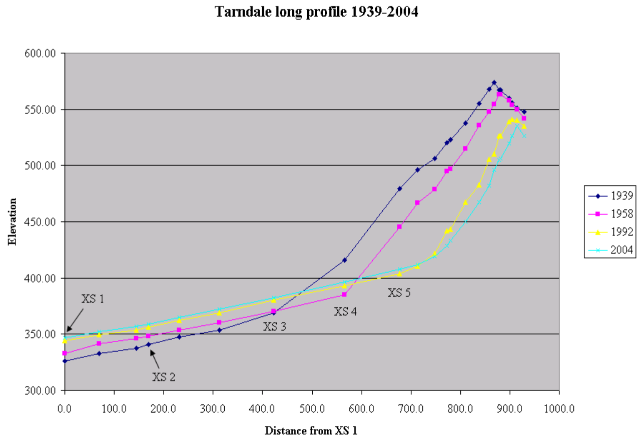
- 1939=18 ha
- 1958=27 ha

Planted in ~1963

- 2004=13 ha
- Plantings stabilised lower reaches but gully continued to expand by headwall retreat.

Plan view of headwall of Tarndale Gully 1939 (yellow), 1958 (orange), 1985 (red), 2004 (purple) superimposed on the 1939 DEM.





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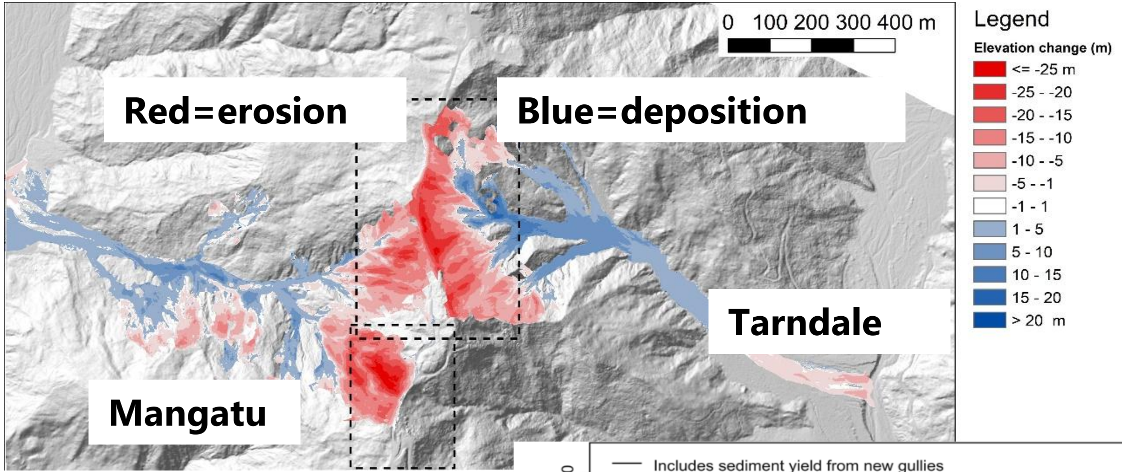
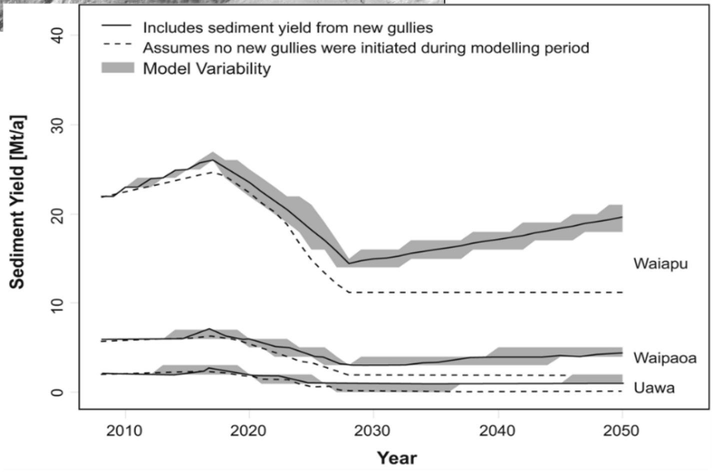
- In Tairawhiti, gullies contribute ~50% of total long-term suspended sediment yield of each of Waipaoa (15 Mt/yr), Uawa (5 Mt/yr) and Waipapu (35 Mt/yr) rivers.
- The **most effective** way to reduce future sediment yield is to afforest all treatable gullies.
- For many gullies this will include all of the surrounding watershed.
- If existing and new gullies <10 ha are not treated, sediment yield will more than double by 2050.
- Gullies >10 ha at the time of planting are often too large and too active for afforestation to stabilise them.

