Ngā Awa River Restoration Programme

Case Study Report

Further Advice on Revegetation Options for the Awapoko, Oruru, and Oruaiti Catchments in Doubtless Bay, Northland

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Report Prepared for The Department of Conservation

March 2025

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Acknowledgements:

The project technical team comprised the following members who reviewed and added to the report: Sue Clearwater (DOC), Dave West (DOC), Maddy Jopling (DOC), Katie Collins (DOC), Lester Bridson (KMR), Jon Tunnicliffe (Auckland University), Brad Case (AUT). Haina Tamehana (DOC), Summit Forests and Jeff and Helen Martin assisted greatly with case study sites. We thank the hapu, landowners and other members of the public who engaged with us on this phase of the project and allowed access to and otherwise participated in the December 2024 field visits.

Cover photograph:

Favourable land use practices in an Otangaroa headwater sub catchment.

1. INTRODUCTION

1.1 Background

The Ngā Awa River Restoration Programme[1] co-led by mana whenua and Te Papa Atawhai Department of Conservation supports freshwater restoration initiatives in the Doubtless Bay catchment, that includes the Awapoko, Oruru and Oruaiti Rivers. Ngā Awa is a collaborative programme that is focussed on co-design and co-leadership with mana whenua.

In Doubtless Bay mana whenua are working as a hapū collective with Te Papa Atawhai and in 2023 requested freshwater restoration planting advice for the catchment that takes into account climate change issues such as drought, coastal salinization and increased wildfire risk. This advice included catchment-scale geospatial risk assessments to assist planning and was provided in a report, provided on the Ngā Awa Doubtless Bay website in mid-2024[2]. Also, a webinar was delivered to the hapū collective and other key contacts and has been recorded for future reference.

Waterways in the area have been degraded by a range of factors. Riparian cover has been lost, sediment and nutrient inputs are elevated above natural levels, and natural waterway alignments and form have been modified through diversion and channelisation to enhance drainage values at the expense of stream values.

This follow-up project provided a subset of the revegetation advice in a field-based workshop in December 2024 (locations shown in Fig. 1). The workshop used on a case study format and was designed for stakeholders unlikely to read all of the first report or for those seeking more specific advice. This report documents the more specific advice provided in the December workshop. The workshop format is also expected to elicit further critique of the advice provided to date and to identify further opportunities for improvement.

In addition to revegetation, complementary restoration treatments are recommended such as reconnecting diverted waterway reaches and rewetting wetlands in order to reactivate and reinstate natural waterway processes that will increase resilience to climate change across the landscape.

[1] See more about the Ngā Awa River Restoration Programme here: https://www.doc.govt.nz/our-work/freshwater-restoration/nga-awa/
[2] See the initial restoration advice report here: https://dxcprod.doc.govt.nz/globalassets/documents/our-work/nga-awa-river-restoration/doubtless-bay-nga-awa-revegetation-options-web.pdf

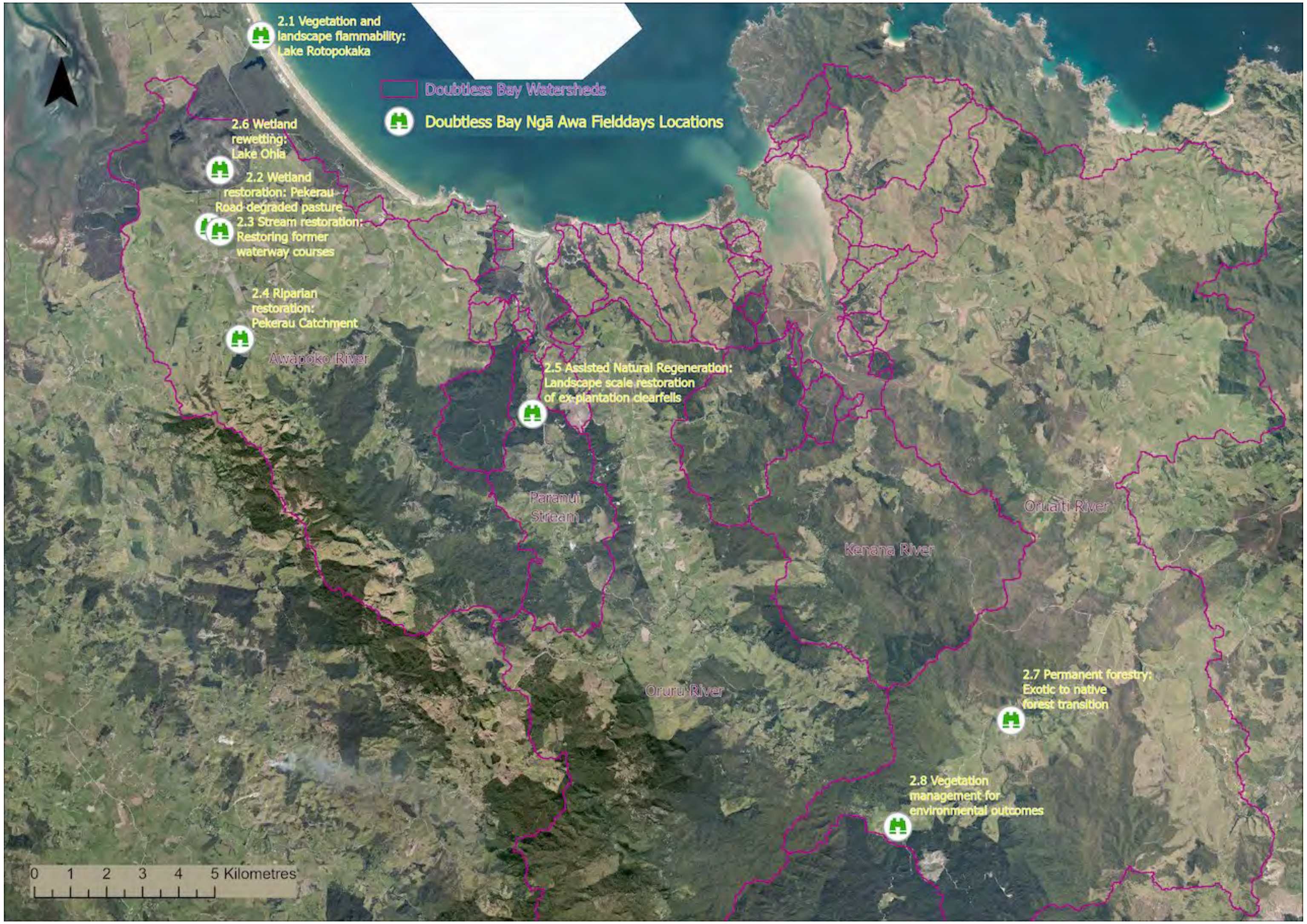

Figure 1. Sites covered in the 2024 follow up assessments. Provided courtesy of Dave West (Department of Conservation).

1.2 Objectives

The overarching goal is to enable the Doubtless Bay catchment community to increase the climate change resilience of their freshwater catchment via specialised revegetation and freshwater advice - including developing the relationships, knowledge, and restoration locations needed to effectively progress waterway restoration.

The specific objectives include:

1. Delivering the revegetation advice in person to a broad range of catchment stakeholders – particularly those that are less likely to receive the advice via other formats,
2. Receiving feedback on the advice and improving it, and
3. Delivering the follow-up report.

Short and medium-term outcomes will ideally include:

1. Workshop attendance by (and thus information delivered to) a broad range of community members,
2. Updated advice recorded in this short report,
3. Advice acted upon at a subset of the demonstration locations,
4. Potential long-term case study locations (and relationships) identified, and
5. Ngā Awa engagement increased with landowners (especially farmers).

