Meeting the requirements of the Biosecurity Act 1993 and National Policy Direction for Pest Management 2015: Analysis of costs and benefits

Report prepared for Environment Canterbury as part of the preparation of a Regional Pest Management Plan

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Table of Contents

Executive Summary

Approach

This report provides the information required for Environment Canterbury (ECan) to determine whether their options for management of pests in the region are likely to meet the requirements of the Biosecurity Act (1993) and the National Policy Direction for Pest Management (NPD). The report analyses four options for each pest based on the categories described in the NPD. These are:

- Sustained Control – where further spread onto uninfested properties is prevented, but the pest is allowed to increase in density on already infested areas.
- Progressive Containment – where the pest is reduced in extent over a 50 year time period.
- Eradication – where the pest is removed from the region, typically within 20 years.
- Do Nothing – where the pest is allowed to continue to spread, and land holders undertake control as their own circumstances indicate.

The costs and benefits of each option are modelled using estimates of the pest's spread into new areas, rate of increase in density, the costs of control, and lost production. It also takes into account the costs of intervention in the form of inspection, monitoring and enforcement costs. The inspection, monitoring and enforcement costs are subject to change through the plan development process and are indicative only in this report. The net benefit is estimated over 100 years and is the difference between the costs and benefits of the proposed option and the costs and benefits that would be incurred if the region were not to intervene – i.e. the Do Nothing scenario. It should be noted that losses of production will occur from other causes in all scenarios, but the production losses included here are only those that are associated with the pest. This net benefit is then adjusted for the risk that the proposed objective will not be achieved to provide an estimate of the risk adjusted net benefit. Assumptions used in undertaking the modelling were provided by Environment Canterbury and are described in detail in the report and in Appendix A.

The results of the analysis of costs and benefits are summarised in Table 1. The table describes each proposed plan objective, the risk adjusted net benefit associated with that option, and the option which provides the highest risk adjusted net benefit.

However, the risk adjusted net benefit is based only on those costs that are quantified – these are the loss of production and the costs of control. Pests are also associated with a range of other impacts that cannot be reliably quantified in monetary terms, including those to mana whenua, biodiversity, recreation, and amenity values. For pests where the risk adjusted net benefit is positive, the proposed plan option is justified even without consideration of those items. Where the risk adjusted net benefit is negative it is important that these other impacts are taken into consideration. Table 1 provides estimates of the threshold value that these other biodiversity, recreation, and amenity values would need to exceed in order for the plan objective to be positive. This is the negative risk adjusted net benefit (NPV) divided by the area protected by the strategy. This threshold value is provided for both the proposed plan option and for the option with the highest net benefit, because in some cases the proposed plan objective is more costly than an alternative plan option.

Outcomes of analysis of costs and benefits

The outcomes of the analysis of costs and benefits is described below according to the plan option and outcome of the analysis.

Eradication pests with positive quantified net benefit – these include Rooks, Egeria, Moth Plant, Yellow Bristle Grass, Yellow Water Lily and Knotweed. The extent of the pest and the cost of eradication now are likely to be less than the cost of allowing the pest to spread and controlling it at specific sites later on or allowing land holder control and loss of production. Even taking into account the risk of not achieving eradication the production pests are generally worth controlling at these low levels because of the greater quantified benefit, and the biodiversity pests generally have a larger ratio of potentially infested area to eradication cost or higher ratio of rate of spread to eradication cost.

Eradication pests with a negative risk adjusted quantified net benefit – these are Entire Marshwort and Phragmites, and have smaller potential habitats to occupy, so the costs of control if they were allowed to spread are less than controlling at specific sites. However, this does not take into account the impacts on biodiversity on any areas occupied by the pest. In the case of Entire Marshwort there would need to be a NPV value of $40/ha - $110/ha of habitat affected in order for a plan objective to be worthwhile, while Phragmites would require a value of $5000/ha - $10,000/ha in order for a plan objective to be worthwhile. These pests affect waterways and wetlands, which do tend to be viewed as having higher biodiversity and recreation values, and in the case of Entire Marshwort these values are likely to be exceeded. Further investigation of non-market valuations undertaken elsewhere would be required if the Phragmites threshold were to be considered as being exceeded.

Progressive Containment pests with a positive quantified net benefit – these include Baccharis, African feather grass, African Love Grass , and Puna Grass. These pests are production pests, and because they are all of a very small extent the costs of maintaining them under control is lower than the cost of allowing them to spread and cause production losses and increased control costs in the future.

Sustained Control pests with a positive net benefit - Rabbits, Bennett's Wallabies, Bur Daisy, Chilean needle grass, Saffron Thistle, Broom, Darwin's Barberry, Gorse, Nassella Tussock, Purple Loosestrife, and Wilding Conifers. These Sustained Control pests all produce a positive net benefit, although it is important to remember that those pests which rely on boundary control have only a limited chance of achieving anything different from the Do Nothing option.

Sustained Control pests with a negative quantified net benefit – Coltsfoot and Boneseed are in the plan for biodiversity reasons. Both have no production benefits and are palatable to stock. They have biodiversity, recreation and amenity related benefits, and a threshold value of $9,600/ha for Coltsfoot and $1100/ha for Boneseed of land affected would need to be attributed to those other benefits in order for the programme to produce a positive outcome. It may be that a more targeted regime to protect high biodiversity areas, rather than attempting to prevent spread everywhere, would produce a lower cost outcome. Bell heather has both production and biodiversity benefits, the threshold value for any biodiversity benefits would need to exceed NPV $240/ha in order for the proposed objective to be worthwhile.

Exclusion pests – These are considered likely to be of net benefit because of the small costs involved and the potential costs of establishment of the Exclusion pests, which are known to have had impacts elsewhere.

The *Site led pests* programme is considered likely to have a net benefit because of the requirement for land holder agreement, which suggests that the costs of control will be exceeded by the benefits to the parties involved.

The *Wilding Conifer* analysis resulted in Sustained control having the highest net benefit. In order for the Progressive Control option to be preferred over the Sustained control option in risk adjusted terms the net value of non quantified benefits (landscape and amenity, fire control, drinking water supply, cultural and historic values, honey production, carbon sequestration, erosion control) would need to exceed NPV $560/ha or $34/ha/annum. Because the analysis only takes a regional viewpoint, national benefits and costs have been excluded. However there are additional national benefits that will arise from Wilding Conifer control, and there will also be an input of national funding into reduction of areas infested by wilding conifers that will reduce the regional costs. These factors makes it likely that the benefits of the Progressive Containment strategy would exceed those of Sustained Control were these national implications included.

Outcomes of funding analysis

The report also provides information on each of the items that must be considered in developing a funding policy for the pest management plan, and provides a recommendation on the funding options based on that information. The funding recommendations are provided in the last five columns of Table 1. They are divided into the programme related costs of inspection, monitoring and enforcement; and the cost of undertaking the control work. For cost of control the funding is divided into whether the funding is sourced from General Rate, a Targeted rate (generally on productive land), and /or from exacerbators in the form of contribution or requirement for control.

In general the recommendation for pests that are solely of biodiversity benefit is that plan related costs are funded from General Rates. Control costs for solely biodiversity related pests are recommended either from General Rate or exacerbator control depending on the efficiency of control.

For pests that are solely production related the funding recommendations are similar – Targeted rate on productive land for plan related costs, and either targeted rate or exacerbator control depending on efficiency of the measure.

For the significant number of pests where there is both a productive and biodiversity related benefit, the costs are apportioned between the General and Targeted rate depending on a qualitative assessment of the relative benefit to each party. These apportionments are based on the factors outlined in the main report and expert assessment. As such they are not definitive and it is entirely appropriate that decision makers attach different weightings to various considerations to produce an alternative conclusion.

Good Neighbour Rules (GNR)

GNRs are proposed for Feral rabbits, Bennett's wallabies, Broom, Gorse, Old Man's Beard and wilding conifers as part of wider Sustained Control programmes for which the costs and benefits are assessed above. The relative reasonableness of the costs incurred between the occupier required to control and the neighbour otherwise affected must be considered under Section 7 of the NPD.

For rabbits the difference in costs between the source and landholder affected depends on the proneness of the land involved, requiring control on land where the source is High or Extreme proneness will result in the costs of the source being between 1.7 and 7.7 times the additional

costs of control for the receptor landholder. For Bennett's wallabies the cost for the source landholder are significantly higher than for the landholder affected by spread, and the boundary control would need to decrease the control costs of the affected party by 85% in order for the source costs to be no more than 20% greater than the receptor costs.

For light infestations of all plant pests the costs incurred by occupiers who would be required to control under the GNR would be similar to the costs for the neighbour otherwise affected. In this situation, the relative costs are similar and therefore likely to be considered reasonable. For dense infestations of broom and gorse the costs for occupiers are 50% higher than for the neighbour otherwise affected. For dense infestations of Old Man's Beard the costs are 2.3 times that for the neighbour otherwise affected, and for wilding conifers the costs are 8.9 times the cost for the neighbour otherwise affected. In these situations a judgement needs to be made as to whether the costs of compliance are reasonable, relative to the costs that the adjacent land occupier would incur from the pest spreading in the absence of the rule.

Table 1: Summary of cost benefit outcomes and funding recommendations.

Analytical outcomes						Funding of inspection and monitoring costs		Funding of control costs		
Pest	**Proposed Objective**	**Risk Adjusted Net Benefit of Proposed Objective (NPV6% $m)**	**Highest Value Plan Objective**	**Biodiversity or other benefits needed for plan to be positive ($/ha NPV)**	**Biodiversity or benefits for Highest Value Plan objective ($/ha NPV)**	**General Rate**	**Targeted rate on productive land**	**General Rate**	**Targeted rate on productive land**	**Land holder control or contribution**
Rooks	Eradication	$0.1 - $0.14	Eradication	-	-	100%		100%		
Rabbits (feral)	Sustained Control with Boundary only	$4.58	Sustained Control with full control		-	-	100%			100%
Bennett's Wallabies	Sustained Control	$85 ($31 - $174)	Buffer zone with control inside infested area	[1]		20%	80%	20% (Buffer)	80% (Buffer)	100% (Current area)
Baccharis	Progressive Containment	$40.6	Progressive Containment	-	-	50%	50%		100%	
Egeria	Eradication	$44.73	Eradication	-	-	100%		100%		
Entire Marshwort	Eradication	-$0.05	Sustained Control	$110	$40	100%		100%		
Moth Plant	Eradication	$0.17	Eradication	-	-	100%		100%		
Phragmites	Eradication	-$0.1	Sustained Control	$10,000	$5,000	100%		100%		
Yellow Bristle Grass	Eradication	$2.47	Eradication	-	-		100%		100%	
Yellow water lily	Eradication	$206.61	Eradication	-	-	100%		100%		
African Feather Grass	Progressive Containment	$103.49	Progressive Containment	-	-	100%		100% public land		100% productive land
African Love Grass	Progressive Containment	$84.94	Progressive Containment	-	-	50%	50%	50% public land	50% public land	100% productive land
Bell Heather	Sustained Control	-$0.61	Sustained Control	$240	$240	100%				100%
Bur Daisy	Sustained Control	$33.66	Eradication	-	-		100%			100%
Chilean Needle Grass	Sustained Control	$1.17	Sustained Control	-	-		100%			100% with transitional
Coltsfoot	Sustained Control	$-0.48	Sustained Control	$9,600	$9,600	100%		100%		
Puna Grass	Progressive Containment	$0.15	Progressive Containment	-	-		100%		100%	
Saffron Thistle	Sustained Control	$8.99	Sustained Control	-	-		100%			100%
Boneseed	Sustained Control	-$1.44	Sustained Control	$1,290	$1,290	100%		100% difficult to control and reduce prevalence		100% prevent spread

[1] Note that a value of $17.6/ha/annum was included for the benefit associated with biodiversity values in landscapes affected by wallabies after Latham, Latham, & Warburton (2016)

Analytical outcomes						Funding of inspection and monitoring costs		Funding of control costs		
Pest	**Proposed Objective**	**Risk Adjusted Net Benefit of Proposed Objective (NPV6% $m)**	**Highest Value Plan Objective**	**Biodiversity or other benefits needed for plan to be positive ($/ha NPV)**	**Biodiversity or benefits for Highest Value Plan objective ($/ha NPV)**	**General Rate**	**Targeted rate on productive land**	**General Rate**	**Targeted rate on productive land**	**Land holder control or contribution**
Broom	Sustained Control	$41.92	Sustained Control	-	-	50% biodiversity-	50% biodiversity, 100% productive	50% biodiversity		50% biodiversity, 100% to prevent spread
Darwin's Barberry	Sustained Control	$0.05	Sustained Control	-	-	100% high value sites		100% high value sites		100% to prevent spread to high value sites
Gorse	Sustained Control	$42.05	Sustained Control	-	-		100%			100%
Nassella Tussock	Sustained Control	$98.08	Sustained Control	-	-	25%	75%			100%
Purple Loosestrife	Sustained Control	$01.86	Sustained Control	-	-	75%	25%	75%	25%	
Wilding Conifers	Sustained Control	$5.32	Sustained Control	[2]	-	100%		90%		10%
Knotweed	Eradication	$2.37	Progressive Containment			100%		100%		
Old Man's Beard	Sustained Control	$0.98	Sustained Control			100%		100% high value sites		100% to prevent spread to high value sites
Exclusion Pests	Exclusion	Likely to be positive	Exclusion			100%		100%		
Site Led Pests	Site Led	Likely to be positive assuming land holder agreement	Site Led			100%		100%		To be determined

[2] Assume a biodiversity benefit of $35.5/ha/annum based on a willingness to pay survey (Kerr & Sharp, 2007).

1 Background

Environment Canterbury is reviewing its Regional Pest Management Plan (RPMP) to bring it in line with the requirements of the National Policy Direction (2015) (NPD). The NPD specifies a number of potential outcomes which are:

- Exclusion (Exclusion Programme)
- Eradication (Eradication Programme)
- Progressive Containment (Progressive Containment Programme)
- Sustained Control (Sustained Control Programme).
- Protecting values in places (Site led pest programme).

Section 6 of the NPD also specifies the requirements for analysing costs and benefits of the RPMP. Section 6 has 5 requirements:

1. Considerations to determine the level of analysis.
2. Requirements for undertaking the analysis of costs and benefits
3. Considerations for assessing the risks that the plan will not meet its objectives.
4. Requirements for taking into account risks that the plan will not meet its objectives.
5. Requirements for documentation of the analysis and the underlying assumptions.

The NPD also sets out how an assessment of the allocation of costs for the plan is to be undertaken in Section 7. This has two sections:

1. Considerations in grouping for the purposes of cost allocation.
2. Requirements in determining the appropriate cost allocation.

As with Section 6 on the analysis of costs and benefits, there is a requirement to document the analysis and underlying assumptions.

Ministry for Primary Industry (MPI) has also released guidance notes to accompany the NPD (NPD Guidance).

The analysis undertaken here follows the requirements of the NPD for each of the pests to be assessed. ECan has categorised its pests into the new plan types, and has developed approaches to meet the desired objectives. It has also categorised the pests according to the requirements of Section 6(1) to determine the level of analysis that needs to be undertaken using the guidance material provided by MPI. This indicates that all pests in the RPMP are either low or medium in terms of the level of analysis required with the exception of Wilding Conifers which require a high level of analysis.

The sections that follow set out the analysis undertaken and results of the analysis in a format that responds to the requirement of the NPD and provides analysis of the potential funding arrangements for each pest.

The analysis is undertaken in two parts. For plant pests a generic model was applied to all pests as described in Section 5, with assumptions varied by pest. For animal pests separate

modelling was undertaken for each pest, with the method for each of the animal pests described within the section.

2 Rooks

2.1 Description

Rooks (*Corvus frugilegus*) are native to Great Britain and Europe and were introduced to New Zealand in the 1860s to control insect pests. They are considered pests of farms because they cause losses primarily to crop production through eating of newly sown seed, and to a lesser extent from mature crops. There are also localised instances of severe damage to horticultural crops and there may be some damage to pasture from disturbance as rooks seek invertebrates in the soil. Rooks can form large breeding colonies, called rookeries, of several hundred birds.

Rooks have been under control for a long period in Canterbury and are currently at very low levels with only one bird thought to be left in the region.

2.2 Proposed plan

ECan are proposing an Eradication plan for Rooks.

2.3 Level of analysis

The assessment of rooks is considered to require a Level 1 analysis under the guidelines of the NPD Guidance.

2.4 Method

Two models of linear population growth are used, with population maxima being reached in 100 or 200 years' time under each model. These population growth scenarios may overestimate the rate of growth of an undisturbed population because in the 30 years following their introduction in 1870s the rooks appeared to inhabit only a limited number of sites in the central city. Rooks do not seem to migrate from their home rookery unless disturbed. Expansion rates under disturbance however, may amount to 1.3 to 1.6 km per year (Coleman 1995) so the range of times to occupy the region are likely to appropriately bracket the potential time spans for damage to occur. The increase in population densities will be too high for the initial years, and too low during the period of maximum expansion. However, for the purposes of this level of analysis the assumption is considered to be sufficient.

Maximum populations of uncontrolled rooks are taken from Coleman (1995) who considers that rooks in Canterbury may reach the highest levels seen in Hawkes Bay in the 1960s of 5.2 adult birds per square kilometre. A factor of 50% was added to this for counting errors and non-breeding birds. This amounts to a maximum population of approximately 100,000 birds in Canterbury Plains area (where damage is most likely to be sustained (approximately 13,000 square kilometres).

The main source of rook damage is feeding on newly sown cereal and vegetable seed and young shoots. Legumes are not eaten as newly sown or young shoots but may be eaten as ripening pods. Rooks also feed on mature grain, and grain in stubble, but the financial cost of this is probably small or very localised. Rooks may also cause damage to pasture in their search for invertebrates, but this damage is not included in the analysis. They also provide some positive benefits by reducing populations of pest insect species.

The amount which rooks are likely to eat is estimated from Gromaxzka (1980)[3] at 13kg cereal and 16kg of animal matter annually. In a rook feeding study in Hawkes Bay, Purchas (1980) recorded a relatively small proportion of total feeding time spent in newly sown cereal fields. In autumn, spring, and early summer rooks spent 1 - 2% of their time in newly sown cereal fields. Critical periods for cereal crop growth in Canterbury will be May - June (autumn sown) and August - mid October (spring sown), a total of 20 weeks. The analysis uses figures of 1.5% per day for the time which rooks spend feeding on newly sown crops.

Because the rooks feed *en masse* and down rows it is assumed that they will strip the row relatively bare of seed so there will be negligible compensatory growth by surrounding crop plants. For this analysis the proportion of loss is equal to the amount eaten, with the impact of the seed eaten based on sowing rates from the Lincoln University Farm Technical Manual.

The areas of crops available for rook damage are taken from NZ Statistics Agricultural Census information for 2012. Crop loss per ha is assessed using the Gross Margin derived from the Beef and Lamb NZ farm economic survey, using the average of the last five years of their Class 8 (Mixed Cropping) model ($897/ha).

Inspection and control costs are estimated by ECan at $8600 for inspection and a further $900/annum for monitoring. These costs are subject to change through the planning process and are indicative only. It is assumed that the costs are only required for a further 5 or 10 years until eradication can be deemed to have been achieved.

A discount rate of 6% is used for the analysis (see Section 5.4).

2.5 NPD Section 6 Assessment

2.5.1 Impacts of Rooks

Rooks feed on a range several kilometres around their roost and have a wide range of food in their diet. Losses are caused primarily to crop production through eating of newly sown seed and to a lesser extent from mature crops. There are also localised instances of severe damage to horticultural crops and there may be some damage to pasture from disturbance as rooks seek invertebrates in the soil. Individuals with rooks on their property may regard the roost as an attractive feature and eradication of rooks causes a loss of this value.

2.5.2 Options for response

The analysis considers two options for Rooks:

1. Do Nothing
2. Eradication.

No other options are considered appropriate given the low level of rook populations currently.

[3] Gromadzka, J. 1980. Food composition and food consumption of the Rook (*Corvus frugilegus*) in agrocoenoses in Pol and . Acta Ornothilogica, Polish Academy of Sciences. 17:227:256

2.5.3 Benefits and costs of options for management of Rooks

The benefits and costs of the two management options are shown in Table 2. This shows the net benefit of the plan relative to the Do Nothing, and suggests there is a positive net benefit under a range of assumptions about rate of spread.

Table 2: Benefits and Costs of Rook Management options

Option		**Losses for newly sown crops (PV)**	**Control costs (PV)**	
			Eradication achieved in :	
			5 years	**10 years**
Do Nothing	**100 yrs to max**	$191,567		
	200 yrs to max	$101,552		
Eradication		0	$49,517	$79,421

Table 3: Net Benefit of Eradication at two different rates of spread

	Eradication achieved in : (NPV(6%))	
Rate of spread	**5 years**	**10 years**
Linear - 100 yrs to max	$142,049	$112,146
Linear - 200 yrs to max	$101,552	$101,552

2.5.4 Risks of Rooks Plan

Technical and operational risks: It is difficult to ensure eradication with a very small number of mobile birds. However, this risk is mitigated by the high expertise of staff in controlling rooks, and the likelihood that the three remaining birds are all male.