Gullies are a significant source of sediment



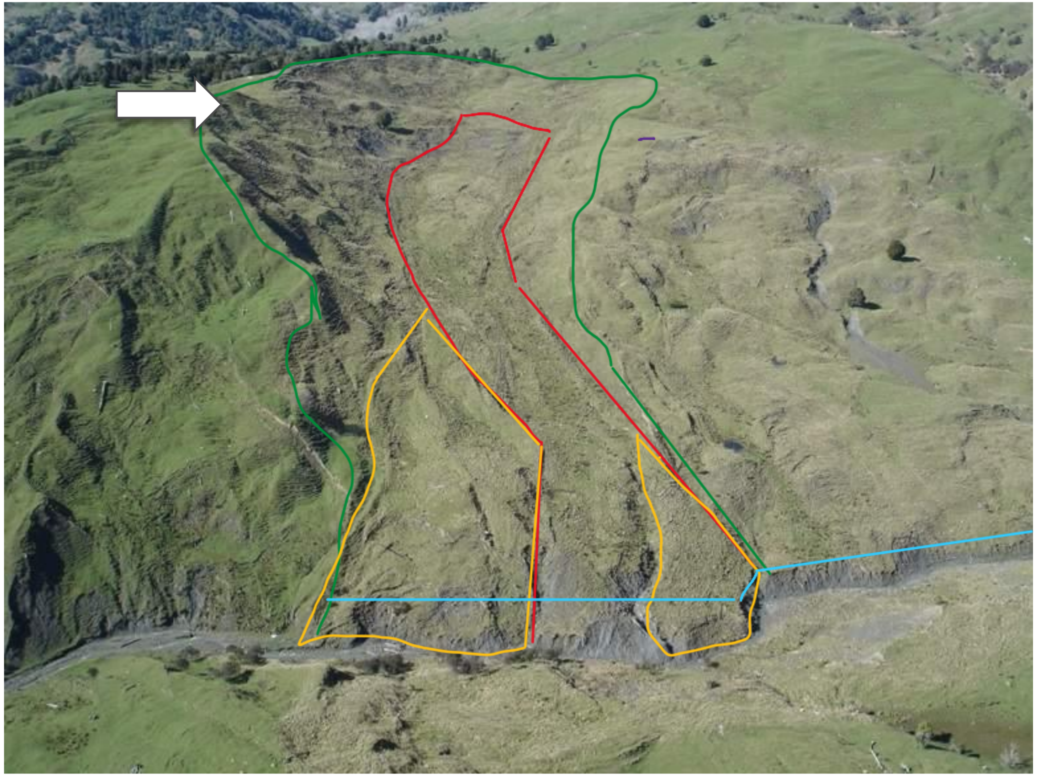
Channel aggradation
Tarndale Gully
10-15 m near base, decreasing downstream to 1-5 m.
Mangatu Gully
1-10 m
Elevation change at ridge line:
1939-2004=-50m
2005-2019=-25m

Source: Fuller et al. (2020), Herzig et al. (2011)

