Pest Management Plan for Taranaki

Impact assessments and cost-benefit analyses

Taranaki Regional Council

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May 2017

Document number: 1809440

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Executive Summary

This report is entitled *Pest Management Plan for Taranaki - Impact Assessment and Cost Benefit Analyses* (the report).

The report sets out an assessment of the impacts of plant and animal species proposed to be declared 'pests' for inclusion in the Regional Pest Management Plan (RPMP) and an evaluation of the costs and benefits of regional management. This report meets the requirements of Section 70–71 of the Biosecurity Act 1993 (the BSA) and the *Proposed National Policy Direction for Pest Management*.

The Taranaki Regional Council's (the Council) review of its pest management strategies for plants and animals, adopted in 2007, will commence with the public notification of a proposed Plan that will address both animal and plant pest management. The review is the first review of the Council's pest management plans following the enactment of the Biosecurity Law Reform Act in 2012, which, amongst other things, significantly amended the pest management provisions of the Biosecurity Act.

In determining which plants and animals to declare pests, the Council commissioned consultants to undertake an analysis to determine the most sensible, equitable, practicable and affordable management objectives for individual candidate species included in the *Proposed Regional Pest Management Plan for Taranaki*. That analysis involved reviewing existing literature on pest ecology to determine what values are affected, researching pest management data, and running a cost benefit economic modelling programme. This evaluation broadly compares the costs and benefits of the proposed regional intervention.

This report summarises data on the known impacts of the following 16 candidate 'pest' animal and plant species for which rules/regulation are being proposed:

Climbing spindleberry, Giant buttercup, Giant gunnera, Giant reed, Gorse, Madeira vine (Mignonette vine), Nodding and plumeless thistle, Old man's beard, Possum, Senegal tea, Variegated thistle, Wild broom, Wild ginger (yellow and kahili), Yellow ragwort.

In relation to each of the proposed pests, this report examines and documents:

- The pest attributes and distribution of the species
- The qualitative and quantitative impacts of the species on the region
- An assessment of the benefits and costs of the proposed regional intervention and the alternatives
- The risks of success that the preferred option will not achieve the plan objectives
- The allocation of costs for intervention.

The Council considers that any decision to undertake regional intervention should not be taken lightly. Typically pest management reviews result in demand for more services. However, Council and land occupier resources (through the provision of services, contribution to rates, and/or requirements to incur control costs) are finite, and any regional intervention needs to be weighed against many other priorities.

The non-inclusion of a species in the RPMP does not mean that it does not have significant adverse effects. Rather it is a recommendation that it may be more efficient or reasonable to address the species outside the Plan's regulatory framework — i.e., without the need for rules. Separate to its RPMP the Council has prepared a Biosecurity Strategy that addresses all harmful organisms (not just ones for which rules or regulation is required) and sets out programmes and activities for achieving their control, including site-led programmes, by way of advice and information, or through biological control.

The Council considers it has the right balance between its pest management funding priorities and the optimal level of regional funding. These assumptions have previously been tested and confirmed through the preparation of previous plans and through the annual planning processes under the Local Government Act 2002. Nevertheless, this review is an opportunity to re-test previous assumptions and priorities, and examine whether there are opportunities to do things better, or for less cost.

The findings of this review have been encapsulated in the *Pest Management Plan for Taranaki*, which has been publicly notified for submissions.

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1. Introduction

1.1 Purpose

This report is a companion document to the *Proposed Regional Pest Management Plan for Taranaki* (RPMP) and was prepared by the Taranaki Regional Council (the Council) to inform its pest plan review.

The report assesses the impacts of plant and animal pests proposed, or being considered for inclusion in the Proposed RPMP and evaluates the costs and benefits of the proposed management response. This assessment is required to satisfy sections 70 and 71 of the Biosecurity Act 1993 (BSA) and the *National Policy Direction for Pest Management 2015* (NPD).

1.2 Background

The *Pest Management Strategy for Taranaki: Animals* and *Pest Management Strategy for Taranaki: Plants* both became operative on 1 May 2007. The strategies set out management programmes for the 23 harmful animal species and 27 harmful plant species in Taranaki that the local community believe warrant regional intervention. Rules are included setting out land occupier obligations to destroy the pests and/or ban their sale, release, distribution and propagation.

The BSA re-stated and reformed the law relating to the exclusion, eradication, and effective management of pests and unwanted organisms. The Council's review of its pest management strategies for plants and animals commences with the public notification of the proposed RPMP, which addresses both animal and plant pest management.

This review is the first review of the Council's pest management plans following amendments to the BSA in 2012, which, amongst other things, significantly amended the pest management provisions of the Biosecurity Act by the inclusion of:

- New policy instruments such as the NPD and pathway management plans
- Good neighbour rules and a requirement that the Crown comply with such rules in a regional management plan
- Changes to the development and review process for pest management plans.

The Council knows that any decision to undertake regional intervention should not be taken lightly. Typically pest management reviews result in demand for more services. However, Council and land occupier resources (through the provision of services, contribution to rates, and/or requirement to incur the costs of control) are finite, and any regional intervention needs to be weighed against many other priorities.

Outlined below is a broad description of management options considered in this report potentially available for managing adverse and unintended impacts of pests in the region. The options range from no regional intervention (i.e. do nothing) to the adoption of RPMP rules and powers to undertake eradication or sustained control programmes:

a. No coordinated management or regional intervention

This involves leaving the control of a harmful species to the discretion of individuals, organisations and land occupiers in accordance with their priorities and interests. Leaving it to the individual or organisation to consider if, when, and where to control the species, means no compliance costs on other land occupiers and no public costs for the Council to administer, monitor and enforce rules or undertake control.

b. Eradication programme

This involves regular ongoing control by the Council to reduce infestation levels of the pest species, in the short to medium term, to zero density levels across the region and across all habitats and properties. This type of management is only technically feasible where species are present in very low numbers in the region. The public good benefits of this programme lie in preventing a species becoming established and imposing much more significant costs on the region in the future.

c. Sustained Control programme

This involves a candidate species being identified in an RPMP and the imposition of rules and associated costs on organisations and individuals to maintain pest numbers below, or at, a certain level. The effect of the rules may apply to the whole property, parts of the property (i.e. on its boundaries), the whole region, or parts of the region, depending upon the biological and pest characteristics of the species.

Within this programme type, there are two scenarios that directly impact on the CBA. They are:

- good neighbour rules that apply in boundary situations only to address pest impacts of

neighbouring properties

- combination of good neighbour rules and general rules (that apply only to private land and across the whole property).

Under sections 70(c)(vii) and 71(d), (e) and (f) of the BSA (see **Appendix A**) a regional council is required to be cognisant of, and evaluate and document the benefits, costs, funding arrangements and adverse effects associated with the management of pests prior to the notification of a proposed regional pest management plan.

The NPD specifies additional requirements for councils proposing, assessing and documenting the benefits and costs of a regional pest management plan (see **Appendix B**). Pursuant to the NPD a council must:

- conduct the cost-benefit analysis at an appropriate level in relation to the level and quality of data available and cost of the programme,
- identify potential risks to the proposed management being successful, and
- quantify the range of potential outcomes (level of success) of each proposed management option.

This report satisfies cost benefit analysis requirements of the BSA and NPD by comparing "no regional management" to one or more of the proposed regional pest management options. The results of these assessments provide an indication of whether the benefits of the proposed regional investment in managing a pest are likely to be greater than the costs, whether the inclusion of the pest in the RPMP is justified, and whether the proposed regional management option is appropriate.

Note:

While this report establishes whether there is a case to support regional intervention for a particular species it is not a determination that regional intervention should occur.

Typically pest management reviews result in demand for more services. Council and land occupier resources (through the provision of services, contribution to rates, and or requirement to incur the costs of control) are finite and any regional intervention needs to be weighed against other priorities. [1]

Determining priorities and the optimal level of regional funding require a more nuanced and political discussion than is provided in this report. Such matters will be addressed through the public submission process for the proposed Plan.

1.3 Structure

This report has five sections.

Section 1 introduces the report, including purpose, background and structure.

Section 2 presents a readers' guide to this report to assist in the interpretation of the impact and CBA assessments (refer sections 3, 4 and 5 of the report). The section explains key concepts, methodologies, and assumptions that underpin the individual impact and CBA assessments that follow.

Section 3 presents, in relation to each candidate Eradication Programme species, information on their pest attributes and distribution, their impacts, the costs and benefits of eradication, the risks to success, and determining who should pay the costs of the proposed programme.

Sections 4 presents, in relation to possums, their pest attributes and distribution, their impacts, the costs and benefits of the proposed Sustained Control programme, the risks to success, and determining who should pay the costs of the proposed programme.

Sections 5 presents, in relation to each Sustained Control pest plant, their pest attributes and distribution, their impacts, the costs and benefits of the proposed programme, the risks to success, and determining who should pay the costs of the programme.

Appendices are presented at the back of the report.

[1] *Pest management (both weed and animal) already accounts for $2,115,579 of Council expenditure, representing 15% of total rates.*

2. Readers' guide

This section presents a readers' guide to the report, including key assumptions that underpin the information the impact and CBA information that follows.

To assist in the interpretation of the impact and CBA assessments, information is grouped around key headings adopted in sections 3, 4 and 5 of this report.

2.1 Candidate species assessed

Eighteen pest animal and plant species are proposed for inclusion in the Proposed RPMP (refer Table 1) and for which the application of rules and/or regulatory powers to control these species are considered appropriate.

These pests have previously been identified as having regionally significant impacts warranting regional intervention. In particular, these species were fully considered by the Council and the wider community through the public and review processes for regional pest management strategies in 1996, 2001 and 2007.

Table 1: Candidate animal and plant species assessed

Animals	Plants
Possums	Climbing spindleberry Giant buttercup Giant gunnera Giant reed Gorse Madeira vine Nodding and Plumeless thistles Old man's beard Pampas (purple and common) Senegal tea Variegated thistle Wild broom Wild ginger (yellow and kahili) Yellow ragwort

In relation to each candidate pest species, an evaluation and summary of information is provided on:

- Pest attributes and regional distribution
- Impact evaluation
- Cost-benefit analysis
- CBA statement and risks to success
- Who should pay (beneficiaries and exacerbators).

2.2 Pest attributes and distribution

The information informs the pest impact assessments and the CBA.

Information under this heading provides a description of the biological characteristics of the candidate pest species. It refers to the form, preferred habitats, competitive ability, reproductive ability, resistance to control, and dispersal methods (pest plants only) of each pest.

2.3 Impact evaluation

For each candidate pest species a series of tables sets out qualitative (non monetarized) and quantitative (monetarised) impact assessments based upon a review of available literature.

2.3.1 Where it is a problem

This information identifies current and potential land use types where the candidate pest can be a major problem (i.e. preferred or most infested habitat type where it is capable of having medium or high impacts on particular values).

Land use types are grouped around the following seven land use types relevant to Taranaki and the RPMP review:[2]

- *Dairy:* dairy farm operations, including the rearing of replacements
- *Sheep and beef (intensive)* intensive sheep, beef, deer and goat farms on easy contour or flat farmland with the potential for high production (mostly carrying between six and 15 stock units per hectare)
- *Hill country:* extensive sheep farming on steep slopes largely in the eastern hill country (central North Island hill country typically carry between 6 –13 stock units per hectare)
- *Forestry:* timber producing plantations and woodlots
- *Horticulture:* arable cropping and orchards
- *Native / conservation:* native forest, shrub land, wetland vegetation, grassland (includes estuarine, coastal and freshwater LCDB land use types)

[2] *Land use types are based upon the New Zealand Land Cover Database version 3 (LCDB3) classifications. Ministry for the Environment 2012.*

- *Non productive:* non rural uses – includes urban areas, transport corridors, and land not otherwise managed for conservation or productive purposes.

Table 2 below provides an overview of the extent of these land use types in the region.

Table 2: Land use types within Taranaki

Land use types	LCDB description	Area (ha)
Dairy	High producing exotic grassland	296,962
Sheep and beef		
Hill country	Low producing grassland	90,859
Forestry	Deciduous hardwoods Exotic forest Forest - harvested	27,396
Arable / horticulture	Orchard vineyard and other perennial crops Short-rotation cropland	1,810
Native / conservation	Alpine grass/herbfield Broadleaved indigenous hardwoods Depleted grassland Fernland Flaxland Indigenous forest Manuka and/or kanuka Matagouri or grey scrub Tall tussock grassland	292,792
Non - productive	Built-up area (settlement) Urban parkland/Open space	6,944
Other	Sand and gravel Estuarine open water Herbaceous saline vegetation Mangrove Herbaceous freshwater vegetation Lake and pond River	4,003
Total hectares in Taranaki region		*725,870*

2.3.2 How is it a problem

For each candidate pest species a table sets out a broad assessment of current and potential adverse impacts assessment based upon the values identified in section 71(d) of the BSA. These being:

- *Production:* impacts on dairy, sheep/beef/deer farming, forestry, horticulture, viticulture, international trade or other production.
- *Soil resources:* causes soil loss or erosion, alters soil fertility or moisture levels.
- *Water quality:* increases siltation or sedimentation, reduces oxygenation of water, or reduces water supply.
- *Native species diversity:* impacts on the diversity, abundance, or composition of native species.
- *Threatened species:* impacts on nationally 'Threatened' or 'At Risk' native species (i.e. plants listed in de Lange et al. (2009) and animals listed in Hitchmough *et al*. (2005)) and other native plants or animals identified as regionally distinctive.
- *Human health:* species are poisonous, or known to sting or bite.
- *Recreation:* impacts on recreation or amenity values (prevents or restricts recreational use, causes toxic algal blooms in water ways etc.)
- *Maori culture:* impact on food fathering, hunting, tourism, or recreation, or impacts on important cultural sites (e.g. marae, urupa) or water purity (life force, mauri). Comments and references are only provided here for impacts additional to those already specified under water quality and recreation.

The table summarises the most important impacts (at a regional scale) and assigns a "low", "moderate", or "high" impact value for each impact category. The sources of this information are referenced for each post.

The report also assessed any beneficial impacts and incorporates them into the CBA (where relevant).

2.3.3 How much does it cost

In addition to the qualitative assessment, the quantitative (monetarized) impacts of the candidate pest on the relevant values are estimated.

Monetarised pest impacts are the benefits of regional intervention and are calculated by Wildlands[3] as:

The Economic value per land use type x Pest impact level x Pest infestation level.

a. Economic values of land use types

The annual economic values of land use types (minimum and maximum values) were estimated for the CBA (see Table 3 overleaf).

Economic values for production land (i.e. dairy, sheep and beef and horticulture land use types) were estimated from Ministry for Primary Industries sources.

Economic values for environmental and other land use types are inherently more difficult to monetarize. For the purposes of this report, a range of monetarized values were derived from studies listed

[3] *Ecological and analytical services that largely informed the impact and CBA assessments of this report were provided by Wildlands and Lincoln University.*

in Geoff Kerr's New Zealand non-market valuation database (www2.lincoln.ac.nz/nonmarketvaluation). The non-market values are based on New Zealand studies of recreation values, existence values, and ecosystem services of Wildlands.

The non-market valuations are a very conservative estimate of the 'true' value for these land use types but are a starting point for wider public consideration through the RPMP review process.

b. Impact level

Quantitative impacts per hectare are calculated as the current or anticipated proportional impact on land value across the region. Impact levels are ranked as:

- "*Low*" impact on land use = 1–4% reduction in the economic value per hectare per annum for that land use type (see Table 3)
- "*Moderate*" impact on land use = 5–9% reduction in the economic value per hectare per annum for that land use type (see Table 3)
- "*High*" impact on land use = 10–50% reduction in the economic value per hectare per annum for that land use type (see Table 3).

All CBA amounts are in net present value (NPV, $).

c. Infestation level

The area (hectares) in the region currently infested by each pest was determined using Taranaki Regional Council estimates.

For Sustained Control programme pests, data on the current area infested is imprecise and an approximate estimate only was made. However, for Eradication Programme pests, data for current area infested were considered to be reasonably accurate as the distributions of these species were relatively limited and reasonably well known.

Table 3: Estimated economic values for different land use types in Taranaki

Land use type	Economic value per ha per annum		Explanation
	Minimum	Maximum	
Dairy	$6,587	$6,587	The economic values for Dairy were calculated from the average farm net cash income per hectare for Dairy in the Taranaki region (2008-2012) (Ministry for Primary Industries, 2014)
Sheep and beef - intensive - hill country	$660	$1,198	The minimum value for Sheep/Beef was calculated from the average farm net cash income per hectare for Central North Island Hill Country Sheep and Beef and the maximum value was calculated from average farm net cash income per ha for North Island Deer (2008-2012) (Ministry for Primary Industries, 2014)
Forestry	$500	$1,500	Forestry values were estimated from the per hectare values for radiata pine provided in the Forestry Facts and Figures report (New Zealand Forest Owners Association 2012). The maximum value per hectare was estimated from figures for high quality pruned stands, and the minimum value was estimated from the value for unpruned stands
Arable and horticulture	$46,228	$46,228	The values for Horticulture were calculated from the average net cash income per hectare for Hawkes Bay Pipfruit for 2008-2012 (Ministry for the Primary Industries, 2014), as there were no figures specifically for the Taranaki horticulture sector
Native / Conservation	$485	$30,855	The native wildland values are based on New Zealand Studies of recreation values, existence values, and ecosystem services of natural areas The economic values for native terrestrial ecosystems were based on estimated values in Patterson and Cole (2013) and ranged from $485 for 'scrub' to $585 for 'forest' (i.e. assuming no extractive use of native forests). The economic values for native freshwater ecosystems were based on estimated values in Patterson and Cole (2013) and ranged from $17,159 for 'lakes' to $30,855 for 'wetlands'.
Non -productive	$100	$1,000	These are conservative estimates provided by Wildlands for Taranaki (NB. Auckland Council data were Min = $551, Max = $4,151).

2.4 Cost-benefit analysis (CBA)

For each pest species, the CBAs[4] in sections 3, 4 and 5 identify the monetarised and non monetarised benefits and costs. The CBA evaluations compare the proposed management response (i.e. Eradication or Sustained Control) with no regional management.

For Eradication programmes or Sustained Control programmes involving general rules, the evaluation uses a CBA model developed by Wildlands[5] and ascertains whether the net benefits[6] of regional investment outweigh the costs.

For Sustained Control programmes involving good neighbour rules, an additional evaluation is applied for assessing the ability of good neighbour rules to meet NPD requirements.[7]

CBA estimates can give the illusion of being precise. While estimates are based upon the best information available, there are significant data limitations and a number of assumptions that need to be made when estimating pest impacts, their spread, and the costs of their control in the next decades. Because of this uncertainty, a range is provided for monetarised values. In addition the CBAs allow for the inclusion of a range of ecological values where a precise number is unknown (e.g. potential rate of spread) and allows for the inclusion of non-production costs.

Monetary assessments of the benefits and costs take into consideration:

- The distribution of the pest
- Its preferred (and less preferred) habitat
- The value of the land that it impacts upon
- The cost of Council and or land occupier control.

2.4.1 Benefits of pest control

The proposed programme benefits are assumed to be the monetarised benefits of avoiding or mitigating the pest impacts on land use values on a per hectare per annum basis (refer Table 3 on page 5). The CBA calculation also takes into consideration the pest's impact and infestation levels. Refer section 2.3.3 above for further information.

In the event that the species has not reached its full areal extent (i.e. Eradication Programme pests and some Sustained Control pests) the following additional considerations apply:

a. Estimating pest spread time

When predicting the expansion of pests the report uses a logistic growth curve for weed modelling widely used in ecology.

A key part of the CBA for where pests have not yet reached there full areal extent is estimating the number of years a species will take to reach its maximum extent in the region.[8]

For the purposes of the report, scientific literature was reviewed to match pest life forms to average times to reach their maximum extent, from the year they are first discovered in the wild (Table 4). Pest spread time was then adjusted by the dispersal abilities of each pest (Table 5).