Implementation and compliance: Requires expertise to control rooks due to specialised techniques and their mobility. This risk is mitigated by the existence of those skills within the Council and contractors.

Other legislative risks: None known

Public or political concerns: None known

Other risks: None known

The level of risk that the plan is not achieved for the plan to no longer be worthwhile is shown in Table 4. It shows that risks would have to be a greater than 22% - 74% in order for the plan to no longer be worthwhile. Given the low levels of rooks, this level of risk is unlikely to be realised and the plan should be considered worthwhile.

Table 4: Maximum risk of non-achievement for benefits of the Rook plan to still outweigh the costs

	Eradication achieved in :	
Rate of spread	**5 years**	**10 years**
Linear - 100 yrs to max	74%	59%
Linear - 200 yrs to max	51%	22%

2.6 NPD Section 7 - Allocation of Costs and Benefits

2.6.1 Beneficiaries, exacerbators and costs of proposed plan for control of Rooks

The beneficiaries and exacerbators of the plan are:

- Beneficiaries: Arable farmers, pastoral farmers, general public.
- Active exacerbators: Any persons transporting Rooks into the region
- Passive exacerbators: Any persons with Rooks on their property not undertaking control.

The direct costs of rook control are the inspection and control costs which are estimated at between $50,000 and $79,000 NPV(6%). There are also some indirect costs associated with reduced aesthetic benefits from rookeries.

The benefits of the plan accrue to all arable and pastoral land holders for avoided losses of between $100,000 and $140,000 NPV(6%). There are also some potential benefits to the wider community from the avoidance of impacts to biodiversity.

2.6.2 Matters for consideration in allocation of costs of Rook Plan

The matters for consideration are spelt out in Section 7(2)(d) of the NPD, and the analysis for each of these matters is shown in Table 4 below.

Table 4: Matters for consideration in allocating costs for proposed Rooks plan

Legislative rights and responsibilities	None known.
Management objectives	Eradication.
Stage of infestation	Very low (3 individuals) following a long control programme.
Most effective control agents	Specialist rook control agents (contractors and Council staff) required.
Urgency	Very high in that if allowed to expand several decades of control effort will be wasted.
Efficiency and effectiveness	It is likely to be more efficient to eradicate than other options. Management and control by the Council is likely to be the most effecitve due to specialist skills required.

Practicality of targeting beneficiaries	Arable beneficiaries cannot be easily targeted at a regional level other than through a levy on arable products. This would be expensive and difficult for the small funding required. Wider beneficiaries can be targeted through General Rate.
Practicality of targeting exacerbators	Rooks are very mobile so difficult to target exacerbators.
Administrative efficiency	General Rate is highly efficient for small sums required and the difficulty of targeting the main beneficiaries.
Security	General Rate offers high security of funding for long term control effort required to achieve eradication.
Fairness	The main beneficiaries are not targeted.
Reasonable	Given the small funding requirements and difficulty of alternative approaches the General Rate is a reasonable approach.
Parties bearing indirect costs	No indirect costs are expected.
Transitional cost allocation arrangements	Not required.
Mechanisms available	General Rate, targeted rate (rural properties) and direct charges are the most readily available mechansisms. Levies are expensive to establish and administer.

2.6.3 Proposed allocation of costs

Because of the low level of costs, and the difficulty of targeting beneficiaries or exacerbators, it is recommended that the costs for eradication of rooks be charged to the General Rate.

3 Rabbits (Feral)

3.1 Description

Rabbits were first released in the 1800s and soon became a significant agricultural pest as well as affecting native tussock ecosystems. Mustelids and cats were brought in an attempt to control rabbits but had little impact on rabbits but significant impact on native birdlife and other fauna. Rabbits survive best in dry and semi-arid environments, where although their reproduction rate is lower than in more productive agricultural environments, mortality is significantly lower.

Rabbits have a life span of up to seven years but there are high rates of mortality among young animals. Female rabbits can be pregnant for 70% of a year and a single adult doe can produce 20 – 50 young.

The introduction of Rabbit Haemorrhagic Disease (RHD) in 1997 significantly reduced rabbit numbers to the point where they were no longer considered a significant problem but there is evidence that RHD is losing its effectiveness in some situations.

3.2 Proposed Plan

The proposed programme for rabbits is for Sustained Control, with intervention undertaken only by complaint when rabbits on one side of a boundary are being controlled and those on the other side are not. The general requirement will be for rabbits to be at or below Maclean's Scale 3 but this will only be enforced within 500m of the boundary based on complaint from a neighbour with lower rabbit numbers.

3.3 Method for analysis of Rabbit options

The analysis undertaken here is based on information collected for an earlier report[4] - most of the assumptions are derived from the experience of workers in the field or are extrapolated from other data. This section details the background assumptions, the model used, the results, and the significance of the results.

In order to determine the costs of spillover, an estimate was made of the likely impact on costs from rabbits moving between properties. This requires assumptions regarding the increase in control costs, the amount of area on a property likely to be affected by these increased control costs, and the proportion of land holders not controlling rabbits.

While there is no reliable guide to the increase in population as a result of rabbit spillover, experience in the field suggests that on high and extremely rabbit prone land a poisoning interval of three years would be reduced to at least two years by spillover[5]. On moderately prone land a poisoning interval of seven years would be reduced to 3 - 4 years[6]. The cost for highly rabbit prone land increases from $17.36h/a/year to $30.38/ha/year with spillover, and from $67/ha/year to $100/year for extremely prone land because of the shortened poisoning interval[7].

Table 5: Estimate of annual costs of control by rabbit proneness class

Rabbit Proneness Class	Total Operation cost/ha	Annual cost/ha without spillover	Annual cost/ha with spillover	Increase in cost/ha/year from spillover
Moderate	$121.53	$17.36	$30.38	$13.02
High	$114.58	$28.65	$57.29	$28.65
Extreme	$200.00	$66.67	$100.00	$33.33

The proportion of land in the different rabbit proneness classes is shown for the Mackenzie/Waitaki area. North Canterbury and Banks Peninsula have been excluded from the analysis because there is no evidence that a significant rabbit problem exists there and there is unlikely to be any benefit associated with control in those areas at this stage. The data for Mackenzie/Waitaki was developed at the end of the Rabbit and land Management

[4] Brown Copeland and Co Ltd. 1994. "Meeting the Requirements of the Biosecurity Act 1993: Economic Evaluation of Options for Regional Pest Management Strategies". Contract report prepared for Environment Canterbury.
[5] In other words, if a property owner undertakes no control, high rabbit numbers will cause rabbits to migrate onto the neighbour's property and thereby cause the neighbour to have to poison more frequently.
[6] Without discounting
[7] These costs assume an operation cost of $200/ha on extremely prone land , reducing on high and moderately prone land in proportion to the operation costs used in the 1994 report.

Programme (RLMP) in the early 1990s, and it may be that with development there has been a reduction in area for some classes. For example the use of irrigation and lucerne in high country properties has altered rabbit proneness on some classes from High and Extreme to Low and Moderate. However, for the purposes of this analysis the data is sufficient to assess the approximate impacts of a boundary control regime.

Table 6: Area in each rabbit proneness class (ha)

Sub Region	**Area of land in Rabbit Proneness Class (ha)**					**Total Area**
	Negligible	**Low**	**Moderate**	**High**	**Extreme**	
Mackenzie/Upper Waitaki RLMP	19,000	165,000	32,000	90,000	9,500	316,000
Mackenzie/Upper Waitaki non - RLMP	75,000	348,000	81,000	112,000	1800	621,000
Total Mackenzie/upper Waitaki	**94,000**	**513,000**	**113,000**	**202,000**	**11,300**	**937,000**

The spread model is based on the concept that poisoning occurs in areas within which rabbits are able to move freely, but which have some sort of physical or natural boundary preventing rabbits from moving between them (such as altitude, rabbit proof fencing, rivers etc.). A complete area is poisoned because this ensures that migrating rabbits are not easily able to reinfest a poisoned area, which maximises the poison interval and lowers overall control costs.

Within a property these poisoning areas are referred to as blocks, and while a block will have a natural boundary with other blocks in the same property there is not necessarily a migratory boundary with the neighbouring property. It is assumed here that all blocks on a clear property which are on the boundary with a property which is not controlling rabbits are affected by spillover. The degree of infestation is not critical, since the increased levels of rabbits on one part of any block will necessitate the entire block being re-poisoned at the earlier interval. Using this methodology, it is calculated that one property not controlling rabbits will cause a reduced poison interval on an area of poisoning blocks equal to ~60% of the average property size.

The numbers of properties not controlling is estimated at 10% and this will occur only within the Mackenzie/upper Waitaki area. This proportion is significantly lower than the proportion that were not controlling rabbits during the RLMP period (up to 70%), but it is expected that with better returns from high country farming, a better equity position, and the presence of RHD, more control will be undertaken now than was the case at that time. While it is possible to produce an extreme case where 50% of the land holders do not control rabbits, a lower limit is used in this paper so that the results are conservative with respect to the benefit which land holders gain from reducing spillover.

It is assumed that the properties not controlling are evenly distributed among those controlling, which produces a higher cost to spillover than if they were to all clump together.

Production benefits are derived on a stock unit basis from work undertaken by Ogle Consulting for the upper Waitaki Zone Committee (Ogle, 2014). These stocking rates and returns are shown in Table 7

Table 7: Stocking rates and returns per stock unit for rabbit prone land

	Moderate	High	Extreme	Returns per su ($)
Stocking Rate (su/ha)	2	1	0.1	$46.73

Inspection and monitoring costs are estimated at $312,000 per annum, although these are indicative only and are subject to change through the planning process.

3.4 NPD Section 6 Assessment

3.4.1 Level of analysis

The Sustained Control objective for rabbits is considered to require a medium level of analysis. This assessment is provided in Appendix B.

3.4.2 Impacts of Rabbits (Feral)

Rabbits (*Oryctolagus cuniculus)* cause damage to pastoral agriculture through reduced pasture quality and animal intake. There are also potential damages to biodiversity associated with high rabbit because they browse on vulnerable native plant communities, and as prey they support the mammalian predators of native birds and animals.

Rabbits also provide some benefits associated with commercial hunting for meat and recreational hunting.

3.4.3 Options for response

Two options for response are considered:

- Boundary control, where rabbits must be kept below Maclean's Scale 3 within 500m of a boundary where the neighbour is controlling rabbits.
- Full control, where rabbits are required to be kept under Maclean's Scale 3 throughout rabbit prone areas.

Because rabbits are only considered to be a significant problem in the highly prone areas of the upper Waitaki basin, the plan is only likely to be implemented in that area.

3.5 Risks of Rabbits (Feral) Plan

Technical and operational risks: Operational risks with failure of poisoning operations are known, particularly with repeated control efforts in high population densities causing neophobia (bait avoidance). These risks are lower with the presence of RHD, and regular poisoning operations are less common.

Implementation and compliance: There is a high risk of non-compliance with the plan given the history of high rabbit population numbers in rabbit prone areas, and the low return from grazing in very rabbit prone areas. This will be mitigated by the use of complaints to identify problem areas.

Other legislative risks: Risks arise to the availability of poisons through the Hazardous Substances and New Organisms (HSNO) Act. There are also RMA requirements to be met in relation to poisoning operations.

Public or political concerns: The use of 1080 to is considered controversial and may attract opposition.

Other risks: None known

Summary: There are risks associated with the rabbit plan although these are likely to be reasonably low as long as RHD has a reasonable level of effectiveness and returns for high country sheep and beef remain at a reasonable level. There was a combination of factors that caused widespread problems in the late 1980s and 1990s including low product prices, and difficulty with control technologies associated with neophobia. These conditions do not currently exist, and therefore the risks associated with plan non-achievement can be considered reasonably low.

3.5.1 Net Benefit and Risk Adjustment

The analysis produces an estimate of the total costs and benefits of the different options for the plan. These are shown in Table 8 below. In addition to the quantified costs and benefits, there are potential benefits associated with preventing damage to biodiversity. There are also intergenerational implications that should be taken into account.

The analysis shows that at 100% probability of success the Boundary Control option generates a net benefit of $4.58 million (NPV(6%)), compared with $23.48 million (NPV(6%)) for the Full Control plan that requires control on all rabbit infested land. The sensitivity analysis (Table 9) shows that the results are reasonably robust to the assumptions made about discount rate, proportion controlling, and whether moderately rabbit prone land is included[8].

In order for the options to be worthwhile there would need to be a greater than 89% probability of success for the Boundary Control option, and 44% for the Full Control option. There are also potentially biodiversity benefits on 3,000 ha for the Boundary Control option, and 33,000 ha for the Full Control option.

While the question of which plan is more worthwhile will ultimately depend on the risks assigned to each and the value assigned to the biodiversity protected, the analysis suggests that the Full Control has the highest net benefit of the options considered for those values quantified.

Table 8: Outcomes of analysis of costs and benefits for Rabbits (Feral) (NPV6%)

Scenario Option	Control Costs ($m)	Production loss ($m)	Inspection, monitoring and enforcement ($m)	Total ($m)	Net Benefit of plan option ($m)	Probability of success for plan to still be positive
Do Nothing	$7.36	$34.62	$0.00	$41.98	$0.00	
Boundary Control	$1.39	$31.09	$4.92	$37.40	$4.58	89%
Full Control	$13.58	$0.00	$4.92	$18.50	$23.48	44%

[8] This was tested because it is reasonable to assume that control may take place regardless of the plan on moderately prone land because it is significantly more worthwhile than rabbit control on high and extreme prone land .

Table 9: Assessment of sensitivity of results to assumptions for Rabbits (Feral) (NPV(6%) $million)

	Discount rate			Proportion not controlling			Moderate rabbit prone land included in the analysis	
Do Nothing	6%	4%	8%	10%	5%	20%	Yes	No
Boundary Control	$4.58	$6.24	$3.56	$4.58	-$0.17	$14.08	$4.58	$1.83
Full Control	$23.48	$32.00	$18.23	$23.48	$9.28	$51.88	$23.48	$8.63

NPD Section 7 - Allocation of Costs and Benefits

3.5.2 Beneficiaries, exacerbators and costs of proposed plan for control of Rabbits (Feral)

The beneficiaries and exacerbators of the plan are:

- Beneficiaries: The beneficiaries of the plan are land holders with high rabbit populations (production benefits), neighbouring land holders from the prevention of spread, and the wider community from prevention of damage to biodiversity, and prevention of soil erosion.
- Active exacerbators: Any persons transporting Rabbits (Feral) into or around the region
- Passive exacerbators: Any persons with Rabbits (Feral) on their property not undertaking control.

The direct and indirect costs associated with the plan are shown below in Table 10. The benefits and costs of the plan options, and the parties to whom they accrue, are shown in Table 11. They show that the inspection and monitoring costs are a major part of the Boundary control plan, and control costs for land holders are the largest cost for the Full Control plan. There are potentially some indirect costs for commercial and recreational hunting from the Full Control plan that have not been assessed here. There are however significant benefits for the exacerbators in both the Boundary and Full Control approaches.

Table 10: Direct and indirect costs of plan for Rabbits (Feral) ($ million PV6%)

Plan option	Control costs on land holders	Inspection and monitoring costs
Boundary Control	$1.39	$4.92
Full Control	$13.58	$4.92

Table 11: Benefits and costs of plan for Rabbits (Feral) that accrue to different beneficiaries and exacerbators ($ million PV(6%))

	Plan option	Those currently infested	Those experiencing spillover costs
Benefits	**Boundary Control**	$3.53	$7.36
	Full Control	$34.62	$7.36
Costs for exacerbators	**Boundary Control**	$1.39	$0.00
	Full Control	$13.58	$0.00

3.5.3 Matters for consideration in allocation of costs

The matters for consideration are spelt out in Section 7(2)(d) of the NPD and the analysis for each of these matters is shown in Table 4 below.

Table 4: Matters for consideration in allocating costs for proposed Rabbits (Feral) plan

Legislative rights and responsibilities	None known.
Management objectives	Sustained Control.
Stage of infestation	Widespread but only a problem in limited areas.
Most effective control agents	Land holders are the most effective agents to undertake control at low levels, since this ensures that management of the land is aimed at reducing rabbit proneness. At high levels specialist skills are required to undertaken aerial or ground poisoning operations.
Urgency	Low because populations appear generally stable and rabbits are very widespread.
Efficiency and effectiveness	It is most efficient to require land holders to control since this will encourage management of the land to reduce population densities. Inspection and enforcement costs are most efficiently targeted at beneficiaries, which are neighbouring properties for the prevention of spillover, and the wider community from biodiversity and soil erosion benefits.
Practicality of targeting beneficiaries	Beneficiaries from production gains are able to be targeted through a rate based on rabbit proneness or geographical area. Wider community beneficiaries are able to be targeted through General Rate.
Practicality of targeting exacerbators	Rabbit numbers can be established through inspection and land holders can be targeted. Exacerbators can therefore be readily targeted.
Administrative efficiency	The administrative efficiency of a targeted rate based on rabbit proneness will be low, and a geographically based rate on pastoral properties (area based) is likley to be most efficient for targeting the production beneficiaries from preventing spillover. The wider benefits can be most appropriately targeted through the General Rate.
Security	Rating mechanisms are generally secure.
Fairness	Charges relate directly to benefits or exacerbators. Fairness is a politically determined judgement.
Reasonable	The costs of the programme are reasonably high and ongoing for some land holders. However, some immediate benefit is received in terms of saved production losses.
Parties bearing indirect costs	No indirect costs are expected.
Transitional cost allocation arrangements	Programmes for rabbit control have been in place over a long period. There are no specific problems likely to be encountered requiring transitional arrangements.
Mechanisms available	General Rate, targeted rate (rural properties) and direct charges are the most readily available mechanisms. Levies are expensive to establish and administer. User charges are appropriate for costs of control.

3.5.4 Proposed allocation of costs

The control costs are appropriately targeted at exacerbators since they are able to be targeted, and by requiring them to undertake control there is likely to be greater efficiency in control of the rabbit populations.

The inspection, monitoring, and control costs are likely to be significant, but in both options they are less than the spillover costs avoided from uncontrolled rabbits on a boundary. Therefore the majority of the costs should be charged to land holders in the prone areas.

- Inspection and monitoring costs: 100% targeted rate for rabbit prone areas where inspection will occur.
- Control costs: 100% land holder control.

4 Bennett's Wallabies.

4.1 Description

Bennett's Wallabies were liberated in the Hunter's Hills in 1874 and became widespread over a reasonably large area of South Canterbury (350,000 ha) bounded by the Waimate river to the South, the Main divide to the west and north, and lack of suitable habitat to the East and North. The species present here is Bennett's Wallabies (*Macropus rufrogriseus rufrogriseus)*. Surveys in the late 1940's indicated that wallabies had reached levels as high as 14/ha in suitable habitat.

Control of Bennett's Wallabies began in 1947 under the Department of Internal Affairs with a shooting programme, although little effect on population numbers was recorded. Aerial 1080 poisoning was carried out on the Eastern Hunter Hills between 1961 and 1963, resulting in a marked decrease in wallaby numbers. Until the Canterbury Regional Council took over responsibility for control of wallabies the South Canterbury Wallaby Board conducted gun and dog control with the occasional poisoning operation. The gun and dog control ceased in 1992 when local ratepayers refused to support the costs of service delivery.

4.2 Impacts of Wallabies

Wallabies cause losses in agricultural production from competition with sheep and some prevention of isolated damage to fodder crops (Warburton pers.com.), and impacts to young forestry seedlings during establishment (Warburton 1986[9]).

There are also potential impacts to biodiversity and other ecosystem services. Warburton et al (1995) surveyed different vegetation types in the wallaby endemic areas. They concluded that wallabies do affect the sustainability and biodiversity of vegetation communities in the Hunters Hills. The observed effects were localised (1 - 5 ha), and were mainly significant in the tall tussock grasslands where browsing damage could be considerable. Plant species were browsed to extinction or severely hedged, and short matted turf and moss appeared in place of clumped tussock and mountain daisies in these pockets. In the short tussock grasslands wallabies have little effect, and in forest areas the effects of wallabies may be significant but were not readily distinguishable from those of other browsing herbivores such as sheep, goats, cattle, possums and deer. Adverse effects on soil and water were minimal and confined to areas of high density and in their current state were readily reversed. Latham et al (2016[10]) undertook a wide review of literature related to wallaby impacts and the identified benefits

[9] Warburton, B. 1986: Wallabies in New Zeal and : history, current status, research, and management need. FRI Bulletin 114. Forest Research Institute, Christchurch. 29 p.