Ideally the long-term outcome of this project will be action to increase the resilience of freshwater restoration-related revegetation, at different locations throughout the three catchments of Doubtless Bay, and progress towards a catchment-scale restoration plan informed by the geospatial analysis of climate change risks.

2. MANAGEMENT RECOMMENDATIONS

2.1 Vegetation and landscape flammability – Lake Rotopokaka

<u>Outline</u>

This option aims to reduce the risk of wildfire damage to properties and residents through establishment of green breaks upwind of the existing dwellings, and at strategic locations subject to rubbish dumping and car accidents. The Lake Rotopokaka and Lake Ohia area has a history of human induced wildfires. Fires have started from arson or via accidental means such as motor vehicle crashes. Recent examples of wildfire have threatened dwellings located near Lake Rotopokaka (Fig. 2). The dominant vegetation cover comprises highly flammable species which exacerbates the risk of wildfire to the dwellings and their residents[3] (Fig. 2). Green fire breaks are one action that can be used to address wildfire risk to vulnerable sites such as residential dwellings (Fig. 3).

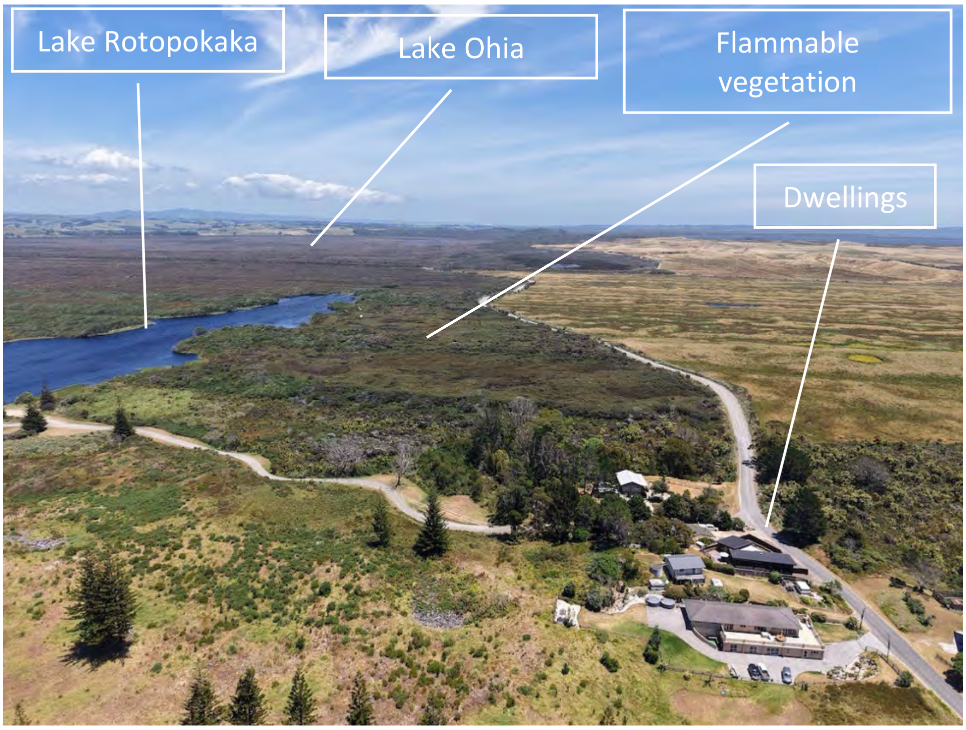

Figure 2. Case study site viewed looking southwest. Lake Rotopokaka to left (east) and Lake Ohia in the distance. Dwellings bottom right are at risk of wildfire spreading through high flammability native vegetation to the west.

[3] Marshall, E., Holyland, B., Parkins, K., Raulings, E., Good, M. K., Swan, M., ... & Penman, T. D. (2024). Can green firebreaks help balance biodiversity, carbon storage and wildfire risk?. *Journal of Environmental Management*, *369*, 122183.

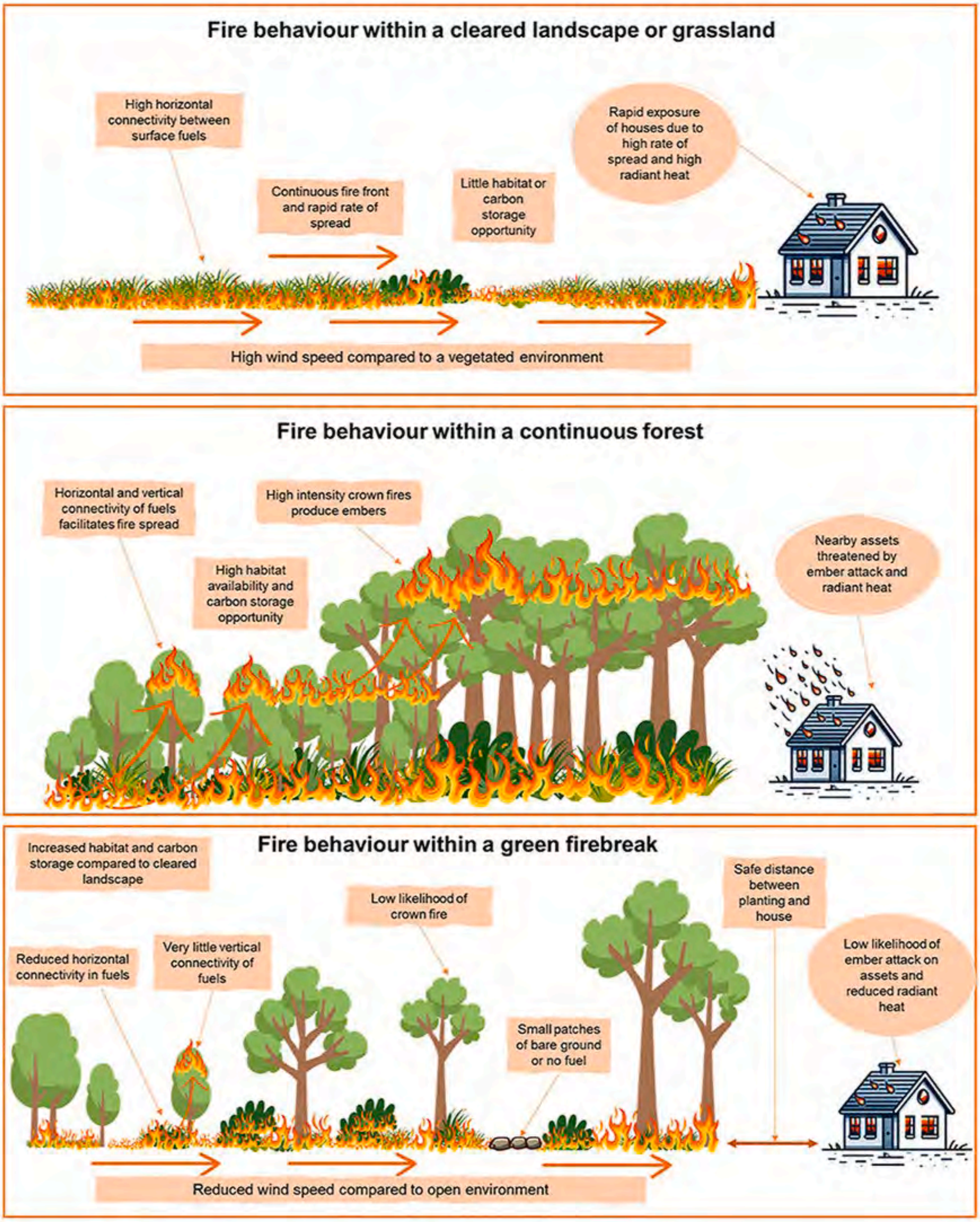

Figure 3. Generalised effects of fire behaviour according to amount, configuration and flammability of vegetation relative to assets (sourced from Marshall et al., 2024).