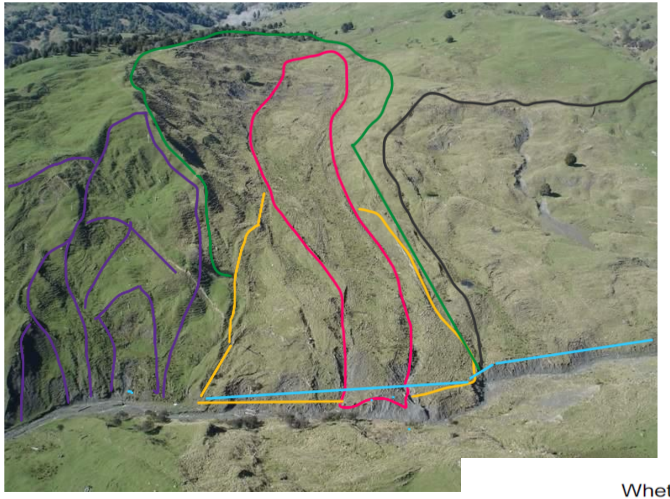


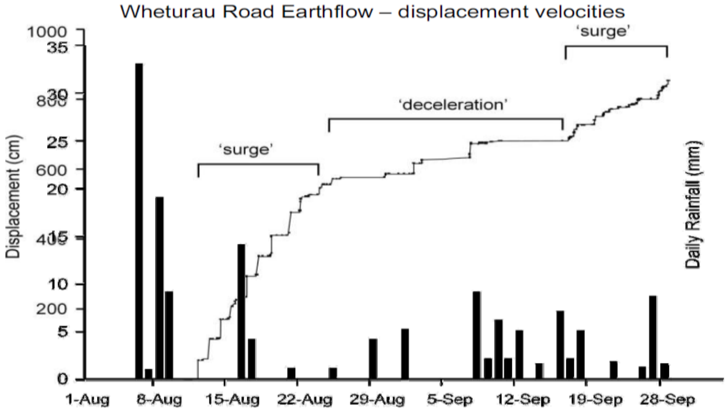
Earthflows

- Earthflows have been a significant erosion process in the development of landscapes for 1000's of years.
- Natural triggers of earthflow displacement include:
- **Prolonged periods of rainfall=** high water tables and high pore water pressures.
- **Groundwater springs emerging at ridgelines**- lubricates basal shear plane.
- **Top loading** of sediment at head scarp (white arrow) onto body of earthflow to trigger renewed phase of activity (i.e. inside red outline).
- **Bank undercutting** of toe slope (light blue line).



- Earthflows fail multiple times at the same location (red=most recent, orange= previous event, black=similar or older age as large earthflow outlined in green).
- Following periods of heavy or prolonged rainfall, cycles of accelerated displacement (surges) are followed by periods when displacement rates decelerate.
- Although **highly connected to** streams, due to their **low frequency of activity,** earthflows are a minor contributor to the total sediment load delivered to streams.





Source: Marden et al. (2023).

Large-scale slumps

- Outlines of ‘relict’ slumps are very evident on aerial photographs.
- Often signs of incremental movement at the same location, multiple times, spanning several decades to millennia.
- Failure occurs along a deep-seated failure plane.
- Irrespective of the type and maturity of vegetation cover they eventually fail ‘en masse’.
- Failure usually coincides with extreme weather events or earthquakes.
- Top-loading of sediment, discharge of drainage from roads and landings and removal of toe slope support can increase their potential to fail.
- Unpredictable

Summary

- Exotic forests planted as the answer to restoring stability to severely eroding pastoral hill country have in places resulted in unintended consequences.
- It is the responsibility of land owners to better identify areas of differing 'risk' of slope failure, and where practical to do so, adopt mitigation strategies to reduce the susceptibility of slopes to erosion and the ongoing delivery of woody debris to waterways from 'high risk' locations.
- It is important for regulators to understand that not all 'at risk' areas are of equal 'risk', and that exotic afforestation has and will remain an important strategy and solution to mitigating mass movement and gully erosion, the effectiveness of which will be variable across different geologies and regions.
- For regulators to also acknowledge that during the period it will take to transition 'high risk' areas currently planted in exotic forest to a dense stand of mature permanent (non-harvestable) forest species (exotic and/or indigenous):
  - (i) the delivery of sediment and woody debris to streams will increase,
  - (ii) any reduction in exotic woody debris won't become apparent for decades

- (iii) any reduction in sediment will be negligible (cf. other sources) and
- (iv) irrespective of species and across all land uses, 'high-risk' parts of the landscape will forever remain the primary source of sediment and woody debris.