[10] Latham, A.D.M., Latham, M.C., and Warburton, B. 2016. Review of current and future predicted distributions and impacts of Bennett's and dama wallabies in mainland New Zeal and . land care contract research report prepared for MPI. MPI Technical Paper No: 2016/15 March 2016.

associated with wallaby control, including ecosystem services associated with erosion control and sediment retention, and cultural services (i.e. aesthetic, educational, and scientific opportunities provided by ecosystems such as native tussock, scrub and forest).

Wallabies provide a quarry for recreational hunters, and as such the plan of control will have a potential cost to the community. However, it is unlikely that the plan will cause wallaby numbers to be depressed to the extent that recreational hunting is not possible.

4.3 Proposed plan

ECan are proposing a Sustained Control plan for Wallabies with the aim of maintaining them within their current boundaries.

4.4 Method

The analysis undertaken here relies on Latham *et al.* (2016) to estimate the annual costs and benefits of wallaby control. Their data is converted to a NPV(6%) figure using a linear interpolation of wallaby population impacts from their current estimate to that in 2065. A full list of assumptions is shown in Table 12, Table 13, and Table 14.

The Latham *et al*. (2016) estimates are dependent on the assumptions made about the current range. Some assumptions are needed because no comprehensive survey of wallaby presence has been undertaken in large parts of Canterbury, and there have been known releases by hunters of wallabies into new areas. For the purposes of this analysis three different distributions and associated rates of spread are used as shown in Table 12. These are the known distribution of 5322 km^2, the probable distribution of 14,135km^2, and the probable distribution including illegal liberations. Because the rates of spread were estimated based on the changes from 1975 – 2015 the different assumptions about 2015 distributions produce three associated rates of spread.

Using the assumptions in Latham et al (2016) lost production from wallaby infestation is based on an assumption about the stocking rate of wallabies and a conversion between wallaby numbers and sheep stock units of 3.8. That is for every 3.8 wallabies there will be 1 sheep stock unit (su) displaced. Stocking rates for wallabies are assumed to be 0.15/ha on flat country and 2 per ha on hill and high country. Density post control is estimated at 0.15 wallabies/ha on flat land and 0.2 wallabies/ha on hill and high country.

Losses associated with displaced stock units are based on the last five year's data for sheep and beef properties based on Beef and Lamb NZ Economic Survey data. The three classes used are Class 6 for flat land , Class 2 for hill country, and Class 1 for high country. The loss is estimated as a gross margin/ha which is the reduced revenue less the variable working expenses. The gross margin/ha is estimated at $76/su for flat country, $52/ha for hill country, and $47/ha for high country.

Control costs are also taken from the Latham et al (2016) report. These are estimated at $15.50/ha across all land uses including inspection costs. For the buffer area these are estimated at $26/ha including inspection costs. The inspection costs are estimated at $1/ha for the buffer zone and half that for extensive control in typical infested areas. The buffer area control is estimated based on the change in area infested when wallabies have spread 5km, with the buffer area differing across the three scenarios. This assumes 181.7m/year spread for Known, 827.8m/year for both Probable, and Probable with illegal liberation.

If control is undertaken inside the currently infested area in addition to the maintenance of a buffer zone, control costs in the buffer are assumed to be 1/10th of the cost if there were not

control inside the containment area, because the number of wallabies spilling over into the buffer zone should be very small. However inspection costs are maintained at $1/ha, although these costs should be seen as indicative and are subject to change through the planning process.

In the absence of intervention by the Council it is likely that a proportion of land holders will undertake control on their own behalf. The analysis assumes that 50% of land holders undertake control and adjusts the losses and control costs accordingly for the Do Nothing and Buffer scenarios.

Biodiversity costs are estimated at $17.6/ha after Latham et al (2016) and Patterson & Cole (2013).

A discount rate of 6% is used for the analysis, although this is sensitivity tested at 4% and 8% (see Section 5.4).

Table 12: Predicted distributions (km^2) of Bennett's Wallabies at five time periods using four different estimates of rate of spread (RS, in m/yr) and three different current range polygons. (Latham et al. 2016)

	Year 2015 'known distribution'		**2015 'probable distribution'**		**2015 'probable distribution', with illegal liberations**
	1st quartile	**3rd quartile**	**1st quartile**	**3rd quartile**	**3rd quartile**
Year	(RS = 16.5)	(RS = 181.7)	(RS = 353.5)	(RS = 827.8)	(RS = 827.8)
2015	5322	5322	14 135	14 135	15 229
2020	5395	5947	14 925	15 949	18 328
2025	5443	6477	15 703	17 444	21 529
2035	5553	7434	17 018	20 257	28 048
2065	5883	9621	20 631	28 447	44 226

Table 13: Assumptions for production losses by land use type

	Flat	Hill	High
Stocking rate sheep	14	7.5	0.7
Stocking rate wallabies/ha	0.15	2	2
Conversion rate wallabies/su	3.8	3.8	3.8
Gross margin/su	$75.87	$52.44	$46.73
Net loss/ha	$2.99	$27.60	$24.59
Ecosystem benefit	17.6		
Post control wallaby stocking rate	0.2	0.2	0.2
Post control losses	3.0	2.8	2.5

Table 14: Assumptions for control costs by scenario

	Known, 3rd quartile spread	Probable, 3rd quartile spread	Probable, illegal liberation
Control cost/ha Current	$15.5	$15.5	$15.5
Control costs/ha delayed	$15.5	$15.5	$15.5
Control costs buffer	$26	$26	$26
Control costs in absence of plan	$15	$15	$15
5km buffer area (km2e)	1824.9	2113	2113

4.5 NPD Section 6 Assessment

4.5.1 Level of Analysis

The Wallaby plan has been assessed as requiring a medium level of analysis. The assessment is provided in the table in Appendix B.

4.5.2 Impacts of Wallabies

Bennett's Wallaby causes loss of production from pastoral agriculture and crops. They also have impacts on biodiversity in tussock landscapes, scrub and forested areas. Wallabies provide recreational benefits for hunting.

4.5.3 Options for response

The analysis considers five options for Bennett's Wallabies:

1. Do Nothing
2. Control at current infestation levels
3. Control delayed 10 years

4. Buffer zone with no control in currently infested area.
5. Buffer zone with control in currently infested area.

4.5.4 Benefits and costs of options for management of Bennett's Wallabies

The benefits and costs of the five options for management of Bennett's Wallabies are shown in Table 15 for each of the three scenarios of current infestation and rates of spread. The analysis shows that in the absence of a plan (Do Nothing) there will be a loss in production of between $100 million and $380 million, control costs for land holders who do undertake control of between $60 million and $220 million, and a loss in biodiversity values of between $30 million and $750 million (all PV(6%)).

Table 15: Impacts of options for management of Bennet's Wallabies

Plan	Impact	Known ($million PV(6%))	Probable ($million PV(6%))	Probable with illegal liberation ($million PV(6%))
Do Nothing	**Lost production without control**	$107.43	$293.78	$381.54
	Control costs	$62.00	$169.61	$220.64
	Lost biodiversity without control	$30.35	$57.08	$74.36
	Total	**$199.77**	**$520.47**	**$676.55**
Control at current infestation levels	**Lost production with control**	$21.03	$57.52	$74.86
	Control at current	$130.02	$345.33	$372.06
	Total	**$151.05**	**$402.85**	**$446.92**
Control delayed 10 years	**Lost production**	$60.35	$162.74	$195.27
	Lost biodiversity	$6.15	$11.32	$13.10
	Control	$112.66	$303.27	$371.97
	Total	**$179.16**	**$477.33**	**$580.33**
Buffer zone with no control in current area	**Lost production**	$91.62	$243.34	$262.17
	Cost of control inside buffer	$50.33	$133.68	$144.02
	Lost biodiversity	$11.82	$21.59	$23.26
	Control costs for buffer	$74.79	$86.59	$86.59
	Total	**$228.56**	**$485.19**	**$516.04**
Buffer zone with control in current area	**Lost production**	$21.03	$57.52	$74.86
	Cost of control inside buffer	$130.02	$345.33	$372.06
	Lost biodiversity	$0.00	$0.00	$0.00
	Control costs for buffer	$10.07	$11.66	$11.66
	Total	**$161.11**	**$414.51**	**$458.58**

4.5.5 Risk Assessment

Technical and operational risks: Containment is difficult to achieve under the current regime because of a lack of co-ordinated control and the mobile nature of wallabies. Therefore, there is risk that a Sustained Control plan which focused on either the currently infested area, or on the boundaries of the currently infested area, would be unsuccessful in containing the pest in its current area.

Implementation and compliance: There is potential for non-compliance by land holders due to the cost of control. While this will be somewhat mitigated by the inspection and compliance regime, and minor breaches are unlikely to affect the achievement of the containment plan

overall, it appears that to date the current regime has not been successful in achieving widespread compliance. There is significant potential for the spread of wallabies by the hunting community which is difficult to prevent because those responsible cannot be identified. An ongoing surveillance regime outside the current infested area will be required.

Other legislative risks: Risks arise to the availability of poisons through the HSNO Act. There are also RMA requirements to be met in relation to poisoning operations.

Public or political concerns: Wallabies are high value for hunting activities, which may create pressures against the plan. There are also public concerns relating to the widespread use of poisons which may cause risks for the programme.

Other risks: None known

Summary: The analysis shows that there are some risks associated with the programme if reliance remains on the current approach of control below Guildford 3 scale through an inspection and compliance regime. It is assumed that there is a 40% probability of success in containing wallabies for the two control intervention options based on the current approach (with and without delay), and an 80% chance of success for the buffer zone options which have more intensive control and inspection with and without control in the currently infested area.

4.5.6 Net benefit and risk adjustment

Table 16 shows the Net Benefit of each of the plan intervention options when compared with the Do Nothing scenario. This table shows that all intervention options produce a positive net benefit relative to the Do Nothing scenario, apart from the Buffer Zone option under the Known Wallaby infestation area scenario. This option and set of assumptions produce a negative net benefit, probably primarily because the rates of spread in the Known assumptions are very low, and the additional cost of the Buffer Zone is substantial in comparison with the lost production. The control at Current Infestation scenario, where control is undertaken across the known infestation area, produces the highest net benefit under the Known and Probable scenarios, largely because of the assumption about the production benefits that are associated with control.

When the options are adjusted for the assessment of risk a different pattern emerges. The inclusion of the Buffer Zone in the options increases the relative net benefit of those options. When the Buffer Zone is included alongside control in the current area this option produces the highest net benefit across all scenarios of current infestation and rate of spread. The Buffer Zone without control in the currently infested area has the second highest net benefit under the largest currently infested area assumption (Probable with illegal liberation). Control at current infestation has the second highest net benefit under the Known and Probable set of assumptions.

It is clear therefore that when adjusted for risk the Buffer Zone with control in the currently infested area has the highest net benefit and would have the greatest certainty of success in managing the spread of wallabies.

Table 16: Net Benefit for management intervention options ($ million NPV(6%))

	Known ($million NPV(6%))	Probable ($million NPV(6%))	Probable with illegal liberation ($million NPV(6%))
Control at current infestation	$49	$118	$230
Control delayed 10 Years	$21	$43	$96
Buffer zone with no control in place	-$29	$35	$161
Buffer zone with control in place	$39	$106	$218

Table 17: Risk Adjusted Net Benefit for management intervention options ($million NPV(6%)))

	Known ($million NPV(6%))	Probable ($million NPV(6%))	Probable with illegal liberation ($million NPV(6%))
Control at current infestation	$19	$47	$92
Control delayed 10 Years	$8	$17	$38
Buffer zone with no control in place	-$23	$28	$128
Buffer zone with control in place	$31	$85	$174

4.6 NPD Section 7 - Allocation of Costs and Benefits

4.6.1 Beneficiaries, exacerbators and costs of proposed plan for control of Bennett's Wallaby

The beneficiaries and exacerbators of the plan are:

- Beneficiaries: Pastoral agriculture, some crop adjacent to high density areas, general public from biodiveristy benefits.
- Active exacerbators: Persons who release wallabies into new areas for hunting purposes.
- Passive exacerbators: Any persons with Bennett's Wallaby on their property not undertaking control.

The direct and indirect costs associated with the plan are shown below in Table 18 and the size of the benefits and costs to different parties in relation to the plan options are shown in Table 19.

Table 18: Direct and indirect costs of plan for Bennett's Wallaby

Plan option	Control costs land holders ($m PV(6%))	Inspection and monitoring costs ($m PV(6%))
Control at current infestation	$57	$11
Buffer zone with no control in place	$130	$3
Buffer zone with control in current area	$343	$14

Table 19: Bennett's Wallaby programme benefits by beneficiary type and costs for exacerbators

	Plan option	Those currently infested ($m PV(6%))	Those not currently infested ($m PV(6%))	Community for biodiversity and ecological benefits ($m PV(6%))
Benefits	**Control at current infestation**	$1,858	$504	$570
	Buffer zone with no control in place	$0	$504	$355
	Buffer zone with control in current area	$1,858	$504	$570
Control costs for exacerbators	**Control at current infestation**	$680	$0	$0
	Buffer zone with no control in place	$0	$833	$0
	Buffer zone with control in current area	$680	$83	$0

4.6.2 Matters for consideration in allocation of costs

The matters for consideration are spelt out in Section 7(2)(d) of the NPD, and the analysis for each of these matters is shown in Table 2 below.

Table 20: Matters for consideration in allocating costs for proposed Bennett's Wallaby plan

Legislative rights and responsibilities	None known.
Management objectives	Sustained Control.
Stage of infestation	Expanding - currently found in South Canterbury but have expanded range northward over the last decade.
Most effective control agents	Wallabies are mobile and require targeting by hunters and poisoning. These are generally specialist skills.
Urgency	Moderate - spread is occurring but is relatively slow and limited to adjacent areas. Major river systems present a barrier to northward spread.
Efficiency and effectiveness	Efficiency and effectiveness maximised by focusing on preventing spread beyond current established areas. Within infested areas land holders are best placed to determine appropriate levels of control. May be some gains from ensuring uniform levels to prevent spillover between properties.
Practicality of targeting beneficiaries	Beneficiaries are widespread throughout the region, although largely related to pastoral agriculture.
Practicality of targeting exacerbators	Location of Bennett's Wallaby is defined and passive exacerbators are able to be targeted. Difficult to target active exacerbators who move wallabies.
Administrative efficiency	General Rate is highly efficient for collecting community benefits related to biodiversity. Targeted rural rate is appropriate for benefits to pastoral agriculture.
Security	Rating mechanisms are generally secure.
Fairness	Charges relate directly to benefits or exacerbators. Fairness is a politically determined judgement.
Reasonable	The costs of the programme are potentially high for some land holders in the containment areas with little benefit received.
Parties bearing indirect costs	Hunters experience some loss of value associated with reduced hunting opportunity.
Transitional cost allocation arrangements	Transitional cost arrangements may be required when controlling high levels of wallabies in the buffer zone areas because of the low level of benefits received by land holders.
Mechanisms available	General Rate, targeted rate (rural properties) and direct charges are the most readily available mechanisms. Levies are expensive to establish and administer.

4.6.3 Proposed allocation of costs

Control in Current Area

Because there is significant benefit to currently infested land holders it is most appropriate to bear the cost of control of wallabies. They are also the major exacerbators and it is likely that requiring them to bear the cost of control will achieve some efficiency gains.

Control in Buffer zone

The major beneficiaries of control in the buffer zone are land holders protected from spread of wallabies onto their land . This plan also provides benefit to the wider community for prevention of damage to biodiversity values.

Because there is little that land holders in the buffer zone can to do reduce wallaby movement onto their property it is not appropriate to charge them as exacerbators.

Therefore, the costs of control should fall on land holders outside the currently infested area and the wider community. The estimates show that approximately 20% of the costs are to the wider community and the remaining costs for land holders outside the currently infested area.

General Rate is most appropriate for the community benefit, and a targeted rate based on productive land in the region is most appropriate for the wider land holder benefits.

- Inspection and monitoring costs: 20% General Rate, 80% targeted rate on productive land .
- Control costs in currently infested area: land holder control
- Control costs in buffer zone: 20% General Rate, 80% targeted rate on productive land.

5 Method for Plant Pests

For plant pests a generic model was developed to assist in estimating the change in costs associated with a pest over time under the different management options. This model mathematically calculates the estimated impacts associated with pest management options, and has four components discussed below. Detailed assumptions used for each pest are included in a table in Appendix A.

5.1 Infested area

The infested area is determined by the area currently infested, the number of active sites, the rate of spread, and the generation of new sites which are user inputs. The area of the largest current site is user input, then it is assumed that the remaining sites are of equal size covering the remaining area. The area of each site is increased annually by the rate of spread on a quadrant basis. Each quadrant of an infested area keeps expanding until it reaches its nearest boundary then stops increasing in area. The distance from boundaries is user input but there is no assumption about the proximity of infestations to each other – i.e. the model assumes that the current infestations and new infestations are equidistant, and do not coalesce into a larger site until the area is fully occupied.

New sites are generated at a user input rate each year. This allows for the fact that mathematically the rate of increase in area of a larger number of sites is greater than for a single site expanding on its boundary.

Once the fully available area is occupied all infested areas cease expanding. It is assumed that pest spread will continue under the Do Nothing scenario regardless of land holder control, but that other plan options will have user input success in preventing spread depending on the option.

5.2 Density

The density of pests in an infested area increases in a logistic fashion according to the equation:

$$N_y = N_{y-1} + N_{y-1} * r * (1 - \frac{N_{y-1}}{D})$$

Where

N_y = density in year y

r = logistic growth constant

D = maximum density

The value for r is estimated from the period between first arrival at a site and full density, which is a user input estimate (sensitivity tested).

5.3 Losses

Losses arise from control costs and production loss, as well as from displaced biodiversity and impacts on other values. The model calculates production loss and control costs and uses area displaced as a proxy for the impact on other biodiversity, amenity, and recreation values.

It is assumed that once an area is infested control costs are required and that a proportion will undertake control, with the proportion under each plan option user input. The control costs are fixed on an area basis.

Production losses are assumed where control is not undertaken, with the loss proportional the area displaced. It is assumed that infested land where control is not undertaken is unable to be used for productive purposes, hence both revenue and variable costs are zero. The losses are greater than the straight operating profit/ha because fixed costs are still incurred by the operation. For each land use type, the losses equal the revenue/ha less the variable costs/ha. The revenue, costs and production losses used in the model are shown in Table 21. These are based on the last five year's reported farm budgets from DairyNZ[11] and Beef and Lamb NZ Table 21.

Table 21: Estimated revenue, costs and production losses by land use type in pest model

Land use	Revenue ($/ha/year)	Fixed Cost ($/ha/year)	Variable Cost ($/ha/year)	Reduction in operating profit/ha ($/ha/year)
High country	$105	$35	$49	$56
Hill country	$347	$123	$151	$195
Intensive finishing breeding	$1,065	$375	$438	$627
Crop	$3,041	$1,405	$1,263	$1,778
Dairy	$10,188	$2,931	$7,811	$2,377
Intensive pasture	$4,106	$1,227	$2,896	$1,210
All intensive systems	$3,948	$1,253	$2,654	$1,294
All extensive pasture	$245	$86	$108	$137

5.4 Estimate of NPV

The analysis is collated into an annual cashflow for each management option for 100 years. These are then converted into a net present value at a discount rate of 6% (NPV(6%)). Sensitivity testing is undertaken for the r value, rate of spread, cost of control, gross margin for loss of production, and discount rate (4% and 8%).

Choice of discount rate is important and a higher rate favours investments with earlier returns or costs that are further in the future. The discount rate of 6% is chosen because it matches the NZ Treasury recommendation[12]. It is higher than the 4% used by Auckland and Regional Council, but because most of the quantified benefit is associated with agricultural losses and control costs for land holders the 6% better reflects their cost of capital. Decision makers should note the impact of the higher and lower discount rates in the sensitivity testing when determining the best course of action.

The risks that the option will not meet the objective were identified for each pest and mitigation options considered where appropriate. The residual risk associated with the different outcomes was estimated as a user input based on observation of success rates in similar

[11] DairyNZ data for revenue and operating expenses at the Canterbury level is used, then adjusted using more detailed national data to estimate the proportion of fixed expenses.
[12] http://www.treasury.govt.nz/publications/guidance/planning/costbenefitanalysis/currentdiscountrates

programmes. The assumptions differ for each objective. For example if the objective is Eradication then there is a probability of achieving Eradication, but also a probability that some other outcome will be achieved – reduction, stable infestations, or continued expansion. The probabilities are assigned to each potential outcome such that the probabilities sum to 1. The risks for each plan option are assumed to be the same unless there is a reason why a particular pest is likely to differ from the standard assumptions for that objective type. The risk assumptions for each plan option are shown in Table 153 to Table 156.

In addition to this approach sensitivity tests were undertaken on the risk adjusted outcome for a range of variables. These show whether the highest rated option changes as different variables are changed and are presented as a table of the highest rated option for each sensitivity test.

5.5 Scenarios

The model tests four scenarios – one , the Do Nothing scenario, and three that relate to the three primary NPD objectives of Sustained Control, Progressive Containment, and Eradication. This approach allows the model to efficiently test a wide range of pests regardless of the proposed objective, and compares it with the other potential objectives for the plant. The descriptions for each of three scenarios are set out below.