Management recommendations

Table 1 presents a recommendation for green fire break(s) including species suited to this location which also provide biodiversity benefits (such as seasonal bird food). The principles and/or plant species in Table 1 could also be applied to strategic locations (e.g., roadside locations often subject to rubbish dumping) where fires have a higher probability of starting.

Table 1. Reducing risk to dwellings from wildfire.

Objectives	
To reduce risk to dwellings from wildfire in adjacent highly flammable vegetation.	
Methods	
Site preparation	1. Clear existing vegetation from future green break site. 2. Retain existing unvegetated firebreak around the western side of the dwellings.
Pest control	• Remove remaining wilding pines in vicinity of houses
Revegetation	1. Plant two 10-20 m wide strips at right angles to the prevailing wind direction. 2. Clear and maintain an unvegetated/low biomass fire break of at least 8 m width upwind of each planted strip.
Composition and structure	Canopy tier: • Ngaio (*Myoporum laetum*). • Taupata (*Coprosma repens*). • Karaka (*Corynocarpus laevigatus*). Shrub tier: • Karamu (*Coprosma robusta*). • Five finger (*Pseudopanax arboreum*). • Koromiko (*Veronica stricta*).
Management and maintenance	• Maintain intervening low biomass areas by mowing to avoid biomass accumulation (such as by regeneration of manuka or gorse).
Implementation	
Risks	• Consenting and environmental requirements around initial vegetation clearance requirement. • Insufficient ongoing maintenance to maintain low biomass areas.
Resources needed	• Seedlings and resources for plant establishment and follow-up maintenance (e.g., pest control, e.g., rabbit control). • Planning advice regarding resource consent requirements and DOC requirements.
Avenues of support	• Plant nurseries • Fire and Emergency representatives

2.2 Wetland restoration – Pekerau Road degraded pasture

Outline

A triangular shaped area of low terrace on the true left side of an unnamed tributary of the main stem waterway in the Pekerau valley has proven to be unproductive for pastoral use and is earmarked for restoration (Fig. 4). The site is tidal and brackish conditions have been measured upstream of the location. An existing partial bund (to be retained) exists along the true left margin of the adjacent waterway which is probably the result of side casting of dredging/formation materials of the waterway. The landowner aims to restore the area in wetland vegetation and fencing to permanently exclude stock from the restored wetland.

Figure 4. Rank pasture area for retirement and wetland restoration.

Management recommendations

Table 2. Management recommendations for wetland restoration of retired rank pasture

Objectives	
To restore native wetlands compositions on retired pasture with the wetland being self-sustaining and resilient to inundation while providing habitat for native birds and fish (e.g., inanga spawning).	
Methods	

Site preparation	• Retain the existing bund.
	• Relocate existing fence to the landward margin of the wetland. Follow the upper edge of the terrace riser for the new fence alignment.
	• Four weeks from planting:
	  o Reduce existing ground cover with hard grazing followed by tractor mulching.
	  o Spot spray 1 m dia. dots at planting sites.

Pest control	• Control rabbits and hares prior to planting and for 3-5 years following planting. • Be alert to new weed encroachment over time.
Revegetation	• Reconstructing a wetland composition via planting of nursery raised seedlings.
Composition and structure	• See recommended species in Tables 3 and 4. • Plant appropriate species at appropriate spacing to create adequate shade and occupancy so weed issues are minimised early.
Management and maintenance	• Install biodegradable plant guards with tall stakes. Paint tops of stakes to make them easier to find. This helps address weed competition and makes it easier to find seedlings through the establishment period. • Undertake weed releasing annually or more frequently as required. • Replace dead seedlings in the next available planting season.
Implementation	
Risks	• Weeds overgrowing planted seedings.

	• Flooding from adjacent channel. • Damage by animal pests.
Resources needed	• Fencing materials and labour. • Nursery raised seedlings and planting materials.
Avenues of support	• Local plant nursery.

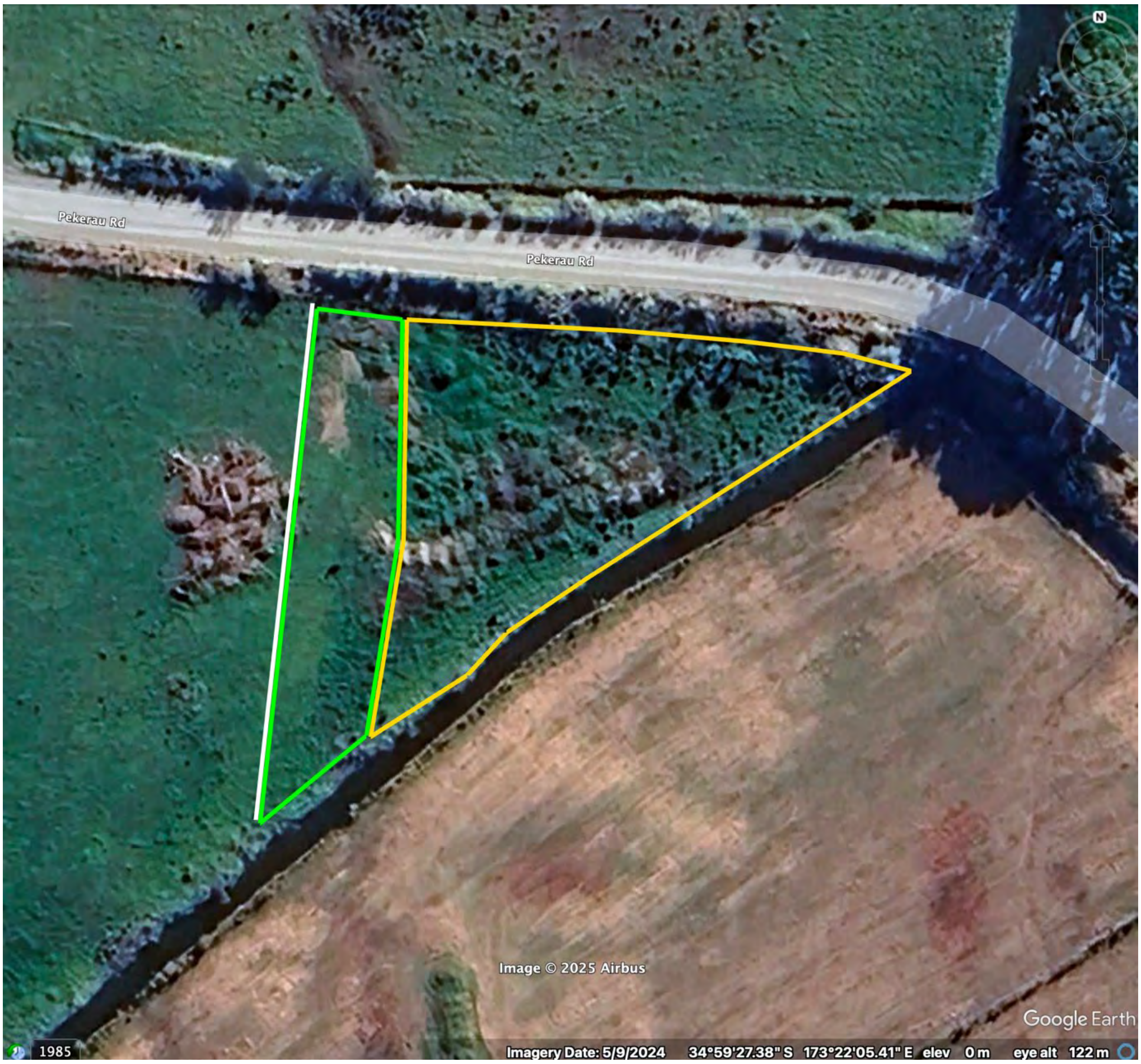

Figure 5. Upper terrace (green, 0.1 ha/690 m^2) and lower terrace (yellow, 0.16 ha/1,560 m^2) areas for wetland restoration. Indicative fence location (65 m long) shown in white at left of green polygon.