Table 4: Time for pests of different life forms to reach maximum extent from the year first found wild

Life form	Spread time
Pest animals	50
Short-lived herb	75
Long-lived herb	100
Short-lived woody	125
Long-lived woody	150

Table 5: Adjustment to the anticipated spread of pests based on their dispersal capabilities

Dispersal	Adjustment
Low	-25 years
Moderate	+0 years
High	-25 years

b. Potential area infested (ha)

The total area in the region potentially infested by Eradication Programme pests and Sustained Control pests where they have not yet reached there full areal

[4] *Cost-benefit analyses are an economic tool to estimate all relevant costs and benefits in the same currency, usually in current dollars (termed the net present value or NPV).*

[5] *Wildlands, 2015 and 2017.*

[6] *Net benefits = benefits x success probability/costs.*

[7] *Harris. S, et al, 2017.*

[8] *Pest spread estimations are less relevant for candidate pest species that have already reached there full areal extent in the region. For these species, regional intervention will largely be confined to the enforcement of good neighbour rules where the focus is on reducing pest densities and off site pest impacts rather than the geographical spread of the pest.*

extent was calculated by multiplying the potential land use types occupied by primary (5–25%), secondary (1–4%) or unsuitable (0%), multiplied by the total area of each land use type in the Taranaki region (see Table 2).

2.4.2 Cost of pest control

The proposed programme costs, and consideration of alternatives, involve two component parts:

a. Council costs

These are the costs directly incurred by the Council to support, undertake or provide pest control, surveillance, monitoring, research, advice and information, administration, governance, plus RPMP review and funding expenses.

The annual Council cost for the proposed pest management programme were adapted and based upon Long Term Plan estimates. The alternative – no regional intervention – assumes there will be no Council costs.

b. Compliance costs[9]

Compliance costs are the costs incurred by land occupiers to comply with the requirements set out in the Plan, e.g. on-farm costs to undertake control, and/or interference to farming operations.

The report includes pest control costs cost on a per hectare basis for determining compliance costs (a minimum and maximum of a range of costs was inputted into Wildland's model). Wildlands were then commissioned to multiply this per hectare cost by an estimate of how much of the current extent of the pest will likely incur private control costs above and beyond the current private control. To do this, Wildlands used the following simple algorithm in combination with estimates of the proportion of the current extent of a pest in each major land use type.

1. The pest is a primary pest of a land use type.
   (a) The pest has a high impact on this land use. We assume that all private land owners who can afford to do so are already controlling this pest, and compliance requirements will not increase this.
   (b) The pest has a moderate impact on this land use. We assume 10%–50% of private land owners are already controlling this pest. The control required by the additional 90%–50% of land owners are additional compliance costs.
   (c) The pest has a low impact on this land use. We assume 1%–9% of private land owners are already controlling this pest. The control required by the additional 99%–91% of land owners are additional compliance costs.
2. The pest is a secondary pest of a land use type. We assume that no land owners of this land use will be currently controlling the pest and that any requirements to do so by the RPMP are compliance costs.
3. The pest is not known to occur above negligible numbers on a land use type. The compliance costs for land owners of that land type are set to zero.

A separate assessment was undertaken to determine the 'reasonableness' of any good neighbour rules based upon a regional sector model.[10] This required consideration as to whether pest control on source properties was net beneficial across different 'receptor' land use types on a property to property basis.

Boundary control / good neighbour rules

For candidate pests that are established in the region it is proposed that these be managed through 'good neighbour rules'.

Good neighbour rules apply only along the boundaries of properties. Land occupiers are required to keep their land pest-free within a set boundary distance. These rules are aimed at reducing the movement of pests from an infested property onto neighbouring properties, and avoiding the imposition of pest on neighbours. The proposed boundary distance is based upon scientific literature relating to pest spread dispersal.

The control costs imposed on land occupiers with pests will always be higher than the immediate monetarised benefits that neighbours get from reduced pest spread onto their land. This is because the pest is already on the land occupiers land and not on the adjacent land.

The benefit to the region of boundary rules is assessed as the pest control cost savings to neighbouring land occupiers.

[9] *One of the important but difficult to quantify aspects of a pest CBA is estimating the cost of additional pest control carried out by private land owners. These compliance costs only apply to Sustained Control category pests. The control costs of Eradication Programme pests are entirely met by the Council.*

[10] *Harris, S, et al, 2017.*

2.4.3 50 year assessments

The 50 year assessments compare the option of no pest management with the preferred management option. Fifty year assessments are particularly applicable for Eradication Programme pests because pests at the early stages of their invasion typically take many decades to reach their full extent and impacts across the region.

2.5 CBA statement and risks to success

This section presents the preferred option for pest management based upon the findings of the impact assessments and CBA.

In relation to the preferred option, the report then provides an assessment of the risks and the probability of success that the proposed programme will not achieve its objective. The 'risks to success' assessment is based on the section 6(3) matters set out in the NPD:

- *Technical risks* – the risk that technical methods or management approach underpinning the proposed programme cannot address the problem or effectively meet the objective
- *Operational risks* – the risk that management will be inadequately applied or complied with
- *Legal risks* – the risk that compliance with other legislation or legal processes will adversely affect implementation of the programme
- *Socio-political risks* – the risk of public and/or political concerns adversely affecting the implementation of the programme
- *Other risks* – for example, the risk of causing unintended adverse effects.

The risks to success were categorised as either 'Low', 'Medium' or 'High' , taking into consideration operational costs, the feasibility or achievability of control, the availability of effective control techniques, and whether the Council is better placed to undertake the delivery or coordinate control. Council views were based on their experience and expertise, experiences over the life of current and previous strategies, and whether a programme has previously been supported or tested through a public process.

2.6 Determining who should pay

This section has two components:

a. Identification of beneficiaries and exacerbators

Beneficiaries and exacerbators were identified for all proposed pest programmes.

Beneficiaries and exacerbators were grouped and classed as 'minor' or 'major', based on the impact evaluation and whether the habitats were defined as primary or secondary habitat.

b. Who should pay?

Determining 'who should pay' for the costs of control for any specific pest is made by assessing who are the beneficiaries and exacerbators and whether control provides largely a private or public benefit, and/or whether some groups are exacerbating or contributing to the problem..

Recommendations on who should pay are made based upon the matters set out in section 7(2) of the NPD. These being:

- Is the group expected to be able to change its behaviour to reduce the costs of pest control or reduce the risks that give rise to the need for the pest control?
- Can the group determine whether the benefits of the pest control outweigh the costs of such control?
- Can the group determine whether the pest control is being delivered most cost-effectively?
- The costs and benefits and cost effectiveness of control for the regional community are assessed through political and annual planning reporting processes

The report's recommendation's will be tested through a public review process.

2.7 Key assumptions

Table 6 overleaf summaries key assumptions that underpin the pest impact and CBA evaluations provided in sections 3 and 4 below.

Table 6: Key report assumptions

Key assumption	Discussion
Not all costs and benefits can be monetarised	Pest impacts on biodiversity, amenity and other environmental values are extremely difficult to 'monetarised'. For environmental pests, the monetarised net benefit of regional intervention (or otherwise) is estimated. However, it is still likely to be an underestimate. In determining the non monetarized costs for candidate species having an impact on environmental values, assumptions have necessarily been made on the local community's willingness to pay. These assumptions will be tested through the Plan review process.
Different pests require different management approaches	In determining the size of the problem and who should pay for any management response, the following assumptions have been made: – when dealing with newly established and or expanding pest populations, early action is by far the most cost effective approach even when there is inadequate knowledge of impacts (Harris & Timmins, 2009) – the beneficiaries of regional intervention and/or exacerbators of pest problems are identifiable having regard to the different habitats/land use types impacted on by the candidate species – for Eradication programmes, the benefits are predominantly a public good rather than a private good – good neighbour rules are not considered appropriate if it requires a greater level of control necessary to address their externality impacts having regard to the biological attributes and pest characteristics of the candidate species – harmful species for which there are no rules or requirement to access the Part 6 regulatory powers of the Act will be addressed separately in the through exclusion, pathway, site-led and other non regulatory programmes set out in the *Biosecurity Strategy for the Taranaki Regional Council*.
Pest costs to the region are linear to their area of infestation	The economic and environmental costs/impacts of pests scale linearly with their area of infestation (e.g. twice as much area of weeds means twice as much impact on the region).
$1 invested today will have grown to $6.83 in 50-years time	A standard discounting rate of 4% is applied to the CBA where all future costs and benefits are "discounted" by the amount a dollar could earn if invested now rather than spent. With an annual compounding interest rate of 4%, $1 invested today will have grown to $6.83 in 50-years time. For this reason, for it to be economically sensible to spend $10,000 today on pest control to prevent impacts in 50-years time, those impacts would need to be worth $69,000.
The beneficial attributes of the species must also be recognised	Potential beneficial attributes or values associated with individual pest were categorised as Minor (L), Moderate (M), or Major (H). The annual value of any benefits attributable to pests was unknown for most species and therefore had to be estimated. The values of benefits assigned to the three categories were Minor $0.1-$1/ha, Moderate $1-$10/ha, and Major $10-$100/ha. For example, a report on the possum fur industry in Hawkes Bay stated that the income for possum control contractors from possum fur was estimated at $3-$5 per hectare (Warburton, 2008)
Rules may apply at the regional or sub-regional level	Some proposed pest management programmes only apply to a subset of the region. For example, the proposed RPMP programme for possums is limited to a defined area covered by the 'Self-help Possum Control Programme'. Where this occurs, the cost-benefit calculations are restricted to that part of the region covered by the programme (not the whole region).
Property rights include both rights and obligations	Avoiding pests spreading from your land to the neighbours is a social responsibility incumbent with land ownership. Through good neighbour rules, that social responsibility becomes a regional regulatory requirement whereby individual land occupiers must control pests to avoid their spread to neighbours.

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3. Proposed Eradication Programme pests

This section sets out, information in relation to each candidate species for which an Eradication Programme is proposed.

3.1 Climbing spindleberry

Celastrus orbiculatus

NO CHANGE:

Continuation of an existing eradication programme

a. Pest attributes and distribution

Relevant biology

Attribute	Description
Form	Deciduous climber that can grow to 12 m high. Young stems green, often with sharp 1-2 mm long spines. Leaves are alternate, roundish (but can be variable in shape), and 5-10 cm long, with toothed margins. Inconspicuous flowers have 5 petals and are greenish-yellow. Produces showy yellow-orange fruit, 6-8 mm in diameter, which open to expose a scarlet centre. Leaves turn yellow in autumn before dropping off.
Habitat	Forest margins, scrub, riparian areas, and gardens. Tolerates hot to very cold temperatures. Frost tolerant.
Regional distribution	Very limited distribution (23 known sites covering 2.5 hectares). Maximum suitable habitat area that could be infested is estimated to be 49,134.
Competitive ability	Can rapidly climb through forest and shrub land and form dense layering thickets, which smother and out-compete native species.
Reproductive ability	Rapid growth rate. Can root sucker. Produces seed which is viable for 2-5 years.
Dispersal methods	Seeds can be dispersed long distances by birds.
Resistance to control	Has an extensive root system, which sends up suckers, but can be effectively controlled using foliar or stump application of herbicide.
Benefits	None

Where is it a problem?

Land use type	Current land use infested*	Potential land use infested*	Pest significant problem on this land type**
Dairy	-	-	False
Sheep and beef (intensive)	-	-	False
Hill country (sheep)	-	-	False
Forestry	-	High	True
Horticulture	-	Low	False
Native / conservation	High	High	True
Urban / Non productive	High	High	True

* High = Most infested/preferred land use(s), Low = Less infested/preferred land use(s), - = Unsuitable land use. Source: Wildlands, 2017

** True = Most 'at risk' or impacted land use(s), False = Less 'at risk' or impacted land use(s) based upon impact assessment overleaf.

b. Impact evaluation

How is it a problem?

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-	Negligible at a regional level although property impacts on farm shelterbelts is possible	
Sheep and beef	-	-	As per Dairy	
Forestry	-	M	Smothers trees in plantation forests. Creates safety hazard during harvest of plantation trees	1
Horticulture	-	L	Can smother fruit trees	
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	L	H	Stems strangle host, overtop most canopies and cause collapse	2, 3
Threatened species	-	H	Could invade open habitats occupied by threatened species and spread into nesting areas of sand dune fauna	2, 3, 4
Social/Cultural				
Human health	-	-		
Recreation	-	L	Layering stems can become very dense and obstruct access	2, 3
Maori culture	-	-		

L – 'low' impact (1–4% reduction in the economic value per ha per annum); **M** – 'moderate' impact (5–9% reduction in the economic value per ha per annum; **H** – 'high' impact (10–50% reduction in the economic value per ha per annum)

Source: 1: Popay et al. (2010), 2: Craw (2000), 3: Environment Canterbury (2004), 4: Williams & Timmins (2003).

How much does it cost?

For the purposes of this report, the monetarised impacts of Climbing spindleberry are calculated as the current or anticipated proportional impact on forestry, horticulture, environmental (native / conservation) and social and cultural values across the region. However, this is a conservative estimate. The potential impacts are likely to be much higher with significant additional non-monetised costs being incurred where habitat degradation impacts on nationally threatened or regionally distinctive native species (and given the 'value' of these species).

Land use type	Current impact per ha	Potential impact per ha
Production	$0	$2.82 – $14.05
Dairy	$0	$0
Sheep and beef	$0	$0
Forestry	$0	$2.26 – $12.27
Horticulture	$0	$0.55 - $1.78
Native / conservation	$4.43 – $21.60	$46.95 – $284.20
Social/Cultural	$0	$0.03 – $0.27

All amounts are in net present value (NPV, $). Source: Wildlands, 2017.

c. Cost-benefit analysis

CBA assumptions and inputs

Pest assumptions	Values	Programme assumptions	Values
Current area infested:	4 ha	Proposed Programme:	**Eradication**
Maximum potential area infested:º	49,134 ha	Proposed annual expenditure by Council:	$10,000
Time to reach maximum extent:†	100 years	Repeated inspections and works required:	Annually
Current impacts ($):*	$13.06 / ha ($4.43 – $21.69 / ha)	Discount rate:	4%

º The potential extent the pest is predicted to achieve in the absence of regional management based upon LCDB

† The time a pest is predicted to take between first going wild in the region and reaching 90% of its potential maximum extent (in the absence of regional intervention)

* Current impact is for the current area of the pest, averaged across the impacts on all land uses within this area.

CBA assessment

The Council has calculated a cost-benefit scenario over 50 years for Climbing spindleberry.

The CBA shows that regional intervention in the form of an eradication programme is cost beneficial through the avoidance of pest impacts that would otherwise occur for forestry and conservation land uses/values as Climbing spindleberry spreads across its full potential extent. The net monetarised benefit of regional intervention over 50 years is estimated to be **$3,634,917**. However, this does not take into account the non-monetarised 'value' of protecting biodiversity values, including some nationally threatened or regionally distinctive native species in Taranaki that would otherwise be impacted upon by this plant.

Scenario	Pest impacts*	Benefits	Council costsº	Compliance costs†	Net benefit
No regional intervention	$3,724,631 min: 641,286 max: 19,136,266	$0	$0	$0	
Eradication (preferred option)	$747 min: 268 max: -1,313	$3,723,884 min: 641,554 max: 19,137,679	$88,967	$0	**$3,634,917** min: 552,587 max: 19,048,712

* Includes economic costs and conservatively valued environmental, social and cultural costs

º Council costs refer to the administration and implementation costs incurred by the Council through the programme

† Compliance costs refer to any costs of control imposed on land occupiers through the programme.

d. CBA statement and risks to success

If Climbing spindleberry were to become established it could seriously affect plantation forests, farm shelterbelts and indigenous biodiversity.

Eradication is technically feasible. The species has a very confined habitat range and occurs at very low densities in the region, and there is a high probability that infestation levels can be reduced to zero densities in the short to medium term.

The CBA for Climbing spindleberry suggests that the eradication programme would be net beneficial over the long term. There are public good benefits in preventing Climbing spindleberry from becoming established and avoiding the possibility of more significant costs for the region in the future.

Risks of the programme being unsuccessful in achieving objectives

Risk	Level of risk	Explanation
Technical risk	Low	Increased focus is required on surveillance and public awareness to identify sites of interest. There is a risk of previously unknown infestation sites being discovered over the life of the Plan and that the distribution and abundance of the species precludes eradication.
Operational risk	Low	The eradication of known Climbing spindleberry is technically feasible and cost-effective over a 50-year timeframe. Public intervention (whereby land occupiers do not incur the cost of control) should encourage the public reporting of infestation and the application of control techniques that will result in the effective control of the species.
Legal risk	Low	
Socio-political risk	Low	To be tested through the Plan review process but proposed approach is a continuation of the existing approach for which no public or political concerns have been raised to date.
Other risks	Low	

e. Who should pay?

Beneficiaries and exacerbators

Group	Beneficiary	Exacerbator	Change behaviour	Assess costs & benefits	Control cost effectively
Forestry sector	Minor	Minor	No	Yes	Yes
Anyone intentionally dumping or incorrectly disposing the plant		Major	Yes	No	No
Regional community‡	Major		No	Yes	Yes

Who should pay for the proposed management approach?

Climbing spindleberry is a major threat to conservation and forestry values. Given the benefits of an eradication objective and the protection of indigenous biodiversity values are a public good rather than a private good, it is appropriate that the costs are paid for directly by the Council on behalf of the regional community. The regional community is able to assess the cost and benefits and effectiveness of the programme through the annual planning and reporting processes under the Local Government Act 2002 and through the review of future pest management plans.

3.2 Giant reed

Arundo donax

NO CHANGE:

Continuation of an existing eradication programme

a. Pest attributes and distribution

Relevant biology

Attribute	Description
Form	Clump-forming bamboo-like grass with a dense root mass and short rhizomes. Grows up to 5-8 m in height, and tends to 'droop' at the edges of clumps where it is not supported by the mass of canes. Hollow stems, up to 4 cm across. Bluish-white (occasionally white-striped) bamboo-like leaves (30-90 x 5 cm) with parallel veins are arranged alternately, clasping the stems. A plume-like flowerhead is produced at the top of the stem in late summer.
Habitat	Often in wasteland, but also moist forest, lowland and coastal forest, riparian margins and gullies, intertidal areas, shrub lands, alluvial areas, farm hedges, domestic gardens, and roadsides.
Regional distribution	Very limited distribution (39 known sites covering 2 hectares). Most known sites in urban areas. Maximum suitable habitat area that could be infested is estimated to be 11,914.
Competitive ability	Rapid growth of tall dense colonies that smother and shade out other species. Has the capacity to displace almost all shrubs and small trees growing around it.
Reproductive ability	Seeding is rare in New Zealand, mostly spreads by rhizomes. Needs to be watched closely for increased occurrences of naturalisation from seed.
Dispersal methods	Rhizomes spread readily down waterways and from garden dumping. New plants can grow from cut stems and root or rhizome fragments.
Resistance to control	Difficult to control with herbicide; may need 4-6 treatments. Cut shoots at ground level and inject 10 ml undiluted amitrole into stems; or cut off and spray regrowth before it reaches 60 cm tall with 150 ml haloxyfop (e.g. Gallant) + 100 ml amitrole + 20 ml crop oil per 10 litres water. Need to apply chemical within 10 minutes of cutting. Grazing may be effective, and slashed vegetation can be left to rot, mulched or composted, but root fragments need careful disposal.
Benefits	Proposed as biofuel crop overseas, but strong resistance from ecologists. Used overseas for fence material, roof thatching, construction of baskets, food preparation (tamale wraps), and production of reeds for musical instruments (flutes).

Where is it a problem?

Land use type	Current land use infested*	Potential land use infested*	Pest significant problem on this land type**
Dairy	-	-	False
Sheep and beef (intensive)	-	Low	False
Hill country (sheep)	-	Low	False
Forestry	-	Low	False
Horticulture	-	-	False
Native / conservation	High	High	True
Urban / Non productive	High	High	True

* High = Most infested/preferred land use(s), Low = Less infested/preferred land use(s), - = Unsuitable land use. Source: Wildlands 2017

** True = Most 'at risk' or impacted land use(s), False = Less 'at risk' or impacted land use(s) based upon impact assessment overleaf.

b. Impact evaluation

How is it a problem?