Do Nothing – no control is required of land holders, and although land holders may individually undertake control, the lack of co-ordination means that the pest continues to spread. The majority of the model is focused on assessing impacts of the expected rate of spread and rate at which infested habitats are occupied. The outcomes for the Do Nothing scenario reflect the loss of production from land infested by the pest when control is not undertaken by landholders, and the costs of control where landholders do undertake control and don't incur production losses.

Sustained Control – In this scenario control is undertaken and the model assumes that because control is co-ordinated there is no further spread of the pest but also no reduction in its extent. The proportion of the land controlled is greater than in the Do Nothing scenario because the rules require land holder control under a range of circumstances with the proportion controlled generally high in pests with limited distribution (90%) but lower in widespread pests (30% - 50%). However, in the areas where control is not undertaken the pest continues to increase in density. Per ha costs of control are the same as for the Do Nothing scenario.

Progressive Containment– This scenario is essentially the same as the Sustained Control scenario but the control effort results in a reduction in the area of the pest affected. The reduction is estimated by the period over which area affected is reduced to 0 - 50 years for the pests of limited distribution, and 100 – 1000 years for more widespread pests. The proportion controlling is also assumed to be higher and is set at 95% for all pests. In areas not under control the pest continues to increase in density. Per ha costs of control are twice that of the Do Nothing scenario to reflect the fact that more careful control is required.

Eradication – This scenario assumes that all land is under control and no further increase in density or area is expected. It is assumed that Eradication can be achieved in 20 years for all pests of limited distribution and 50 years for more widespread pests. It is assumed that inspection and monitoring costs are 1.5 times that for Progressive Containment for all pests of limited distribution, and 2.5 times that of Progressive Containment for widespread pests.

Per ha control costs are assumed to be 5 times that of the Do Nothing scenario to reflect the fact that very high levels of control are required if Eradication is to be achieved.

The costs of inspection, monitoring and enforcement are varied by scenario for each pest to reflect the fact that these costs vary in both intensity and aggregate requirements depending on how widespread a pest is and how intensively it is being managed. Thus where the objective is Eradication, significantly more intensive inspection is required than where the objective is Sustained Control. The ratio of inspection costs are given in relation to the costs for Sustained Control inspection, and are shown in Table 22 below. The inspection costs should be seen and indicative only and are subject to change through the planning process.

Table 22: Ratio of inspection costs by objective for each scenario considered (base Sustained Control = 1)

	Ratio of inspection costs (Sustained Control = 1)	
Pest	**Progressive Control/ Sustained Control**	**Eradication/ Sustained Control**
Baccharis	2	3
Egeria	2	3
Entire Marshwort	2	3
Moth Plant	2	3
Phragmites	2	3
Yellow Bristle Grass	2	3
Yellow water lily	2	3
African Feather Grass	4	6
African Love Grass	4	6
Bell Heather	4	6
Bur Daisy	4	6
Chilean needle grass	4	6
Coltsfoot	4	6
Puna Grass	4	6
Saffron Thistle	4	6
White-edged nightshade	4	6
Boneseed	20	50
Broom	20	50
Darwin's barberry	20	50
Gorse	20	50
Nassella Tussock	20	50
Wild Thyme	20	50
Wilding conifers	20	50
Purple Loosestrife	20	50
Knotweed	2	3
Old Man's Beard	20	50

5.6 Net Benefit analysis

The net benefit is estimated over 100 years and is the difference between the costs and benefits of the proposed option and the costs and benefits that would be incurred if the region were not to intervene – i.e. the Do Nothing scenario. This is calculated by subtracting the alternative scenarios from the Do Nothing scenario, and if the result is positive it indicates that the overall losses caused by the pest are lower than in the alternative scenarios, and therefore the alternatives are preferred. This net benefit is then adjusted for the risk that the proposed objective will not be achieved to provide an estimate of the risk adjusted net benefit. Assumptions used in undertaking the modelling were provided by Environment Canterbury and are described in detail in the report and in Appendix A.

However, the risk adjusted net benefit is based only on those costs that are quantified – these are the loss of production and the costs of control. Pests are also associated with a range of other impacts that cannot be reliably quantified in monetary terms, including those to mana whenua, biodiversity, recreation, and amenity values. For pests where the risk adjusted net benefit is positive, the proposed plan option is justified even without consideration of those items. Where the risk adjusted net benefit is negative it is important that these other impacts are taken into consideration.

The analysis therefore provides estimates of the threshold value that these other biodiversity, recreation, and amenity values would need to exceed in order for the plan objective to be positive. This threshold value is calculated by dividing any negative net benefit by the area protected by the proposed programme.

5.6.1 Caveats

The results generated from the plant pest model are based on a range of user inputs and assumptions about the behaviour of the pest. The best information available is used in generating these inputs, but the results should be treated as indicative of the likely outcomes under those conditions, and not definitive. They are intended as appropriate for the level of analysis required and the degree of information available rather than the most comprehensive CBA that could be undertaken for any given pest.

6 Baccharis

6.1 Description

Baccharis (*Baccharis halimifolia*) is an evergreen shrub growing to approximately 4m height. It is likely to have been introduced as a garden ornamental, can be found growing in rock crevices, on open and dry hillsides, non productive places, and in private gardens. It is currently limited to a few active sites on the Port Hills and Banks Peninsula in Canterbury.

6.2 Impacts of Baccharis

Baccharis has the potential to cause damage to pastoral agriculture through reduced pasture quality and animal intake, and damage to biodiversity through displacement of native tussock grassland.

6.3 Proposed Plan

ECan is proposing that Baccharis is controlled through the Progressive Containment outcome described in Section 1(b) of the NPD.

6.4 NPD Section 6 Assessment

6.4.1 Level of analysis

The assessed level of analysis for Baccharis under the requirements of the NPD and using the NPD Guidance approach is Level 1. The detail of the requirement for assessment is shown in Appendix B.

6.4.2 Impacts of Baccharis

Baccharis causes damage to pastoral agriculture through reduced pasture quality and animal intake, and damage to biodiversity through displacement of native tussock grassland .

6.4.3 Benefits and costs for management of Baccharis

The management of Baccharis will prevent damage to pastoral agriculture through reduced pasture quality and animal intake, and damage to biodiversity through displacement of native tussock grassland. Cost of lost production and control if allowed to spread are estimated at NPV(6%) $46 million. There is also the prevention of any impacts to biodiversity on an area of 90,000 ha after 100 years if it is allowed to spread.

6.4.4 Costs of Baccharis Plan

The plan will incur costs for inspection and monitoring and control undertaken by Council. These are $7500 annually for the plan option. Costs for all three options considered are NPV(6%) $60,000 for Sustained Control, NPV(6%) $100,000 for Progressive Containment, and NPV(6%) $100,000 for Eradication (due to the shorter time period).

6.4.5 Risks of Baccharis Plan

Technical and operational risks: Containment is technically difficult to achieve. It will also require control on non productive areas and in the Port Hills which is currently inaccessible. However, this risk will be mitigated by the use of Council staff to undertake inspection and control

Implementation and compliance: Having the work undertaken and managed by the Council minimises implementation and compliance risks.

Other legislative risks: None known

Public or political concerns: None known

Other risks: None known

Summary: The major risks associated with the Baccharis plan are related to the technical difficulty of achieving containment, particularly the control on non productive areas and in the Port Hills. The risks of non-achievement are adjusted accordingly (see Appendix C).

6.4.6 Net Benefit and risk adjustment

The analysis produces an estimate of the total costs and benefits of the different options for the plan, as shown in Table 1 below. In terms of those alternatives considered, the Progressive Containment option has the highest net value. The sensitivity of this conclusion to changes in various input parameters is shown in Table 24 below, and it proves reasonably robust to changes in the major assumption areas. In addition to the quantified costs and benefits, there are potential benefits associated with preventing damage to biodiversity on 90,000 ha and intergenerational implications of the costs for future land holders and wider community that should be taken into account.

These factors suggest that the Progressive Containment option is favoured as producing the highest net benefit if the assumptions made in this analysis are considered reasonable.

Table 23: Outcomes of analysis of costs and benefits for Baccharis ($ NPV6%)

Plan option	Total control costs and lost production PV(6%)	Net Benefit of plan (NPV(6%))	Risk adjusted net benefit (NPV(6%))
Do nothing	$46,000,000		
Sustained Control	$60,000	$45,690,000	$22,350,000
Progressive Containment	$100,000	$45,630,000	$40,600,000
Eradication	$100,000	$45,620,000	$40,590,000

Table 24: Impact of sensitivity testing on highest value option

Sensitivity test	Highest value option
Base net benefit	Progressive Containment
Time to full occupation 50% of base	Progressive Containment
Time to full occupation 150% of base	Progressive Containment
Distance of spread 50% of base	Progressive Containment
Distance of spread 200% of base	Progressive Containment
Cost of control +20% from base	Progressive Containment
Cost of control -20% from base	Progressive Containment
Loss of production impacts -20% from base	Progressive Containment
Loss of production impacts +20% from base	Progressive Containment
Discount rate 4%	Eradication
Discount rate 8%	Progressive Containment

6.5 NPD Section 7 - Allocation of Costs and Benefits

6.5.1 Beneficiaries, exacerbators and costs of proposed plan for control of Baccharis

The beneficiaries and exacerbators of the plan are:

- Beneficiaries: Rural community from prevention of spread and production benefits.
- Active exacerbators: Any persons transporting Baccharis into or around the region
- Passive exacerbators: Any persons with Baccharis on their property not undertaking control.

The direct and indirect costs associated with the plan are shown below in Table 25 and Table 26.

Table 25: Direct and indirect costs of plan for Baccharis

Plan option	Control costs land holders (PV (6%))	Inspection and monitoring costs (PV (6%))
Sustained Control	$300	$60,000
Progressive containment	$500	$100,000
Eradication	$1000	$100,000

Table 26: Benefits and costs of plan for Baccharis that accrue to different beneficiaries and exacerbators

Plan option	Benefits for those currently infested (PV (6%))	Benefits for those not currently infested (PV (6%))	Costs for exacerbators (PV (6%))
Sustained Control	$1,000	$46,000,000	$300
Progressive containment	$1,000	$46,000,000	$500
Eradication	$700	$46,000,000	$1,000

6.5.2 Matters for consideration in allocation of costs

The matters for consideration are spelt out in Section 7(2)(d) of the NPD, and the analysis for each of these matters is shown in Table 27 below.

Table 27: Matters for consideration in allocating costs for proposed Baccharis plan

Legislative rights and responsibilities	None known.
Management objectives	Progressive Containment.
Stage of infestation	Low - 16 active sites on Port Hills.
Most effective control agents	Control is likely best undertaken by the Council. The location of the plant and level of infestation make reliance on land holder control unreliable.
Urgency	Very high if containment is to be achieved at an early stage of infestation.
Efficiency and effectiveness	Control at an early stage is likely to be more efficient than when it is better established.
Practicality of targeting beneficiaries	Wider community can be targeted through targeted rural rate or General Rate.
Practicality of targeting exacerbators	Locations are limited and known, and exacerbators can be targeted.
Administrative efficiency	Exacerbator control requires inspection and enforcement, while General Rate would have greater administrative efficiency.
Security	Exacerbator control is difficult with a small scale pest where containment and reduction is desired, because highly effective control is required. Rating mechanisms are generally very secure.
Fairness	Charges relate directly to benefits or exacerbators. Fairness is a politically determined judgement.
Reasonable	Costs are likely to be more reasonable under Progressive Containment than Eradication.
Parties bearing indirect costs	None known.
Transitional cost allocation arrangements	None required.
Mechanisms available	General Rate, targeted rate (rural properties) and direct charges are the most readily available mechanisms. Levies are expensive to establish and administer.

6.5.3 Proposed allocation of costs

The analysis suggests that the benefits of eradication of Baccharis accrue largely to the rural land holders who benefit from production gains, but there are also benefits to the wider community for prevention of damage to biodiversity benefits. The costs of control, monitoring, and inspection should be funded jointly from a rate on productive rural properties and the General Rate, while control costs should be funded from a rate on productive land to reflect the mix of benefits.

- Inspection and monitoring cost: 50% General Rate, 50% targeted rate on productive land

- Control Costs: 100% targeted rate on productive land .

7 Egeria

7.1 Description

Egeria (*Egeria densa*) is an aquatic plant with large dark green leaves. It is usually submerged but can grow to the surface and form a tangled mat. It is easily confused with Lagaraosiphon and Elodea. It grows in most water types, is long lived and will grow from any stem fragments. It is difficult to kill and shades out native aquatic flora and fauna. It is understood to be present only in the Avon river in Christchurch at present.

7.2 Impacts of Egeria

Egeria has the potential to cause damage to biodiversity in waterways and to impact on flooding.

7.3 Proposed Plan

ECan is proposing that Egeria is controlled through the Eradication objective described in Section 1(b) of the NPD.

7.4 NPD Section 6 Assessment

7.4.1 Level of analysis

The assessed level of analysis for Egeria under the requirements of the NPD and using the Guidance approach is Level 1. The detail of the requirement for assessment is shown in Appendix B.

7.4.2 Impacts of Egeria

Egeria causes damage to biodiversity in waterways, and has potential impacts on flooding.

7.4.3 Benefits and costs for management of Egeria

Prevention of damage to biodiversity in waterways and potential impacts on flooding. The costs of lost production and control costs if allowed to spread are NPV(6%) $48 million based on assumed level of control of 10% in the absence of a plan. There is also the benefit from prevention of any impacts to biodiversity on an area of 450 ha after 100 years if the pest is allowed to spread.

7.4.4 Costs of Egeria Plan

The plan will incur costs of control, inspection, and monitoring. Costs of control, inspection, and monitoring. These are $4000 annually for the plan option. Costs for all three options considered are a NPV of $20,000 for Sustained Control, NPV $40,000 for Progressive Containment, and NPV $50,000 for Eradication (which has a shorter time frame).

7.4.5 Risks of Egeria Plan

Technical and operational risks: Control of any pest is difficult in water bodies which is mobile and the difficult to contain. Eradication with zero density is technically difficult to achieve under any circumstance and will be a major challenge for Egeria.

Implementation and compliance: Eradication is technically difficult to achieve and control is difficult in water bodies. However, this risk will be mitigated by the use of Council staff to undertake inspection and control.

Other legislative risks: None known

Public or political concerns: None known

Other risks: None known

Summary**:** The major risk for Egeria is the difficulty of achieving eradication or even zero density in a water body. This is mitigated somewhat by the use of specialist control agents and the confined nature of the water body. However, these risks are reflected in the probability assigned to achieving eradication in the risk adjustment discussed below.

7.4.6 Net Benefit and risk adjustment

The analysis produces an estimate of the total costs and benefits of the different options for the plan, as shown in Table 28 below. In terms of those alternatives considered, the Eradication option has the highest net value. The sensitivity of this conclusion to changes in various input parameters is shown in Table 29 below and shows that the analysis is robust to major changes in the primary input assumptions. In addition to the quantified costs and benefits there are potential benefits associated with preventing damage to biodiversity, and intergenerational implications that should be taken into account.

All of the management options will prevent the displacement of biodiversity on 450 ha (assuming 1% maximum density).

These factors suggest that the Eradication option is strongly favoured as producing the highest net benefit if the assumptions made in this analysis are considered reasonable.

Table 28: Outcomes of analysis of costs and benefits for Egeria

Plan	**Total control costs and lost production PV(6%)**	**Net Benefit of plan NPV(6%)**	**Risk adjusted net benefit of plan NPV(6%)**
Do Nothing	$48,000,000		
Eradication	$300,000	$47,460,000	$44,730,000
Progressive containment	$200,000	$47,580,000	$42,370,000
Sustained Control	$90,000	$47,660,000	$23,340,000

Table 29: Impact of sensitivity testing on highest value option

Sensitivity test	Highest value option
Base net benefit	Eradication
Time to full occupation 50% of base	Eradication
Time to full occupation 150% of base	Eradication
Distance of spread 50% of base	Eradication
Distance of spread 200% of base	Eradication
Cost of control +20% from base	Eradication
Cost of control -20% from base	Eradication
Loss of production impacts -20% from base	Eradication
Loss of production impacts +20% from base	Eradication
Discount rate 4%	Eradication
Discount rate 8%	Eradication

7.5 NPD Section 7 - Allocation of Costs and Benefits

7.5.1 Beneficiaries, exacerbators and costs of proposed plan for control of Egeria

The beneficiaries and exacerbators of the plan are:

- Beneficiaries: Wider community from biodiversity benefits and reduced flooding.
- Active exacerbators: Any persons moving Egeria.
- Passive exacerbators: None

The direct and indirect costs associated with the plan are shown below in Table 30 and Table 31.

Table 30: Direct and indirect costs of plan for Egeria

Plan option	Control costs	Inspection and monitoring costs (PV (6%))
Sustained Control	$70,000	$20,000
Progressive containment	$100,000	$40,000
Eradication	$300,000	$50,000

Table 31: Benefits and costs of plan for Egeria that accrue to different beneficiaries and exacerbators

Plan option	Benefits for those currently infested (PV (6%))	Benefits for those not currently infested (PV (6%))	Costs for exacerbators (PV (6%))
Sustained Control	$-60,000	$48,000,000	$70,000
Progressive containment	$-130,000	$48,000,000	$100,000
Eradication	$-240,000	$48,000,000	$300,000

7.5.2 Matters for consideration in allocation of costs

The matters for consideration are spelt out in Section 7(2)(d) of the NPD and the analysis for each of these matters is shown in Table 32 below.

Table 32: Matters for consideration in allocating costs for proposed Egeria plan

Legislative rights and responsibilities	None known.
Management objectives	Eradication.
Stage of infestation	Low infestation - there is only one known site in the Avon River.
Most effective control agents	It is likely that Council control will be required because there are no specific owners of the waterways where Egeria occurs.
Urgency	Very high if eradication is to be achieved at an early stage of infestation and spread is to be prevented.
Efficiency and effectiveness	Control at an early stage is likely to be more efficient than when it is better established. Eradication requires complete control of the pest, which is more likely to be achieved through use of contractors.
Practicality of targeting beneficiaries	Wider community beneficiaries can be targeted through General Rate.
Practicality of targeting exacerbators	Exacerbators difficult to identify and target.
Administrative efficiency	General Rate is highly efficient for collecting community benefits related to biodiversity.
Security	Rating mechanisms are generally secure.
Fairness	Charges relate directly to benefits or exacerbators. Fairness is a politically determined judgement.
Reasonable	The costs for Council are not large compared with the overall budget for pest management.
Parties bearing indirect costs	There are potentially some costs for other parties associated with control in the waterway - particularly rowing clubs unable to use the reach while control is being undertaken. These are not likely to be significant.
Transitional cost allocation arrangements	None required.
Mechanisms available	General Rate, targeted rate (rural properties) and direct charges are the most readily available mechanisms. Levies are expensive to establish and administer.

7.5.3 Proposed allocation of costs

Because of the community nature of the benefits it is recommended that the Egeria plan be funded from General Rate. The recommendation therefore is:

- Inspection and monitoring cost: 100% General Rate
- Control Costs: 100% General Rate

8 Entire Marshwort

8.1 Description

Entire Marshwort (*Nymphoides geminata*) is a freshwater perennial that has heart shaped leaves which float on the water. It is easily spread by fragments, and invades waterways, wetlands, swamps, and damp mud. It forms dense mats of floating weeds that damage native flora and by deoxygenating water it causes harm to aquatic fauna. Large masses can also choke water bodies and cause localised flooding.

8.2 Proposed Plan

ECan is proposing that Entire Marshwort is controlled through the Eradication objective described in Section 1(b) of the NPD.

8.3 NPD Section 6 Assessment

8.3.1 Level of analysis

The assessed level of analysis for Entire Marshwort under the requirements of the NPD and using the Guidance approach is Level 1. The detail of the requirement for assessment is shown in Appendix B.

8.3.2 Impacts of Entire Marshwort

Entire Marshwort has the potential to cause damage to biodiversity in waterways.

8.3.3 Benefits and costs for management of Entire Marshwort

Prevention of damage to biodiversity in waterways. The costs of control if allowed to spread are NPV(6%) $10,000. There is also the prevention of any impacts to biodiversity on an area of 450 ha after 100 years if the pest is allowed to spread.

8.3.4 Costs of Entire Marshwort Plan

The plan will incur costs of control, inspection, and monitoring. These are $5000 annually for the plan option. Costs for all three options considered are a NPV(6%) of $30,000 for Containment, NPV(6%) $50,000 for Progressive Containment, and NPV(6%) $60,000 for Eradication

8.3.5 Risks of Entire Marshwort Plan

Technical and operational risks: Eradication is technically difficult to achieve and control is difficult in water bodies. However, this risk will be mitigated by the use of Council staff to undertake inspection and control.

Implementation and compliance: Having the work undertaken and managed by the Council minimised implementation and compliance risks.