Recommended species

Table 3. Upper terrace/terrace riser/bund composition (1.5 m spacing).

		0.1	4444
Species		Composition	Total number/ha
Kahikatea	DACDAC	0.3	133
Ngaio*	MYOLAE	0.2	89
Lowland totara	PODTOT	0.2	89
Rewarewa	KNIEXC	0.05	22
Karamu	COPROB	0.05	22
Koromiko	VERSTR	0.05	22
Kohuhu	PITTEN	0.05	22
Mahoe	MELRAM	0.05	22
Matai	PRUTAX	0.025	11
Horoeka	PSECRA	0.025	11
		1	444

Note: * locate ngaio in positions where they will be out of reach of stock when mature as the foliage is poisonous to stock.

Table 4. Lower terrace composition (1 m spacing).

		0.16	4444
Species		Composition	Total number/ha
Giant umbrella sedge*	CYPUST	0.2	142
Kahikatea	DACDAC	0.2	142
Harakeke	PHOTEN	0.15	107
Rautahi*	CARGEM	0.15	107
Purei*	CARVIR	0.1	71
Pukatea	LAUNOV	0.05	36
Swamp maire	SYZMAI	0.05	36
Ti kouka	CORAUS	0.05	36
Manuka	LEPSCO	0.05	36
		1	711

Note: * denotes sedge species which are particularly suited to waterlogged ground and wetted margin microsites within the lower terrace area.

2.3 Stream restoration – Reconnecting former stream bed

Outline

The lower Pekerau catchment features a floodplain with threads of former waterway alignments/streams (Fig. 6) which have been isolated from the main stem by straightening, diversion and channelisation to optimise drainage. Straightening waterways 'improves drainage' but means they no longer offer a variety of aquatic habitat such as pools, backwaters, and slow flow areas required by many aquatic invertebrates and fish to survive.

One landowner has retired and planted the margins of relict threads. From an instream ecology perspective, it was identified that additional benefits could be derived from reconnecting former channel segments with the existing channelised main stem. It is thought this could benefit water quality and provide additional habitats for freshwater fish, such as opening up additional bankside inanga spawning beds. The intervention would also boost habitat diversity and restore lost instream habitats. It is not the expectation that the reconnection would direct high flows through the former stream bed/waterway course.

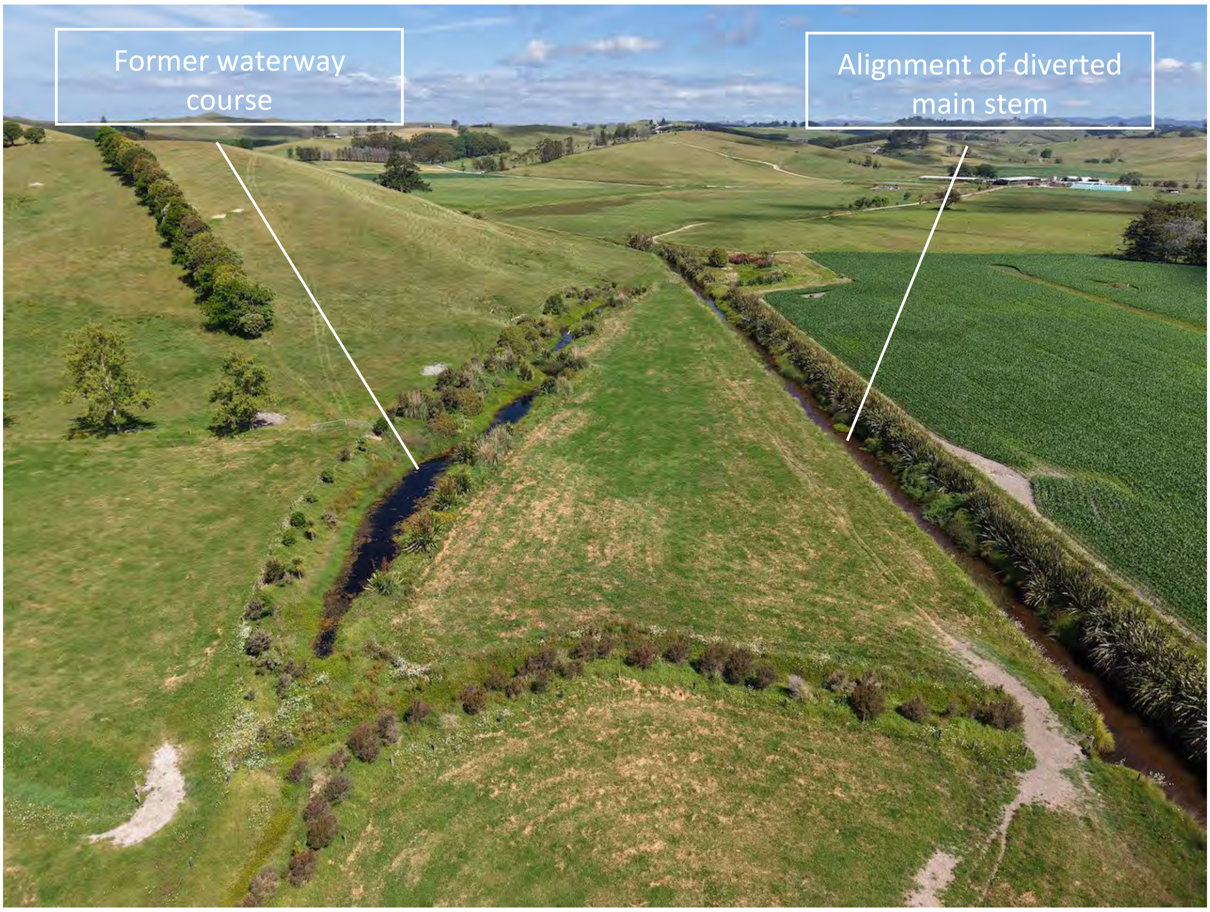

Figure 6. Example in the lower Pekerau valley of a former stream bed/waterway course having been bypassed by diversion and channelisation of the main stem.

Management recommendation

Table 5.Management recommendations for reconnecting the former stream bed with the existing main stem

Objectives	
To restore connectivity between the existing mainstem and the former stream bed, creating aquatic habitat diversity and resilience, and increasing aquatic biodiversity (e.g., insects, birds and fish).	
Methods	
Site preparation	• Add fencing to prevent stock access to rewetted areas. • Minor earthworks (including instream culvert works) to reinstate water flows through the former channels.
Pest control	• Exclude stock from planted areas. • Control browsers (e.g., rabbits) prior to planting and for 3-5 years afterwards. • Do regular release weeding early in the planting and for 3-5 years afterwards until plants and shaded conditions are established (i.e., canopy closure).
Revegetation	• Revegetate the waterway margins, with a view to creating waterway shade (e.g., via overhanging plants) especially on the northern banks. Add grasses/carex along the water margins to support inanga spawning. • Tailor plantings to the level of inundation and water flows expected (depends on the hydrology once the braids are reconnected).
Composition and structure	• See species recommended in Tables 3 and 4 for upper/dry and lower/wet/water's edge sites as required by each planting microsite.
Management and maintenance	• Manage as per wetland/riparian restoration guidance in Table 2. • Install plant guards with tall stakes and weed mat. This helps address weed competition and makes it easier to relocate seedlings through the establishment period. • Undertake weed releasing annually or more frequently as required.