- For educators, the challenge is to provide foresters with:

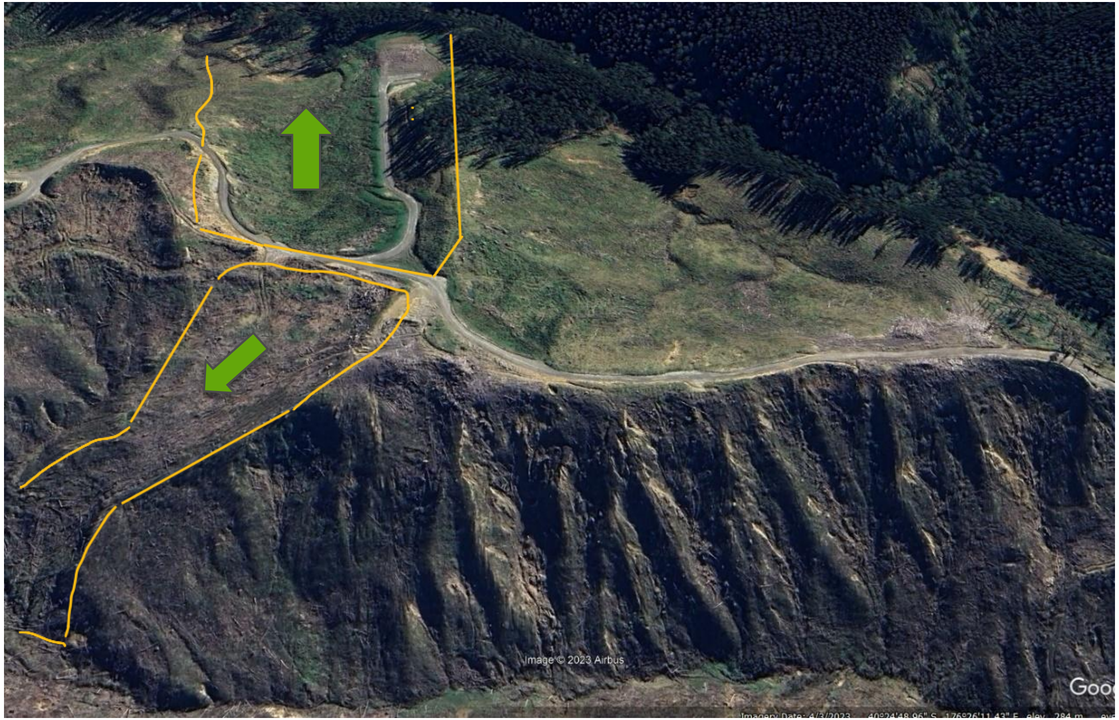
- an understanding of how landscapes develop,
- an ability to recognise 'relict' geomorphic features in the field, fundamental in the identification of 'at risk sites' and in assessing their vulnerability to storm events at all stages of a forest rotation,
- an ability to recognise different types of erosion and why they occur where they do,
- an understanding of the effectiveness of exotic forests in mitigating different types of mass movement and fluvial erosion while also accepting that some erosion features are beyond control using vegetative means alone, and
- an awareness that forest-related practices also result in accelerating erosion.

The End.

Examples of unintended consequences of forest-related practices in accelerating erosion.

Triggers of earthflow re-activation

- Removal of forest canopy and subsequent loss of root reinforcement
- Excessive groundwater pressures.
- Side-casting of roadside/landing spoil onto body of an earthflow.
- Landing failure onto earthflow.
- Discharging drainage from roads and landings onto body of earthflow.
- Constructing road/tracks across earthflow.