Other legislative risks: None known

Public or political concerns: None known

Other risks: None known

Summary: The major risks are associated with the technical feasibility of achieving eradication in water bodies. This is offset somewhat by the less cryptic nature of Entire Marshwort which floats on the surface. These risks are reflected in the adjustment to net benefit shown below.

8.3.6 Net Benefit and risk adjustment

The analysis produces an estimate of the total costs and benefits of the different options for the plan, as shown in Table 33 below. In terms of those alternatives considered, the Sustained Control option has the highest net value. The sensitivity of this conclusion to changes in various input parameters is shown in Table 34 below and shows that Do Nothing is the highest net benefit option (allowing for risk adjustment) for quantified costs and benefits. However, in addition to the quantified costs and benefits there are potential benefits associated with preventing damage to biodiversity, and intergenerational implications that should be taken into account.

All of the management options will prevent the displacement of biodiversity on 450 ha. In order for the proposed plan to be worthwhile there would need to be a benefit of $40/ha associated with that biodiversity (see Table 34 below).

These factors suggest that the Sustained Control option is favoured as producing the highest net benefit if the assumptions made in this analysis are considered reasonable and the Council ascribes a value of more than $40/ha to biodiversity protected and reduced flooding impacts. Eradication would require a benefit of $110/ha to be applied to the biodiversity benefits, or alternately a different risk profile for Eradication to the one assumed here.

Table 33: Outcomes of analysis of costs and benefits for Entire Marshwort

Plan	**Total control costs and lost production PV(6%)**	**Net Benefit of plan NPV(6%)**	**Risk adjusted net benefit of plan NPV(6%)**
Do Nothing	$10,000		
Eradication	$60,000	$-50,000	$-50,000
Progressive containment	$50,000	$-40,000	$-40,000
Sustained Control	$30,000	$-20,000	$-20,000

Table 34: Value of biodiversity required for option to be positive (negative value shows that option is worthwhile even without biodiversity benefits)

Plan	Value of biodiversity needed for plan to be positive ($/ha)	Risk adjusted value of biodiversity for plan to be positive ($/ha)
Eradication	$110	$110
Progressive containment	$90	$90
Sustained Control	$40	$40

Table 35: Impact of sensitivity testing on highest value option

Sensitivity test	Highest value option
Base net benefit	Do Nothing
Time to full occupation 50% of base	Do Nothing
Time to full occupation 150% of base	Do Nothing
Distance of spread 50% of base	Do Nothing
Distance of spread 200% of base	Do Nothing
Cost of control +20% from base	Do Nothing
Cost of control -20% from base	Do Nothing
Loss of production impacts -20% from base	Do Nothing
Loss of production impacts +20% from base	Do Nothing
Discount rate 4%	Do Nothing
Discount rate 8%	Do Nothing

8.4 NPD Section 7 - Allocation of Costs and Benefits

8.4.1 Beneficiaries, exacerbators and costs of proposed plan for control of Entire Marshwort

The beneficiaries and exacerbators of the plan are:

- Beneficiaries: Wider community from biodiversity benefits and reduced flooding.
- Active exacerbators: Any persons moving entire marshwort
- Passive exacerbators: None

The direct and indirect costs associated with the plan are shown below in Table 36 and Table 37.

Table 36: Direct and indirect costs of plan for Entire Marshwort

Plan option	Control costs land holders (PV (6%))	Inspection and monitoring costs (PV (6%))
Sustained Control	$2	$30,000
Progressive containment	$4	$50,000
Eradication	$7	$60,000

Table 37: Benefits and costs of plan for Entire Marshwort that accrue to different beneficiaries and exacerbators

Plan option	Benefits for those currently infested (PV (6%))	Benefits for those not currently infested (PV (6%))	Required benefit for community for biodiversity and ecological benefits in order for option to be positive	Costs for exacerbators (PV (6%))
Sustained Control	$0	$10,000	$20,000	$2
Progressive containment	$0	$10,000	$40,000	$4
Eradication	$0	$10,000	$50,000	$7

8.4.2 Matters for consideration in allocation of costs

The matters for consideration are spelt out in Section 7(2)(d) of the NPD, and the analysis for each of these matters is shown in Table 32 below.

Table 38: Matters for consideration in allocating costs for proposed Entire Marshwort plan

Legislative rights and responsibilities	None known.
Management objectives	Eradication.
Stage of infestation	Low infestation - there are only three known active sites in mid Canterbury.
Most effective control agents	It is likely that Council control will be required because there are no specific owners of the waterways where Entire Marshwort occurs.
Urgency	Very high if eradication is to be achieved at an early stage of infestation and spread is to be prevented
Efficiency and effectiveness	Control at an early stage is likely to be more efficient than when it is better established. Eradication requires complete control of the pest which is more likely to be achieved through use of contractors.
Practicality of targeting beneficiaries	Wider community beneficiaries can be targeted through General Rate.
Practicality of targeting exacerbators	Exacerbators difficult to identify and target.
Administrative efficiency	General Rate is highly efficient for collecting community benefits related to biodiversity.
Security	Rating mechanisms are generally secure.
Fairness	Charges relate directly to benefits or exacerbators. Fairness is a politically determined judgement.
Reasonable	The costs for Council are not large compared with the overall budget for pest management.
Parties bearing indirect costs	There are potentially some costs for other parties associated with control being undertaken in the waterway - but these are not likely to be significant.
Transitional cost allocation arrangements	None required.
Mechanisms available	General Rate, targeted rate (rural properties) and direct charges are the most readily available mechanisms. Levies are expensive to establish and administer.

8.4.3 Proposed allocation of costs

Because of the community nature of the benefits it is recommended that the Entire Marshwort management be funded from General Rate. The recommendation therefore is:

- Inspection and monitoring cost: 100% General Rate
- Control Costs: 100% General Rate

9 Moth Plant

9.1 Description

Moth Plant is an evergreen vine with dark green leaves that grows rapidly to canopy height and forms large, heavy long lived masses. It is tolerant to shade and a wide range of environmental conditions apart from frosts, and is poisonous to stock. It invades forest and margins, tracks, coastline, cliffs, shrublands, and most other frost free habitats. It is considered a limited pest in Canterbury mainly associated with garden escapes. A rust fungus has been released as a biocontrol agent.

9.2 Proposed Plan

ECan is proposing that Moth Plant is controlled through the Eradication objective described in Section 1(b) of the NPD.

9.3 NPD Section 6 Assessment

9.3.1 Level of analysis

The assessed level of analysis for Moth Plant under the requirements of the NPD and using the Guidance approach is Level 1. The detail of the requirement for assessment is shown in Appendix B.

9.3.2 Impacts of Moth Plant

Moth Plant has the potential to cause loss of biodiversity in intact and disturbed forest, coastline, cliffs, and shrublands.

9.3.3 Benefits and costs for management of Moth Plant

Prevention of loss of biodiversity in intact and disturbed forest, coastline, cliffs, and shrublands. The costs of control if allowed to spread are NPV(6%) $200,000. There is also the prevention of any impacts to biodiversity on an area of 22,500 ha after 100 years if the pest is allowed to spread.

9.3.4 Costs of Moth Plant Plan

The plan will incur costs for inspection and monitoring. These are $2500 annually for the proposed plan option. Costs for all three options considered are NPV(6%) $10,000 for Containment, NPV(6%) $30,000 for Progressive Containment, and NPV(6%) $30,000 for Eradication

9.3.5 Risks of Moth Plant Plan

Technical and operational risks: Eradication is technically difficult to achieve and land where infestations occur is not always under management. However, this risk will be mitigated by the use of Council staff to undertake inspection and control.

Implementation and compliance: Having the work undertaken and managed by the Council minimises implementation and compliance risks.

Other legislative risks: None known

Public or political concerns: None known

Other risks: None known

9.3.6 Net Benefit and risk adjustment

The analysis produces an estimate of the total costs and benefits of the different options for the plan, as shown in Table 28 below. In terms of those alternatives considered the Eradication option has the highest net value. The sensitivity of this conclusion to changes in various input parameters is shown in Table 29 below which suggests that Eradication remains highest net benefit even with a change to a range of input assumptions. In addition to the quantified costs and benefits there are potential benefits associated with preventing damage to biodiversity, and intergenerational implications that should be taken into account.

These factors suggest that the Eradication option is recommended as producing the highest net benefit if the assumptions made in this analysis are considered reasonable.

Table 39: Outcomes of analysis of costs and benefits for Moth Plant

Plan	**Total control costs and lost production PV(6%)**	**Net Benefit of plan NPV(6%)**	**Risk adjusted net benefit of plan NPV(6%)**
Do Nothing	$200,000		
Eradication	$30,000	$180,000	$170,000
Progressive containment	$30,000	$190,000	$160,000
Sustained Control	$10,000	$200,000	$90,000

Table 40: Impact of sensitivity testing on highest value option

Sensitivity test	Highest value option
Base net benefit	Eradication
Time to full occupation 50% of base	Eradication
Time to full occupation 150% of base	Eradication
Distance of spread 50% of base	Eradication
Distance of spread 200% of base	Eradication
Cost of control +20% from base	Eradication
Cost of control -20% from base	Eradication
Loss of production impacts -20% from base	Eradication
Loss of production impacts +20% from base	Eradication
Discount rate 4%	Eradication
Discount rate 8%	Eradication

9.4 NPD Section 7 - Allocation of Costs and Benefits

9.4.1 Beneficiaries, exacerbators, and costs of proposed plan for control of Moth Plant

The beneficiaries and exacerbators of the plan are:

- Beneficiaries: Wider community from biodiversity benefits.
- Active exacerbators: Persons who plant Moth Plant in gardens or dump Moth Plant containing material.
- Passive exacerbators: Any persons with Moth Plant on their property not undertaking control.
-

The direct and indirect costs associated with the plan are shown below in Table 41 and Table 42.

Table 41: Direct and indirect costs of plan for Moth Plant

Plan option	Control costs land holders (PV (6%))	Inspection and monitoring costs (PV (6%))
Sustained Control	$300	$10,000
Progressive containment	$700	$30,000
Eradication	$1000	$30,000

Table 42: Benefits and costs of plan for Moth Plant that accrue to different beneficiaries and exacerbators

Plan option	Benefits for those currently infested (PV (6%))	Benefits for those not currently infested (PV (6%))	Costs for exacerbators (PV (6%)) (if charged)
Sustained Control	$-300	$200,000	$300
Progressive containment	$-600	$200,000	$700
Eradication	$-1200	$200,000	$1000

9.4.2 Matters for consideration in allocation of costs

The matters for consideration are spelt out in Section 7(2)(d) of the NPD, and the analysis for each of these matters is shown in Table 32 below.

Table 43: Matters for consideration in allocating costs for proposed Moth Plant plan

Legislative rights and responsibilities	None known.
Management objectives	Eradication.
Stage of infestation	Early with only 8 active sites and less than 1 ha of infestation.
Most effective control agents	Control is likely best undertaken by the Council, DOC, or other agencies with an interest in protection of biodiversity and depending on the location of the infestations. The location of the plant and level of infestation make reliance on land holder control unreliable.
Urgency	Very high if eradication is to be achieved at an early stage of infestation and spread is to be prevented.
Efficiency and effectiveness	Control at an early stage is likely to be more efficient than when it is better established. Eradication requires complete control of the pest, which is more likely to be achieved through use of contractors.
Practicality of targeting beneficiaries	Wider community beneficiaries can be targeted through General Rate.
Practicality of targeting exacerbators	Exacerbators difficult to identify and target.
Administrative efficiency	General Rate is highly efficient for collecting community benefits related to biodiversity.
Security	Rating mechanisms are generally secure.
Fairness	Charges relate directly to benefits or exacerbators. Fairness is a politically determined judgement.
Reasonable	The costs for Council are not large compared with the overall budget for pest management.
Parties bearing indirect costs	There are potentially some costs for other parties associated with control being undertaken in the forest areas - but these are not likely to be significant.
Transitional cost allocation arrangements	None required.
Mechanisms available	General Rate, targeted rate (rural properties) and direct charges are the most readily available mechanisms. Levies are expensive to establish and administer.

9.4.3 Proposed allocation of costs

Given the community benefits associated with eradication of Moth Plant, it is appropriate to fund its control from the General Rate. The recommendation therefore is:

- Inspection and monitoring cost: 100% General Rate
- Control Costs: 100% General Rate

10 Phragmites

Phragmites is a vigorous perennial grass that grows on the margins of water bodies and in wetlands. It has a tough, invasive root system and can form dense stands that exclude native vegetation and modify aquatic habitats. Phragmites has been found at five active sites in Canterbury, including the Bexley wetland in Christchurch and a pond in the Christchurch Botanic Gardens.

10.1 Proposed Plan

ECan is proposing that Phragmites is controlled through the Eradication objective described in Section 1(b) the NPD.

10.2 NPD Section 6 Assessment

10.2.1 Level of analysis

The assessed level of analysis for Phragmites under the requirements of the NPD and using the Guidance approach is Level 1. The detail of the requirement for assessment is shown in Appendix B.

10.2.2 Impacts of Phragmites

Phragmites has the potential to cause damage to biodiversity in waterways and wetland habitats. It also potentially impacts stopbanks and drainage systems.

10.2.3 Benefits and costs for management of Moth Plant

Prevention of damage to biodiversity in aquatic and wetland habitats. The costs of control if allowed to spread are NPV(6%) $20,000. There is also the prevention of any impacts to biodiversity on an area of 10 ha after 100 years if the pest is allowed to spread.

10.2.4 Costs of Phragmites Plan

The plan will incur costs of control, inspection, and monitoring . These are $10,000 annually for the plan option. Costs for all three options considered are an NPV $60,000 for Sustained Control, NPV $100,000 for Progressive Containment, and NPV $100,000 for Eradication (which has a shorter time frame).

10.2.5 Risks of Phragmites Plan

Technical and operational risks: Eradication is technically difficult to achieve. However, this risk will be mitigated by the use of Council staff to undertake inspection and control and the limited occurrence of Phragmites.

Implementation and compliance: Having the work undertaken and managed by the Council minimises implementation and compliance risks.

Other legislative risks: None known

Public or political concerns: Some concern from parties with an interest in use of phragmites for water treatment

Other risks: None known

10.2.6 Net Benefit and risk adjustment

The analysis produces an estimate of the total costs and benefits of the different options for the plan, as shown in Table 44 below. In terms of those alternatives considered, the Sustained Control option has the highest net value in terms of matters quantified and shows that it has the highest net benefit under all changes to assumptions tested. The sensitivity of this conclusion to changes in various input parameters is shown in Table 46 below. In addition to the quantified costs and benefits there are potential benefits associated with preventing damage to biodiversity, and intergenerational implications that should be taken into account.

All of the management options will prevent the displacement of biodiversity on 2200 ha. In order for the proposed plan to be worthwhile there would need to be a benefit of $10,000/ha for eradication to be worthwhile, and $5,000/ha in order for the Sustained Control plan to be worthwhile (see Table 45 below).

These factors suggest that the Sustained Control option is favoured as producing the highest net benefit if the assumptions made in this analysis are considered reasonable, and if the Council considers that the benefits to biodiversity exceed $5,000/ha or $130/ha/annum.

Table 44: Outcomes of analysis of costs and benefits for Phragmites

Plan	Total control costs and lost production PV(6%)	Net Benefit of plan NPV(6%)	Risk adjusted net benefit of plan NPV(6%)
Do Nothing	$20,000		
Eradication	$100,000	$-110,000	$-100,000
Progressive containment	$100,000	$-90,000	$-90,000
Sustained Control	$60,000	$-40,000	$-50,000

Table 45: Value of biodiversity required for option to be positive (negative value shows that option is worthwhile even without biodiversity benefits)

Plan	Value of biodiversity needed for plan to be positive ($/ha)	Risk adjusted value of biodiversity for plan to be positive ($/ha)
Eradication	$11,000	$10,000
Progressive containment	$9,000	$9,000
Sustained Control	$4,000	$5,000

Table 46: Impact of sensitivity testing on highest value option

Sensitivity test	Highest value option
Base net benefit	Do Nothing
Time to full occupation 50% of base	Do Nothing
Time to full occupation 150% of base	Do Nothing
Distance of spread 50% of base	Do Nothing
Distance of spread 200% of base	Do Nothing
Cost of control +20% from base	Do Nothing
Cost of control -20% from base	Do Nothing
Loss of production impacts -20% from base	Do Nothing
Loss of production impacts +20% from base	Do Nothing
Discount rate 4%	Do Nothing
Discount rate 8%	Do Nothing

10.3 NPD Section 7 - Allocation of Costs and Benefits

10.3.1 Beneficiaries, exacerbators and costs of proposed plan for control of Phragmites

The beneficiaries and exacerbators of the plan are:

- Beneficiaries: Wider community from biodiversity benefits.
- Active exacerbators: Any persons moving Phragmites
- Passive exacerbators: None

The direct and indirect costs associated with the plan are shown below in Table 47 and Table 48.

Table 47: Direct and indirect costs of plan for Phragmites

Plan option	Control costs land holders (PV (6%))	Inspection and monitoring costs (PV (6%))
Sustained Control	$4,000	$60,000
Progressive containment	$8,000	$100,000
Eradication	$20,000	$100,000

Table 48: Benefits and costs of plan for Phragmites that accrue to different beneficiaries and exacerbators

Plan option	Benefits for those currently infested (PV (6%))	Benefits for those not currently infested (PV (6%))	Required benefit for community for biodiversity and ecological benefits in order for option to be positive	Costs for exacerbators (PV (6%))
Sustained Control	$-3,656	$20,000	$40,000	$4,000
Progressive containment	$-7,750	$20,000	$90,000	$8,000
Eradication	$-14,885	$20,000	$110,000	$20,000

10.3.2 Matters for consideration in allocation of costs

The matters for consideration are spelt out in Section 7(2)(d) of the NPD, and the analysis for each of these matters is shown in Table 32 below.

Table 49: Matters for consideration in allocating costs for proposed Phragmites plan

Legislative rights and responsibilities	None known.
Management objectives	Eradication.
Stage of infestation	Low infestation - there is only one known site.
Most effective control agents	It is likely that Council control will be required because phragmites occurs in waterways and areas where ownership is not clear.
Urgency	Very high if eradication is to be achieved at an early stage of infestation and spread is to be prevented.
Efficiency and effectiveness	Control at an early stage is likely to be more efficient than when it is better established. Eradication requires complete control of the pest, which is more likely to be achieved through use of contractors.
Practicality of targeting beneficiaries	Wider community beneficiaries can be targeted through General Rate.
Practicality of targeting exacerbators	Exacerbators difficult to identify and target.
Administrative efficiency	General Rate is highly efficient for collecting community benefits related to biodiversity.
Security	Rating mechanisms are generally secure.
Fairness	Charges relate directly to benefits or exacerbators. Fairness is a politically determined judgement.
Reasonable	The costs for Council are not large compared with the overall budget for pest management.
Parties bearing indirect costs	There are potentially some costs for other parties associated with control being undertaken in the waterway - but these are not likely to be significant.
Transitional cost allocation arrangements	None required.
Mechanisms available	General Rate, targeted rate (rural properties) and direct charges are the most readily available mechanisms. Levies are expensive to establish and administer.

10.3.3 Proposed allocation of costs

Given the benefits of the plan for prevention of damage to biodiversity values, the recommended approach is for funding to be sourced from General Rate. The recommendation therefore is:

- Inspection and monitoring cost: 100% General Rate
- Control Costs: 100% General Rate

11 Yellow Bristle Grass

11.1 Description

Yellow Bristle Grass is an aggressive annual-seeding plant which reduces pasture quality and is avoided by stock. It reproduces by the seed passing through the rumen and being spread throughout the farm, and is also spread by water, soil movement, animals and as contaminants of hay and maize. It has barbed seeds that can be carried in fur, feathers, or clothing. Yellow Bristle Grass is present in 2 known active sites in Canterbury.

11.2 Proposed Plan

ECan is proposing that Yellow Bristle Grass is controlled through the Eradication objective described in Section 1(b) of the NPD.

11.3 NPD Section 6 Assessment

11.3.1 Level of analysis

The assessed level of analysis for Yellow Bristle Grass under the requirements of the NPD and using the Guidance approach is Level 1. The detail of the requirement for assessment is shown in Appendix B.

11.3.2 Impacts of Yellow Bristle Grass

Yellow Bristle Grass has the potential to cause damage to pastoral agriculture through reduced pasture quality and animal intake.

11.3.3 Benefits and costs for management of Yellow Bristle Grass

The plan would prevent damage to pastoral agriculture through reduced pasture quality and animal intake. The cost of lost production and control if allowed to spread are NPV(6%) $3,000,000.

11.3.4 Costs of Yellow Bristle Grass Plan

The plan will incur costs of control, monitoring, and stock movement control. These are $10,000 annually for the plan option. Costs for all three options considered are an NPV $60,000 for Sustained Control, NPV $100,000 for Progressive Containment, and NPV $100,000 for Eradication (which has a shorter time frame).