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	• Replace dead seedlings in the next available planting season (infill planting).
Implementation	
Risks	• Unexpected hydrological response – could delay plantings until new hydrological regime is understood (e.g., under flood/drought conditions).
Resources needed	• Plants, fencing materials and labour. • Northland Regional Council resource consent for instream works. • Earthmoving machinery.
Avenues of support	• Local plant nursery. • Hydrological guidance (Northland Regional Council).

2.4 Riparian restoration – Pekerau Catchment

Outline

The Pekerau main stem is a modified waterway with considerable potential for restoration (Fig. 7). A number of aspects could be restored (natural waterway course (i.e., not straightened), natural bed gradient, channel cross-section), however, the aspect addressed here is riparian cover and a connected seepage area. Riparian composition and structure has a profound effect on instream ecology and health. Riparian restoration is a significant step towards restoring the Pekerau main stem. Appropriate species are recommended (Tables 8 and 9) which have an early stage form (i.e., foliage characteristics and trunk/branch architecture) that creates a microclimate that rapidly outcompetes light-demanding ground cover (rank grass) and directs the stand toward a trajectory of increasing forest interior microclimate conditions. Species are recommended (Table 10) for a retired seepage area (Fig. 8) which could be planted in the next available planting season. Protecting seepage areas and wetlands can help waterways by strategic interception of fine sediments and nutrients, prior to entry into the mainstem. Wetlands also provide significant biodiversity benefits by increasing the number of plant, invertebrate, fish and bird species present, as well as slowing and storing water (i.e., moderating water flows).

Figure 7. View of the Pekerau main stem looking upstream in its current form.

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Management recommendations

Table 6. Management recommendations for Pekerau main stem riparian restoration.

Objectives	
To establish a native riparian cover to reduce water temperatures and macrophyte biomass, and provide a basis for ecosystem restoration.	
Methods	
Site preparation	• Ideally, locate fences 10 m landward (or further) from top of each bank – but at a minimum exclude stock. Variable width fencing can also be used strategically. • Spot spray planting sites.
Pest control	• Rabbits and hares.
Revegetation	• Species are proposed in a composition which creates rapid shading and ecological functionality. • Plant in manageable stages, matched to labour available to control weeds and infill plant in following years.
Composition and structure	• See Tables 8 and 9 below.
Management and maintenance	• Blanking (i.e., infill planting) during the establishment period • Ongoing weed control. • Plan long-term management of mature trees already present, so when they fall/are removed they don't damage plantings and fences.
Implementation	
Risks	• Damage to fences during floods. • Damage to new plantings during floods and drought.
Resources needed	• Funding.
Avenues of support	• DOC. • Local plant nurseries. • Northland Regional Council grant funding.

Table 7. Management recommendations for seepage wetland adjacent to the Pekerau main stem.

Objectives	
To establish a swamp forest composition in the seepage wetland in order to enhance water quality and biodiversity values.	
Methods	
Site preparation	• Spot spray planting sites.
Pest control	• Control rabbits and hares.

Revegetation	• Species are proposed in a composition which creates rapid shading and ecological functionality. • Plant in manageable stages, matched to labour available to control weeds and infill plant.
Composition and structure	• See Table 10 below.
Management and maintenance	• Blanking (i.e., infill planting) during the establishment period. • Ongoing weed control.
Implementation	
Risks	• Weed invasions.
Resources needed	• Funding.
Avenues of support	• DOC. • Local plant nurseries. • Northland Regional Council grant funding.

<u>Recommended species</u>

Table 8. Pekerau riparian pioneer composition (2 m spacing).

Species		Composition	Total number/ha
		1	2500
Mahoe	MELRAM	0.3	750
Karamu	COPROB	0.15	375
Koromiko	VERSTR	0.1	250
Kohuhu	PITTEN	0.1	250
Manatu	PLAREG	0.1	250
Mapou	MYRAUS	0.1	250
Cabbage tree	CORAUS	0.025	63
Kanuka	KUNZEA sp.	0.025	63
Manuka	LEPSCO	0.025	63
Horoeka	PSECRA	0.025	63
Lowland totara	PODTOT	0.025	63
Large-leaved kowhai	SOPTET	0.025	63
		1	2500

Table 9. Pekerau riparian enrichment composition (4 m spacing)

Species		Composition	Total number/ha
		1	1250
Titoki	ALEEXC	0.2	250
Rimu	DACCUP	0.05	63
Kahikatea	DACDAC	0.35	438
Matai	PRUTAX	0.2	250
Tarairi	BEITAR	0.2	250
		1	1250

Table 10. Pekerau riparian wetland composition (2 m spacing)

Species		Composition	Total number/ha
		0.3	2500
Ngaio^	MYOLAE	0.3	225
Mahoe^	MELRAM	0.2	150
Kahikatea*^	DACDAC	0.1	75
Karamu^	COPROB	0.1	75
Koromiko^	VERSTR	0.1	75
Harakeke*	PHOTEN	0.1	75
Purei*	CARSEC	0.035	26
Kohuhu^	PITTEN	0.025	19
Manatu^	PLAREG	0.01	8
Mapou^	MYRAUS	0.01	8
Swamp maire*	SYZMAI	0.01	8
Pukatea*	LAUNOV	0.01	8
		1	750

Notes: ^ means locate on dry soils, * means locate on saturated soils. ^* means either dry or saturated soils.

Figure 8. Approximate boundary of retired seepage restoration area.

2.5 Assisted Natural Regeneration – Landscape scale restoration of ex-plantation clearfells

<u>Outline</u>

The case study area is land harvested of pines and riparian to the Paranui Stream. The area has been permanently retired from plantation forestry with the objective of transitioning the vegetation cover to native forest. The area currently features some native woody regeneration and has a dominant cover of gorse and privet. The site has a reasonable level of resilience and an assisted natural regeneration approach to restoration is the most cost-effective option.

Figure 9. The clear-fell area permanently retired from plantation forestry showing the current vegetation cover dominated by gorse and privet.

Management recommendations

Table 11. Management recommendations for assisted natural regeneration of clear-felled land.

Objectives	
To restore native conifer forest following assisted natural regeneration techniques.	
Methods	
Context[4]	• Mean annual rainfall: 1,500-1,600 mm. • Mean annual temperature: 15-16 °C. • Seed source proximity: Most seed source influence would be from surrounding land within the valley. • Pre-human forest type: Native conifer forest.
Site preparation	• No desiccation and minimal disturbance. • Clear and mark seed island locations and access routes. • Clear vegetation from seed island sites in preparation for native planting. • Consider laying deep mulch or weed matting across seed island sites to reduce early maintenance. • Cut-and-paste cut stumps of gorse to prevent them resprouting.
Pest control	• Possums. • Eradicate environmental weed species likely to interrupt regeneration and successional processes: o Tree privet (*Ligustrum lucidum*), o Chinese privet (*Ligustrum sinense*), o Wilding pine (*Pinus radiata*), o Woolly nightshade (*Solanum mauritianum*). • Environmental weeds unlikely to interrupt regeneration and successional processes at this site: o Gorse (*Ulex europaeus*), o Pampus (*Cortaderia* spp.).
Revegetation	• Assisted natural regeneration with seed island establishment.