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-		
Sheep and beef	-	L	The tall dense clumps can rapidly take over production land.	
Forestry	-	L	Can invade forestry areas and outcompete young trees. Could post a fire risk.	1
Horticulture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	L	M	Rapid growth, fallen stems, and accumulating debris can block water ways and cause flooding.	2
Species diversity	L	M	Forms dense colonies that outcompete and/or shade indigenous species, particularly in riparian areas and wetlands. Low-growing plants (e.g. parataniwha), shade-loving ferns, herbs, and bryophytes could be heavily impacted.	1, 2
Threatened species	L	M	Has the ability to shade out riparian species. This may include threatened species. Can harbour rats.	3
Social/Cultural				
Human health	L	L	Can host vermin such as rats and possums, which can be vectors for disease that affect humans.	2, 4
Recreation	-	M	Obstructs access to waterways.	2
Maori culture	-	M	See Recreation.	2

L – 'low' impact (1–4% reduction in the economic value per ha per annum); **M** – 'moderate' impact (5–9% reduction in the economic value per ha per annum; **H** – 'high' impact (10–50% reduction in the economic value per ha per annum)

Source: 1: Bay of Plenty Regional Council (2013), 2: Ministry for Primary Industries (2009), 3: Williams (2010), 4: Ministry of Health (2011).

How much does it cost?

For the purposes of this report, the monetarised impacts of Giant reed are calculated as the current or anticipated proportional impact on sheep and beef, forestry, environmental (native / conservation) and social and cultural values across the region. However, this is a conservative estimate. The potential impacts are likely to be much higher with significant additional non-monetised costs being incurred where habitat degradation impacts on nationally threatened or regionally distinctive native species (and given the 'value' of these species).

Land use type	Current impact per ha	Potential impact per ha
Production	$0	$0.49 – $3.18
Dairy	$0	$0
Sheep and beef	$0	$0.40 – $2.31
Forestry	$0	$0.09 – $0.87
Horticulture	$0	$0
Native / conservation	$1.72 – $12.53	$13.79 – $37.80
Social/Cultural	$0.02 – $0.88	$0.10 – $1.22

All amounts are in net present value (NPV, $). Source: Wildlands, 2017.

c. Cost-benefit analysis

CBA assumptions and inputs

Pest assumptions	Values	Programme assumptions	Values
Current area infested:	2 ha	Proposed Programme:	**Eradication**
Maximum potential area infested:º	11,914 ha	Proposed annual expenditure by Council:	$10,000
Time to reach maximum extent:†	100 years	Repeated inspections and works required:	Annually
Current impacts ($):*	$7.57 / ha ($1.74 – $13.40 / ha)	Discount rate:	4%

º The potential extent the pest is predicted to achieve in the absence of regional management based upon LCDB

† The time a pest is predicted to take between first going wild in the region and reaching 90% of its potential maximum extent (in the absence of regional intervention)

* Current impact is for the current area of the pest, averaged across the impacts on all land uses within this area.

CBA assessment

The Council has calculated a cost-benefit scenario over 50 years for Giant reed.

The CBA shows that regional intervention in the form of an eradication programme is cost beneficial through the avoidance of pest impacts that would otherwise occur for conservation and production land uses/values as Giant reed spreads across its full potential extent. The net monetarised benefit of regional intervention over 50 years is estimated to be **$84,769**. However, this does not take into account the non-monetarised 'value' of protecting biodiversity values, including some nationally threatened or regionally distinctive native species in Taranaki that would otherwise be impacted upon by this plant.

Scenario	Pest impacts*	Benefits	Council costsº	Compliance costs†	Net benefit
No regional intervention	$173,952 min: $53,054 max: $671,679	$0	$0	$0	
Eradication (preferred option)	$216 min: -$53 max: -$406	$173,736 min: $53,107 max: $672,085	$88,967	$0	**$84,769** min: -$35,860 max: $583,118

* Includes economic costs and conservatively valued environmental, social and cultural costs

º Council costs refer to the administration and implementation costs incurred by the Council through the programme

† Compliance costs refer to any costs of control imposed on land occupiers through the programme

d. CBA statement and risks to success

If Giant reed were to become established it could seriously affect sheep and beef, forestry and biodiversity (plus water quality, riparian and wetland species diversity) values across the region. Eradication is technically feasible. The species has a very confined habitat range and occurs at very low densities in the region, and there is a high probability that infestation levels can be reduced to zero densities in the short to medium term.

The CBA for Giant reed suggests that the eradication programme would be net beneficial over the long term. There are public good benefits in preventing Giant reed from becoming established and avoiding the possibility of more significant costs for the region in the future.

Risks of the programme being unsuccessful in achieving objectives

Risk	Level of risk	Explanation
Technical risk	Low to Medium	Increased focus is required on surveillance and public awareness to identify sites of interest. There is a risk of previously unknown infestation sites being discovered over the life of the Plan and that the distribution and abundance of the species precludes eradication.
Operational risk	Low	The eradication of known Giant reed is technically feasible and cost-effective over a 50-year timeframe. Public intervention (whereby land occupiers do not incur the cost of control) should encourage the public reporting of infestation and the application of control techniques that will result in the effective control of the species.
Legal risk	Low	
Socio-political risk	Low	To be tested through the Plan review process but proposed approach is a continuation of the existing approach for which no public or political concerns have been raised to date.
Other risks	Low	

e. Who should pay?

Beneficiaries and exacerbators

Group	Beneficiary	Exacerbator	Change behaviour	Assess costs & benefits	Control cost effectively
Land occupiers (Crown and private)	Minor	Major	Yes	Yes	Yes
Anyone intentionally dumping or disposing of the plant		Major	Yes	Yes	Yes
Regional community‡	Major		Yes	Yes	Yes

Who should pay for the proposed management approach?

Giant reed is a major threat to conservation and, to a lesser extent, production values. Given the benefits of an eradication objective and the protection of indigenous biodiversity values are a public good rather than a private good, it is appropriate that the costs are paid for directly by the Council on behalf of the regional community. The regional community is able to assess the cost and benefits and effectiveness of the programme through the annual planning and reporting processes under the Local Government Act 2002 and through the review of future pest management plans.

3.3 Madeira vine (Mignonette vine)

Anredera cordifolia

NO CHANGE:

Continuation of an existing eradication programme

a. Pest attributes and distribution

Relevant biology

Attribute	Description
Form	Evergreen woody vine that grows from a fleshy underground tuber and can climb to 7 m tall. Have thick, shiny, alternating, slightly heart-shaped leaves on reddish-brown hairless vines. Ginger-like tubers are produced on aerial (above ground) stems. Stem tubers detach easily and re-sprout on the ground. Produces fragrant cream flowers in late summer to early autumn (January to April), but not fruit.
Habitat	Thrives in warm, moist climates and fertile soils. Invades bush margins, disturbed or low forest, rocky places, coastal areas, and waste places, especially shrub-covered areas such as coastal gullies. Tolerates drought and damp conditions, wind, salt, many soil types, moderate shade and damage.
Regional distribution	Limited distribution, confined to areas near the coast (53 known sites). Most sites located in urban areas.
Competitive ability	Grows at a moderate rate but forms dense, long-lived masses that dominate medium to high canopy; smothering other plants and blocking out light.
Reproductive ability	No viable seed in New Zealand. Spreads via cuttings/broken stems or ginger-like aerial tubers. Each of these can generate a new plant.
Dispersal methods	No viable seed in New Zealand. Spreads via cuttings/broken stems or aerial tubers. Spread is usually by humans dumping garden refuse or moving topsoil containing tubers. Floodwaters can also disperse tubers and rhizomes.
Resistance to control	Difficult to control with herbicides due to the persistence of numerous viable aerial and subterranean tubers, which are very hard to kill. Tubers may persist in soil for 2-5 years and up to 5 years on cut vines. Need to remove and burn all underground and stem tubers, or take the whole plant to a refuse transfer station. Home composing will not kill mignonette vine. Any stems or tubers touching the ground will re-grow. Mature vines and attached tubers can be controlled with herbicides such as metsulfuron-methyl (apply to cut or scraped surfaces) but need to continue control methods monthly to prevent regrowth.
Benefits	Underground roots and fleshy leaves supposedly edible.

Where is it a problem?

Land use type	Current land use infested*	Potential land use infested*	Pest significant problem on this land type**
Dairy	-	-	False
Sheep and beef (intensive)	-	-	False
Hill country (sheep)	-	-	False
Forestry	-	Low	False
Horticulture	-	-	False
Native / conservation	Low	High	True
Urban / Non productive	High	High	True

* High = Most infested/preferred land use(s), Low = Less infested/preferred land use(s), - = Unsuitable land use. Source: Wildlands, 2017

** True = Most 'at risk' or impacted land use(s), False = Less 'at risk' or impacted land use(s) based upon impact assessment overleaf.

b. Impact evaluation

How is it a problem?

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-		
Sheep and beef	-	-		
Forestry	-	M	Can smother and break forestry trees.	1, 2
Horticulture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	M	H	Dense, long-lived infestations smother indigenous plants and block out light. The weight of tubers can topple small trees. Can alter successional patterns and prevent native regeneration, thus modifying the structure of the ecosystem.	1, 3
Threatened species	L	H	See Species diversity.	1, 3, 4
Social/Cultural				
Human health	-	-		
Recreation	-	M	Dense, heavy, long-lived masses obstruct access to forest.	1
Maori culture	-	M	See Recreation.	1

L – 'low' impact (1–4% reduction in the economic value per ha per annum); **M** – 'moderate' impact (5–9% reduction in the economic value per ha per annum; **H** – 'high' impact (10–50% reduction in the economic value per ha per annum)

Source: 1: Waikato Regional Council (2013), 2: Webb & Harrington (2005), 3: Northland Regional Council (2013), 4: Auckland Regional Council (1999).

How much does it cost?

For the purposes of this report, the monetarised impacts of Madeira vine are calculated as the current or anticipated proportional impact on environmental (native / conservation), production and social and cultural values across the region. However, this is a conservative estimate. The potential impacts are likely to be much higher with significant additional non-monetised costs being incurred where habitat degradation impacts on nationally threatened or regionally distinctive native species (and given the 'value' of these species).

Land use type	Current impact per ha	Potential impact per ha
Production	$0	$0.45 – $1.96
Dairy	$0	$0
Sheep and beef	$0	$0
Forestry	$0	$0.45 – $1.96
Horticulture	$0	$0
Native / conservation	$4.43 – $7.81	$46.95 – $284.20
Social/Cultural	$0.07 – $0.29	$0.16 – $1.67

All amounts are in net present value (NPV, $). Source: Wildlands, 2017.

c. Cost-benefit analysis

CBA assumptions and inputs

Pest assumptions	Values	Programme assumptions	Values
Current area infested:	0.5 ha	Proposed Programme:	**Eradication**
Maximum potential area infested:º	45,760 ha	Proposed annual expenditure by Council:	$15,000
Time to reach maximum extent:†	75 years	Repeated inspections and works required:	Annually
Current impacts ($):*	$6.30 / ha ($4.50 – $8.09 / ha)	Discount rate:	4%

º The potential extent the pest is predicted to achieve in the absence of regional management based upon LCDB

† The time a pest is predicted to take between first going wild in the region and reaching 90% of its potential maximum extent (in the absence of regional intervention)

* Current impact is for the current area of the pest, averaged across the impacts on all land uses within this area.

CBA assessment

The Council has calculated a cost-benefit scenario over 50 years for Madeira vine.

The CBA shows that regional intervention in the form of an eradication programme is cost beneficial through the avoidance of pest impacts that would otherwise occur for forestry and conservation land uses/values as Madeira vine spreads across its full potential extent. The net monetarised benefit of regional intervention over 50 years is estimated to be **$10,823,041**. However, this does not take into account the non-monetarised 'value' of protecting biodiversity values, including some nationally threatened or regionally distinctive native species in Taranaki that would otherwise be impacted upon by this plant.

Scenario	Pest impacts*	Benefits	Council costsº	Compliance costs†	Net benefit
No regional intervention	$10,954,230 min: $1,873,933 max: $56,193,115	$0	$0	$0	
Eradication (preferred option)	$45 min: -$34 max: -$61	$10,954,185 min: $1,873,967 max: $56,193,176	$131,144	$0	**$10,823,041** min: $1,742,823 max: $56,062,032

* Includes economic costs and conservatively valued environmental, social and cultural costs

º Council costs refer to the administration and implementation costs incurred by the Council through the programme

† Compliance costs refer to any costs of control imposed on land occupiers through the programme

d. CBA statement and risks to success

If Madeira vine were to become established it could seriously affect plantation forests, farm shelterbelts and indigenous biodiversity. Eradication is technically feasible. The species has a very confined habitat range and occurs at very low densities in the region, and there is a high probability that infestation levels can be reduced to zero densities in the short to medium term.

The CBA for Madeira vine suggests that the eradication programme will be net beneficial over the long term. There are public good benefits in preventing Madeira vine from becoming established and avoiding the possibility of more significant costs for the region in the future.

Risks of the programme being unsuccessful in achieving objectives

Risk	Level of risk	Explanation
Technical risk	Low to Medium	Increased focus is required on surveillance and public awareness to identify sites of interest. There is a risk of previously unknown infestation sites being discovered over the life of the Plan and that the distribution and abundance of the species precludes eradication.
Operational risk	Low	The eradication of known Madeira vine is technically feasible and cost-effective over a 50-year timeframe. Public intervention (whereby land occupiers do not incur the cost of control) should encourage the public reporting of infestation and the application of control techniques that will result in the effective control of the species.
Legal risk	Low	
Socio-political risk	Low	To be tested through the Plan review process but proposed approach is a continuation of the existing approach for which no public or political concerns have been raised to date.
Other risks	Low	

e. Who should pay?

Beneficiaries and exacerbators

Group	Beneficiary	Exacerbator	Change behaviour	Assess costs & benefits	Control cost effectively
Forestry sector	Minor	Minor	No	Yes	Yes
Anyone intentionally dumping or incorrectly disposing the plant		Major	Yes	No	No
Regional community‡	Major		No	Yes	Yes

Who should pay for the proposed management approach?

Madeira vine is a major threat to conservation values. Given the benefits of an eradication objective and the protection of indigenous biodiversity values are a public good rather than a private good, it is appropriate that the costs are paid for directly by the Council on behalf of the regional community. The regional community is able to assess the cost and benefits and effectiveness of the programme through the annual planning and reporting processes under the Local Government Act 2002 and through the review of future pest management plans.

3.4 Senegal tea

Gymnocoronis spilanthoides

NO CHANGE:

Continuation of an existing eradication programme

a. Pest attributes and distribution

Relevant biology

Attribute	Description
Form	Mat-forming perennial semi-aquatic herb with scrambling, floating stems, which produce roots at nodes. Stems erect to 1.5 m tall when flowering, 5–10 mm diameter at first, with age become hollow, inflated and floating (up to 20 mm diameter). Leaves are paired with opposite stalks joined at stem, 50–200 x 25–50 mm, lance-shaped, dark green, hairless, shiny, serrated, and slightly wavy. Flower heads are highly scented, clover-like, with many thin white 'petals' (florets) in November to April. Seed yellow-brown, 5 mm diameter.
Habitat	Wetlands, waterways, riparian areas, wet marshy ground. Tolerates hot to warm temperatures, partial drying of stems and root crowns, most soils and water nutrient levels.
Regional distribution	Very limited distribution (2 sites). Known sites in urban areas.
Competitive ability	Matures and grows quickly. Overtops and scrambles over shorter herbaceous vegetation. Floating mats shade out submerged species.
Reproductive ability	Few seeds are produced in New Zealand, however seeds are highly fertile. Dormant over winter, dies back to rootstock if chilled, then re-sprouts in spring.
Dispersal methods	Spreads by stem fragmentation, humans, and machinery. Seeds dispersed by water and soil movement, also livestock hooves.
Resistance to control	Mechanical control unsuccessful as it spreads fragments of the plant. Can be controlled with herbicides.
Benefits	None

Where is it a problem?

Land use type	Current land use infested*	Potential land use infested*	Pest significant problem on this land type**
Dairy	-	-	False
Sheep and beef (intensive)	-	-	False
Hill country (sheep)	-	-	False
Forestry	-	-	False
Horticulture	-	-	False
Native / conservation	High	High	True
Urban / Non productive	-	-	False

* High = Most infested/preferred land use(s), Low = Less infested/preferred land use(s), - = Unsuitable land use. Source: Wildlands, 2017

** True = Most 'at risk' or impacted land use(s), False = Less 'at risk' or impacted land use(s) based upon impact assessment overleaf.

b. Impact evaluation

How is it a problem?

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-		
Sheep and beef	-	-		1
Forestry	-	-		
Horticulture	-	-		
Other	-	L	Blocks up water channels, which could affect irrigation.	
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	L	H	Blocks up waterways and drainage channels, can exacerbate flooding.	1, 2, 3
Species diversity	L	H	Dominates shorter vegetation, and floating mats shade out submerged species.	1, 2, 3
Threatened species	-	H	Could threaten some threatened or regionally distinctive wetland species.	1, 2, 3
Social/Cultural				
Human health	-	-		
Recreation	-	M	Dense mats restrict access to waterways for fishing, swimming, kayaking etc.	1, 3
Maori culture	-	M	See Recreation.	1, 3

L – 'low' impact (1–4% reduction in the economic value per ha per annum); **M** – 'moderate' impact (5–9% reduction in the economic value per ha per annum; **H** – 'high' impact (10–50% reduction in the economic value per ha per annum)

Source: 1: Environment Canterbury (2007a), 2: Craw (2000), 3: Department of Primary Industries (2009)

How much does it cost?

For the purposes of this report, the monetarised impacts of Senegal tea are calculated as the current or anticipated proportional impact on wetland values across the region. However, this is a conservative estimate. The potential impacts are likely to be much higher with significant additional non-monetised costs being incurred where wetland degradation impacts on nationally threatened or regionally distinctive native species (and given the 'value' of these species).

Land use type	Current impact per ha	Potential impact per ha
Production	$0	$0
Dairy	$0	$0
Sheep and beef	$0	$0
Forestry	$0	$0
Horticulture	$0	$0
Native / conservation	$1.72 – $12.53	$18.19 – $164.12
Social/Cultural	$0	$0

All amounts are in net present value (NPV, $). Source: Wildlands, 2017.

c. Cost-benefit analysis

CBA assumptions and inputs

Pest assumptions	Values	Programme assumptions	Values
Current area infested:	0.1 ha	Proposed Programme:	**Eradication**
Maximum potential area infested:º	481 ha	Proposed annual expenditure by Council:	$500
Time to reach maximum extent:†	100 years	Repeated inspections and works required:	Annually
Current impacts ($):*	$7.12 / ha ($1.72 – $12.53 / ha)	Discount rate:	4%

º The potential extent the pest is predicted to achieve in the absence of regional management based upon LCDB. This is likely to be an underestimate of potential habitat with alternative source identifying about 3,291 hectares of wetland habitat remains in Taranaki.[11]

† The time a pest is predicted to take between first going wild in the region and reaching 90% of its potential maximum extent (in the absence of regional intervention)

* Current impact is for the current area of the pest, averaged across the impacts on all land uses within this area.

CBA assessment

The Council has calculated a cost-benefit scenario over 50 years for Senegal tea.

The CBA shows that regional intervention in the form of an eradication programme is cost beneficial through the avoidance of pest impacts that would otherwise occur for wetland and other freshwater values as Senegal tea spreads across its full potential extent. The net monetarised benefit of regional intervention over 50 years is estimated to be **$10,248**. However, this does not take into account the non-monetarised 'value' of protecting wetland and freshwater values, including some nationally threatened or regionally distinctive native species in Taranaki that would otherwise be impacted upon by this plant.