11.3.4.1 Risks of Yellow Bristle Grass Plan

Technical and operational risks: Eradication is technically difficult to achieve, and requires adaptation of management techniques by farmers. It will also require control on non-productive areas. However, this risk will be mitigated by the use of Council staff to undertake inspection and control

Implementation and compliance: Requires complete control and prevention of stock movement, which is difficult to achieve consistently.

Other legislative risks: None known

Public or political concerns: None known

Other risks: None known

11.3.5 Net Benefit and risk adjustment

The analysis produces an estimate of the total costs and benefits of the different options for the plan as shown in Table 50 below. In terms of those alternatives considered, the Eradication option has the highest net value. The sensitivity of this conclusion to changes in various input parameters is shown in Table 51 below which demonstrates that Eradication remains the highest net benefit option even under changes to a range of input assumptions.

These factors suggest that the Eradication option is strongly favoured as producing the highest net benefit if the assumptions made in this analysis are considered reasonable.

Table 50: Outcomes of analysis of costs and benefits for Yellow Bristle Plant

Plan	**Total control costs and lost production PV(6%)**	**Net Benefit of plan NPV(6%)**	**Risk adjusted net benefit of plan NPV(6%)**
Do Nothing	$3,000,000		
Eradication	$100,000	$2,630,000	$2,470,000
Progressive containment	$100,000	$2,640,000	$2,340,000
Sustained Control	$60,000	$2,690,000	$1,290,000

Table 51: Impact of sensitivity testing on highest value option

Sensitivity test	**Highest value option**
Base net benefit	Eradication
Time to full occupation 50% of base	Eradication
Time to full occupation 150% of base	Eradication
Distance of spread 50% of base	Eradication
Distance of spread 200% of base	Eradication
Cost of control +20% from base	Eradication
Cost of control -20% from base	Eradication
Loss of production impacts -20% from base	Eradication
Loss of production impacts +20% from base	Eradication
Discount rate 4%	Eradication
Discount rate 8%	Eradication

11.4 NPD Section 7 - Allocation of Costs and Benefits

11.4.1 Beneficiaries, exacerbators, and costs of proposed plan for control of Yellow Bristle Grass

The beneficiaries and exacerbators of the plan are:

- Beneficiaries: All pastoral farmers
- Active exacerbators: Any persons transporting Yellow Bristle Grass into or around the region
- Passive exacerbators: Any persons with Yellow Bristle Grass on their property not undertaking control.

The direct and indirect costs associated with the plan are shown below in Table 52 and Table 53.

Table 52: Direct and indirect costs of plan for Yellow Bristle Grass

Plan option	Control costs land holders (PV (6%))	Inspection and monitoring costs (PV (6%))
Sustained Control	$20	$60,000
Progressive containment	$50	$100,000
Eradication	$90	$100,000

Table 53: Benefits and costs of plan for Yellow Bristle Grass that accrue to different beneficiaries and exacerbators

Plan option	Benefits for those currently infested (PV (6%))	Benefits for those not currently infested (PV (6%))	Costs for exacerbators (PV (6%))
Sustained Control	$1	$3,000,000	$20
Progressive containment	$-19	$3,000,000	$50
Eradication	$-59	$3,000,000	$90

11.4.2 Matters for consideration in allocation of costs

The matters for consideration are spelt out in Section 7(2)(d) of the NPD, and the analysis for each of these matters is shown in Table 54 below.

Table 54: Matters for consideration in allocating costs for proposed Yellow Bristle Grass plan

Legislative rights and responsibilities	None known.
Management objectives	Eradication.
Stage of infestation	Very low .
Most effective control agents	Council control is likely to be more effective at achieving eradication.
Urgency	Very high if eradication is to be achieved at an early stage of infestation.
Efficiency and effectiveness	Control at an early stage is likely to be more efficient than when it is better established. Eradication requires complete control of the pest which is more likely to be achieved through use of contractors.
Practicality of targeting beneficiaries	Wider benefits can be targeted through General Rate or more efficiently targeted on productive land.
Practicality of targeting exacerbators	Locations are limited and known, and exacerbators can be targeted.
Administrative efficiency	Exacerbator control requires inspection and enforcement, while General Rate would have greater administrative efficiency.
Security	Exacerbator control is difficult with a small scale eradication pest because highly effective control is required. Rating mechanisms are generally very secure.
Fairness	Charges relate directly to benefits or exacerbators. Fairness is a politically determined judgement.
Reasonable	Costs are likely to be high and ongoing to achieve eradication.
Parties bearing indirect costs	None known.
Transitional cost allocation arrangements	None required.
Mechanisms available	General Rate, targeted rate (rural properties), and direct charges are the most readily available mechanisms. Levies are expensive to establish and administer.

11.4.3 Proposed allocation of costs

The analysis suggests that because the benefits are to the wider community of rural land holders they should be charged through a targeted rate on productive land . Because the extent of the pest is small there is unlikely to be any gain through requiring exacerbators to undertake control, and it would work against the efficiency of achieving the Eradication objective. The recommendation therefore is:

- Inspection and monitoring cost: 100% targeted rate on productive land .
- Control Costs: 100% targeted rate on productive land

12 Yellow Water Lily

12.1 Description

Yellow Water Lily (*Nuphar lutea*) has large oval floating leaves and has a strong alcoholic scent. It develops a stout submerged tuber like rhizome up to 10cm thick that can cause problems for hydro power intakes, reduce flows in waterways, and impact on recreation values. It spreads through rhizomes and seeds, and dense mats eliminate native water plants and affect native fauna through water loss and oxygen deprivation. It is found in nutrient rich streams, lakes, reservoirs, ponds, and canals, and is known at only two active sites in Canterbury.

12.2 Proposed Plan

ECan is proposing that Yellow Water Lily is controlled through the Eradication objective described in Section 1(b) of the NPD.

12.3 NPD Section 6 Assessment

12.3.1 Level of analysis

The assessed level of analysis for Yellow Water Lily under the requirements of the NPD and using the Guidance approach is Level 1. The detail of the requirement for assessment is shown in Appendix B.

12.3.2 Impacts of Yellow Water Lily

Yellow Water Lily has the potential to cause damage to biodiversity in waterways and other water bodies, and has potential impacts on hydro power and recreation values.

12.3.3 Benefits and costs for management of Yellow Water Lily

Prevention of damage to biodiversity in waterways and other water bodies. The costs of control if allowed to spread are NPV(6%) $221,000,000. There is also the prevention of any impacts to biodiversity on an area of 18,000 ha after 100 years if the pest is allowed to spread.

12.3.4 Costs of Yellow Water Lily Plan

The plan will incur costs of control, inspection, and monitoring. These are $7000 annually for the plan option. Costs for all three options considered are an NPV of $40,000 for Sustained Control, NPV $70,000 for Progressive Containment, and NPV $80,000 for Eradication (which has a shorter time frame).

12.3.5 Risks of Yellow Water Lily Plan

Technical and operational risks: Eradication is technically difficult to achieve, and requires adaptation of management techniques by farmers. It will also require control on non productive areas. However, this risk will be mitigated by the use of Council staff to undertake inspection and control.

Implementation and compliance: Having the work undertaken and managed by the Council minimises implementation and compliance risks.

Other legislative risks: None known

Public or political concerns: None known

Other risks: None known

12.3.6 Net Benefit and risk adjustment

The analysis produces an estimate of the total costs and benefits of the different options for the plan, as shown in Table 55 below. In terms of those alternatives considered, the Eradication option has the highest net value. The sensitivity of this conclusion to changes in various input parameters is shown in Table 56 below which demonstrates that the conclusion is robust to changes in a number of input assumptions. In addition to the quantified costs and benefits, there are potential benefits associated with preventing damage to biodiversity on 18000 ha.

These factors suggest that the Eradication option is strongly favoured as producing the highest net benefit if the assumptions made in this analysis are considered reasonable.

Table 55: Outcomes of analysis of costs and benefits for Yellow Water Lily

Plan	Total control costs and lost production PV(6%)	Net Benefit of plan NPV(6%)	Risk adjusted net benefit of plan NPV(6%)
Do Nothing	$221,000,000		
Eradication	$2,000,000	$218,950,000	$206,610,000
Progressive containment	$1,000,000	$219,740,000	$195,740,000
Sustained Control	$500,000	$220,220,000	$107,870,000

Table 56: Impact of sensitivity testing on highest value option

Sensitivity test	Highest value option
Base net benefit	Eradication
Time to full occupation 50% of base	Eradication
Time to full occupation 150% of base	Eradication
Distance of spread 50% of base	Eradication
Distance of spread 200% of base	Eradication
Cost of control +20% from base	Eradication
Cost of control -20% from base	Eradication
Loss of production impacts -20% from base	Eradication
Loss of production impacts +20% from base	Eradication
Discount rate 4%	Eradication
Discount rate 8%	Eradication

12.4 NPD Section 7 - Allocation of Costs and Benefits

12.4.1 Beneficiaries, exacerbators and costs of proposed plan for control of Yellow Water Lily

The beneficiaries and exacerbators of the plan are:

- Beneficiaries: Wider community from biodiversity benefits and recreational values. Hydro power companies from prevention of clogging of intakes.
- Active exacerbators: Any persons moving yellow water lily.
- Passive exacerbators: None

The direct and indirect costs associated with the plan are shown below in Table 57 and Table 58.

Table 57: Direct and indirect costs of plan for Yellow Water Lily

Plan option	Control costs land holders (PV (6%))	Inspection and monitoring costs (PV (6%))
Sustained Control	$400,000	$40,000
Progressive containment	$900,000	$70,000
Eradication	$2,000,000	$80,000

Table 58: Benefits and costs of plan for Yellow Water Lily that accrue to different beneficiaries and exacerbators

Plan option	Benefits for those currently infested (PV (6%))	Benefits for those not currently infested (PV (6%))	Costs for exacerbators (PV (6%))
Sustained Control	$-3,990,000	$221,000,000	$400,000
Progressive containment	$-845,000	$221,000,000	$900,000
Eradication	$-1,624,000	$221,000,000	$2,000,000

12.4.2 Matters for consideration in allocation of costs

The matters for consideration are spelt out in Section 7(2)(d) of the NPD, and the analysis for each of these matters is shown in Table 59 below.

Table 59: Matters for consideration in allocating costs for proposed Yellow Water Lily plan

Legislative rights and responsibilities	None known
Management objectives	Eradication
Stage of infestation	Low infestation - there are only two known active sites in Canterbury.
Most effective control agents	It is likely that Council control will be required because there are no specific owners of the waterways where Yellow Water Lily occurs.
Urgency	Very high if eradication is to be achieved at an early stage of infestation and spread is to be prevented.
Efficiency and effectiveness	Control at an early stage is likely to be more efficient than when it is better established. Eradication requires complete control of the pest, which is more likely to be achieved through use of contractors.
Practicality of targeting beneficiaries	Wider community beneficiaries can be targeted through General Rate
Practicality of targeting exacerbators	Exacerbators difficult to identify and target.
Administrative efficiency	General Rate is highly efficient for collecting community benefits related to biodiversity.
Security	Rating mechanisms are generally secure.
Fairness	Charges relate directly to benefits or exacerbators. Fairness is a politically determined judgement
Reasonable	The costs for Council are not large compared with the overall budget for pest management.
Parties bearing indirect costs	None likely
Transitional cost allocation arrangements	None required.
Mechanisms available	General Rate, targeted rate (rural properties) and direct charges are the most readily available mechanisms. Levies are expensive to establish and administer.

12.4.3 Proposed allocation of costs

Given the community nature of the benefits it is appropriate to target the costs of the plan to General Rate. There is some potential to target hydro power companies, but the administrative costs would be high relative to the funding accessed. The recommendation therefore is:

- Monitoring and inspection costs: 100% General Rate
- Control costs: 100% General Rate.

13 African Feather Grass

13.1 Description

African Feather Grass (*Pennisetum macrourum*) has whitish green rough leaves. It forms dense tussock clumps up to 2m high and produces fibrous roots and rhizomes. The windblown seeds also have bristles that allow them to attach to clothing, animal hair, or wool. It is easily confused with pampas grass and toetoe.

African Feather Grass prefers damp places such as ponds, river systems, coastlines, estuaries and gullies, but also grows on bare sand, shrubland and disturbed forest. It represents a danger to native species particularly in grasslands and shrublands, creates a fire hazard, blocks access and can block narrow waterways. In Canterbury it is found primarily near Kaikōura, but is also present in other parts of the region.

13.2 Proposed Plan

ECan is proposing that African Feather Grass is controlled through the Progressive Containment objective described in Section 1(b) of the NPD.

13.3 NPD Section 6 Assessment

13.3.1 Level of analysis

The assessed level of analysis for African Feather Grass under the requirements of the NPD and using the Guidance approach is Level 1. The detail of the requirement for assessment is shown in Appendix B.

13.3.2 Impacts of African Feather Grass

African Feather Grass has the potential to cause loss of biodiversity in wetlands, waterbodies, coastal areas, tussock landscapes, and also some loss to grassland production from pastoral agriculture in hill and high country.

13.3.3 Benefits for management of African Feather Grass

- Prevention of impacts to biodiversity in tussock landscapes and grassland.
- Prevention of loss of production from pastoral agriculture in hill and high country.

Cost of control and lost production if allowed to spread are NPV(6%) $110,000,000 from prevented cost of control and reduced production losses. There is also the prevention of any impacts to biodiversity on an area of 108,500 ha after 100 years if the pest is allowed to spread, with an estimated cost of $1.6 million to return it to its current state if allowed to occupy the full area.

13.3.4 Costs of African Feather Grass Plan

The plan will incur costs for inspection and monitoring. These are $20,000 annually for the plan option. Costs for all three options considered are a NPV(6%) of $80,000 for Sustained Control, NPV(6%) $300,000 for Progressive Containment, and NPV(6%) $300,000 for Eradication.

13.3.5 Risks of African Feather Grass Plan

Technical and operational risks: Progressive Containment is technically difficult to achieve and requires adaptation of management techniques by land holders and agencies managing land where African Feather Grass is present. African Feather Grass has been under control for a long period with limited progress.

Implementation and compliance: Ensuring compliance with management regime will be difficult and will require education, inspection, and potentially enforcement. These all carry risks.

Other legislative risks: None known

Public or political concerns: None known

Other risks: None known

13.3.6 Net Benefit and risk adjustment

The analysis produces an estimate of the total costs and benefits of the different options for the plan, as shown in Table 60 below. In terms of those alternatives considered, the Progressive Containment option has the highest net value, although it should be noted that the difference between Eradication and Progressive Containment is very small. The sensitivity of this conclusion to changes in various input parameters is shown in Table 61 below which shows that Progressive Containment is favoured under all tests apart from a 4% discount rate when Eradication is the highest value option. In addition to the quantified costs and benefits, there are benefits associated with preventing the displacement of biodiversity on 108,500 ha, and intergenerational implications that should be taken into account because the cost of recovering from any damage caused by allowing spread is high.

These factors suggest that the Progressive Containment option is favoured as producing the highest net benefit if the assumptions made in this analysis are considered reasonable.

Table 60: Outcomes of analysis of costs and benefits for African Feather Grass

Plan	Total control costs and lost production PV(6%)	Net Benefit of plan NPV(6%)	Risk adjusted net benefit of plan NPV(6%)
Do Nothing	$110,000,000		
Eradication	$400,000	$110,070,000	$103,460,000
Progressive containment	$300,000	$110,110,000	$103,490,000
Sustained Control	$100,000	$110,350,000	$54,030,000

Table 61: Impact of sensitivity testing on highest value option

Sensitivity test	Highest value option
Base net benefit	Progressive containment
Time to full occupation 50% of base	Progressive containment
Time to full occupation 150% of base	Progressive containment
Distance of spread 50% of base	Progressive containment
Distance of spread 200% of base	Progressive containment
Cost of control +20% from base	Progressive containment
Cost of control -20% from base	Progressive containment
Loss of production impacts -20% from base	Progressive containment
Loss of production impacts +20% from base	Progressive containment
Discount rate 4%	Eradication
Discount rate 8%	Progressive containment

13.4 NPD Section 7 - Allocation of Costs and Benefits

13.4.1 Beneficiaries, exacerbators and costs of proposed plan for control of African Feather Grass

The beneficiaries and exacerbators of the plan are:

- Beneficiaries: Rural community from prevention of spread and production benefits. There are also some biodiversity benefits to the wider community.
- Active exacerbators: Any persons transporting African Feather Grass into or around the region
- Passive exacerbators: Any persons with African Feather Grass on their property not undertaking control.

The direct and indirect costs associated with the plan are shown below in Table 62 and Table 63.

Table 62: Direct and indirect costs of plan for African Feather Grass

Plan option	Control costs land holders (PV (6%))	Inspection and monitoring costs (PV (6%))
Sustained Control	$10,000	$80,000
Progressive containment	$20,000	$300,000
Eradication	$40,000	$300,000

Table 63: Benefits and costs of plan for African Feather Grass that accrue to different beneficiaries and exacerbators

Plan option	Benefits for those currently infested (PV (6%))	Benefits for those not currently infested (PV (6%))	Costs for exacerbators (PV (6%))
Sustained Control	$1000	$110,000,000	$10,000
Progressive containment	$-6,000	$110,000,000	$20,000
Eradication	$-23,000	$110,000,000	$40,000

13.4.2 Matters for consideration in allocation of costs

The matters for consideration are spelt out in Section 7(2)(d) of the NPD, and the analysis for each of these matters is shown in Table 64 below.

Table 64: Matters for consideration in allocating costs for proposed African Feather Grass plan

Legislative rights and responsibilities	None known.
Management objectives	Progressive Containment.
Stage of infestation	Moderate infestations with 100 properties and 2350 ha in Canterbury.
Most effective control agents	Land holders are most effective because it requires control and measures to ensure that seed does not spread.
Urgency	Moderate urgency to prevent spread.
Efficiency and effectiveness	It is likely that requiring land holders to control will improve the efficiency of control measures as land will be managed to reduce infestation and spread.
Practicality of targeting beneficiaries	Beneficiaries are the wider community for biodiversity values and the wider rural community for prevention of spread onto productive land .
Practicality of targeting exacerbators	Locations are limited and know, and exacerbators can be targeted.
Administrative efficiency	Exacerbators control requires inspection and enforcement, while generate rate would have greater administrative efficiency.
Security	Rating mechanisms are most secure.
Fairness	Charges relate directly to benefits or exacerbators. Fairness is a politically determined judgement.
Reasonable	Costs are likely to be significant on some properties.
Parties bearing indirect costs	None likely.
Transitional cost allocation arrangements	None required as control has been required for African Feather Grass for some time.
Mechanisms available	General Rate, targeted rate (rural properties) and direct charges are the most readily available mechanisms. Levies are expensive to establish and administer.

13.4.3 Proposed allocation of costs

The primary benefits are for biodiversity protection which suggests that there should be a charge against the General Rate for at least part of the costs. Because of the reasonably widespread nature of African Feather Grass it is likely that exacerbator management will be required to ensure that management is adapted to controlling the pest. Therefore, the recommended funding apportionment is:

- General Rate for inspection, monitoring, and enforcement.
- Exacerbator control through requirement to control pests on a property for control on land where an identifiable owner is present.
- General Rate for control in areas where an owner is not able to be identified, or where land is publicly owned.

14 African Love Grass

14.1 Description

African Love Grass (*Eragrostis curvula*) is a clump forming perennial grass that grows up to 1.5m tall. It has fibrous roots up to 50cm deep and grows in a wide range of habitats. It grows in short and tall tussock grasslands, coastal areas, riverbeds, cliffs, and non-productive land. It displaces productive and native species, and has a limited distribution in 3 active sites in South Canterbury and Christchurch.

14.2 Proposed Plan

ECan is proposing that African Love Grass is controlled through the Progressive Containment objective described in Section 1(b) of the NPD.

14.3 NPD Section 6 Assessment

14.3.1 Level of analysis

The assessed level of analysis for African Love Grass under the requirements of the NPD and using the Guidance approach is Level 1. The detail of the requirement for assessment is shown in Appendix B.

14.3.2 Impacts of African Love Grass

African Love Grass has the potential to cause loss of production from pastoral agriculture in hill and high country. It also causes impacts to biodiversity in tussock landscapes and grassland .

14.3.3 Benefits for management of African Love Grass

- Prevention of loss of production from pastoral agriculture in hill and high country.
- Prevention of impacts to biodiversity in tussock landscapes and grassland.

Cost of control and lost production if allowed to spread are NPV(6%) $91,000,000. There is also the prevention of any impacts to biodiversity on an area of 108,500 ha after 100 years if the pest is allowed to spread.

14.3.4 Costs of African Love Grass Plan

The plan will incur costs of control, inspection, and monitoring. These are $15,000 annually for the plan option. Costs for all three options considered are an NPV of $60,000 for Sustained Control, NPV $200,000 for Progressive Containment, and NPV $300,000 for Eradication (which has a shorter time frame).