[4] Climate variables are taken from https://webstatic.niwa.co.nz/static/Northland%20ClimateWEB.pdf. Native forest extent and pre-human forest composition are taken from https://ourenvironment.scinfo.org.nz.

	• Seed islands: o Recommended composition in Table 12. o Scale size and number to suit budget and ability to maintain. o A small number of larger islands more efficient to manage and maintain. o Scale the planting effort based on what you can reasonably manage to maintain rather than what you can afford to plant. o Anticipate maintenance of seed islands for up to 10 years (enough time for the native trees to reach a height above the surrounding weed canopy). o Use plant guards and mark each seedling with a tall stake (painted ends). o Mark each corner of the seed island with a waratah or similar marker. o Record GPS coordinates.
Composition and structure	• Aiming for native conifer forest with a broadleaved component.
Management and maintenance	• Release seed islands from weed competition (years 1-5). • Replace dead seedlings (blanking) (years 1-5). • Ongoing control of privet, wilding pines, and woolly nightshade to eradicate these species from the restoration area.
Implementation	
Risks	• Seed islands overcome by weed regrowth. • Seedling locations become unclear over time. • New weeds arriving at the restoration area. • Personal injury from working in a rough site.
Resources needed	• Persons skilled in identifying the key weed species and safely controlling them. • Native plant nursery supply of adequate seedling stock.

Avenues of support	• Native plant nursery. • Northland Regional Council. • Online resources regarding weed control and native species[5]

Recommended species for seed islands

Table 12. Species composition for clear-fell restoration (1.5 m spacing)

Species		Composition	Total number/ha
		1	4444
Kahikatea	DACDAC	0.3	1333
Lowland totara	PODTOT	0.2	889
Matai	PRUTAX	0.05	222
Towai	WEISIL	0.05	222
Rewarewa	KNIEXC	0.05	222
Karamu	COPROB	0.05	222
Koromiko	VERSTR	0.05	222
Kohuhu	PITTEN	0.05	222
Mahoe	MELRAM	0.05	222
Kohekohe	DYSSPE	0.025	111
Horoeka	PSECRA	0.025	111
Kanuka	KUNZEA sp.	0.025	111
Rimu	DACCUP	0.025	111
Puriri	VITLUC	0.025	111
Titoki	ALEEXC	0.025	111
		1	4444

[5] Such as https://www.weedbusters.org.nz and https://www.nzpcn.org.nz/ .

2.6 Wetland rewetting – Lake Ohia

Outline

In addition to the issues covered in the initial project report[6], the following practical aspects were further developed through the course of site visits to two locations, and some follow up mapping. Public access to Lake Ohia at informal access points brings problems in terms of dumping (vehicles, rubbish, garden waste/biosecurity risks) and wild fire risk. Dumping is a growing issue and the existing vegetation composition is highly flammable. Terrestrial weeds are establishing and spreading. Some of these weeds are clearly linked to dumped vegetation material. Others are regionally distributed and will be expanding within the drained wetland (e.g., Sydney golden wattle). The current nature of access is setting up bigger issues for Lake Ohia in the future, as is its drained status.

Figure 10. Existing state of Lake Ohia as of December 2024.

[6] Forbes, A. & Case, B. (2024). Ngā Awa River Restoration Programme. Revegetation Options to Increase Climate Change Resilience and Support Restoration of the Awapoko, Oruru and Oruaiti Catchments in Doubtless Bay, Northland. Contract Report prepared for the Department of Conservation.

Management recommendations

One option the team looked at was restructuring the existing weir (Fig. 11) so it more effectively holds water and potentially at a higher level to create a larger area of upgradient inundation. This would rewet areas that have previously been drained. Inundation would be an option to resolve illegitimate access, which in turn would help to resolve the growing issues of dumping. Standing water would shift the vegetation composition towards lower flammability by creating areas of open water or creating conditions suitable for establishment of wetland vegetation.

Figure 11. View looking upstream at the existing weir which is currently poorly functioning and could be upgraded to improve the hydrology of Lake Ohia.

In addition to these benefits, rewetting has a multitude of benefits for hydrology, biodiversity, and I expect cultural aspects. Benefits and drawbacks need to be defined and investigated. The team recognises that the topic is complex and involves a number of parties who were not part of the discussions. However, a simple exercise was undertaken to project a possible water level extent from amendment of the existing weir (Fig. 12).

From the ground levels shown in Figure 12, it appears that the lake is well bounded by prior earthworks, such that some solid weir control at the outlet could be reasonably effective in rewetting the wetland. Some further modelling and field surveys would be required to confirm, however there is some potential here for rewetting via amendment of the existing weir.

If rewetting was pursued, the team recommended a staged approach to the project, to ensure each step could be managed effectively. Lessons learned as rewetting proceeded could be applied to later stages.