Scenario	Pest impacts*	Benefits	Council costsº	Compliance costs†	Net benefit
No regional intervention	$19,090 min: $2,376 max: $103,065	$0	$0	$0	
Eradication (preferred option)	$10 min: -$3 max: -$19	$19,080 min: $2,379 max: $103,084	$8,832	$0	**$10,248** min: -$6,453 max: $94,252

* Includes economic costs and conservatively valued environmental, social and cultural costs

º Council costs refer to the administration and implementation costs incurred by the Council through the programme

† Compliance costs refer to any costs of control imposed on land occupiers through the programme

d. CBA statement and risks to success

If Senegal tea were to become established it could seriously affect waterways and wetlands in Taranaki, including aquatic flora and fauna species. Eradication is technically feasible. The species has a very confined habitat range and occurs at very low densities in the region, and there is a high probability that infestation levels can be reduced to zero densities in the short to medium term.

The CBA for Senegal tea suggests that the eradication programme would be net beneficial over the long term. There are public good benefits in preventing Senegal tea from becoming established and avoiding the possibility of more significant costs for the region in the future.

[11] *Taranaki Regional Council: State of the Environment Report, 2015.*

Risks of the programme being unsuccessful in achieving objectives

Risk	Level of risk	Explanation
Technical risk	Low to Medium	Increased focus is required on surveillance and public awareness to identify sites of interest. There is a risk of previously unknown infestation sites being discovered over the life of the Plan and that the distribution and abundance of the species precludes eradication.
Operational risk	Low	The eradication of known Senegal tea is technically feasible and cost-effective over a 50-year timeframe. Public intervention (whereby land occupiers do not incur the cost of control) should encourage the public reporting of infestation and the application of control techniques that will result in the effective control of the species.
Legal risk	Low	
Socio-political risk	Low	To be tested through the Plan review process but proposed approach is a continuation of the existing approach for which no public or political concerns have been raised to date.
Other risks	Low	

e. Who should pay?

Beneficiaries and exacerbators

Group	Beneficiary	Exacerbator	Change behaviour	Assess costs & benefits	Control cost effectively
Land occupiers (Crown and private)	Minor	Major	Yes	No	No
Anyone intentionally dumping or disposing of the plant		Major	Yes	No	No
Regional community[‡]	Major		No	Yes	Yes

Who should pay for the proposed management approach?

Senegal tea is a major threat to wetland and freshwater conservation values. Given the benefits of an eradication objective and the protection of indigenous biodiversity values are a public good rather than a private good, it is appropriate that the costs are paid for directly by the Council on behalf of the regional community. The regional community is able to assess the cost and benefits and effectiveness of the programme through the annual planning and reporting processes under the Local Government Act 2002 and through the review of future pest management plans.

4. Proposed Sustained Control Programme for possums

This section sets out, information in relation to possums for which a Sustained Control Programme - involving the continued implementation of the Self-help Possum Control Programme - is proposed.

KEY CHANGE:

New good neighbour rules for properties adjacent to Self-help Possum Control Programme

4.1 Possum

Trichosurus vulpecula

a. Pest attributes and distribution

Relevant biology

Attribute	Description
Form	Small marsupial similar in size to a cat with large eyes, oval ears, cat-like whiskers and a pointed snout. Has thick bushy tail and can be grey, brown or black in colour.
Habitat	Native and exotic forest, shrub land, farmland, orchards and urban areas. Has favoured food species, but will feed on wide range of species.
Regional distribution	Established and widespread throughout the region. Long term sustained possum control on the ring plain and coastal terraces through Self-help Possum Control Programme
Competitive ability	Has the ability to cause local extinctions of palatable plant species and cause major forest structure modifications. Eats invertebrates and will also take fledging birds and eggs from nests. Significant silvicultural and horticultural pests, possums also compete with stock for pasture.
Reproductive ability	Females breed from age one. In ideal conditions can produce two offspring per year.
Resistance to control	Controlled by poisoning, trapping and shooting. Can become 'shy' to any one method if constantly used.
Benefits	Fur trade (according to the fur buying company Basically Bush, in one year the region produced 4800 kg of possum fur worth $95/kg = $465,000).

Where is it a problem?

Land use type	Current land use infested*	Potential land use infested*	Pest significant problem on this land type**
Dairy	Low	Low	True
Sheep and beef (intensive)	Low	Low	True
Hill country (sheep)	Low	Low	True
Forestry	High	High	True
Horticulture	Low	Low	True
Native / conservation	High	High	True
Urban / Non productive	Low	Low	False

* High = Most infested/preferred land use(s), Low = Less infested/preferred land use(s), - = Unsuitable land use. Source: Wildlands 2017

** True = Most 'at risk' or impacted land use(s), False = Less 'at risk' or impacted land use(s) based upon impact assessment overleaf.

b. Impact evaluation

How is it a problem?

Category	Current	Potential	Comment	Source
Production				
Dairy	L	H	Competes with cattle for pasture. Potential risk to animal health with possums being the main vector for bovine Tb spread.	
Sheep and beef	L	M-H	Competes with sheep and cattle for pasture and, for beef, is a vector for bovine Tb spread.	
Forestry	L	M	Significant silvicultural pest.	1, 2
Horticulture	M	H	Major horticultural pest.	
Other	-	-		
International trade	M	H	Vector for bovine Tb in cattle. The presence of bovine Tb in cattle herds is a risk to dairy and meat exports.	2, 3
Environment				
Soil resources	L	L	Removal of vegetation and forest collapse can lead to soil erosion.	2
Water quality	L	L	Erosion of soil can lead to increased sedimentation in waterways.	2
Species diversity	H	H	Has a major impact on native forest and shrub land. Can suppress or eliminate preferred (palatable) plant species by selective browsing, which alters vegetation composition. Excessive browse can also lead to collapse of palatable canopy species e.g. Northern rata. Competes with native bird species for food, and eats chicks and eggs.	1, 2
Threatened species	M	M	Can eliminate or suppress threatened plant species e.g. mistletoes. Predator of eggs of North Is kiwi. Can compete for nest sites with hole-nesting birds such as kiwi and parakeets.	2
Social/Cultural				
Human health	L	M	Could transmit Tb to humans.	2
Recreation	M	H	Damage to native forests can affect recreational experiences.	2
Maori culture	M	H	Destroys native forests and eats culturally important plants (e.g. koromiko).	2

L – 'low' impact (1–4% reduction in the economic value per ha per annum); **M** – 'moderate' impact (5–9% reduction in the economic value per ha per annum; **H** – 'high' impact (10–50% reduction in the economic value per ha per annum)

Source: 1: Auckland Regional Council (2004), 2: King (2005), 3: TBfree New Zealand (2013).

How much does it cost?

For the purposes of this report, the monetarised impacts of possums are calculated as the current or anticipated proportional impact on production, environmental (native / conservation) and social and cultural values across the region (refer overleaf). However, this is a conservative estimate. The potential impacts are likely to be much higher with significant additional non-monetised costs being incurred where habitat degradation impacts on nationally threatened or regionally distinctive native species (and given the 'value' of these species).

Land use type	Current impact per ha	Potential impact per ha
Production	$9.43 – $29.56	$93.28 – $397.85
Dairy	$8.22 – $26.69	$87.11 – $349.72
Sheep and beef	$0.43 – $1.15	$4.58 – $41.74
Forestry	$0.05 – $0.66	$0.06 – $0.25
Horticulture	$0.72 – $1.05	$1.53 - $6.14
Native / conservation	$1.51 – $9.26	$1.60 – $9.71
Social/Cultural	$0	$0

All amounts are in net present value (NPV, $). Source: Wildlands, 2017.

c. Cost-benefit analysis

CBA assumptions and inputs

Pest assumptions	Values	Programme assumptions	Values
Current area infested:º	235,000 ha	Proposed Programme:	**Sustained Control** (Good neighbour and general rules)
Maximum potential area infested:º	235,000 ha	Proposed annual expenditure by Council:	$866,000
Time to reach maximum extent:†	Not applicable	Proposed boundary width:	500 m (Crown land) Whole property (private land)
Current impacts ($):*	$24.88 / ha ($10.94 – $38.81 / ha)	Repeated inspections required	Annually
Current benefits ($):	$5 / ha	Discount rate:	4%

º Refers to that part of the region covered by the Self-help Possum Control Programme and for which regional intervention is proposed

† Possums have reached their maximum potential extent in the region. Regional intervention is not about preventing the spread of the species but is about managing possum population densities

* Current impact is for the current area of the pest, averaged across the impacts on all land uses within this area.

CBA assessment

The Council has calculated a cost-benefit scenario over 50 years for possum control, within and adjacent to the Self-help Possum Control Programme, involving both good neighbour and general (whole of property) rules.

Good neighbour rule

On a property to property basis, the control of possums on source properties, over 500 metres, is cost beneficial for dairying, sheep and beef, forestry, horticulture and conservation receptor land use types/values. The intent of the good neighbour rules is to ensure Crown land on the Egmont National Park, ring plain and coastal terraces are managing possum numbers below a 10% residual trap catch to minimise externality impacts on properties in the Self-help Possum Control Programme.

General rule

The general rules targets intensively farmed land on the ring plain and coastal terraces where through the Self-help Possum Control Programme, private land occupier are keeping possums at very low levels (below 10% residual trap catch). The CBA assessment confirms that, in the absence of regional intervention, possum numbers would return to their previously high levels on the ring plain and coastal terraces. Regional intervention in the form of the Self-help possum Control Programme is cost beneficial through the avoidance of possum impacts that would otherwise occur for production and conservation land uses/values on the ring plain and coastal terraces. The net monetarised benefit of regional intervention over 50 years is estimated to be **$12,735,880**. However, this does not take into account the non-monetarised 'value' of protecting remnant biodiversity values on the ring plain and coastal terraces plus the Egmont National Park, including some nationally threatened or regionally distinctive native species in Taranaki that would otherwise be impacted upon by possums.

Scenario	Pest impacts*	Benefits	Council costsº	Compliance costs†	Net benefit
No regional intervention	$131,430,629 min: $57,789,805 max: $205,071,452	$0	$0	$0	
Sustained control (preferred option)	$94,336,822 min: $46,208,480 max: $130,413,584	$37,093,807 min: $11,581,325 max: $74,657,868	$19,347,715	$5,010,212	**$12,735,880** min: -$13,193,880 max: $50,094,675

* Includes economic costs and conservatively valued environmental, social and cultural costs

º Council costs refer to the administration and implementation costs incurred by the Council through the programme

† Compliance costs refer to any costs of control imposed on land occupiers through the programme. Estimate based upon average contractor costs on a per hectare basis.

d. CBA statement and risks to success

Possums have a continuing and significant impact on production (dairy, intensive sheep and beef, forestry, and horticulture), environmental and social/cultural values. They are widespread across all forms of habitat in Taranaki.

Sustained possum control through the Self-help Possum Control Programme is technically achievable on those parts of the region that are intensively farmed. Rules requiring land occupiers to maintain possum numbers at low levels are necessary to support the programme so as to protect production and biodiversity values and address externality impacts on neighbouring properties.

The CBA for possums suggests that this form of regional intervention will have monetarised benefits over a 50 year timeframe. However, significant additional non-monetised benefits associated with the protection of biodiversity values are also anticipated.

Risks of the programme being unsuccessful in achieving objectives

Risk	Level of risk	Explanation
Technical risk	Low to Medium	The Self-help Possum Control Programme has been demonstrated to be sustainable and cost-effective in addressing the externality impacts of possums on intensively-farmed land. There is some risk on the boundaries of the programme of high possum impacts on properties adjacent to Egmont National Park or State Highway 3, but to date this has been manageable
Operational risk	Low	See above.
Legal risk	Low to medium	Continued success of Self-help Possum Control Programme will rely on willingness of Department of Conservation to undertake regular boundary control measures in the Egmont National Park and TRC allocating resources to control the eastern boundary to reduce re-infestation
Socio-political risk	Low	Public concerns relating to Department of Conservation's use of 1080 have previously been noted but the risks are considered acceptable. The proposed programme will be tested through the Plan review process but it is a continuation of the existing approach for which no public or political concerns have been raised to date.
Other risks	Low	

e. Who should pay?

Beneficiaries and exacerbators

Group	Beneficiary	Exacerbator	Change behaviour	Assess costs & benefits	Control cost effectively
Land occupiers (Crown and private)	Major	Major	Yes	Yes	Yes
Dairy / sheep and beef sector	Major		No	Yes	Yes
Regional community[‡]	Major		No	Yes	Yes

Who should pay for the proposed management approach?

Possum are a major threat to production and conservation values in the Taranaki region. Land occupiers with infestations are the principal exacerbators of the problem and beneficiaries of possum control. Land occupiers with infestations are therefore best placed to undertake and pay for the costs of any control and ensure that infestations are not impacting on production and conservation values and/or spreading to their neighbours.

In terms of managing possums on private land for the public good, for the protection of production and biodiversity values (which includes newly planted riparian margins and supporting the protection of the Egmont national Park), there is general acceptance that the wider regional community is a beneficiary and that Council support is appropriate to maximise the effectiveness of individual control across the region. The regional community is able to assess the cost and benefits and effectiveness of the programme through the annual planning and reporting processes under the Local Government Act 2002 and through the review of future pest management plans.

5. Proposed Sustained Control Programmes – plants

This section sets out, information in relation to pest plants for which a Sustained Control Programme is proposed.

5.1 Giant Buttercup

Ranunculus acris

KEY CHANGE:

New good neighbour rules

a. Pest attributes

Relevant biology and distribution

Attribute	Description
Form	Hairy perennial, with stoat rhizome and erect solid stems up to 1.5 m tall. Large leaves, deeply divided into 3–7 segments. Yellow flowers up to 25mm in diameter on round hairy stalks. Begins to grow strongly in spring and starts to flower in November–December. Seedlings are difficult to identify until the strongly pointed leaves develop.
Habitat	Prefers well-drained pasture with high rainfall. In drier areas it is confined to ditches and wet patches. In its native range, occupies damp meadows and pastures on calcareous or neutral substrata. Most infested or preferred habitat types are dairying and sheep and beef properties.
Regional distribution	Relatively confined in Taranaki – Stratford, Inglewood, and Opunake rural areas.
Competitive ability	Can form dense clumps up to 1 metre in diameter. Tolerates low-oxygen conditions created by flooding for 30 days by the formation of air storage aerenchyma cells in the roots.
Reproductive ability	Can flower in first year, but often not until second year. Establishes both by seed and rhizomes. Many seeds germinate within the first year, but less than 1% of seedlings survive. Survival increases when disturbance removes neighbouring vegetation.
Dispersal methods	Via seed or rhizomes. Seeds have a hooked beak which allows them to be carried long distances in animal pelts. Seed can also be transported in soil stuck to animal hooves and, when ingested, in the gut of grazing animals. Spread of giant buttercup in Taranaki is principally due to seed distribution in hay or on hay balers.
Resistance to control	Can be difficult to control and develop herbicide resistance with repeat herbicide applications. Best results with thifensulfuron-methyl (e.g. Harmony) achieved when the plant is growing most actively (June–Feb). Repeat treatment the following spring may be necessary. Control with flumetsulam (e.g. Preside) is best in the warmer months of the year, but prior to flowering (Sept–Dec). Repeat the spring treatment for two successive seasons.
Benefits	None.

Where is it a problem?

Land use type	Current land use infested*	Potential land use infested*	Pest significant problem on this land type**
Dairy	High	High	True
Sheep and beef (intensive)	Low	High	True
Hill country (sheep)	-	-	False
Forestry	-	-	False
Horticulture	Low	Low	False
Native / conservation	-	-	False
Urban / Non productive	-	-	False

* High = Most infested/preferred land use(s), Low = Less infested/preferred land use(s), - = Unsuitable land use. Source: Wildlands 2017

** True = Most 'at risk' or impacted land use(s), False = Less 'at risk' or impacted land use(s) based upon impact assessment overleaf and Harris, *et al*, 2017.

b. Impact evaluation

How is it a problem?

Category	Current	Potential	Comment	Source
Production				
Dairy	M	H	Unpalatable to cattle and poisonous in large quantities as it contains protoanemonin, which causes blistering of tongue and lips, ventricular fibrillation, intestinal disorders, and respiratory failure. Highly invasive in pasture, out-competing grasses and clover. At peak cover (November) can reduce edible pasture by 50%, and reduce dairy production by up to $1000 per hectare.	
Sheep and beef	L	M	See Dairy. Sheep can graze it without adverse effects.	
Forestry	-	-		1, 2, 3, 4
Horticulture	L	L		
Other	-	-		
International trade	L	M	Estimated to be responsible for loss of up to $150 million annually due to lost milk solids revenue in dairy industry.	4
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	-	L	Can form dense clumps and become dominant in grasslands or habitats with low species diversity. Not as prolific if species diversity is high, or when surrounded by taller growing species.	5
Threatened species	-	L	See Species diversity.	5
Social/Cultural				
Human health	-	-	-	
Recreation	-	-		
Maori culture	-	-		

L – 'low' impact (1–4% reduction in the economic value per ha per annum); **M** – 'moderate' impact (5–9% reduction in the economic value per ha per annum; **H** – 'high' impact (10–50% reduction in the economic value per ha per annum)

Source: 1: Russel (2013), 2: Taranaki Regional Council (2002a), 3: Radio New Zealand (2013), 4: AgResearch (2011), 5: Jacobs et al. (2010).

How much does it cost?

For the purposes of this report, the monetarised impacts of Giant buttercup are calculated as the current or anticipated proportional impact on dairying, beef, and horticultural production values across the region.

Land use type	Current impact per ha	Potential impact per ha
Production	$305.93 – $561.19	$649.26 – $3,252.37
Dairy	$305.04 – $557.29	$646.73 – $3,245.40
Sheep and beef	$0.37 – $2.21	$1.98 – $5.20
Forestry	$0	$0
Horticulture	$0.52 – $1.70	$0.55 - $1.78
Native / conservation	$0	$0
Social/Cultural	$0	$0

All amounts are in net present value (NPV, $). Source: Wildlands, 2017.

c. Cost-benefit analysis

CBA assumptions and inputs

Pest assumptions	Values	Programme assumptions	Values
Seed bank included:	Yes	Proposed Programme:	**Sustained Control** (Good neighbour rule only)
Pest abundance:	Locally common	Proposed boundary width:	5 m
Density of source infestations:	Dense	Repeated inspections required:	Once (over life of the Plan)
		Discount rate:	4%

CBA assessment

Giant buttercup is relatively widespread in Taranaki and is toxic to cattle. The plant is therefore capable of having significant impacts on dairy and beef pasture and production. The CBA assessment[12] shows that on a property to property basis, the control of Giant buttercup within five metres of the property boundary is cost beneficial when the source property is dairying and sheep and beef land use types, or when the receptor properties are dairying and sheep and beef (intensive) receptor land use types.

Reasonableness of good neighbour rules		
Land uses affected	Dairying	Sheep and beef (intensive)
Benefits from controlling pest ($/ per ha/ per annum)	$3,430	$564
Land occupier cost of controlling dense infestations*	$485	$485

All amounts are in net present value (NPV, $). Source: Harris, et al, 2017

* In addition to the potential compliance costs imposed on the source land occupier are the costs to the Taranaki Regional Council of enforcing a good neighbour rule. Enforcement activities are in the order of $330 to $440 per property inspection.

d. CBA statement and risks to success

Giant buttercup is toxic to both cattle and humans and has major effects on dairy and beef pasture and production. It is relatively confined to dairying areas in Stratford, Inglewood and Opunake.

A Sustained Control programme involving the imposition of good neighbour rules requiring source land occupiers to destroy Giant buttercup infestations is net beneficial within five metres on source properties adjacent to dairying and sheep and beef (intensive) properties.