14.3.5 Risks of African Love Grass Plan

Technical and operational risks: Progressive Containment is technically difficult to achieve and requires adaptation of management techniques by farmers. African Love Grass has been under control for a long period with limited progress.

Implementation and compliance: Ensuring compliance with management regime will be difficult and will require education, inspection, and potentially enforcement. These all carry risks.

Other legislative risks: None known

Public or political concerns: None known

Other risks: None known

14.3.6 Net Benefit and risk adjustment

The analysis produces an estimate of the total costs and benefits of the different options for the plan, as shown in Table 65 below. In terms of those alternatives considered, the Progressive Containment option has the highest net value, although the differences between it and Eradication are small. The sensitivity of this conclusion to changes in various input parameters is shown in Table 66 below and it shows that Progressive Containment remains favoured under all tests of assumptions apart from a discount rate of 4%. In addition to the quantified costs and benefits, there are potential benefits associated with preventing damage to biodiversity on 108,500 ha, and intergenerational implications that should be taken into account because the costs of allowing to spread and returning to the current state may be significant.

These factors suggest that the Progressive Containment option is favoured as producing the highest net benefit if the assumptions made in this analysis are considered reasonable.

Table 65: Outcomes of analysis of costs and benefits for African Love Grass

Plan	Total control costs and lost production PV(6%)	Net Benefit of plan NPV(6%)	Risk adjusted net benefit of plan NPV(6%)
Do Nothing	$91,000,000		
Eradication	$300,000	$90,340,000	$84,920,000
Progressive Containment	$300,000	$90,370,000	$84,940,000
Sustained Control	$70,000	$90,550,000	$44,340,000

Table 66: Impact of sensitivity testing on highest value option

Sensitivity test	Highest value option
Base net benefit	Progressive containment
Time to full occupation 50% of base	Progressive containment
Time to full occupation 150% of base	Progressive containment
Distance of spread 50% of base	Progressive containment
Distance of spread 200% of base	Progressive containment
Cost of control +20% from base	Progressive containment
Cost of control -20% from base	Progressive containment
Loss of production impacts -20% from base	Progressive containment
Loss of production impacts +20% from base	Progressive containment
Discount rate 4%	Eradication
Discount rate 8%	Progressive containment

14.4 NPD Section 7 - Allocation of Costs and Benefits

14.4.1 Beneficiaries, exacerbators, and costs of proposed plan for control of African Love Grass

The beneficiaries and exacerbators of the plan are:

- Beneficiaries: Rural community from prevention of spread and production benefits.
- Active exacerbators: Any persons transporting African Love Grass into or around the region.
- Passive exacerbators: Any persons with African Love Grass on their property not undertaking control.

The direct and indirect costs associated with the plan are shown below in Table 67 and Table 68 .

Table 67: Direct and indirect costs of plan for African Love Grass

Plan option	Control costs land holders (PV (6%))	Inspection and monitoring costs (PV (6%))
Sustained Control	$8000	$60,000
Progressive Containment	$20,000	$200,000
Eradication	$30,000	$300,000

Table 68: Benefits and costs of plan for African Love Grass that accrue to different beneficiaries and exacerbators

Plan option	Benefits for those currently infested (PV (6%))	Benefits for those not currently infested (PV (6%))	Costs for exacerbators (PV (6%))
Sustained Control	$2,000	$91,000,000	$8000
Progressive Containment	$-4,000	$91,000,000	$20,000
Eradication	$-17,900	$91,000,000	$30,000

14.4.2 Matters for consideration in allocation of costs

The matters for consideration are spelt out in Section 7(2)(d) of the NPD, and the analysis for each of these matters is shown in Table 32 below.

Table 69: Matters for consideration in allocating costs for proposed African Love Grass plan

Legislative rights and responsibilities	None known.
Management objectives	Progressive Containment.
Stage of infestation	Low infestations with only 3 properties infested across 94 ha in Canterbury.
Most effective control agents	Land holders are most effective because it requires control and measures to ensure that seed does not spread.
Urgency	Moderate urgency to prevent spread.
Efficiency and effectiveness	It is likely that requiring land holders to control will improve the efficiency of control measures as land will be managed to reduce infestation and spread.
Practicality of targeting beneficiaries	Beneficiaries are the wider communicty for biodiversity values and the wider rural community for prevention of spread onto productive land.
Practicality of targeting exacerbators	Locations are limited and known, and exacerbators can be targeted.
Administrative efficiency	Exacerbator control requires inspection and enforcement, while General Rate would have greater administrative efficiency.
Security	Rating mechanisms are most secure.
Fairness	Charges relate directly to benefits or exacerbators. Fairness is a politically determined judgement.
Reasonable	Costs are likely to be singificant on some properties.
Parties bearing indirect costs	None likely.
Transitional cost allocation arrangements	May need to be some transitional mechanisms if moving to land holder control.
Mechanisms available	General Rate, targeted rate (rural properties) and direct charges are the most readily available mechansisms. Levies are expensive to establish and administer.

14.4.3 Proposed allocation of costs

African Love Grass causes damage to both production values and biodiversity. It is therefore appropriate that both the wider community and rural land holders contribute to the plan. Because of the reasonably extensive nature of the pest, it is appropriate that exacerbators contribution is made in the form of land holder control on productive properties, with a mixture of General Rate and targeted rural rate contribution to any control on non-productive areas and public land, and for inspection, monitoring and control. The recommended regime is:

- Inspection and monitoring costs – 50% General Rate, 50% rural targeted rate
- Control on non productive areas and public land – 50% General Rate, 50% rural targeted rate
- Control on productive land – land holder control.

15 Bell Heather

15.1 Description

Bell Heather (*Erica cinera*) is a low growing bushy shrub that occurs on rocky sites and high country tussock grasslands. It forms a dense cover that suppresses other vegetation and displaces productive species. It spreads by both seed and vegetatively, and is known only in the Hunter Hills in South Canterbury in the Canterbury region.

15.2 Proposed Plan

ECan is proposing that Bell Heather is controlled through the Sustained Control objective described in Section 1(b) of the NPD.

15.3 NPD Section 6 Assessment

15.3.1 Level of analysis

The assessed level of analysis for Bell Heather under the requirements of the NPD and using the Guidance approach is Level 1. The detail of the requirement for assessment is shown in Appendix B.

15.3.2 Impacts of Bell Heather

Bell Heather has the potential to cause loss of production from pastoral agriculture in hill and high country, and causes impacts to biodiversity in tussock landscapes and grassland.

15.3.3 Benefits for management of Bell Heather

Prevention of loss of production from pastoral agriculture in hill and high country.

Prevention of impacts to biodiversity in tussock landscapes and grassland.

Cost of control and lost production if allowed to spread are NPV (6%) $600,000. There is also the prevention of any impacts to biodiversity on an area of 2,540 ha after 100 years if the pest is allowed to spread.

15.3.4 Costs of Bell Heather Plan

The plan will incur costs of control, inspection, and monitoring. These are $50,000 annually for the plan option. Costs for all three options considered are an NPV of $800,000 for Sustained Control, NPV $3,000,000 for Progressive Containment, and NPV $3,000,000 for Eradication (which has a shorter time frame).

15.3.5 Risks of Bell Heather Plan

Technical and operational risks: Sustained Control will require less effort than progressive containment but it is difficult to ensure that Bell Heather does not spread further. However, it is assisted by its limited distribution.

Implementation and compliance: Because of its limited distribution and extended period under control there are no major risks expected from compliance with the plan.

Other legislative risks: None known

Public or political concerns: None known

Other risks: None known

15.3.6 Net Benefit and risk adjustment

The analysis produces an estimate of the total costs and benefits of the different options for the plan, as shown in Table 70 below. In terms of those alternatives considered, the Do Nothing option has the highest net value. The sensitivity of this conclusion to changes in various input parameters is shown in Table 72 below, which suggests that for quantified benefits and costs under most parameter changes the Do Nothing scenario produces the highest net benefit. In addition to the quantified costs and benefits, there are benefits associated with preventing damage to biodiversity, and intergenerational implications that should be taken into account because all of the management options will prevent the displacement of biodiversity on 2540 ha.

In order for the proposed plan to be worthwhile there would need to be a benefit of $240/ha for protecting biodiversity benefits under the Sustained Control option (see Table 71 below). The intergenerational implications are that the cost of returning to the current state are potentially significant.

These factors suggest that either the Do Nothing option or Sustained Control should be favoured as producing the highest net benefit depending on the value that is assigned to the protection of biodiversity.

Table 70: Outcomes of analysis of costs and benefits for Bell Heather

Plan	Total control costs and lost production PV(6%)	Net Benefit of plan NPV(6%)	Risk adjusted net benefit of plan NPV(6%)
Do Nothing	$600,000		
Eradication	$4,000,000	$-3,730,000	$-3,250,000
Progressive containment	$4,000,000	$-3,010,000	$-3,000,000
Sustained Control	$1,000,000	$-440,000	$-610,000

Table 71: Value of biodiversity required for option to be positive (negative value shows that option is worthwhile even without biodiversity benefits)

Plan	Value of biodiversity needed for plan to be positive ($/ha)	Risk adjusted value of biodiversity for plan to be positive ($/ha)
Eradication	$1470	$1280
Progressive containment	$1190	$1180
Sustained Control	$170	$240

Table 72: Impact of sensitivity testing on highest value option

Sensitivity test	Highest value option
Base net benefit	Do Nothing
Time to full occupation 50% of base	Do Nothing
Time to full occupation 150% of base	Do Nothing
Distance of spread 50% of base	Do Nothing
Distance of spread 200% of base	Sustained Control
Cost of control +20% from base	Do Nothing
Cost of control -20% from base	Do Nothing
Loss of production impacts -20% from base	Do Nothing
Loss of production impacts +20% from base	Do Nothing
Discount rate 4%	Do Nothing
Discount rate 8%	Do Nothing

15.4 NPD Section 7 - Allocation of Costs and Benefits

15.4.1 Beneficiaries, exacerbators, and costs of proposed plan for control of Bell Heather

The beneficiaries and exacerbators of the plan are:

- Beneficiaries: Rural community from prevention of spread and production benefits.
- Active exacerbators: Any persons transporting Bell Heather into or around the region
- Passive exacerbators: Any persons with Bell Heather on their property not undertaking control.

The direct and indirect costs associated with the plan are shown below in Table 73 and Table 74.

Table 73: Direct and indirect costs of plan for Bell Heather

Plan option	Control costs land holders (PV (6%))	Inspection and monitoring costs (PV (6%))
Sustained Control	$300,000	$800,000
Progressive containment	$500,000	$3,000,000
Eradication	$900,000	$3,000,000

Table 74: Benefits and costs of plan for Bell Heather that accrue to different beneficiaries and exacerbators

Plan option	Benefits for those currently infested (PV (6%))	Benefits for those not currently infested (PV (6%))	Required benefit for community for biodiversity and ecological benefits in order for option to be positive	Costs for exacerbators (PV (6%))
Sustained Control	$-120,000	$500,000	$440,000	$300,000
Progressive containment	$-370,000	$500,000	$3,010,000	$500,000
Eradication	$-810,000	$500,000	$3,730,000	$900,000

15.4.2 Matters for consideration in allocation of costs

The matters for consideration are spelt out in Section 7(2)(d) of the NPD, and the analysis for each of these matters is shown in Table 75 below.

Table 75: Matters for consideration in allocating costs for proposed Bell Heather plan

Legislative rights and responsibilities	None known
Management objectives	Sustained Control
Stage of infestation	Early stage with occurrence limited to a few active sites in Canterbury.
Most effective control agents	Council control is likely to be most effective as Bell Heather infests non productive land and land holders are unlikely to be able to alter land management to improve efficiency of control.
Urgency	Moderate urgency to prevent spread – it does not appear to have been spreading rapidly.
Efficiency and effectiveness	It is not likely that requiring land holders to control will improve the efficiency of control measures. Requiring community control and funding will ensure benefits match costs.
Practicality of targeting beneficiaries	Beneficiaries are the wider communicty for biodiversity values.
Practicality of targeting exacerbators	Locations are limited and known, and exacerbators can be targeted.
Administrative efficiency	Exacerbator control requires inspection and enforcement, while General Rate would have greater administrative efficiency.
Security	Rating mechanisms are most secure.
Fairness	Charges relate directly to benefits or exacerbators. Fairness is a politically determined judgement.
Reasonable	Costs are likely to be significant on some properties as control is difficult.
Parties bearing indirect costs	None likely.
Transitional cost allocation arrangements	None required if control undertaken by Council.
Mechanisms available	General Rate, targeted rate (rural properties), and direct charges are the most readily available mechansisms. Levies are expensive to establish and administer.

15.4.3 Proposed allocation of costs

The limited occurrence of Bell Heather and the negative outcome in terms of quantified values suggests that the major benefits associated with Bell Heather will be to the wider community.

If Sustained Control is adopted and the demands for a reduction in the presence of Bell Heather are less, exacerbator control could be a better option than Council funded control. In this circumstance the recommended approach would be:

- Inspection and monitoring – General Rate
- Control – land holder requirement.

16 Bur Daisy

16.1 Description

Bur Daisy (*Calotis lapulacea*) is a small perennial herb that grows up to 40cm tall and has many fine green branches. It causes damage to the wool industry because the seed burs lodge in sheep fleeces and increase costs for their removal. Bur Daisy also replaces productive plant species on dry, eroded hill slopes, and rocky outcrops, and if uncontrolled will move onto productive hill country. It is limited in distribution in Canterbury, but has potential to occupy dry hill country across the east coast of the region.

16.2 Proposed Plan

ECan is proposing that Bur Daisy is controlled through the Sustained Control objective described in Section 1(b) of the NPD.

16.3 NPD Section 6 Assessment

16.3.1 Level of analysis

The assessed level of analysis for Bur Daisy under the requirements of the NPD and using the Guidance approach is Level 1. The detail of the requirement for assessment is shown in Appendix B.

16.3.2 Impacts of Bur Daisy

Bur Daisy has the potential to cause loss of production from pastoral agriculture in hill and high country. It also causes impacts to biodiversity in tussock landscapes and grassland .

16.3.3 Benefits for management of Bur Daisy

- Prevention of loss of production from pastoral agriculture in hill and high country.
- Prevention of impacts to biodiversity in tussock landscapes and grassland .

Cost of control and lost production if allowed to spread are NPV(6%) $57,000,000. There is also the prevention of any impacts to biodiversity on an area of 37,810 ha after 100 years if the pest is allowed to spread.

16.3.4 Costs of Bur Daisy Plan

The plan will incur costs of control, inspection, and monitoring. These are $30,000 annually for the plan option. Costs for all three options considered are an NPV $50,000 for Sustained Control, NPV $2,000,000 for Progressive Containment, and NPV $2,000,000 for Eradication (which has a shorter time frame).

16.3.5 Risks of Bur Daisy Plan

Technical and operational risks: Bur Daisy has been under control for a long period with limited progress. However, it appears possible to maintain Sustained Control and limit spread with an intensive regime. There are additional technical risks because bur daisy plants are located in inaccessible and rockfall prone areas.

Implementation and compliance: Ensuring compliance with management regime will be difficult and will require education, inspection, and potentially enforcement. These all carry risks.

Other legislative risks: None known

Public or political concerns: None known

Other risks: None known

16.3.6 Net Benefit and risk adjustment

The analysis produces an estimate of the total costs and benefits of the different options for the plan, as shown in Table 76 below. In terms of those alternatives considered, the Eradication option has the highest net value. The sensitivity of this conclusion to changes in various input parameters is shown in Table 77 below which suggests that Eradication remains the highest value option under a variety of assumptions. In addition to the quantified costs and benefits there are potential benefits associated with preventing damage to biodiversity on 37,810 ha, and intergenerational implications that should be taken into account.

These factors suggest that the Eradication option is favoured as producing the highest net benefit if the assumptions made in this analysis are considered reasonable. There would need to be higher costs for Eradication, or a different spread of risk in order for Sustained Control to be preferred.

Table 76: Outcomes of analysis of costs and benefits for Bur Daisy

Plan	Total control costs and lost production PV(6%)	Net Benefit of plan NPV(6%)	Risk adjusted net benefit of plan NPV(6%)
Do Nothing	$57,000,000		
Eradication	$2,000,000	$54,770,000	$40,620,000
Progressive containment	$2,000,000	$55,000,000	$37,940,000
Sustained Control	$500,000	$56,430,000	$33,660,000

Table 77: Impact of sensitivity testing on highest value option

Sensitivity test	Highest value option
Base net benefit	Eradication
Time to full occupation 50% of base	Eradication
Time to full occupation 150% of base	Eradication
Distance of spread 50% of base	Eradication
Distance of spread 200% of base	Eradication
Cost of control +20% from base	Eradication
Cost of control -20% from base	Eradication
Loss of production impacts -20% from base	Eradication
Loss of production impacts +20% from base	Eradication
Discount rate 4%	Eradication
Discount rate 8%	Eradication

16.4 NPD Section 7 - Allocation of Costs and Benefits

16.4.1 Beneficiaries, exacerbators and costs of proposed plan for control of Bur Daisy

The beneficiaries and exacerbators of the plan are:

- Beneficiaries: Rural community from prevention of spread and production benefits.
- Active exacerbators: Any persons transporting Bur Daisy into or around the region.
- Passive exacerbators: Any persons with Bur Daisy on their property not undertaking control.

The direct and indirect costs associated with the plan are shown below in Table 78 and Table 79.

Table 78: Direct and indirect costs of plan for Bur Daisy

Plan option	Control costs land holders (PV (6%))	Inspection and monitoring costs (PV (6%))
Sustained Control	$40,000	$500,000
Progressive containment	$70,000	$2,000,000
Eradication	$100,000	$2,000,000

Table 79: Benefits and costs of plan for Bur Daisy that accrue to different beneficiaries and exacerbators

Plan option	Benefits for those currently infested (PV (6%))	Benefits for those not currently infested (PV (6%))	Costs for exacerbators (PV (6%))
Sustained Control	$-10,000	$57,000,000	$40,000
Progressive Containment	$-40,000	$57,000,000	$70,000
Eradication	$-100,000	$57,000,000	$100,000

16.4.2 Matters for consideration in allocation of costs

The matters for consideration are spelt out in Section 7(2)(d) of the NPD, and the analysis for each of these matters is shown in Table 80 below.

Table 80: Matters for consideration in allocating costs for proposed Bur Daisy plan

Legislative rights and responsibilities	None known.
Management objectives	Sustained Control.
Stage of infestation	Moderate infestations with 33 properties and 235 ha in Canterbury.
Most effective control agents	Land holders are most effective because it requires control and measures to ensure that seed does not spread.
Urgency	Moderate urgency to prevent spread.
Efficiency and effectiveness	It is likely that requiring land holders to control will improve the efficiency of control measures as land will be managed to reduce infestation and spread.
Practicality of targeting beneficiaries	Beneficiaries are the wider communicty for biodiversity values and the wider rural community for prevention of spread onto productive land .
Practicality of targeting exacerbators	Locations are limited and known, and exacerbators can be targeted.
Administrative efficiency	Exacerbator control requires inspection and enforcement, while General Rate would have greater administrative efficiency.
Security	Rating mechanisms are most secure.
Fairness	Charges relate directly to benefits or exacerbators. Fairness is a politically determined judgement.
Reasonable	Costs are likely to be significant on some properties.
Parties bearing indirect costs	None likely.
Transitional cost allocation arrangements	None required as control has been required for Bur Daisy for some time.
Mechanisms available	General Rate, targeted rate (rural properties), and direct charges are the most readily available mechansisms. Levies are expensive to establish and administer.

16.4.3 Proposed allocation of costs

Because the benefits of Bur Daisy are primarily productive the costs of the plan should be largely borne by a rural rate targeted at productive land uses. The use of land holder control is appropriate given the gains to individual land holders and the potential for improved management. The recommended approach therefore is:

- Costs of inspection and monitoring - Rural rate targeted at productive properties
- Control – Land holders with the Bur Daisy present on the property as exacerbators.

17 Chilean Needle Grass

17.1 Description

Chilean needle grass (*Nassella neesiana*) is an erect, tufted perennial grass, which can grow up to one metre high in the absence of grazing. It originates from South America, and has naturalised in New Zealand in Hawke's Bay, Marlborough, and Auckland. Plants form dense clumps which exclude preferred pasture species and are unpalatable to stock during the flowering period. Chilean needle grass flowers between November and April and produces sharp tipped seeds which can bore into the eyes and pelts of grazing animals. The seeds can be moved by stock, waterways, feral animals, machinery, hay, grain, and to some extent by wind.

Chilean needle grass is recognised as a weed of national significance in Australia. In New Zealand there are localised infestations in Auckland and Hawke's Bay in the North Island and more extensive infestations in Marlborough. Until the late 2000's Canterbury was thought to be free of Chilean needle grass. However, an infestation was discovered in a vineyard in Spotswood and it is currently known to be on 17 active sites across 325 ha.

17.2 Proposed Plan

ECan is proposing that Chilean needle grass is controlled through the Sustained Control objective described in Section 1(b) of the NPD.