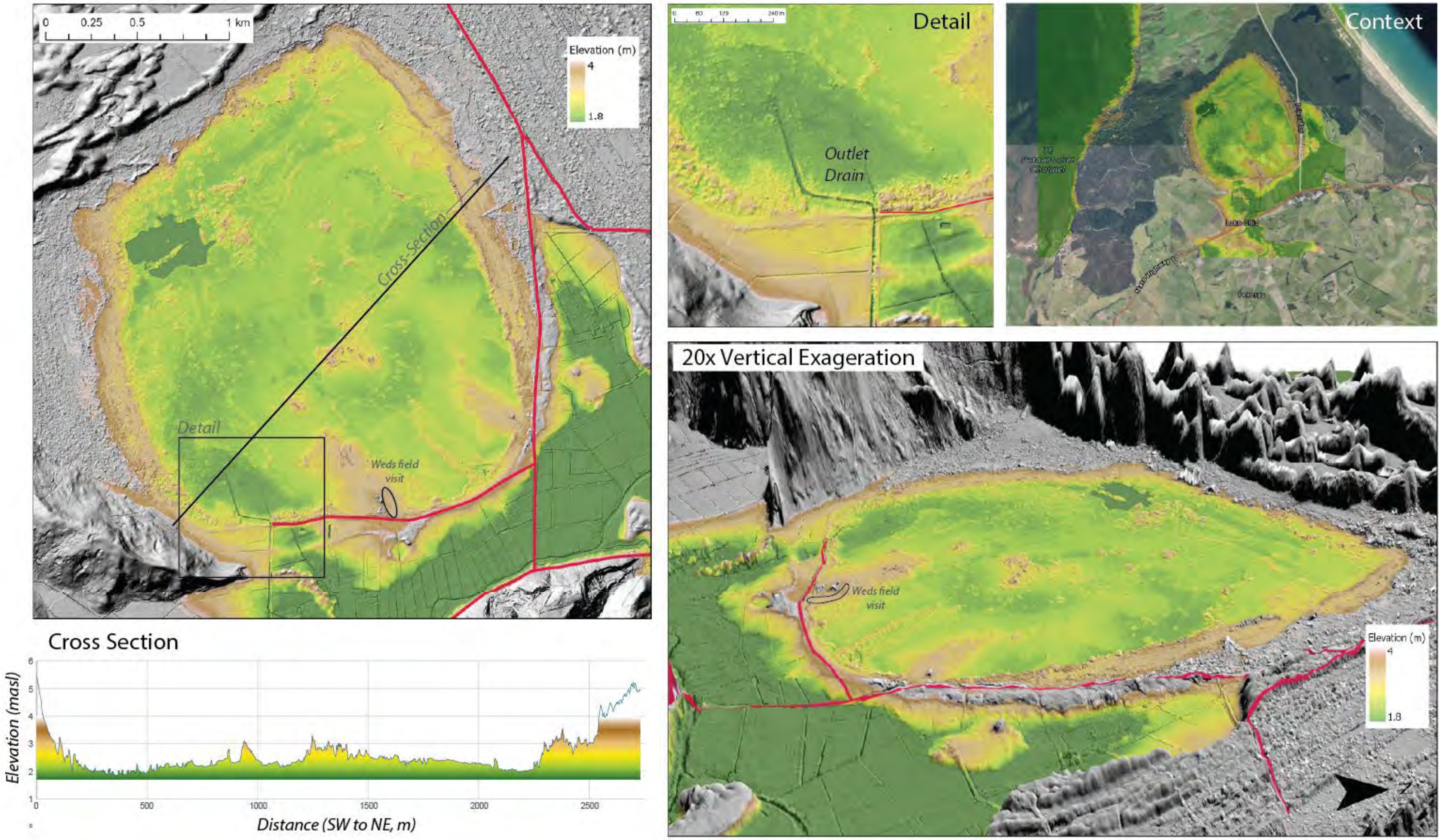

Figure 12. LiDAR representation of Lake Ohia with outlet drain/weir location and location visited during field visit identified. Provided courtesy of Jon Tunnicliffe (University of Auckland).

2.7 Permanent forestry – Exotic to native forest transition

Outline

Radiata pine and poplar stands have been established on hill country and one future management option is to retain those stands and nurture native regeneration and a long term transition to native forest dominance (Fig. 13). Advice is required regarding how to manage a transition from exotic to native dominance. The regeneration seen in mature radiata pine plantations located nearby indicates a strong level of forest resilience in this landscape.

Figure 13. Hill country planted in radiata pine with the potential future management option of transitioning to permanent native forest.

Management recommendations

The following advice relates to management of a mature (>25 years) radiata pine stand. Note this advice relates only to radiata pine and not to poplar.

Table 13. Management recommendations for hill country transitional forestry.

Objectives	
Transition mature radiata pine stands to native dominance with limited management interventions	
Methods	
Context[7]	• Mean annual rainfall: 1,600-1,800 mm. • Mean annual temperature: 15-16 °C. • Seed source proximity: Abundant within 5 km radius. • Pre-human forest type: Kauri forest.
Site preparation	• Ensure the stand is stock proof.
Pest control	• Address browsing mammals. • Address shade tolerant weeds.
Revegetation	• Assisted natural regeneration[8] meaning a reliance on natural regeneration with management to support and enhance what occurs naturally.
Composition and structure	• Whatever is naturally occurring.
Management and maintenance	• Apply basal poisoning of canopy pines (canopy gap creation) conservatively to release regeneration from the limitations of heavy shade. • Use existing vegetation to indicate where gap creation would be beneficial. (A) Look for the adequacy of native regeneration (including in the seedling tier) density and composition. This will vary with landform and other site factors. (B) Look for the presence of light-demanding species (exotic grass) and avoid gap creation in those areas. Be conservative – it's possible to make gaps bigger but not

[7] Climate variables are taken from https://webstatic.niwa.co.nz/static/Northland%20ClimateWEB.pdf. Native forest extent and pre-human forest composition are taken from https://ourenvironment.scinfo.org.nz

[8] Assisted natural regeneration is a blend of active planting and passive restoration, where local people intervene to help trees and native vegetation naturally recover by eliminating barriers and threats to their growth, leaning on their knowledge of the land.

	smaller. Too much disturbance will make the area vulnerable to invasion by light demanding weeds. Shade builds resilience and a basis for regeneration of shade-tolerant species. • Also consider the need for manipulating understory growth (e.g., dense tree fern stands) to promote native tree establishment and growth. • Gap creation should be of a stand height to gap width ratio no more than 1:1. • Enrichment plant gaps with old-growth species to ensure their inclusion in the succession. Look at local old-growth forests for the most relevant species to plant. • Match species to microclimate gradients within the stand (i.e., from intact canopy through to gap centre locations).
Implementation	
Risks	• Adverse disturbance from natural disasters (stand scale windthrow, wildfire, insect attack) opening the stand leaving it vulnerable to weed invasions. • Adverse levels of browse from introduced mammals. • Inadequate levels of regeneration needing planting to top up to achieve adequate levels of native understorey. • Shifts in long-term/intergenerational management priorities.
Resources needed	• Understanding of species as they relate to forest shelter and forest microclimate.
Avenues of support	• Experienced forest ecologists. • Native plant nurseries. • Existing research results and MPI guideline documents.[9]

[9] Forbes, A. S., Richardson, S. J., Carswell, F. E., Mason, N. W. H., Burrows, L. E. (2023). Knowing when native regeneration is for you, and what you should do about it. The Aotearoa New Zealand context. *New Zealand Journal of Ecology, 47*(1), 3524. [see additional resources at footnote of following page].

2.8 Vegetation management for environmental outcomes

Outline

The case study site is an unnamed headwater sub catchment of Otamatai Stream (Fig. 14). The upper portion of the sub catchment has a cover of native forest which is contiguous with Maungataniwha Forest. The hill slopes are grazed under a rotational regime which is designed to optimise multiple factors including pasture performance, stock welfare, soil health, and waterway health. Management efficiency and staff safety is also a consideration. A seepage wetland occurs in the valley floor and has been recently fenced to exclude stock. Several exotic trees have been planted in the wetland with the idea they will extract nutrients from the wetland.

This case study shows progressive farming practices which take account of land and water typology and potential stock pressures. The case study captures a scenario of management decisions which have multiple benefits and these options can be applied at multiple scales in other locations.

[9]Forbes, A. (2021). Transitioning Exotic Plantations to Native Forest: Practical Guidance for Landowners. MPI Information Paper No: 2021/07. Prepared for Te Uru Rākau - New Zealand Forestry Service by Forbes Ecology Limited.

[9]Forbes, A., & Norton, D. (2021). Transitioning Exotic Plantations to Native Forest: A Report on the State of Knowledge. MPI Technical Paper No: 2021/22. Prepared for Te Uru Rākau - New Zealand Forestry Service by Forbes Ecology Limited.