[12] *Harris, et al, 2017.*

Risks of the programme being unsuccessful in achieving objectives

Risk	Level of risk	Explanation
Technical risk	Medium	Giant buttercup has potential to spread through dairy and beef country and has developed increasing resistance to herbicide.
Operational risk	Medium	The cost of control is expensive and does not fully destroy infestations. Increasing resistance to herbicide may compromise the land occupier's ability to comply with rules. Weed hygiene by road controlling authorities and agricultural contractors is important as the pest is known to spread via roadside verges and machinery. However Lack of road controlling authority resources may reduce systematic implementation.
Legal risk	Low	Weed hygiene by agricultural contractors and road-controlling authorities is important.
Socio-political risk	Low	To be tested through the Plan review process but proposed approach is a continuation of the existing approach for which no public or political concerns have been raised to date.
Other risks	Low	Control can upset normal paddock rotation.

e. Who should pay?

Beneficiaries and exacerbators

Group	Beneficiary	Exacerbator	Change behaviour	Assess costs & benefits	Control cost effectively
Dairy / Sheep and Beef sector	Major	Major	Yes	Yes	Yes
Land occupiers (Crown and Private)	Minor	Major	Yes	Yes	Yes
Regional community‡	Minor		No	Yes	Yes
Road controlling authorities / hay contractors		Major	Yes	Yes	Yes

Who should pay for the proposed management approach?

Giant buttercup is a major threat to dairying and sheep and beef farmers. Land occupiers are usually the principal beneficiaries of control on their land. The principal exacerbators of the spread of Giant buttercup are land occupiers (of any land use) with infestations and or those who spread the weed through poor weed hygiene practices e.g. in hay or along roadside verges. Land occupiers with infestations are best placed to undertake and pay for the costs of any control and ensure they are not impacting on their neighbours.

To maximise the effectiveness of individual control across the region and to minimise the externality impacts of the plant the Council will implement an advisory, inspectorial, and compliance regime. The benefits of this part of the programme are a public good rather than a private good and it is appropriate that these indirect costs are paid for by the Council on behalf of the regional community. The regional community is able to assess the costs and benefits and the effectiveness of the programme through the annual planning and reporting processes under the Local Government Act 2002 and through the review of future pest management plans.

5.2 Giant gunnera

Gunnera tinctoria, and G. manicata

KEY CHANGE:

New good neighbour rules

a. Pest attributes

Relevant biology and distribution

Attribute	Description
Form	Summer green herb with massive prickly umbrella-like leaves up to 2 m long. Looks like very large rhubarb. Petiole to 1 m long, studded with short, often reddish prickles. Has large reddish-brown flower spike up to 1 m long, with very small flowers. Small round orange fruit 1.5-2 mm long.
Habitat	Can inhabit coastal cliffs, riparian margins and wetlands. Tolerant of salt spray and a wide range of climatic and soil conditions. Most infested or preferred habitat types are native, urban, coastal, freshwater and estuarine land uses.
Regional distribution	Heavy infestations in southern and coastal areas. Currently occupies 450ha but maximum potential extent in Taranaki is 10,000 ha over 75 yrs.
Competitive ability	Large spreading leaves shade out other species. In severe winter conditions the plant dies down, but grows new leaves in spring.
Reproductive ability	Produces huge amounts of viable seed. Each seed head contains over 80,000 seeds. Can also grow from rhizomes.
Dispersal methods	Seed dispersed by birds and water. Rhizomes and fragments spread by water and soil movement, also by deliberate planting.
Resistance to control	Best control and least bi-kill of desirable plants with Grazon (triclopyr) at 10 ml/litre plus a penetrant. Tordon Brushkiller (picloram and triclopyr) at 10 ml/litre plus a penetrant is also effective, but can damage desirable plants.
Benefits	Valued as an ornamental plant by some gardeners.

Where is it a problem?

Land use type	Current land use infested*	Potential land use infested*	Pest significant problem on this land type**
Dairy	-	-	False
Sheep and beef (intensive)	-	-	False
Hill country (sheep)	-	-	False
Forestry	Low	Low	True
Horticulture	Low	Low	False
Native / conservation	Low	High	True
Urban / Non productive	High	High	False

* High = Most infested/preferred land use(s), Low = Less infested/preferred land use(s), - = Unsuitable land use. Source: Wildlands 2017

** True = Most 'at risk' or impacted land use(s), False = Less 'at risk' or impacted land use(s) based upon impact assessment overleaf.

b. Impact evaluation

How is it a problem?

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-		
Sheep and beef	-	-		
Forestry	L	L	Can invade moist areas in plantation forests.	1
Horticulture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	L	L	Can impede water flow in drainage channels, waterways, and wetlands, leading to increased flooding risk.	1, 5
Species diversity	L	H	Forms dense colonies and displaces native riparian, wetland and coastal vegetation.	3, 4, 5
Threatened species	M	H	Has invaded coastal cliffs in Taranaki which are home to a number of low-growing endangered native plants.	3, 4
Social/Cultural				
Human health	-	-		
Recreation	L	M	Obstructs access to waterways and wetlands.	4
Maori culture	-	M	See Recreation.	4

L – 'low' impact (1–4% reduction in the economic value per ha per annum); **M** – 'moderate' impact (5–9% reduction in the economic value per ha per annum; **H** – 'high' impact (10–50% reduction in the economic value per ha per annum)

Source: 1: Williams et al (2005), 2: Williams et al (2005)); Taranaki Regional Council (2013g), 3: Biosecurity New Zealand (2009), 4: Environment Canterbury (2006b), 5: Taranaki Regional Council (2013g)

How much does it cost?

For the purposes of this report, the monetarised impacts of Giant gunnera are calculated as the current or anticipated proportional impact on forestry, environmental and social and cultural values across the region. However, this is a conservative estimate. The potential impacts are likely to be much higher as the plant spreads across the region with significant additional non-monetised costs being incurred where habitat degradation impacts on nationally threatened or regionally distinctive native species (and given the 'value' of these species).

Land use type	Current impact per ha	Potential impact per ha
Production	$0.09 – $0.83	$0.09 – $0.87
Dairy	$0	$0
Sheep and beef	$0	$0
Forestry	$0.09 – $0.83	$0.09 – $0.87
Horticulture	$0	$0
Environment	$2.60 – $16.00	$27.58 – $209.59
Social/Cultural	$0.01 – $0.13	$0.16 – $1.67

All amounts are in net present value (NPV, $). Source: Wildlands, 2017.

c. Cost-benefit analysis

CBA assumptions and inputs

Pest assumptions	Values	Programme assumptions	Values
Current area infested	450 ha	Proposed Programme	**Sustained Control** (Good neighbour and general rules)
Maximum potential area infested[º]	9,687 ha	Proposed annual expenditure by Council	$80,000
Time to reach maximum extent[†]	75 years	Proposed boundary width	500 m (Crown land) Whole property (private land)
Seed bank included	Yes	Repeated inspections required	Biannual
Current impacts ($)*	$9.83/ha ($2.7-$16.96 / ha)	Discount rate	4%

º Gant gunnera is still expanding its range. This is the potential extent the pest is predicted to achieve in the absence of regional management based upon LCDB

† The time Giant gunnera is predicted to take between first going wild in the region and reaching 90% of its potential maximum extent (in the absence of regional intervention)

* Current impact is for the current area of the pest, averaged across the impacts on all land uses within this area.

CBA assessment

The Council has calculated a cost-benefit scenario over 50 years for Giant gunnera, involving both good neighbour and general (whole of property) rules.

Good neighbour rule

Giant gunnera is capable of having significant impacts on conservation and forestry values. The CBA assessment[13] shows that on a property to property basis, the control of Giant gunnera within 500 metres of the property boundary is cost beneficial for forestry and conservation receptor land use types/values.

General rule

Giant gunnera has not yet reached its full potential extent in Taranaki. The CBA assessment confirms that regional intervention in the form of an general rules requiring private land occupier to destroy infestations is cost beneficial through the avoidance of pest impacts that would otherwise occur on forestry and conservation land uses. The net monetarised benefit of regional intervention over 50 years is estimated to be **$587,345**. However, this does not take into account the non-monetarised 'value' of protecting native riparian, wetland and coastal ecosystem types particularly threatened by Giant gunnera and associated habitat loss for some nationally threatened or regionally distinctive native species in Taranaki.

Scenario	Pest impacts*	Pest benefits	Council costsº	Compliance costs†	Net benefit
No regional intervention	$2,886,953	$0	$0	$0	
Sustained Control (preferred option)	$63,236	$2,823,717	$733,308	$1,503,064	**$587,345**

*Includes economic costs and conservatively valued environmental, social and cultural costs

ºCouncil costs refer to the administration and implementation costs incurred by the Council through the programme

†Compliance costs refer to any costs of control imposed on land occupiers through the programme.

[13] *Harris, et al, 2017.*

d. CBA statement and risks to success

Giant gunnera can form dense colonies which can invade plantation forests, displace native vegetation (especially on Taranaki's coastal cliffs and in wetland and riparian areas), and impede access to waterways.

A Sustained Control programme involving the imposition of rules requiring source land occupiers to destroy Giant gunnera infestations on their property is net beneficial to protect biodiversity values and address its spread to neighbouring properties.

The CBA for Giant gunnera suggests that this form of regional intervention will have monetarised benefits over a 50 year timeframe. However, significant additional non-monetised benefits associated with the protection of biodiversity values are also anticipated.

Risks of the programme being unsuccessful in achieving objectives

Risk	Level of risk	Explanation
Technical risk	Medium	Density, inaccessibility, and spread of current infestations can make control challenging in some situations.
Operational risk	Low	
Legal risk	Low	DOC is working closely with the Council to ensure effective control.
Socio-political risk	Low	To be tested through the Plan review process but proposed approach is a continuation of the existing approach for which no public or political concerns have been raised to date.
Other risks	Low	

e. Who should pay?

Beneficiaries and exacerbators

Group	Beneficiary	Exacerbator	Change behaviour	Assess costs & benefits	Control cost effectively
Anyone intentionally dumping or disposing of the plant		Major	Yes	Yes	Yes
Land occupiers (Crown or private)	Major	Major	Yes	Yes	Yes
Regional community‡	Major		No	Yes	Yes

Who should pay for the proposed management approach?

Giant gunnera is a major threat to conservation values in the Taranaki region. Land occupiers with infestations are the principal exacerbator of the problem. Land occupiers with infestations are therefore best placed to undertake and pay for the costs of any control and ensure that infestations are not impacting on conservation values or spreading to their neighbours.

To maximise the effectiveness of individual control across the region and to minimise the externality impacts of the plant the Council can implement an advisory, inspectorial, and compliance regime. The benefits of this part of the programme are a public good rather than a private good and it is appropriate that these indirect costs are paid for by the Council on behalf of the regional community. The regional community is able to assess the cost and benefits and effectiveness of the programme through the annual planning and reporting processes under the Local Government Act 2002 and through the review of future pest management plans.

5.3 Gorse

Ulex europaeus

KEY CHANGE:

New good neighbour rules

a. Pest attributes

Relevant biology and distribution

Attribute	Description
Form	Sharply spiny perennial shrub up to 4 m tall. Leaves reduced to a spine-like tip. Spines deeply furrowed. Very deep tap root and extensive lateral roots. Flowers are pea-like, yellow, 13-20 mm long. May-Nov (sometimes all year). Seed pod hairy, turning black, 13-25 mm long, explosive.
Habitat	Grassland, shrubland, forest margins (including plantation forests), hill country, coastal habitats, sand dunes, and wastelands. Tolerant of hot to cold, high to low rainfall, wind, salt, damage, grazing, and all soil types. Optimum growth on low fertility soils.
Regional distribution	Widespread throughout the region.
Competitive ability	Fast growth and being a nitrogen fixer means it can compete effectively with tree seedlings.
Reproductive ability	Seeds have hard coat, can be dormant for up to 30 years. Huge seed bank in soil (estimated 20,000 seeds/m^2).
Dispersal methods	Most seed fall close to parent plant but may be ejected up to 6 m. Also spread by water, birds, road making gravel and machinery.
Resistance to control	Difficult to control on infertile and steep land, as burning and grazing not effective. Stumps re-sprout quickly after damage or fire. Reseeds profusely, especially after fire, disturbance or non-selective spraying. Best controlled by a combination of methods, including selective herbicide use, and management for native forest succession.
Benefits	Can increase soil nitrogen and act as a nursery crop to facilitate regeneration of native forest on cleared land. Important source of pollen for bees, particularly in winter.

Where is it a problem?

Land use type	Current land use infested*	Potential land use infested*	Pest significant problem on this land type**
Dairy	Low	High	True
Sheep and beef (intensive)	Low	High	True
Hill country (sheep)	High	High	True
Forestry	Low	High	True
Horticulture	-	Low	False
Native / conservation	Low	Low	False
Urban / Non productive	Low	High	False

* High = Most infested/preferred land use(s), Low = Less infested/preferred land use(s), - = Unsuitable land use. Source: Wildlands 2017

** True = Most 'at risk' or impacted land use(s), False = Less 'at risk' or impacted land use(s) based upon impact assessment overleaf and Harris, *et al*, 2017.

b. Impact evaluation

How is it a problem?

Category	Current	Potential	Comment	Source
Production				
Dairy	L	M	Out-competes grass and clover, reducing pasture availability.	
Sheep and beef	M	H	Can rapidly invade hill country pastures and out-compete grass and clover, reducing food for stock. Spines pull fleece and lower value of wool.	
Forestry	L	M		1, 2, 3, 4
Horticulture	L	L		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	L	L	Nitrogen leaching from dense Gorse stands can increase nitrate levels in waterways and lakes.	
Species diversity	L	L-M	Forms dense stands, outcompetes low-growing species. Increases soil nitrogen, can induce succession to forest, to the detriment of specialised plants (e.g. herbs, orchids). Native forest succession through gorse results in different composition and lower diversity than succession through kanuka.	1, 2, 4, 5, 6, 7
Threatened species	L	M	Can invade rare habitat types (e.g. coastal sites, rock outcrops), which support specialist indigenous species.	2
Social/Cultural				
Human health	-	-		
Recreation	M	M	Dense shrubs with prickly spines restrict access.	8
Maori culture	L	M	Restricts access to historic cultural sites (e.g. Waahi tapu, urupa).	2

L – 'low' impact (1–4% reduction in the economic value per ha per annum); **M** – 'moderate' impact (5–9% reduction in the economic value per ha per annum; **H** – 'high' impact (10–50% reduction in the economic value per ha per annum)

Source: 1:Williams & Karl (2002):, 2: Craw (2000), 3: Roy *et al*. (2004), 4: Environment Bay of Plenty (2005a), 5: Lee *et al*. (1986), 6: Hill *et al*. (2001), 7: Sullivan *et al*. (2007), 8: Popay et al. (2010).

How much does it cost?

For the purposes of this report, the monetarised impacts of Gorse are calculated as the current or anticipated proportional impact on land use values across the region.

Land use type	Current impact per ha	Potential impact per ha
Production	$21.64 – $71.48	$87.32 – $288.13
Dairy	$12.20 – $39.63	$64.67 – $93.47
Sheep and beef	$9.35 – $31.01	$19.83 – $180.61
Forestry	$0.09 – $0.83	$2.26 – $12.27
Horticulture	$0	$0.55 - $1.78
Native / conservation	$0.89 – $3.47	$23.48 – $51.16
Social/Cultural	$0.07 – $0.29	$0.08 – $0.30

All amounts are in net present value (NPV, $). Source: Wildlands, 2017.

c. Cost-benefit analysis

CBA assumptions and inputs

Pest assumptions	Values	Programme assumptions	Values
Seed bank included:	Yes	Proposed Programme:	**Sustained Control** (Good neighbour rule only)
Pest abundance:	Locally common	Proposed boundary width:	10 m
Density of source infestations:	Scattered º	Repeated inspections required:	Once (over life of the Plan)
		Discount rate:	4%

º Gorse likely to be present in scattered infestations that, while significant, do not totally suppress other vegetation species.

CBA assessment

Gorse is widespread throughout the Taranaki region and has continuing and significant impacts on the dairy, sheep and beef, and plantation forestry sectors.[14] The CBA assessment[15] shows that on a property to property basis, the control of Gorse within ten metres of the property boundary is cost beneficial when the source property is a dairying, sheep and beef, hill country (sheep), and forestry land use type, or when the receptor properties are dairying, sheep and beef, hill country (sheep), and forestry receptor land use types.

Reasonableness of good neighbour rules				
Land uses affected	Dairying	Sheep and beef	Hill country	Forestry
Benefits from controlling pest ($/ per ha/ per annum)	$3,430	$564	$564	$8,000
Land occupier cost of controlling scattered infestations*	$100	$100	$100	$100

All amounts are in net present value (NPV, $). Source: Harris, 2017

* In addition to the potential compliance costs imposed on the source land occupier are the costs to the Taranaki Regional Council of enforcing a good neighbour rule. Enforcement activities are in the order of $330 to $440 per property inspection.

d. CBA statement and risks to success

Gorse is widespread throughout the Taranaki region and has continuing and significant impacts on production values in the region.

A Sustained Control programme involving the imposition of good neighbour rules requiring source land occupiers to destroy Gorse infestations on land is net beneficial within ten metres adjacent to dairying, sheep and beef (intensive), hill country and forestry properties.

[14] *As noted in the preceding impact evaluation, at some sites and places, Gorse can have significant **localised** adverse effects where it invades rare habitat types (e.g. coastal sites, rock outcrops) that support specialist indigenous species. However, at a regional level, the impacts of Gorse on Native / conservation land uses/values are generally beneficial or benign through its role as a nursery crop to facilitate regeneration of native forest. It is therefore proposed that good neighbour rules focus on the production impacts only.*

[15] *Harris, et al, 2017.*

Risks of the programme being unsuccessful in achieving objectives

Risk	Level of risk	Explanation
Technical risk	Low	Current programme has been successful to date in addressing externality impacts of gorse
Operational risk	Low	
Legal risk	Low	Weed hygiene by road and rail-controlling authorities is important. Gorse may be common along road and rail corridors where it can have significant externality impacts on neighbouring lands.
Socio-political risk	Low	To be tested through the Plan review process. Approach represents a change that focuses on production impacts. Historically most public complaints have come from urban areas where the impacts are primarily on amenity values.
Other risks	Low	

e. Who should pay?

Beneficiaries and exacerbators

Group	Beneficiary	Exacerbator	Change behaviour	Assess costs & benefits	Control cost effectively
Dairy/Sheep and beef sector	Major		Yes	Yes	Yes
Forestry sector	Minor	Minor	Yes	Yes	Yes
Land occupiers (Crown and private)	Minor	Major	Yes	Yes	Yes
Regional community‡	Major		No	Yes	Yes

Who should pay for the proposed management approach?

Gorse is a major threat to dairying, sheep and beef, hill country (sheep), and forestry land uses. Land occupiers are usually the principal beneficiaries of any control on their land. The principal exacerbators of the spread of Gorse are land occupiers with infestations. Land occupiers with infestations are best placed to undertake and pay for the costs of any control and ensure they are not impacting on their neighbours.

To maximise the effectiveness of individual control across the region and to minimise the externality impacts of the plant the Council will implement an advisory, inspectorial, and compliance regime. The benefits of this part of the programme are a public good rather than a private good and it is appropriate that these indirect costs are paid for by the Council on behalf of the regional community. The regional community is able to assess the costs and benefits and the effectiveness of the programme through the annual planning and reporting processes under the Local Government Act 2002 and through the review of future pest management plans.