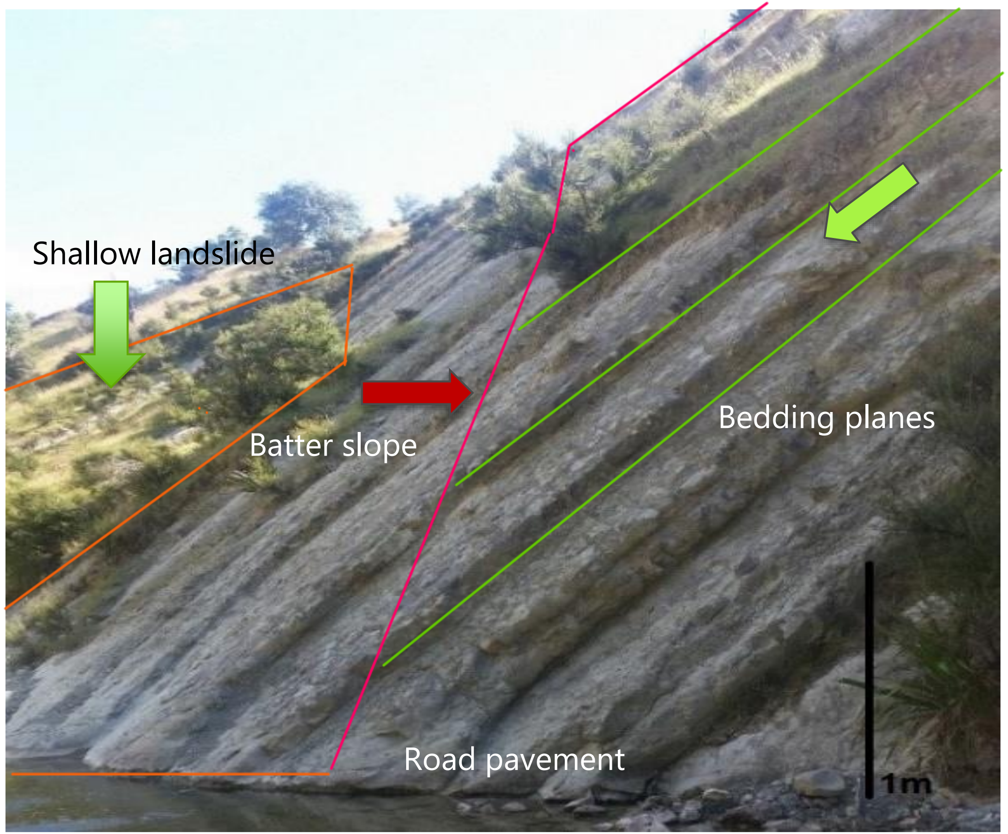


Roads constructed across earthflows

- Ridge-top roads coincident with the head of earthflows show signs of subsidence.
- Mid-slope roads displaced both vertically and horizontally.
- Roads aligned across the toe of earthflows can also be displaced, and/or blocked with debris.

Roads cut through bedrock

- Mock up of observed situations where roads have been cut through steeply inclined, stratified bedrock.
- Potential for batter slope to fail along bedding plane surfaces.
- Failure most likely to occur at contact between weaker mudstones and underlying sandstone.



Effectiveness of exotic forests in mitigating mass movement and fluvial erosion.

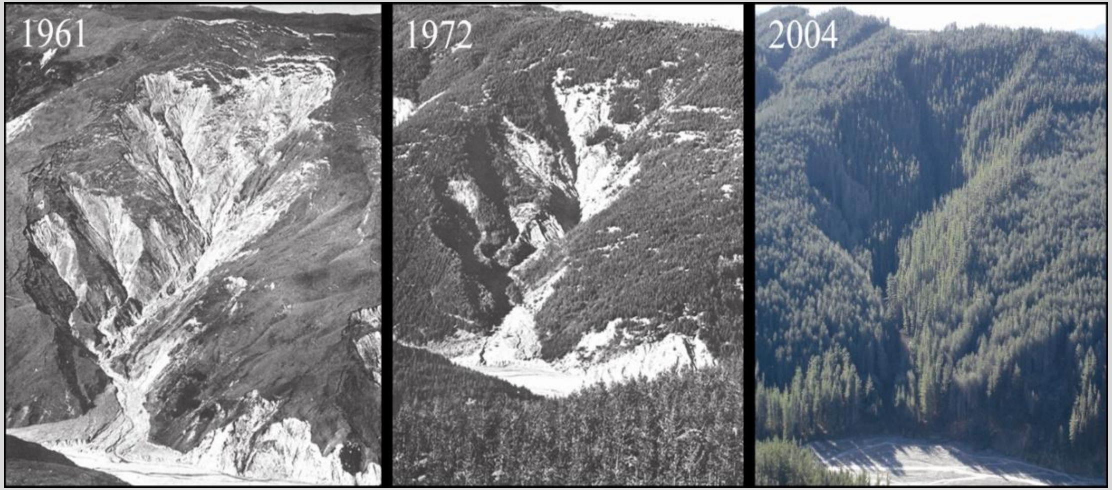
Effective mitigation of shallow landslides

Would the establishment of a permanent cover of mixed exotics or indigenous species at the same time as the exotic forest was planted have been as effective in mitigating landslide initiation on slopes with equally high susceptibility to shallow landsliding?

Long term, what is the future land use of this and other similarly vulnerable slopes:-repeat cycles of pine or a permanent cover of alternative exotics or indigenous species?.

Photos by Peter Scott.