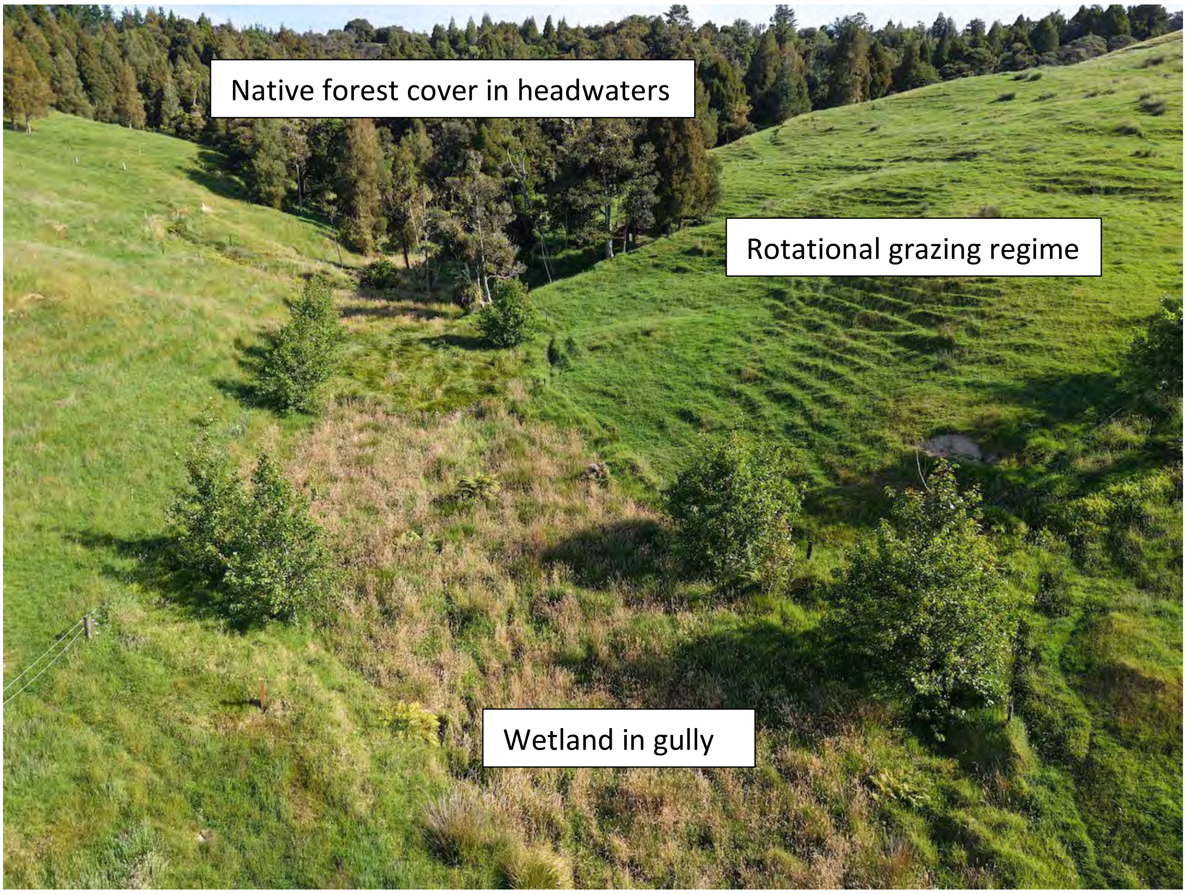

Figure 14. Headwater sub catchment providing an example of three land use aspects important in achieving good ecological and water quality benefits at multiple scales. The wetland has only recently had stock excluded, so specialist wetland species are only just starting to emerge through the rank grass.

Farming practice

- Grazing cattle downhill to preserve buffering/filtering of overland flow by longer grass around gully floor,
- Cattle rotated frequently among small paddocks/cells, adapting this according to season,
- Each cell has water reticulation, that can be readily relocated as required,
- Flexible fencing used to allow ATV to be driven over fences, as well as easily relocated,
- Graze only light/young cattle which have a lower impact on the soil profile and grass sward, which increases grass growth.

Headwater protection

- The upper portion of the sub catchment is in native conifer forest. Native forest cover in headwaters/upper sub catchments are known to have the following benefits in temperate systems[10]:
    - Reduced light and temperature inputs,
    - Strong local microclimate gradients,
    - Higher input rates of organic matter,
    - Low primary production,
    - Biomass for detritus-based communities,
    - High integrity macroinvertebrate community structure.
- The ecological and water quality benefits of intact headwaters relate to the whole catchment[11].
- Intact vegetation cover over headwaters also helps moderate flows downstream.
- In addition to aquatic benefits, retaining native forest cover in headwaters increases terrestrial habitat availability and functionality.

[10] Richardson, J. S., & Danehy, R. J. (2007). A synthesis of the ecology of headwater streams and their riparian zones in temperate forests. *Forest Science*, *53*(2), 131-147.
Storey, R. G., Parkyn, S., Neale, M. W., Wilding, T., & Croker, G. (2011). Biodiversity values of small headwater streams in contrasting land uses in the Auckland region. *New Zealand Journal of Marine and Freshwater Research*, *45*(2), 231-248.
[11] Dodds, W. K., & Oakes, R. M. (2008). Headwater influences on downstream water quality. *Environmental management*, *41*, 367-377.

Gully seepage wetland

- Seepage wetlands in gully floors perform a filtering role for contaminants common in pastural landscapes (i.e., Total Suspended Solids (fine sediments), bacteria (*E. coli*), nitrogen and phosphorus)[12].
- Seepage wetlands support terrestrial species adapted to wetland conditions (e.g., swamp forest specialists) and this habitat diversity boosts biological diversity at landscape scales.

Management recommendations

- Plant long-lived native swamp forest specialists to provide a long-term source of nutrient uptake and to enhance habitat values while reintroducing an immediate seed source for further natural regeneration.
- Suitable swamp forest tree species are:
  - Swamp maire (*Syzygium maire*; At Risk, Declining[13]),
  - Kahikatea (*Dacrycarpus dacrydioides*),
  - Pukatea (*Laurelia novae-zelandiae*).

[12] Hughes, A., McKergow, L., Tanner, C., & Sukias, J. (2013). Influence of livestock grazing on wetland attenuation of diffuse pollutants in agricultural catchments. *National Institute of Water and Atmospheric Research. Hamilton*.
[13] New Zealand (Conservation) Threat Classification.

3. CONCLUDING REMARKS

The eight scenarios presented above are more specific case studies than those presented in the earlier report (Forbes & Case, 2024). The project team acknowledges the valuable discussion provided by the landowners and other workshop participants during the December 2024 workshop.

Each scenario takes the opportunity to increase native vegetation cover, thereby improving water quality through 'downstream' effects (e.g., increasing shade, intercepting silt, altering water movement across the landscape). In many cases aquatic habitat is also improved – generally through increasing aquatic habitat complexity. In other words, fish and aquatic invertebrates (i.e., larval insects, snails, limpets, shrimp) benefit from streams where there are fast- and slow-flowing areas, shallow and deep sections, as well as features such as pools and backwaters. A wider range of species can populate these more 'complex' waterways which creates resilience in the food webs and ecology of the system. Simplified and straightened drains provide a narrower range of flows and water depths and usually less instream cover (shelter) as well as fewer refuges in adverse events (i.e. floods or drought).

Similar resilience is found in diverse native plantings that are better able to provide food and shelter for a range of native insects and birds (for example). Reinstating and protecting wetlands are another powerful tool to create climate resilience in the landscape. As well as providing diverse semi-aquatic habitat, wetlands intercept and slow high flows, while storing water longer during dry periods. Healthy wetlands also improve downstream water quality through removing nutrients and sediment.

Creating complexity in the landscape will help provide refuges during the more extreme climate events expected as climate change progresses.

Several themes emerged from the December 2024 workshop.

- Several landowners indicated they wanted to 'retire' less productive land and protect it. Promoting native revegetation in these locations through strategic and cost-effective approaches creates an attractive asset where there was once a persistent area of 'problematic pasture'. These areas then have positive impacts on the remaining productive land thereby simplifying management in the long run.
- Careful planning of planting/revegetation can provide for maintenance and ease of management. For example, one side of a waterway can be planted to allow for drain

maintenance. Planting the northern side of a waterway will increase shade thereby decreasing aquatic weed growth.

- Applying local knowledge increases the probability of restoration success. Trialling techniques in small manageable areas reduces the risk to landowners.
- Working with natural processes, such as enhancing regeneration of the natural seedbank can reduce costs and risk to landowners.
- It will be useful to provide landscape scale analysis of each catchment in Doubtless Bay so that restoration can be optimised and coordinated to reduce risk from pressures such as wildfire and flood events.
- A landscape scale approach to weeds is needed but also weed management should be incorporated into revegetation planning so that management is as efficient as possible (e.g., in some cases avoid totally clearing sites as this will benefit aggressive weeds).