5.4 Nodding and Plumeless Thistle

Carduus nutans, C. acanthides

KEY CHANGE:

New good neighbour rules

a. Pest attributes

Relevant biology and distribution

Attribute	Description
Form	Nodding thistle grows to 1.6 m. Leaves are up to 18 cm long by 10 cm wide with spiny margins. Leaves are dissected more than half way to the midrib. Upper leaf surfaces may have rough hairs, a metallic sheen, and appear whitish at the base of the spines. Flower stalks have wings. Flowers are fragrant, bright crimson, c.4 cm across, and droop down, nodding in the wind (Nov– Feb). Plumeless thistle is almost identical to nodding thistle, however its flower heads are slightly smaller and don't droop, and its bracts do not curve backwards. Its leaves are not as deeply incised. Flowers are purplish-red (rarely white), and solitary or clustered at stem and branch ends.
Habitat	Pasture, roadsides, and rough open areas. Infrequently found in forest, but can colonise disturbed and open areas. Most infested or preferred habitat types are dairying and sheep and beef properties.
Regional distribution	Heavy infestations are relatively confined in Taranaki.
Competitive ability	Both species are not readily grazed because of their spiny foliage and can form dense patches, achieving almost total ground cover.
Reproductive ability	Nodding thistle is usually biennial, germinating in autumn and flowering the second summer. Has 40-100 flower heads/plant, with c.200 seeds per flower, which are 60-80% viable. Most seeds germinate from late summer to early winter, but can germinate in spring–summer with adequate moisture. Plumeless thistle has 50-80 flower heads/plant. Seed viability can remain high for over 10 years in the soil. Flowers can be insect or self-pollinated.
Dispersal methods	Seeds are mainly dispersed by wind, but can also be spread in mud, water, fodder and agricultural seed, or on machinery.
Resistance to control	Grubbing plants at least 5 cm below the crown is an effective control method, provided it occurs before seed production. Spraying with herbicide before flowering can be effective, however plants may become more palatable after spraying, so stock need to be excluded until plants are dead. Mowing/topping is less effective, as plants can regrow, and repeated mowing is required. Plants mutilated before flowering may persist as perennials until they can flower.
Benefits	None.

Where is it a problem?

Land use type	Current land use infested*	Potential land use infested*	Pest significant problem on this land type**
Dairy	Low	High	True
Sheep and beef (intensive)	Low	High	True
Hill country (sheep)	High	High	True
Forestry	-	Low	False
Horticulture	Low	Low	False
Native / conservation	-	-	False
Urban / Non productive	-	-	False

* High = Most infested/preferred land use(s), Low = Less infested/preferred land use(s), - = Unsuitable land use. Source: Wildlands 2017

** True = Most 'at risk' or impacted land use(s), False = Less 'at risk' or impacted land use(s) based upon impact assessment overleaf and Harris, *et al*, 2017.

b. Impact evaluation

How is it a problem?

Category	Current	Potential	Comment	Source
Production				
Dairy	L	M	Unpalatable to cattle. Reduces pasture availability and could lead to a reduction in milk production.	
Sheep and beef	M	H	Unpalatable to stock and reduces pasture availability. Spiny seed heads will contaminate wool, decreasing its value. When flowering, can reduce stock movement and make mustering difficult. Can increase the viral diseases scabby mouth and parapox, which infect sheep through punctures on the lips and mouth.	1, 2
Forestry	-	-		
Horticulture	L	L	Could compete with and contaminate arable crops.	
Other	-	-		
International trade	-	L	Could be an issue for certified seed growers, as seed contaminated with nodding thistle cannot be exported.	
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	-	L	Could compete with native plants in open habitats, such as grassland, dunes, forest margins and canopy gaps. Dense patches provide cover for pest animals, particularly rabbits.	1, 2
Threatened species	-	-	Not often found competing with threatened native species.	1
Social/Cultural				
Human health	L	L	Sharp spines can penetrate skin, and sometimes fester.	
Recreation	-	-		
Maori culture	-	-		

L – 'low' impact (1–4% reduction in the economic value per ha per annum); **M** – 'moderate' impact (5–9% reduction in the economic value per ha per annum; **H** – 'high' impact (10–50% reduction in the economic value per ha per annum)

Source: 1: Popay (2008):, 2: Environment Bay of Plenty (2005b).

How much does it cost?

For the purposes of this report, the monetarised impacts of Nodding and Plumeless thistles are calculated as the current or anticipated proportional impact on dairying, sheep and beef, forestry, and horticultural production values across the region.

Land use type	Current impact per ha	Potential impact per ha
Production	$22.08 – $72.34	$343.75 – $766.56
Dairy	$12.20 – $39.63	$323.36 – $584.17
Sheep and beef	$9.35 – $31.01	$19.83 – $180.61
Forestry	$0	$0
Horticulture	$0. 25 – $1.70	$0.55 - $1.78
Native / conservation	$0	$0
Social/Cultural	$0	$0

All amounts are in net present value (NPV, $). Source: Wildlands, 2017.

c. Cost-benefit analysis

CBA assumptions and inputs

Pest assumptions	Values	Programme assumptions	Values
Seed bank included:	Yes	Proposed Programme:	**Sustained Control** (Good neighbour rule only)
Pest abundance:	Rare	Proposed boundary width:	100 m
Density of source infestations:	Scattered º	Repeated inspections required:	Once (over life of the Plan)
		Discount rate:	4%

º Thistles likely to be in scattered infestations that, while significant, do not totally suppress other vegetation species.

CBA assessment

Nodding and plumeless thistles are generally well managed in the region but can have significant impacts on dairy, sheep and beef, and hill country production values. The CBA assessment[16] shows that on a property to property basis, the control of Nodding and Plumeless thistles within 100 metres of the property boundary is cost beneficial when the source property is a dairying, sheep and beef, and hill country (sheep) land use type, or when the receptor properties are dairying, sheep and beef, and hill country (sheep) receptor land use types.

Reasonableness of good neighbour rules			
Land uses affected	Dairying	Sheep and beef	Hill country (sheep)
Benefits from controlling pest ($/ per ha/ per annum)	$3,430	$564	$564
Land occupier cost of controlling scattered infestations*	$100	$100	$100

All amounts are in net present value (NPV, $). Source: Harris, 2017

* In addition to the potential compliance costs imposed on the source land occupier are the costs to the Taranaki Regional Council of enforcing a good neighbour rule. Enforcement activities are in the order of $330 to $440 per property inspection.

d. CBA statement and risks to success

Nodding and Plumeless thistles are generally well managed in the region but can have significant impacts on dairying and sheep and beef production values in the region.

A Sustained Control programme involving the imposition of good neighbour rules requiring source land occupiers to destroy Nodding and Plumeless thistle infestations on land is net beneficial within 100 metres from the property boundary adjacent to dairying, sheep and beef, and hill country properties.

[16] *Harris, et al, 2017.*

Risks of the programme being unsuccessful in achieving objectives

Risk	Level of risk	Explanation
Technical risk	Low	Current programme has been successful to date in addressing externality impacts of Nodding and Plumeless thistles.
Operational risk	Low	
Legal risk	Low	
Socio-political risk	Low	To be tested through the Plan review process but proposed approach is a continuation of the existing approach for which no public or political concerns have been raised to date.
Other risks	Low	

e. Who should pay?

Beneficiaries and exacerbators

Group	Beneficiary	Exacerbator	Change behaviour	Assess costs & benefits	Control cost effectively
Land occupiers (Crown and private)	Major	Minor	No	Yes	Yes
Dairy/Sheep and Beef sector	Major	Major	Yes	Yes	Yes
Regional community‡	Minor		No	Yes	Yes

Who should pay for the proposed management approach?

Nodding and Plumeless thistles are a major threat to dairying and hill country farmers. Land occupiers are usually the principal beneficiaries of control on their land. The principal exacerbators of the spread of thistles are land occupiers with infestations. Land occupiers with infestations are best placed to undertake and pay for the costs of any control and ensure they are not impacting on their neighbours.

To maximise the effectiveness of individual control across the region and to minimise the externality impacts of the plant the Council will implement an advisory, inspectorial, and compliance regime. The benefits of this part of the programme are a public good rather than a private good and it is appropriate that these indirect costs are paid for by the Council on behalf of the regional community. The regional community is able to assess the cost and benefits and effectiveness of the programme through the annual planning and reporting processes under the Local Government Act 2002 and through the review of future pest management plans.

KEY CHANGE:

New good neighbour rules

Extension of rules to cover properties adjacent to Kaupokonui and Waingongoro rivers

5.5 Old Man's Beard

Clematis vitalba

a. Pest attributes

Relevant biology and distribution

Attribute	Description
Form	Deciduous woody vine, which grows along the ground or over trees and shrubs. Prolific white flowers.
Habitat	Scrub, wasteland, among willows, forest remnants, hedgerows, roadsides, river banks, in gardens, disturbed native bush, shelterbelts. Prefers well-drained soils. Most infested or preferred habitat types are forestry and native land uses.
Regional distribution	Heavy infestations in south and coastal areas. Currently occupies 600ha but maximum potential extent in Taranaki is 58,000 ha over 125 yrs.
Competitive ability	Rapid growth rate. Can completely shade out canopy species, preferring well-drained alluvial soil. Light-demanding in seedling stage.
Reproductive ability	Produces >10,000 seeds per sq. m, which remain viable on the vine over winter. Seed has an awn that enables it to bury into the soil for germination. Germination rate >80%.
Dispersal methods	Usually spread by wind over short distances, or water over long distances. Can also be spread in road gravel.
Resistance to control	Difficult to destroy but mature vines can be treated by cut and paint techniques using clopyralid, glyphosate or metsulfuron. Use of herbicides comprised by plants' climbing nature.
Benefits	None.

Where is it a problem?

Land use type	Current land use infested*	Potential land use infested*	Pest significant problem on this land type**
Dairy	Low	Low	False
Sheep and beef (intensive)	Low	Low	False
Hill country (sheep)	Low	Low	False
Forestry	Low	High	True
Horticulture	-	Low	False
Native / conservation	High	High	True
Urban / Non productive	Low	Low	False

* High = Most infested/preferred land use(s), Low = Less infested/preferred land use(s), - = Unsuitable land use. Source: Wildlands, 2017

** True = Most 'at risk' or impacted land use(s), False = Less 'at risk' or impacted land use(s) based upon impact assessment overleaf.

b. Impact evaluation

How is it a problem?

Category	Current	Potential	Comment	Source
Production				
Dairy	-	L	Can smother trees in farm shelterbelts.	
Sheep and beef	-	L	The occasional death of cattle from eating this plant has been recorded in England.	
Forestry	L	M	Smothers trees in plantation forests. Prevents access and creates safety hazard during harvest of plantation trees.	1, 2
Horticulture	-	L	Smothers trees in orchards.	
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	M	H	Forms dense, heavy, permanent masses. Smothers and kills all plants to highest canopy. Slows and inhibits regeneration of native plant species.	3,
Threatened species	L	H	See Species diversity.	3
Social/Cultural				
Human health	-	-		
Recreation	L	L	Dense, heavy, long-lived masses obstruct access to forest.	3
Maori culture	L	L	See Recreation.	3

L – 'low' impact (1–4% reduction in the economic value per ha per annum); **M** – 'moderate' impact (5–9% reduction in the economic value per ha per annum; **H** – 'high' impact (10–50% reduction in the economic value per ha per annum)

Source: 1: Department of Conservation (1999), 2: Popay et al. (2010), 3: Craw (2000).

How much does it cost?

For the purposes of this report, the monetarised impacts of Old man's beard are calculated as the current or anticipated proportional impact on production, environmental and social and cultural values across the region. However, this is a conservative estimate. The potential impacts are likely to be much higher as the plant spreads across the region with significant additional non-monetised costs being incurred where habitat degradation impacts on nationally threatened or regionally distinctive native species (and given the 'value' of these species).

Land use type	Current impact per ha	Potential impact per ha
Production	$0.09–0.83	$16.15–57.90
Dairy	$0	$12.93–41.54
Sheep and beef	$0	$0.40–2.31
Forestry	$0.09–0.83	$2.26–12.27
Horticulture	$0	$0.55–1. 87
Environment	$22.15–48.80	$46.95–248.20
Social/Cultural	$0.01–0.15	$0.03–0.27

All amounts are in net present value (NPV, $). Source: Wildlands, 2017.

c. Cost-benefit analysis

CBA assumptions and inputs

Pest assumptions	Values	Programme assumptions	Values
Current area infested	600 ha	Proposed Programme	**Sustained Control** (Good neighbour and general rules)
Maximum potential area infested[º]	57,962 ha	Proposed annual expenditure by Council	$100,000
Time to reach maximum extent[†]	125 years	Proposed boundary width	10 m (Crown land) Whole property (private land)
Seed bank included	Yes	Repeated inspections required	Annually
Current impacts ($)*	$35.96/ha ($22.25-$49.68 / ha)	Discount rate	4%

º Old man's beard is still expanding its range. This is the potential extent the pest is predicted to achieve in the absence of regional management based upon LCDB

† The time Old man's beard is predicted to take between first going wild in the region and reaching 90% of its potential maximum extent (in the absence of regional intervention)

* Current impact is for the current area of the pest, averaged across the impacts on all land uses within this area.

CBA assessment

The Council has calculated a cost-benefit scenario over 50 years for Old man's beard, involving both good neighbour and general (whole of property) rules.

Good neighbour rule

Old man's beard is capable of having significant impacts on conservation and forestry values. The CBA assessment[17] shows that on a property to property basis, the control of Old man's beard within 500 metres of the property boundary is cost beneficial for forestry and conservation receptor land use types/values.

General rule

Old man's beard has not yet reached its full potential extent in Taranaki. The CBA assessment confirms that regional intervention in the form of an general rules requiring private land occupier to destroy infestations is cost beneficial through the avoidance of pest impacts that would otherwise occur on forestry and conservation land uses. The net monetarised benefit of regional intervention over 50 years is estimated to be **$3,126,280**. However, this does not take into account the non-monetarised 'value' of protecting native riparian and forestry ecosystem types particularly threatened by Old man's beard and associated habitat loss for some nationally threatened or regionally distinctive native species in Taranaki.

Scenario	Pest impacts*	Pest benefits	Council costs[º]	Compliance costs[†]	Net benefit
No regional intervention	$8,614,321	$0	$0	$0	
Sustained Control (preferred option)	$308,505	$8,305,816	$915,526	$4,264,010	**$3,126,280**

* Includes economic costs and conservatively valued environmental, social and cultural costs

º Council costs refer to the administration and implementation costs incurred by the Council through the programme

† Compliance costs refer to any costs of control imposed on land occupiers through the programme.

[17] *Harris, et al, 2017.*

d. CBA statement and risks to success

Old man's beard is an invasive climber, which can form dense, heavy, permanent masses that can smother and kills all plants to highest canopy (especially on forest edges and along riparian margins). A Sustained Control programme involving the imposition of rules requiring source land occupiers to destroy Old man's beard infestations on their property is net beneficial to protect biodiversity values and address its spread to neighbouring properties.

The CBA for Old man's beard suggests that this form of regional intervention will have monetarised benefits over a 50 year timeframe. However, significant additional non-monetised benefits associated with the protection of biodiversity values are also anticipated.

Risks of the programme being unsuccessful in achieving objectives

Risk	Level of risk	Explanation
Technical risk	Low	The pest is widespread in the region, particularly in hedgerows and some riparian margins. A focus on control in the Kaupokonui and Waingongoro catchments has achieved initial success in these areas and ongoing monitoring of maintenance control by land occupiers will be required
Operational risk	Low	
Legal risk	Low	
Socio-political risk	Low	Proposed approach is largely a continuation of the existing approach, for which no public or political concerns have been raised to date. Increased public intervention in the Kaupokonui and Waingongoro catchments will be required, with costs incurred by the public. The acceptability of this increased focus to the public will be tested through the public process.
Other risks	Low	

e. Who should pay?

Beneficiaries and exacerbators

Group	Beneficiary	Exacerbator	Change behaviour	Assess costs & benefits	Control cost effectively
Land occupiers (Crown or private)	Minor	Major	Yes	Yes	Yes
Forestry sector	Minor		Yes	Yes	Yes
Anyone intentionally dumping or disposing of the plant		Major	Yes	Yes	Yes
Regional community[‡]	Major		No	Yes	Yes

Who should pay for the proposed management approach?

Old man's beard is a major threat to biodiversity values in the Taranaki region. Land occupiers with infestations are the principal exacerbator of the problem. Land occupiers with infestations are best placed to undertake and pay for the costs of any control and ensure that infestations are not impacting on conservation values or spreading to their neighbours.

To maximise the effectiveness of individual control across the region and to minimise the externality impacts of the plant the Council can implement an advisory, inspectorial, and compliance regime. The benefits of this part of the programme are a public good rather than a private good and it is appropriate that these indirect costs are paid for by the Council on behalf of the regional community. The regional community is able to assess the cost and benefits and effectiveness of the programme through the annual planning and reporting processes under the Local Government Act 2002 and through the review of future pest management plans.

5.6 Pampas (Common and Purple)

Gunnera tinctoria, and G. manicata

KEY CHANGE:

New good neighbour rules

a. Pest attributes

Relevant biology and distribution

Attribute	Description
Form	Tall clump-forming grasses (to 4 m tall), with sharp leaves mostly developing from the base. Leaves with conspicuous midrib which does not reach to leaf base, and no secondary veins between midrib and leaf edge. Leaves snap readily when tugged. Dead leaf bases spiral like wood shavings. Flowerheads are erect, dense and fluffy. Common pampas leaves are blueish-green above, dark green below. Leaf bases are smooth or sparsely hairy, no white waxy surface. Flowerheads are white-pinkish, fading to dirty white-yellow ((Jan)–Mar–Jun). In purple pampas leaf surfaces are dark green. Leaf bases are very hairy, without a white waxy surface. Flowerheads are purple, fading to dirty brown (Jan–Mar). Native toetoe leaves don't snap readily, midrib continues into leaf base, have distinct secondary veins between midrib and edge, and white waxy leaf sheaths. Dead leaves don't spiral.
Habitat	Prefers disturbed areas such as roadside banks, slip faces, cliffs, riverbeds, river banks, coastal areas, estuaries, shrublands, and canopy gaps in forest. Common in forestry blocks. Wide environmental tolerance: tolerates heat, frost, salt, wind, wet and dry conditions, moderate shade, most soils, and low fertility.
Regional distribution	Widespread throughout the region. Most infested or preferred habitat types are forestry, native and coastal land uses.
Competitive ability	Fast growth rate and very hardy. Recovers quickly after fire. A major problem in forestry areas. The root system of a single plant can occupy as much as 103 cubic m of soil.
Reproductive ability	Prolific flowering, with up to 100,000 seeds produced per flower head.
Dispersal methods	Seed dispersed primarily by wind (reputedly 10–25 km), however gravel, vehicles and animals can also carry seed.
Resistance to control	Can be controlled using herbicides, but can be resistant so repeat applications are often necessary. Size of mature plants makes mechanical removal difficult. Sometimes grazed by stock.
Benefits	Valued as hedges and windbreaks on farms.

Where is it a problem?

Land use type	Current land use infested*	Potential land use infested*	Pest significant problem on this land type**
Dairy	Low	Low	False
Sheep and beef (intensive)	Low	Low	False
Hill country (sheep)	High	High	False
Forestry	High	High	True
Horticulture	Low	Low	False
Native / conservation	High	High	True
Urban / Non productive	Low	Low	False

* High = Most infested/preferred land use(s), Low = Less infested/preferred land use(s), - = Unsuitable land use. Source: Wildlands 2017

** True = Most 'at risk' or impacted land use(s), False = Less 'at risk' or impacted land use(s) based upon impact assessment overleaf.

b. Impact evaluation

How is it a problem?

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-		
Sheep and beef	L	L		
Forestry	M	H	Can invade moist areas in plantation forests.	1
Horticulture	L	L		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	L	M	Readily colonises burnt or disturbed sites and quickly becomes very dense. Replaces native ground covers, shrubs, and ferns. Provides habitat for possums, rats, and mustelids.	2
Threatened species	L	L	See species diversity.	2
Social/Cultural				
Human health	L	L	Sharp leaves can cut skin.	1
Recreation	L	M	Forms dense patches which restrict access, especially to waterways and coastal areas.	2
Maori culture	-	M	See Recreation.	2

L – 'low' impact (1–4% reduction in the economic value per ha per annum); **M** – 'moderate' impact (5–9% reduction in the economic value per ha per annum; **H** – 'high' impact (10–50% reduction in the economic value per ha per annum)

Source: 1: Department of Conservation (1997), 2: Craw (2000).

How much does it cost?