Effective stabilisation of gullies



Gully 7.6 ha before planted.

Planted in 1962.

Blanking required in 1974.

Survived Cyclone Bola (1988).

Trees have been harvested and replacement trees survived Cyclones Hale and Gabrielle.

Source: Marden (2004).

Acknowledgements.

1961 and 1972 photographs courtesy of J. Johns; reproduced by permission of New Zealand Forest Research Institute Limited.

2004 photograph courtesy of R. Hambling (Ministry of Agriculture and Forestry).

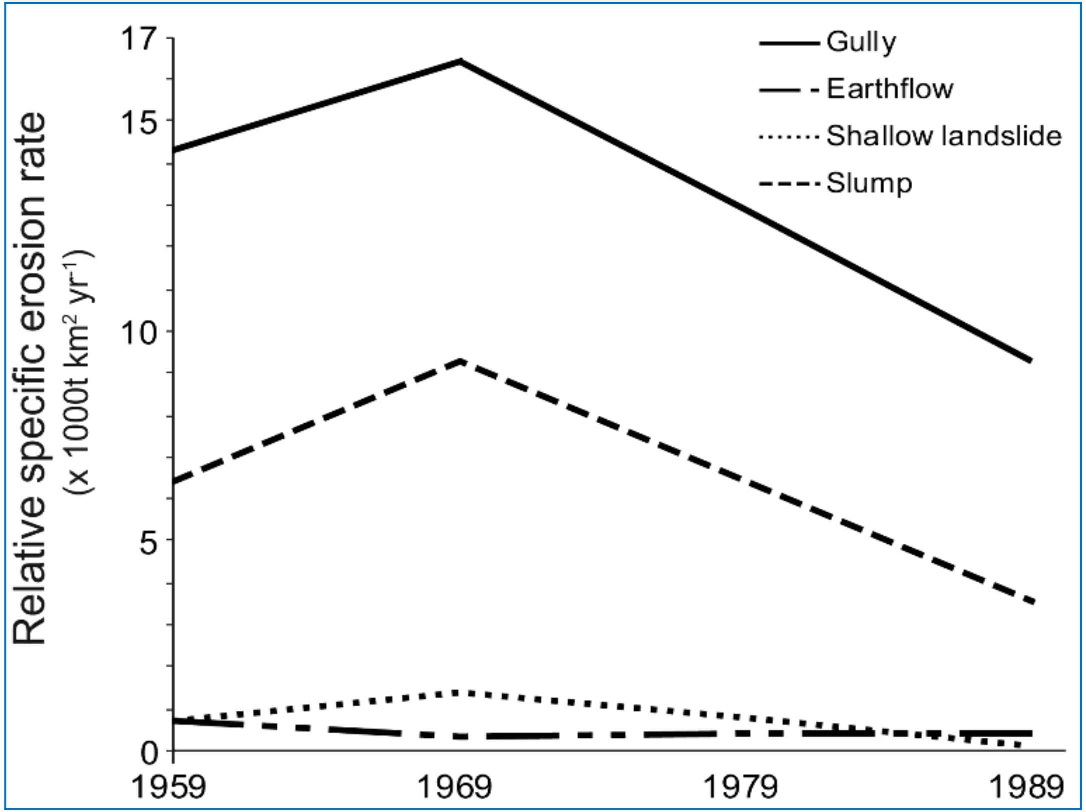
Effective stabilisation of earthflows

- Afforestation of whole of watersheds surrounding earthflows is an appropriate quick fix and sustainable land use.
- However, persistent high water tables for long periods limits root development of pine established within the mobile part of the earthflow where they are ineffective in stabilizing the earthflow.
- For the wettest sites, a mixed–species regime may provide a solution?

Both before and during the afforestation period:

- gully erosion rates were an order of magnitude greater than for earthflows & landslides.
- Shallow landslides and earthflows were the least significant sediment generating process.
- Over a 28-year period the overall erosion rate halved (all processes combined).