For the purposes of this report, the monetarised impacts of Common and Purple pampas are calculated as the current or anticipated proportional impact on land values across the region. However, this is a conservative estimate. The potential impacts are likely to be much higher as the plant spreads across the region with significant additional non-monetised costs being incurred where habitat degradation impacts on nationally threatened or regionally distinctive native species (and given the 'value' of these species).

Land use type	Current impact per ha	Potential impact per ha
Production	$4.53 – $27.19	$7.07 – $84.41
Dairy	$0	$0
Sheep and beef	$1.87 – $13.78	$1.98 – $14.45
Forestry	$2.14 – $11.71	$4.53 – $68.18
Horticulture	$0.52 – $1.70	$0.55 – $1.78
Environment	$4.43 – $21.69	$23.48 – $51.16
Social/Cultural	$0.02 – $0.19	$0.08 – $0.45

All amounts are in net present value (NPV, $). Source: Wildlands, 2017.

c. Cost-benefit analysis

CBA assumptions and inputs

Pest assumptions	Values	Programme assumptions	Values
Seed bank included:	Yes	Proposed Programme:	**Sustained Control** (Good neighbour rule only)
Pest abundance:	Common	Proposed boundary width:	2,000 m
Density of source infestations:	Scattered º	Repeated inspections required:	Once (over life of the Plan)
		Discount rate:	4%

º Pampas likely to be in scattered infestations that, while significant, do not totally suppress other vegetation species.

CBA assessment

Common and Purple pampas can have significant impacts on forestry and conservation values in the region. The CBA assessment[18] shows that on a property to property basis, the control of Pampas within 2,000 metres of the property boundary is cost beneficial for forestry and conservation receptor land use types/values.

	Reasonableness of good neighbour rules	
Land uses affected	Forestry	Native / conservation
Benefits from controlling pest ($/ per ha/ per annum)	$8,000	$793
Land occupier cost of controlling scattered infestations*	$850	$850

All amounts are in net present value (NPV, $). Source: Harris, 2017

* In addition to the potential compliance costs imposed on the source land occupier are the costs to the Taranaki Regional Council of enforcing a good neighbour rule. Enforcement activities are in the order of $330 to $440 per property inspection.

d. CBA statement and risks to success

Pampas can invade plantation forests and, displace native vegetation – especially on Taranaki's coastal cliffs, riparian areas and wetlands.

A Sustained Control programme involving the imposition of rules requiring source land occupiers to destroy Pampas infestations on their property is net beneficial to protect conservation and forestry values and address its spread to neighbouring properties.

[18] *Harris, et al, 2017.*

Risks of the programme being unsuccessful in achieving objectives

Risk	Level of risk	Explanation
Technical risk	Medium	Plant is widespread and has commonly been used as a hedgerow where impacts on biodiversity are negligible. Current available herbicide is costly. It is unlikely that a bio-control agent will be available within the life of this Plan.
Operational risk	Low	Control is difficult to apply in the steep hill country.
Legal risk	Low	Control is more difficult along the rail corridor.
Socio-political risk	Low	Cost of compliance with good neighbour rule may have implications for on-going community and political support for the programme. Community support will be tested through public process.
Other risks	Low	Removal of pampas may exacerbate erosion in the steep hill country.

e. Who should pay?

Beneficiaries and exacerbators

Group	Beneficiary	Exacerbator	Change behaviour	Assess costs & benefits	Control cost effectively
Land occupiers (Crown or private)	Minor	Major	Yes	Yes	Yes
Forestry	Major	Minor	Yes	Yes	Yes
Dairy / sheep and beef	Minor	Minor	Yes	Yes	Yes
Regional community[‡]	Major		No	Yes	Yes

Who should pay for the proposed management approach?

Pampas is a major threat to conservation values in the Taranaki region. Land occupiers with infestations are the principal exacerbator of the problem. Land occupiers with infestations are best placed to undertake and pay for the costs of any control and ensure that infestations are not impacting on conservation values or spreading to their neighbours.

To maximise the effectiveness of individual control across the region and to minimise the externality impacts of the plant the Council can implement an advisory, inspectorial, and compliance regime. The benefits of this part of the programme are a public good rather than a private good and it is appropriate that these indirect costs are paid for by the Council on behalf of the regional community. The regional community is able to assess the cost and benefits and effectiveness of the programme through the annual planning and reporting processes under the Local Government Act 2002 and through the review of future pest management plans

5.7 Variegated Thistle

Silybum marianum

KEY CHANGE:

New good neighbour rules

a. Pest attributes

Relevant biology and distribution

Attribute	Description
Form	Annual or biennial thistle up to 2 m tall. Leaves are very prickly. Stem is hollow without spines. Flowers are large (7 cm diameter) and red/purple in colour; only one flower per stem.
Habitat	Roadsides, pastures, gardens, and wasteland. Grows best on high fertility soils. Most infested or preferred habitat types are dairying and sheep and beef properties.
Regional distribution	Heavy infestations are relatively confined in Taranaki.
Competitive ability	Very aggressive, forming dense impenetrable stands.
Reproductive ability	Flowers produce large numbers of seeds which may remain viable for years.
Dispersal methods	By wind or inclusion in hay bales.
Resistance to control	Spread of germination times across the year increases difficulty of control but the plant is susceptible to several herbicides especially in seedling and rosette stages.
Benefits	Edible (young leaves, peeled young stems, roots, bases of flower heads) and used as medicinal plant (liver complaints).

Where is it a problem?

Land use type	Current land use infested*	Potential land use infested*	Pest significant problem on this land type**
Dairy	Low	High	True
Sheep and beef (intensive)	Low	High	True
Hill country (sheep)	High	High	True
Forestry	-	-	False
Horticulture	-	-	False
Native / conservation	-	-	False
Urban / Non productive	-	-	False

* High = Most infested/preferred land use(s), Low = Less infested/preferred land use(s), - = Unsuitable land use. Source: Wildlands 2017

** True = Most 'at risk' or impacted land use(s), False = Less 'at risk' or impacted land use(s) based upon impact assessment overleaf and Harris, *et al*, 2017.

b. Impact evaluation

How is it a problem?

Category	Current	Potential	Comment	Source
Production				
Dairy	L	M	Forms dense patches, especially on high fertility soils. Prickles may damage stock and can cause nitrate poisoning in cattle and sheep.	
Sheep and beef	L	M	See Dairy.	1, 2
Forestry	-	-		
Horticulture	-	L		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	-	-		
Threatened species	-	-		
Social/Cultural				
Human health	-	-		
Recreation	-	L	Dense patches of large, spiky plants are nasty to work through.	1, 2
Maori culture	-	-		

L – 'low' impact (1–4% reduction in the economic value per ha per annum); **M** – 'moderate' impact (5–9% reduction in the economic value per ha per annum; **H** – 'high' impact (10–50% reduction in the economic value per ha per annum)

Source: 1:Roy et al. (2004), 2: Environment Bay of Plenty (2005d)

How much does it cost?

For the purposes of this report, the monetarised impacts of Variegated thistles are calculated as the current or anticipated proportional impact on dairying, sheep and beef, and hill country production values across the region.

Land use type	Current impact per ha	Potential impact per ha
Production	$14.07 – $53. 14	$74.59 – $125.98
Dairy	$12.20 – $39.63	$64.67 – $93.47
Sheep and beef	$1.87 – $13.78	$9.92 – $32.51
Forestry	$0	$0
Horticulture	$0	$0
Native / conservation	$0	$0
Social/Cultural	$0	$0

All amounts are in net present value (NPV, $). Source: Wildlands, 2017.

c. Cost-benefit analysis

CBA assumptions and inputs

Pest assumptions	Values	Programme assumptions	Values
Seed bank included:	Yes	Proposed Programme:	**Sustained Control** (Good neighbour rule only)
Pest abundance:	Rare	Proposed boundary width:	5 m
Density of source infestations:	Scattered º	Repeated inspections required:	Once (over life of the Plan)
		Discount rate:	4%

º Thistles likely to be in scattered infestations that, while significant, do not totally suppress other vegetation species.

CBA assessment

Variegated thistles are generally well managed in the region but can have significant impacts on dairy, sheep and beef, and hill country production values. The CBA assessment[19] shows that on a property to property basis, the control of Variegated thistles within five metres of the property boundary is cost beneficial when the source property is a dairying, sheep and beef, and hill country (sheep) land use type, or when the receptor properties are dairying, sheep and beef, and hill country (sheep) receptor land use types.

Reasonableness of good neighbour rules			
Land uses affected	Dairying	Sheep and beef	Hill country (sheep)
Benefits from controlling pest ($/ per ha/ per annum)	$3,430	$564	$564
Land occupier cost of controlling scattered infestations*	$150	$150	$150

All amounts are in net present value (NPV, $). Source: Harris, 2017

* In addition to the potential compliance costs imposed on the source land occupier are the costs to the Taranaki Regional Council of enforcing a good neighbour rule. Enforcement activities are in the order of $330 to $440 per property inspection.

d. Risks to success

Variegated thistles are generally well managed in the region but can have significant impacts on dairying and sheep and beef production values in the region.

A Sustained Control programme involving the imposition of good neighbour rules requiring source land occupiers to destroy Variegated thistle infestations on land is net beneficial within five metres from the property boundary adjacent to dairying, sheep and beef, and hill country properties.

[19] *Harris, et al, 2017.*

Risks of the programme being unsuccessful in achieving objectives

Risk	Level of risk	Explanation
Technical risk	Low	Current programme has been successful to date in addressing externality impacts of Variegated thistles.
Operational risk	Low	
Legal risk	Low	
Socio-political risk	Low	To be tested through the Plan review process but proposed approach is a continuation of the existing approach for which no public or political concerns have been raised to date.
Other risks	Low	

e. Who should pay?

Beneficiaries and exacerbators

Group	Beneficiary	Exacerbator	Change behaviour	Assess costs & benefits	Control cost effectively
Land occupiers (Crown and private)	Major	Major	No	Yes	Yes
Dairy/Sheep and Beef sector	Minor		Yes	Yes	Yes
Regional community‡	Minor		No	Yes	Yes

Variegated thistles are a major threat to dairying and sheep and beef farmers. Land occupiers are usually the principal beneficiaries of control on their land. The principal exacerbators of the spread of thistles are land occupiers with infestations. Land occupiers with infestations are best placed to undertake and pay for the costs of any control and ensure they are not impacting on their neighbours.

To maximise the effectiveness of individual control across the region and to minimise the externality impacts of the plant the Council will implement an advisory, inspectorial, and compliance regime. The benefits of this part of the programme are a public good rather than a private good and it is appropriate that these indirect costs are paid for by the Council on behalf of the regional community. The regional community is able to assess the cost and benefits and effectiveness of the programme through the annual planning and reporting processes under the Local Government Act 2002 and through the review of future pest management plans.

5.8 Wild Broom

Cytisus scoparius

KEY CHANGE:

New good neighbour rules

a. Pest attributes

Relevant biology and distribution

Attribute	Description
Form	Erect shrub up to 3 m tall, with ribbed green 5-angled stems. Bright, yellow pealike flowers, which are borne singly, or in pairs, in the leaf forks near the tips of the branches. Flattened, elongated pods (25-70 mm long and 8-13 mm wide) are hairy along their margins and turn brown or black as they mature.
Habitat	Highly invasive weed of waste areas, pasture, forestry, riverbeds, streambank margins, dunes, shrubland, secondary forest, tussock grassland, and low alpine areas, and quarries.
Regional distribution	Relatively confined in Taranaki to Patea catchment.
Competitive ability	Rapidly forms large infestations, smothering young trees in plantation forests, reducing pasture availability, and native revegetation. Can also be a nuisance on roadside verges and streambanks.
Reproductive ability	Produces numerous viable seeds, Has a large soil seed bank which can persist for at least 16 years and probably much longer. Fire and cultivation encourage seed germination.
Dispersal methods	Explosive seed pods that crack open on hot days. Can also be transported in soil, machinery, clothing, and by stock (in wool).
Resistance to control	Can be controlled with herbicides such as glyphosate or metsulfuron (e.g. Escort, Meturon on Zeal). Seedlings need to be hand pulled. Difficult to remove from an area due to persistence of soil seed bank.
Benefits	Nitrogen fixer, enriches soil (although this can facilitate other invasive plant species). Important source of pollen for bees.

Where is it a problem?

Land use type	Current land use infested*	Potential land use infested*	Pest significant problem on this land type**
Dairy	Low	Low	True
Sheep and beef (intensive)	Low	Low	True
Hill country (sheep)	High	High	True
Forestry	Low	High	True
Horticulture	-	Low	False
Native / conservation	Low	High	True
Urban / Non productive	High	High	False

* High = Most infested/preferred land use(s), Low = Less infested/preferred land use(s), - = Unsuitable land use. Source: Wildlands 2017

** True = Most 'at risk' or impacted land use(s), False = Less 'at risk' or impacted land use(s) based upon impact assessment overleaf and Harris, *et al*, 2017.

b. Impact evaluation

How is it a problem?

Category	Current	Potential	Comment	Source
Production				
Dairy	L	M	Readily invades pasture, reducing food available for grazing stock.	
Sheep and beef	M	M	See Dairy.	
Forestry	L	H	Has considerable impacts on production forestry by smothering young trees – potential to cause up to 40% losses of trees.	1
Horticulture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	L	M	Enriches nitrogen in the soil, can change soil composition.	2
Water quality	-	-		
Species diversity	M	H	Forms dense patches and outcompetes most native species. Can prevent forest regeneration.	1, 3
Threatened species	M	H	Changes the soil composition which can affect threatened species, or promote other invasive species. Can shade out low stature species.	2
Social/Cultural				
Human health	-	-		
Recreation	L	M	Dense patches can be difficult to walk through, restricting access to waterways, coastal sites, and native forest margins.	1
Maori culture	-	M	See Recreation.	

L – 'low' impact (1–4% reduction in the economic value per ha per annum); M – 'moderate' impact (5–9% reduction in the economic value per ha per annum; H – 'high' impact (10–50% reduction in the economic value per ha per annum)

Source: 1:New Zealand Forest Health Research Collaborative (2005), 2: Williams (1998), 3: Environment Canterbury (2012).

How much does it cost?

For the purposes of this report, the monetarised impacts of Wild broom are calculated as the current or anticipated proportional impact on land use values across the region.

Land use type	Current impact per ha	Potential impact per ha
Production	$21.64 – $71.48	$79.12 – $194.16
Dairy	$12.20 – $39.63	$64.67 – $93.47
Sheep and beef	$9.35 – $31.01	$9.92 – $32.51
Forestry	$0.09 – $0.83	$4.53 – $68.18
Horticulture	$0	$0
Native / conservation	$4.43 – $7.81	$46.95 – $284.20
Social/Cultural	$0	$0.03 – $0.27

All amounts are in net present value (NPV, $). Source: Wildlands, 2017.

c. Cost-benefit analysis

CBA assumptions and inputs

Pest assumptions	Values	Programme assumptions	Values
Seed bank included:	Yes	Proposed Programme:	**Sustained Control** (Good neighbour rule only)
Pest abundance:	Locally common	Proposed boundary width:	10 m
Density of source infestations:	Scattered º	Repeated inspections required:	Once (over life of the Plan)
		Discount rate:	4%

º Gorse likely to be present in scattered infestations that, while significant, do not totally suppress other vegetation species.

CBA assessment

Wild broom is widespread throughout the Taranaki region and has continuing and significant impacts on the dairy, sheep and beef, and plantation forestry sectors.[20] The CBA assessment[21] shows that on a property to property basis, the control of Wild broom within ten metres of the property boundary is cost beneficial when the source property is a dairying, sheep and beef, hill country (sheep), and forestry land use type, or when the receptor properties are dairying, sheep and beef, hill country (sheep), and forestry receptor land use types.

Reasonableness of good neighbour rules				
Land uses affected	Dairying	Sheep and beef	Hill country	Forestry
Benefits from controlling pest ($/ per ha/ per annum)	$3,430	$564	$564	$8,000
Land occupier cost of controlling scattered infestations*	$100	$100	$100	$100

All amounts are in net present value (NPV, $). Source: Harris, 2017

* In addition to the potential compliance costs imposed on the source land occupier are the costs to the Taranaki Regional Council of enforcing a good neighbour rule. Enforcement activities are in the order of $330 to $440 per property inspection.

d. CBA statement and risks to success

Wild broom is relatively widespread throughout the Taranaki region and has continuing and significant impacts on production values in the region.

A Sustained Control programme involving the imposition of good neighbour rules requiring source land occupiers to destroy Wild broom infestations on land is net beneficial within ten metres adjacent to dairying, sheep and beef (intensive), hill country and forestry properties.

[20] *As noted in the preceding impact evaluation, at some sites and places, Wild broom can also have significant localised adverse effects where it invades rare habitat types (e.g. coastal sites, rock outcrops) that support specialist indigenous species. However, at a regional level, the biodiversity impacts of Wild broom are generally not a problem. It is therefore proposed that good neighbour rules focus on the production impacts only.*

[21] *Harris, et al, 2017.*

Risks of the programme being unsuccessful in achieving objectives

Risk	Level of risk	Explanation
Technical risk	Medium	Current programme has been successful to date in addressing externality impacts of Wild broom.
Operational risk	Low	
Legal risk	Low	
Socio-political risk	Low	To be tested through the Plan review process but proposed approach is a continuation of the existing approach for which no public or political concerns have been raised to date.
Other risks	Low	

e. Who should pay?

Beneficiaries and exacerbators

Group	Beneficiary	Exacerbator	Change behaviour	Assess costs & benefits	Control cost effectively
Land occupiers (Crown and private)	Major	Major	No	Yes	Yes
Forestry sector	Minor	Minor	Yes	Yes	Yes
Dairy/Sheep and Beef sector	Minor	Minor	Yes	Yes	Yes
Regional community‡	Major		No	Yes	Yes

Who should pay for the proposed management approach?

Wild broom is a major threat to dairying, sheep and beef, hill country and forestry land uses. Land occupiers are usually the principal beneficiaries of any control on their land. The principal exacerbators of the spread of Wild broom are land occupiers with infestations. Land occupiers with infestations are best placed to undertake and pay for the costs of any control and ensure they are not impacting on their neighbours.

To maximise the effectiveness of individual control across the region and to minimise the externality impacts of the plant the Council will implement an advisory, inspectorial, and compliance regime. The benefits of this part of the programme are a public good rather than a private good and it is appropriate that these indirect costs are paid for by the Council on behalf of the regional community. The regional community is able to assess the costs and benefits and the effectiveness of the programme through the annual planning and reporting processes under the Local Government Act 2002 and through the review of future pest management plans.

5.9 Wild Ginger (Yellow and Kahili)

Hedychium gardnerianum, H. flavescens

KEY CHANGE:

New good neighbour rules

a. Pest attributes

Relevant biology and distribution

Attribute	Description
Form	Both gingers have large green leaves with spikes and scented flowers and can grow up to 2-3 m tall, with massive branching surface rhizomes. Flowers of kahili ginger are yellow with red stamens. Yellow ginger has creamy flowers.
Habitat	Thrive in warm areas, very shade tolerant. Most infested or preferred habitat types are associated with conservation land and urban waste areas and gardens.
Regional distribution	Infestations occur mainly in urban areas, gardens and waste areas. Currently occupies 150ha but maximum potential extent in Taranaki is 45,000 ha over 75 yrs.
Competitive ability	Both gingers spread rapidly from large rhizomes which form thick mats up to 1 m deep in the soil. Can out-compete and suppress 90% of native vegetation.
Reproductive ability	Kahili ginger produces up to 100 seeds per head. Yellow ginger does not produce seed.
Dispersal methods	Kahili ginger produces seed which is spread by birds. Both species spread also by dumping garden waste.
Resistance to control	Can be controlled using herbicides. Removal by hand is difficult due to the size of the rhizomes.
Benefits	Roots are edible.

Where is it a problem?