Reduction in relative erosion rates during a forest rotation



Erosion features beyond control using only vegetative practices

Large-scale slumps

- Failure occurs along a deep-seated failure plane.
- Irrespective of the type and maturity of vegetation cover they eventually fail ‘en masse’.
- Failure usually coincides with extreme weather events or earthquakes.
- Top-loading, discharge of drainage and removal of toe slope support can increase their potential to fail.
- Unpredictable

Gully occupies whole of watershed: unmanageable

- Gully too large and internal slopes too steep at time of planting.
- Too active for any form of vegetation cover to establish and survive.
- Gullies of this size increase in size over time until they occupy the whole of watershed.
- No vegetative treatment is going to slow gully expansion and headward retreat.
- Trees planted around margin are likely to be undermined and topple into gully.
- Headwall retreat will eventually extend beyond natural ridgeline into adjacent catchment.

What is proposed post–harvest?

There is no viable, practical solution to stabilising this and many gullies of similar size and larger.

Irrespective of species, headward retreat and gully widening will undermine fringe trees and they will topple into the gully.

Transitioning gullies planted in exotic pine within LO3B to a permanent forest cover

Gullies planted in pine within transition zone

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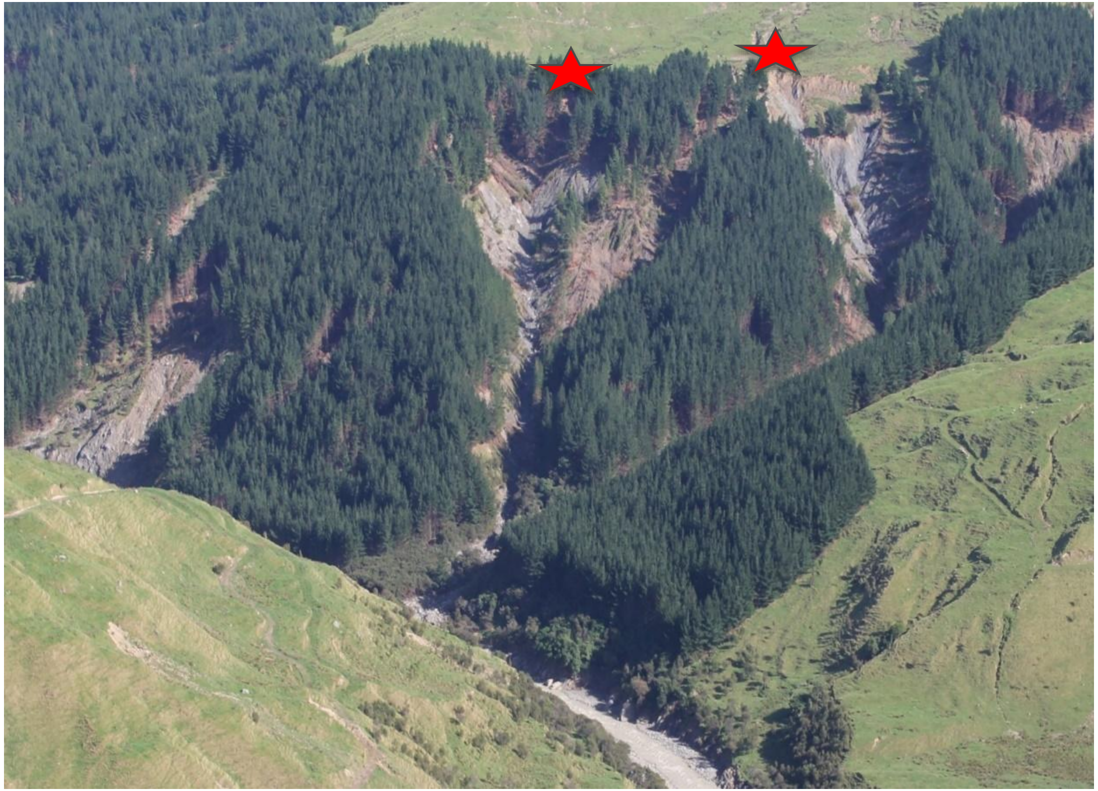
- Exotic forest planted on steep slopes below natural break in slope with good intent.
- This doesn’t address the reason these gullies developed, that is , drainage from the unforested watershed upslope of these gullies.
- To shut down gullies within this size range will in many cases require the whole of watershed to be planted.



- Interestingly, these gullies coincide with LO3B and will require transitioning to a permanent forest cover.
- While resolving the ‘risk’ of delivery of exotic woody debris to stream, the ‘nick’ point will continue to retrogress further upslope until the replacement cover is sufficiently dense to reduce surface runoff into the gully.