Land use type	Current land use infested*	Potential land use infested*	Pest significant problem on this land type**
Dairy	-	-	False
Sheep and beef (intensive)	-	-	False
Hill country (sheep)	-	-	False
Forestry	-	Low	False
Horticulture	-	-	False
Native / conservation	High	High	True
Urban / Non productive	Low	High	False

* High = Most infested/preferred land use(s), Low = Less infested/preferred land use(s), - = Unsuitable land use. Source: Wildlands 2017

** True = Most 'at risk' or impacted land use(s), False = Less 'at risk' or impacted land use(s) based upon impact assessment overleaf.

b. Impact evaluation

How is it a problem?

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-		
Sheep and beef	-	-		
Forestry	-	L	Can establish in plantation forests.	1
Horticulture	-	-		
Other	-	-		
International trade	-	-		
Environment				2
Soil resources	-	L	Shallow-rooted, deep rhizome beds become heavy with rain and slip on steep sites and streambanks, causing erosion.	
Water quality	-	-		
Species diversity	M	H	Forms dense patches and outcompetes almost all native species. Prevents forest regeneration.	1, 2
Threatened species	L	H	Refer above.	1, 2
Social/Cultural				
Human health	-	-		
Recreation	L	M	Dense patches restrict access.	
Maori culture	L	M	Obstructs access to cultural sites (e.g. wâhi tapu, urupa).	

L – 'low' impact (1–4% reduction in the economic value per ha per annum); **M** – 'moderate' impact (5–9% reduction in the economic value per ha per annum; **H** – 'high' impact (10–50% reduction in the economic value per ha per annum)

Source: 1: Williams et al. (2003), 2: Craw (2000).

How much does it cost?

For the purposes of this report, the monetarised impacts of Wild ginger are calculated as the current or anticipated proportional impact on forestry, environmental and social and cultural values across the region. However, this is a conservative estimate. The potential impacts are likely to be much higher as the plant spreads across the region with significant additional non-monetised costs being incurred where habitat degradation impacts on nationally threatened or regionally distinctive native species (and given the 'value' of these species).

Land use type	Current impact per ha	Potential impact per ha
Production	$0	$0.09–0.87
Dairy	$0	$0
Sheep and beef	$0	$0
Forestry	$0	$0.09–0.87
Horticulture	$0	$0
Environment	$22.15 – $48.80	$46.95 – $284.20
Social/Cultural	$0	$0.03 – $0.27

All amounts are in net present value (NPV, $). Source: Wildlands, 2017.

c. Cost-benefit analysis

CBA assumptions and inputs

Pest assumptions	Values	Programme assumptions	Values
Current area infested	150 ha	Proposed Programme	**Sustained Control** (Good neighbour and general rules)
Maximum potential area infested[º]	45,665 ha	Proposed annual expenditure by Council	$40,000
Time to reach maximum extent[†]	75 years	Proposed boundary width	Yellow ginger 5 m (Crown land) Kahili ginger 1,000 m (Crown land) Whole property (private land)
Seed bank included	Yes	Repeated inspections required	Once (over life of Plan)
Current impacts ($)*	$35.47 / ha ($22.15-$48.80 / ha)	Discount rate	4%

º Wild ginger is still expanding its range. This is the potential extent the pest is predicted to achieve in the absence of regional management based upon LCDB

† The time Wild ginger is predicted to take between first going wild in the region and reaching 90% of its potential maximum extent (in the absence of regional intervention)

* Current impact is for the current area of the pest, averaged across the impacts on all land uses within this area.

CBA assessment

The Council has calculated a cost-benefit scenario over 50 years for Wild ginger, involving both good neighbour and general (whole of property) rules.

Good neighbour rule

Wild ginger is capable of having significant impacts on conservation and forestry values. The CBA assessment[22] shows that on a property to property basis, the control of Wild ginger (within five metres of the property boundary for Yellow ginger and 1,000 metres of the boundary for Kahili ginger) is cost beneficial for conservation receptor land use types/values.

General rule

Wild ginger has not yet reached its full potential extent in Taranaki. The CBA assessment confirms that regional intervention in the form of an general rules requiring private land occupier to destroy infestations is cost beneficial through the avoidance of pest impacts that would otherwise occur on forestry and conservation land uses. The net monetarised benefit of regional intervention over 50 years is estimated to be **$14,472,606**. However, this does not take into account the non-monetarised 'value' of protecting native forest, riparian, wetland and coastal ecosystem types particularly threatened by Wild ginger and associated habitat loss for some nationally threatened or regionally distinctive native species in Taranaki.

Scenario	Pest impacts*	Pest benefits	Council costs[º]	Compliance costs[†]	Net benefit
No regional intervention	$15,146,746	$0	$0	$0	
Sustained Control (preferred option)	$76,077	$15,070,669	$368,872	$229,191	**$14,472,606**

*Includes economic costs and conservatively valued environmental, social and cultural costs

ºCouncil costs refer to the administration and implementation costs incurred by the Council through the programme

†Compliance costs refer to any costs of control imposed on land occupiers through the programme.

[22] *Harris, et al, 2017.*

d. CBA statement and risks to success

Wild ginger can displace native vegetation – especially on Taranaki's coastal cliffs, riparian areas and wetlands.

A Sustained Control programme involving the imposition of rules requiring source land occupiers to destroy Wild ginger infestations on their property is net beneficial to protect biodiversity values and address its spread to neighbouring properties.

The CBA for Wild ginger suggests that this form of regional intervention will have monetarised benefits over a 50 year timeframe. However, significant additional non-monetised benefits associated with the protection of biodiversity values are also anticipated.

Risks of the programme being unsuccessful in achieving objectives

Risk	Level of risk	Explanation
Technical risk	Low	Kahili ginger is free-seeding and is the most invasive of the wild ginger species.
Operational risk	Low	
Legal risk	Low	
Socio-political risk	Low	To be tested through the Plan review process. Gardeners like this pest, however the proposed approach is a continuation of the existing approach, for which no public or political concerns have been raised to date.
Other risks	Low	Removal of pest plant may increase erosion in some areas.

e. Who should pay?

Beneficiaries and exacerbators

Group	Beneficiary	Exacerbator	Change behaviour	Assess costs & benefits	Control cost effectively
Land occupiers (Crown and private)		Major	No	Yes	Yes
Conservation estate	Major		No	Yes	Yes
Gardeners or those intentionally dumping or incorrectly disposing the plant		Major	Yes	Yes	Yes
Regional community[‡]	Major		No	Yes	Yes

Who should pay for the proposed management approach?

Wild ginger is a major threat to conservation values in the Taranaki region. Land occupiers with infestations are the principal exacerbator of the problem. Land occupiers with infestations are best placed to undertake and pay for the costs of any control and ensure that infestations are not impacting on conservation values or spreading to their neighbours.

To maximise the effectiveness of individual control across the region and to minimise the externality impacts of the plant the Council can implement an advisory, inspectorial, and compliance regime. The benefits of this part of the programme are a public good rather than a private good and it is appropriate that these indirect costs are paid for by the Council on behalf of the regional community. The regional community is able to assess the cost and benefits and effectiveness of the programme through the annual planning and reporting processes under the Local Government Act 2002 and through the review of future pest management plans.

5.10 Yellow Ragwort

Senecio jacobaea

KEY CHANGE:

New good neighbour rules

a. Pest attributes and distribution

Relevant biology and distribution

Attribute	Description
Form	An erect biennial or perennial herb, usually growing to 45-60 cm. Single or several stems arise from a crown, with dark green leaves. Flowers are bright yellow and clustered at the end of the branches.
Habitat	Waste places and pasture, also riverbeds, open forest, swamps. Occurs in humid temperate regions with annual rainfall >750 mm. Tolerates frost.
Regional distribution	Widespread throughout the region.
Competitive ability	Establishment is poor in pasture but good in disturbed soil. Early growth is slow and seedling mortality high.
Reproductive ability	Can flower all year round. A well-developed plant may produce 250,000 seeds per year of which 80% may be viable. Seed can be viable for at least 8 years and germinate when brought to the surface.
Dispersal methods	Wind is main method of seed spread. A New Zealand study showed bulk of seed feel to ground within 5 m of the parent plant and virtually none was blown more than 37 m.
Resistance to control	Can be controlled by grazing, mowing, grubbing, and herbicides, but can become resistant to chemical control as a result of poor application. Grubbing and spraying can produce multi-headed plants. Plants may regenerate after flowering. Biocontrol agents include ragwort flea beetle and cinnabar moth. When both of these are combined at one site, good control can be achieved.
Benefits	None

Where is it a problem?

Land use type	Current land use infested*	Potential land use infested*	Pest significant problem on this land type**
Dairy	High	High	True
Sheep and beef (intensive)	Low	High	True
Hill country (sheep)	Low	Low	False
Forestry	-	-	False
Horticulture	-	-	False
Native / conservation	-	-	False
Urban / Non productive	-	-	False

* High = Most infested/preferred land use(s), Low = Less infested/preferred land use(s), - = Unsuitable land use. Source: Wildlands 2017

** True = Most 'at risk' or impacted land use(s), False = Less 'at risk' or impacted land use(s) based upon impact assessment overleaf and Harris, *et al*, 2017.

b. Impact evaluation

How is it a problem?

Category	Current	Potential	Comment	Source
Production				
Dairy	L	H	Forms dense stands in pasture, reducing pasture availability, which could reduce milk production. Contains alkaloids that are toxic to cattle, deer and horses.	
Sheep and beef	L	M	See comments for Dairy. Contains alkaloids that are toxic to cattle, deer, and horses. Sheep can graze it with nil effects	
Forestry	-	-		1,2
Horticulture	-	-		
Other	-	-		
International trade	-	L	Prohibited seed of nil tolerance in Australia.	3
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	-	-		
Threatened species	-	-		
Social/Cultural				
Human health	L	L	Can cause skin irritation and allergies when handed extensively.	4
Recreation	-	-		
Maori culture	-	-		

L – 'low' impact (1–4% reduction in the economic value per ha per annum); M – 'moderate' impact (5–9% reduction in the economic value per ha per annum; H – 'high' impact (10–50% reduction in the economic value per ha per annum)

Source: 1: Environment Bay of Plenty (2005c):, 2: Environment Canterbury (2007b), 3: AQIS (2009), 4: Gourlay (2009).

How much does it cost?

For the purposes of this report, the monetarised impacts of Yellow ragwort are calculated as the current or anticipated proportional impact on dairying and beef production values across the region.

Land use type	Current impact per ha	Potential impact per ha
Production	$305.14 – $559.49	$333.28 – $616.68
Dairy	$305. 04 – $557.29	$323.36 – $584.17
Sheep and beef	$0.37 – $2.21	$9.92 – $32.51
Forestry	$0	$0
Horticulture	$0	$0
Native / conservation	$0	$0
Social/Cultural	$0	$0

All amounts are in net present value (NPV, $). Source: Wildlands, 2017.

c. Cost-benefit analysis

CBA assumptions and inputs

Pest assumptions	Values	Programme assumptions	Values
Seed bank included:	Yes	Proposed Programme:	**Sustained Control** (Good neighbour and general rules)
Pest abundance:	Locally rare	Proposed annual expenditure by Council:	$150,000
Density of source infestations:	Scattered °	Proposed boundary width:	20 m (Crown land) Whole property (private land)
Seedbank	Yes	Repeated inspections required:	Annually
Current impacts ($)*	$432.32 / ha ($305.14-$559.49 / ha)	Discount rate:	4%

° Yellow ragwort is likely to be present in scattered infestations that, while significant, do not totally suppress other vegetation species.

* Current impact is for the current area of Yellow ragwort, averaged across the impacts on all land uses across dairying land in Taranaki (assumed to be 235,000 hectares).

CBA assessment

The Council has calculated a cost-benefit scenario over 50 years for Yellow ragwort, involving both good neighbour and general (whole of property) rules.

Good neighbour rule

Yellow ragwort is widespread throughout the Taranaki region and has continuing and significant impacts on dairy and beef production values. The CBA assessment[23] shows that on a property to property basis, the control of Yellow ragwort within 20 metres of the property boundary is cost beneficial when the receptor properties are dairying and beef receptor land use types/values.

General rule

Yellow ragwort has reached its full potential extent across dairying land in Taranaki. The CBA assessment confirms that regional intervention in the form of an general rules requiring private land occupier on the ring plain and coastal terraces to destroy infestations is cost beneficial through the avoidance of pest impacts that would otherwise occur on dairying and beef land uses. The net monetarised benefit of regional intervention over 50 years is estimated to be **$12,390,312**.

Scenario	Pest impacts*	Pest benefits	Council costs°	Compliance costs†	Net benefit
No regional intervention	$23,899,426	$0	$0	$0	
Sustained Control (preferred option)	$3,584,914	$20,314,512	$1,025,002	$6,899,198	**$12,390,311**

*Includes economic costs and conservatively valued environmental, social and cultural costs

°Council costs refer to the administration and implementation costs incurred by the Council through the programme

†Compliance costs refer to any costs of control imposed on land occupiers through the programme.

[23] *Harris, et al, 2017.*

d. CBA statement and risks to success

Yellow ragwort is toxic to both cattle and humans and has major effects on dairy and beef pasture and production. It is effectively being managed in Taranaki and infestations are localised and scattered.

A Sustained Control programme involving the imposition of rules requiring source land occupiers to destroy Yellow ragwort infestations on their property is net beneficial to protect dairying and beef production values and address its spread to neighbouring properties.

The CBA for Yellow ragwort suggests that this form of regional intervention will have monetarised benefits over a 50 year timeframe.

Risks of the programme being unsuccessful in achieving objectives

Risk	Level of risk	Explanation
Technical risk	Low	Current programme has been successful to date in addressing externality impacts of ragwort. Biological control has worked well and new releases are possible.
Operational risk	Low	
Legal risk	Low	
Socio-political risk	Low	To be tested through the Plan review process but proposed approach is a continuation of the existing approach for which no public or political concerns have been raised to date.
Other risks	Low	

e. Who should pay?

Beneficiaries and exacerbators

Group	Beneficiary	Exacerbator	Change behaviour	Assess costs & benefits	Control cost effectively
Dairy / Sheep and Beef sector	Major	Major	Yes	Yes	Yes
Land occupiers (Crown and Private)	Minor	Major	Yes	Yes	Yes
Regional community‡	Minor		No	Yes	Yes

Who should pay for the proposed management approach?

Yellow ragwort is a major threat to dairying and beef farmers. Land occupiers are usually the principal beneficiaries of control on their land. The principal exacerbators of the spread of ragwort are land occupiers (of any land use) with infestations. Land occupiers with infestations are best placed to undertake and pay for the costs of any control and ensure they are not impacting on their neighbours.

To maximise the effectiveness of individual control across the region and to minimise the externality impacts of the plant the Council will implement an advisory, inspectorial, and compliance regime. The benefits of this part of the programme are a public good rather than a private good and it is appropriate that these indirect costs are paid for by the Council on behalf of the regional community. The regional community is able to assess the costs and benefits and the effectiveness of the programme through the annual planning and reporting processes under the Local Government Act 2002 and through the review of future pest management plans.

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Appendix A: Section 71 of the BSA

71 Second step: satisfaction on requirements

If the council is satisfied that section 70 has been complied with, the council may take the second step in the making of a plan, which is to consider whether the council is satisfied—

(a) that the proposal is not inconsistent with—
(i) the national policy direction; or
(ii) any other pest management plan on the same organism; or
(iii) any pathway management plan; or
(iv) a regional policy statement or regional plan prepared under the Resource Management Act 1991; or
(v) any regulations; and

(b) that, during the development of the proposal, the process requirements for a plan in the national policy direction, if there were any, were complied with; and

(c) that the proposal has merit as a means of eradicating or effectively managing the subject of the proposal, which means—
(i) the organism proposed to be specified as a pest under the plan or the organisms proposed to be specified as pests under the plan; or
(ii) the class or description of organism proposed to be specified as a pest under the plan or the classes or descriptions of organisms proposed to be specified as pests under the plan; and

(d) that each subject is capable of causing at some time an adverse effect on 1 or more of the following in the region:
(i) economic wellbeing:
(ii) the viability of threatened species of organisms:
(iii) the survival and distribution of indigenous plants or animals:
(iv) the sustainability of natural and developed ecosystems, ecological processes, and biological diversity:
(v) soil resources:
(vi) water quality:
(vii) human health:
(viii) social and cultural wellbeing:
(ix) the enjoyment of the recreational value of the natural environment:
(x) the relationship between Maori, their culture, and their traditions and their ancestral lands, waters, sites, wahi tapu, and taonga:
(xi) animal welfare; and

(e) that, for each subject, the benefits of the plan would outweigh the costs, after taking account of the likely consequences of inaction or other courses of action; and

(f) that, for each subject, persons who are required, as a group, to meet directly any or all of the costs of implementing the plan—
(i) would accrue, as a group, benefits outweighing the costs; or
(ii) contribute, as a group, to the creation, continuance, or exacerbation of the problems proposed to be resolved by the plan; and

(g) that, for each subject, there is likely to be adequate funding for the implementation of the plan for the shorter of its proposed duration and 5 years; and

(h) that each proposed rule—
(i) would assist in achieving the plan's objectives; and
(ii) would not trespass unduly on the rights of individuals; and

(i) that the proposal is not frivolous or vexatious; and

(j) that the proposal is clear enough to be readily understood; and

(k) that, if the council rejected a similar proposal within the last 3 years, new and material information answers the council's objection to the previous proposal.

Appendix B: Section 6 of the NPD

6 Directions on analysing benefits and costs

1. *When determining the appropriate level of analysis of the benefits and costs of the plan for each subject for the purposes of a proposal for a pest management plan or pathway management plan, a proposer must consider:*

   (a) the level of uncertainty of the impacts of the subject, or an organism being spread by the subject, and of the effectiveness of measures; and

   (b) the likely significance of the subject, or an organism being spread by the subject, or of the proposed measures, in terms of stakeholder interest and contention, and total costs of the proposed plan; and

   (c) the likely costs of the programme relative to the likely benefits; and

   (d) the level of certainty and the quality of the available data.

2. *In the proposal for a pest management plan, or in a pathway management plan, an analysis of the benefits and costs of the plan for each subject must:*

   (a) identify, and quantify (if practicable) the impacts of the proposed subject or an organism being spread by the subject; and

   (b) identify two or more options for responding to the subject or an organism being spread by the subject (one option must be either taking no action or taking the actions that would be expected in the absence of a plan); and

   (c) identify, and quantify (if practicable), the benefits of each option; and

   (d) identify, and quantify (if practicable), the costs of each option; and

   (e) state the assumptions (if any) on which the impacts, benefits and costs are based; and

   (f) be at an appropriate level of detail as determined in accordance with sub clause (1); and

   (g) take into account any risks that each option will not achieve its objective; and

   (h) identify any realistic mitigation options for the risks identified in sub clause (2)(g); and

   (i) adjust the benefits and costs for each option as appropriate to take account of subclause (2)(g) and (h); and

   (j) clearly identify which option is preferred.

3. *When taking into account any risks that each option will not achieve its objective under subclause (2)(g), a proposer must consider:*

   (a) the technical and operational risks of the option; and

   (b) the extent to which the option will be implemented and complied with; and

   (c) the risk that compliance with other legislation will adversely affect implementation of the option; and

   (d) the risk that public or political concerns will adversely affect implementation of the option; and

   (e) any other material risk.

4. *When taking into account any risks that each option will not achieve its objective under sub clause (2)(g), a proposer must:*

   (a) for analyses where the benefits are fully quantified, either:
   (i) estimate the residual risks as a probability of success and calculate the expected benefits of the option by multiplying the benefits by the probability of success; or
   (ii) state the residual risks to the programme and calculate what the probability of success would need to be to make the expected benefits equal the costs; and

   (b) for all other analyses (where the benefits are not fully quantified):
   (i) state the residual risks to the programme and, where practicable, give an indication of likelihood and impact; and
   (ii) specify which of the benefits are most likely to be affected if the risk eventuated.

5. *The proposer of a pest management plan or pathway management plan must document the assessments made in sub clauses (1), (3) and (4) and make them publicly available with the proposal for a pest or pathway management plan.*

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