17.3 NPD Section 6 Assessment

17.3.1 Level of analysis

The assessed level of analysis for Chilean needle grass under the requirements of the NPD and using the Guidance approach is Level 2. The detail of the requirement for assessment is shown in Appendix B.

17.3.2 Impacts of Chilean Needle Grass

Chilean needle grass has the potential to cause damage to pastoral agriculture through reduced pasture quality and animal intake. There are also animal welfare impacts from seed burrowing under the skin and into the eyes of stock and dogs and this requires stock to be kept off pasture where Chilean needle grass is seeding.

17.3.3 Benefits for management of Chilean Needle Grass

- Prevention of damage to pastoral agriculture through reduced pasture quality and animal intake.
- Prevention of animal welfare impacts from seed.

Cost of control and lost production if allowed to spread are NPV(6%) $6,000,000. There is also the prevention of any impacts to biodiversity on an area of 3,500 ha after 100 years if the pest is allowed to spread.

17.3.4 Costs of Chilean Needle Grass Plan

The plan will incur costs of control, monitoring, and stock movement control. These are $145,000 annually for the plan option. Costs for all three options considered are a NPV(6%)

of $2,000,000 for Sustained Control, NPV(6%) $9,000,000 for Progressive Containment, and NPV(6%) $10,000,000 for Eradication (which has higher costs over a shorter time frame).

17.3.5 Risks of Chilean Needle Grass Plan

Technical and operational risks: Control of Chilean needlegrass requires adaptation of management techniques by farmers. Chilean needle grass has been under control in Marlborough for a long period with limited progress.

Implementation and compliance: Requirement for control by land holders has risks as complete control can be difficult to achieve.

Other legislative risks: None known

Public or political concerns: Costs of control and movement control for affected properties. There are also animal welfare concerns associated with Chilean needle grass.

Other risks: Potential for spread from Marlborough.

17.3.6 Net Benefit and risk adjustment

The analysis produces an estimate of the total costs and benefits of the different options for the plan, as shown in Table 81 below. In terms of those alternatives considered, the Sustained Control option has the highest net value. The sensitivity of this conclusion to changes in various input parameters is shown in Table 82 below, which suggests that the conclusion is reasonably robust, but there are a range of changes that would make the Do Nothing option higher in net benefit. A smaller distance of spread or a higher discount rate makes Do Nothing a higher value option because future costs from spread are relatively smaller.

In addition to the quantified costs and benefits, there are potential benefits associated with preventing damage to biodiversity on 3,500 ha, and intergenerational implications that should be taken into account.

These factors suggest that the Progressive Containment option is strongly favoured as producing the highest net benefit if the assumptions made in this analysis are considered reasonable.

Table 81: Outcomes of analysis of costs and benefits for Chilean Needle Grass

Plan	Total control costs and lost production PV(6%)	Net Benefit of plan NPV(6%)	Risk adjusted net benefit of plan NPV(6%)
Do Nothing	$7,000,000		
Eradication	$13,000,000	$-5,800,000	$-5,760,000
Progressive containment	$11,000,000	$-3,780,000	$-5,250,000
Sustained Control	$3,000,000	$3,610,000	$1,170,000

Table 82: Impact of sensitivity testing on highest value option

Sensitivity test	Highest value option
Base net benefit	Sustained Control
Time to full occupation 50% of base	Sustained Control
Time to full occupation 150% of base	Sustained Control
Distance of spread 50% of base	Do Nothing
Distance of spread 200% of base	Sustained Control
Cost of control +20% from base	Sustained Control
Cost of control -20% from base	Sustained Control
Loss of production impacts -20% from base	Sustained Control
Loss of production impacts +20% from base	Sustained Control
Discount rate 4%	Sustained Control
Discount rate 8%	Do Nothing

17.4 NPD Section 7 - Allocation of Costs and Benefits

17.4.1 Beneficiaries, exacerbators and costs of proposed plan for control of Chilean Needle Grass

The beneficiaries and exacerbators of the plan are:

- Beneficiaries: All pastoral farmers
- Active exacerbators: Any persons transporting Chilean needle grass into or around the region
- Passive exacerbators: Any persons with Chilean needle grass on their property not undertaking control.

The direct and indirect costs associated with the plan are shown below in and Table 84.

Table 83: Direct and indirect costs of plan for Chilean Needle Grass

Plan option	Control costs land holders (PV (6%))	Inspection and monitoring costs (PV (6%))
Sustained Control	$700,000	$2,000,000
Progressive containment	$1,000,000	$9,000,000
Eradication	$3,000,000	$10,000,000

Table 84: Benefits and costs of plan for Chilean Needle Grass that accrue to different beneficiaries and exacerbators

Plan option	Benefits for those currently infested (PV (6%))	Benefits for those not currently infested (PV (6%))	Costs for exacerbators (PV (6%))
Sustained Control	$-52,000	$6,000,000	$700,000
Progressive containment	$-710,000	$6,000,000	$1,000,000
Eradication	$-1,890,000	$6,000,000	$3,000,000

17.4.2 Matters for consideration in allocation of costs

The matters for consideration are spelt out in Section 7(2)(d) of the NPD, and the analysis for each of these matters is shown in Table 85 below.

Table 85: Matters for consideration in allocating costs for proposed Chilean Needle Grass plan

Legislative rights and responsibilities	None known.
Management objectives	Sustained Control.
Stage of infestation	Early but established, with some large areas and a number of active sites (17).
Most effective control agents	Specialist contractors.
Urgency	High - moderate, as it is already established and unlikely to be eradicated in the near future. However, with its limited extent there is potential for containing it to a restricted area.
Efficiency and effectiveness	Containment and reduction is likely to be more efficient than alternate approaches because of the reasonably early stage of infestation.
Practicality of targeting beneficiaries	Beneficiaries are widespread throughout the region, although largely related to pastoral agriculture.
Practicality of targeting exacerbators	Location of Chilean needle grass is defined and exacerbators are able to be targeted.
Administrative efficiency	It would be costly to establish a specific rating area to target immediate beneficiaries. A wider targeted rate that overlaps with beneficiaries for other pests, or General Rate, is likely to be most administrateively efficient.
Security	Smaller rating bases are less secure funding sources.
Fairness	Because most of the benefits are to wider pastoral agriculature, targeting them is fair. It is also appropriate that the wider public pay some portion associated with animal welfare benefits if the pest were to become widespread.
Reasonable	The costs of the programme are not onerous, although the movement control requirements do impose significant costs on exacerbators.
Parties bearing indirect costs	No indirect costs are expected.
Transitional cost allocation arrangements	Transitional costs may be required to establish movement control programme.
Mechanisms available	General Rate, targeted rate (rural properties) and direct charges are the most readily available mechansisms. Levies are expensive to establish and administer.

17.4.3 Proposed allocation of costs

Because the benefits of the Chilean needle grass control accrue largely to the primary sector, and because there are significant gains in management of the pest by requiring exacerbator funding, land holder funding of control is most appropriate. However, where costs are significant, particularly with movement control, some beneficiary funding is likely to be appropriate as a transitional mechanism. The largely productive benefits from the pest suggest that a targeted rural rate is most appropriate for inspection and monitoring reflecting the benefit gained from preventing spread. The recommended funding approach therefore is:

- Inspection and monitoring – targeted rural rate on productive land .

- Control – land holder control with input from targeted rural rate for transitional funding associated with initial control.

18 Coltsfoot

18.1 Description

Coltsfoot (*Tussilago farfara*) is a perennial mat forming herb which grows up to 20cm high. It grows in heavy soils, stream margins, and damp loose gravel areas, and is found in the Arthur's Pass area and the Eyre river in Oxford. Coltsfoot spreads by underground rhizomes and windblown seeds, and can enter and clog small waterways and invade irrigated pasture.

18.2 Proposed Plan

ECan is proposing that Coltsfoot is controlled through the Sustained Control objective described in Section 1(b) of the NPD.

18.3 NPD Section 6 Assessment

18.3.1 Level of analysis

The assessed level of analysis for Coltsfoot under the requirements of the NPD and using the Guidance approach is Level 1. The detail of the requirement for assessment is shown in Appendix B.

18.3.2 Impacts of Coltsfoot

Coltsfoot has the potential to cause impacts to biodiversity in short tussock landscapes, riverbeds, and stream margins.

18.3.3 Benefits for management of Coltsfoot

Impacts to biodiversity on riverbeds and stream margins. Cost of control and lost prodcution if allowed to spread are NPV(6%) $500,000. There is also the prevention of any impacts to biodiversity on an area of 50 ha after 100 years if the pest is allowed to spread.

18.3.4 Costs of Coltsfoot Plan

The plan will incur costs of control, inspection, and monitoring. These are $40,000 annually for the plan option. Costs for all three options considered are aan NPV(6%) $700,000 for Sustained Control, NPV(6%) $3,000,000 for Progressive Containment, and NPV(6%) $3,000,000 for Eradication (which has a shorter time frame).

18.3.5 Risks of Coltsfoot Plan

Technical and operational risks: Coltsfoot occurs in situations where it is difficult to find. This can make inspection and control difficult.

Implementation and compliance: None known.

Other legislative risks: None known

Public or political concerns: None known

Other risks: None known

18.3.6 Net Benefit and risk adjustment

The analysis produces an estimate of the total costs and benefits of the different options for the plan, as shown in Table 86 below. In terms of those alternatives considered, the Do

Nothing option has the highest net value for quantified costs and benefits. The sensitivity of this conclusion to changes in various input parameters is shown in Table 88 below which suggests it is relatively unaffected by changes in assumptions. In addition to the quantified costs and benefits there are potential benefits associated with preventing damage to biodiversity on 50 ha.

In order for the proposed plan for Sustained Control to be worthwhile there would need to be a benefit associated with preventing damage to biodiversity of $9600/ha (see Table 87 below) and the risks of not achieving the objective would have to be greater under Sustained Control.

These factors suggest that either Do Nothing or the Sustained Control option is favoured as producing the highest net benefit if the assumptions made in this analysis are considered reasonable, and depending on the value that is assigned to the biodiversity benefits.

Table 86: Outcomes of analysis of costs and benefits for Coltsfoot

Plan	**Total control costs and lost production PV(6%)**	**Net Benefit of plan NPV(6%)**	**Risk adjusted net benefit of plan NPV(6%)**
Do Nothing	$500,000		
Eradication	$3,000,000	$-2,880,000	$-2,580,000
Progressive containment	$3,000,000	$-2,360,000	$-2,370,000
Sustained Control	$800,000	$-340,000	$-480,000

Table 87: Value of biodiversity required for option to be positive (negative value shows that option is worthwhile even without biodiversity benefits)

Plan	**Value of biodiversity needed for plan to be positive ($/ha)**	**Risk adjusted value of biodiversity for plan to be positive ($/ha)**
Eradication	$57,600	$51,600
Progressive containment	$47,200	$47,400
Sustained Control	$6,800	$9,600

Table 88: Impact of sensitivity testing on highest value option

Sensitivity test	Highest value option (risk adjusted)
Base net benefit	Do Nothing
Time to full occupation 50% of base	Do Nothing
Time to full occupation 150% of base	Do Nothing
Distance of spread 50% of base	Do Nothing
Distance of spread 200% of base	Sustained Control
Cost of control +20% from base	Do Nothing
Cost of control -20% from base	Do Nothing
Loss of production impacts -20% from base	Do Nothing
Loss of production impacts +20% from base	Do Nothing
Discount rate 4%	Do Nothing
Discount rate 8%	Do Nothing

18.4 NPD Section 7 - Allocation of Costs and Benefits

18.4.1 Beneficiaries, exacerbators and costs of proposed plan for control of Coltsfoot

The beneficiaries and exacerbators of the plan are:

- Beneficiaries: Rural community from prevention of spread and production benefits.
- Active exacerbators: Any persons transporting Coltsfoot into or around the region.
- Passive exacerbators: Any persons with Coltsfoot on their property not undertaking control.

The direct and indirect costs associated with the plan are shown below in Table 89 and Table 90.

Table 89: Direct and indirect costs of plan for Coltsfoot

Plan option	Control costs land holders (PV (6%))	Inspection and monitoring costs (PV (6%))
Sustained Control	$200,000	$700,000
Progressive containment	$300,000	$3,000,000
Eradication	$600,000	$3,000,000

Table 90: Benefits and costs of plan for Coltsfoot that accrue to different beneficiaries and exacerbators

Plan option	Benefits for those currently infested (PV (6%))	Benefits for those not currently infested (PV (6%))	Costs for exacerbators (PV (6%))
Sustained Control	$-91,000	$400,000	$200,000
Progressive containment	$-257,000	$400,000	$300,000
Eradication	$-547,000	$400,000	$600,000

18.4.2 Matters for consideration in allocation of costs

The matters for consideration are spelt out in Section 7(2)(d) of the NPD and the analysis for each of these matters is shown in Table 91 below.

Table 91: Matters for consideration in allocating costs for proposed Coltsfoot plan

Legislative rights and responsibilities	None known.
Management objectives	Sustained Control.
Stage of infestation	Moderate infestation - there are 40 known active sites across 633 ha in Canterbury.
Most effective control agents	It is likely that a mix of Council control will be required because in some cases there will be no specific owners of the waterways where coltsfoot occurs.
Urgency	Moderate if further spread is to be prevented.
Efficiency and effectiveness	Control will be difficult in waterways and may require contractors to achieve effective control.
Practicality of targeting beneficiaries	Wider community beneficiaries can be targeted through General Rate.
Practicality of targeting exacerbators	Exacerbators can be identified on land where Coltsfoot is present.
Administrative efficiency	General Rate is highly efficient for collecting community benefits related to biodiversity.
Security	Rating mechanisms are generally secure.
Fairness	Charges relate directly to benefits or exacerbators. Fairness is a politically determined judgement.
Reasonable	The costs for Council are moderate, and may be significiant for individual land holders where Colstfoot is found.
Parties bearing indirect costs	None likely as only small waterways involved.
Transitional cost allocation arrangements	None required.
Mechanisms available	General Rate, targeted rate (rural properties), and direct charges are the most readily available mechansisms. Levies are expensive to establish and administer.

18.4.3 Proposed allocation of costs

There are minor production benefits and the biodiversity benefits accrue to the wider community. Exacerbator control is not feasible because of the locations where Coltsfoot occurs. Therefore, the plan should be funded by the wider community through General Rate. The recommended approach for funding is:

- Inspection and monitoring costs – General Rate
- Control costs – General Rate.

19 Puna Grass

19.1 Description

Puna Grass is a tall tussock that grows up to 1m tall and is unpalatable to stock. It is a weed of grasslands and riparian areas, and is known only to be at 2 locations in Canterbury.

19.2 Proposed Plan

ECan is proposing that Puna Grass is controlled through the Progressive Containment objective described in Section 1(b) of the NPD.

19.3 NPD Section 6 Assessment

19.3.1 Level of analysis

The assessed level of analysis for Puna Grass under the requirements of the NPD and using the Guidance approach is Level 1. The detail of the requirement for assessment is shown in Appendix B.

19.3.2 Impacts of Puna Grass

Puna Grass has the potential to cause loss of production from pastoral agriculture in hill and high country, and impacts to biodiversity in tussock landscapes and grassland.

19.3.3 Benefits for management of Puna Grass

Prevention of loss of production from pastoral agriculture in hill and high country and prevention of impacts to biodiversity in tussock landscapes and grassland. The costs of lost production and control if allowed to spread are NPV(6%) $300,000. There is also the prevention of any impacts to biodiversity on an area of 5,000 ha after 100 years if the pest is allowed to spread.

19.3.4 Costs of Puna Grass Plan

The plan will incur costs of control, inspection, and monitoring. These are $10,000 annually for the plan option. Costs for all three options considered are a an NPV(6%) of $40,000 for Sustained Control, NPV(6%) $200,000 for Progressive Containment, and NPV(6%) $200,000 for Eradication (which has a shorter time frame).

19.3.5 Risks of Puna Grass Plan

Technical and operational risks: Progressive Containment is technically difficult to achieve, and requires adaptation of management techniques.

Implementation and compliance: Ensuring compliance with management regime will be difficult and will require education, inspection and potentially enforcement. These all carry risks.

Other legislative risks: None known

Public or political concerns: None known

Other risks: None known

19.3.6 Net Benefit and risk adjustment

The analysis produces an estimate of the total costs and benefits of the different options for the plan, as shown in Table 92 below. In terms of those alternatives considered, the Progressive Containment option has the highest net value. The sensitivity of this conclusion to changes in various input parameters is shown in Table 93 below, which suggests that the outcomes are sensitive to the assumptions made. In addition to the quantified costs and benefits, there are potential benefits associated with preventing damage to biodiversity on 5,000 ha, and intergenerational implications that should be taken into account.

These factors suggest that the Progressive Containment option is the preferred option with the highest net benefit if the assumptions made in this analysis are considered reasonable. However, it should be noted that the conclusion is sensitive to the assumptions made and decision makers should check they are comfortable with the key assumptions that would affect the outcome.

Table 92: Outcomes of analysis of costs and benefits for Puna Grass

Plan	Total control costs and lost production PV(6%)	Net Benefit of plan NPV(6%)	Risk adjusted net benefit of plan NPV(6%)
Do Nothing	$300,000		
Eradication	$200,000	$140,000	$140,000
Progressive containment	$200,000	$170,000	$150,000
Sustained Control	$50,000	$290,000	$120,000

Table 93: Impact of sensitivity testing on highest value option

Sensitivity test	Highest value option (risk adjusted)
Base net benefit	Progressive Containment
Time to full occupation 50% of base	Progressive Containment
Time to full occupation 150% of base	Sustained Control
Distance of spread 50% of base	Sustained Control
Distance of spread 200% of base	Progressive Containment
Cost of control +20% from base	Progressive Containment
Cost of control -20% from base	Progressive Containment
Loss of production impacts -20% from base	Progressive Containment
Loss of production impacts +20% from base	Progressive Containment
Discount rate 4%	Eradication
Discount rate 8%	Sustained Control

19.4 NPD Section 7 - Allocation of Costs and Benefits

19.4.1 Beneficiaries, exacerbators and costs of proposed plan for control of Puna Grass

The beneficiaries and exacerbators of the plan are:

- Beneficiaries: Rural community from prevention of spread and production benefits.
- Active exacerbators: Any persons transporting Puna Grass into or around the region
- Passive exacerbators: Any persons with Puna Grass on their property not undertaking control.

The direct and indirect costs associated with the plan are shown below in Table 94 and Table 95.

Table 94: Direct and indirect costs of plan for Puna Grass

Plan option	Control costs land holders (PV (6%))	Inspection and monitoring costs (PV (6%))
Sustained Control	$9,000	$40,000
Progressive containment	$20,000	$200,000
Eradication	$30,000	$200,000

Table 95: Benefits and costs of plan for Puna Grass that accrue to different beneficiaries and exacerbators

Plan option	Benefits for those currently infested (PV (6%))	Benefits for those not currently infested (PV (6%))	Costs for exacerbators (PV (6%))
Sustained Control	$3,000	$300,000	$9,000
Progressive containment	$-3,900	$300,000	$20,000
Eradication	$-19,000	$300,000	$30,000

19.4.2 Matters for consideration in allocation of costs

The matters for consideration are spelt out in Section 7(2)(d) of the NPD, and the analysis for each of these matters is shown in Table 96 below.

Table 96: Matters for consideration in allocating costs for proposed Puna Grass plan

Legislative rights and responsibilities	None known.
Management objectives	Progressive Containment.
Stage of infestation	Early infestation with only two active sites in Canterbury.
Most effective control agents	Difficulty in controlling Puna Grass means that Council control is likely to be most effective.
Urgency	High urgency to prevent spread.
Efficiency and effectiveness	While it may be more efficient to require land holder control to ensure land management is undertaken to prevent spread, the difficulty in control may mean that Council control is most effective.
Practicality of targeting beneficiaries	Beneficiaries are widespread throughout the region, although largely related to pastoral agriculture.
Practicality of targeting exacerbators	Exacerbators can be identified on land where Puna Grass is present.
Administrative efficiency	General Rate is highly efficient for collecting community benefits related to biodiversity.
Security	Rating mechanisms are generally secure.
Fairness	Charges relate directly to benefits or exacerbators. Fairness is a politically determined judgement.
Reasonable	The costs for Council are moderate, and may be significiant for individual land holders where Puna Grass is found.
Parties bearing indirect costs	No indirect costs are expected.
Transitional cost allocation arrangements	None required.
Mechanisms available	General Rate, targeted rate (rural properties), and direct charges are the most readily available mechansisms. Levies are expensive to establish and administer.

19.4.3 Proposed allocation of costs

The benefits of the plan for management of Puna Grass accrue primarily to the pastoral sector. It is therefore appropriate for this benefit to be funded from a targeted rate on productive land. Land holder control is not likely to be effective because of the difficulty of identifying and controlling Puna Grass and its very limited distribution. The recommendations for funding are therefore:

- Inspection and monitoring costs – targeted rate on productive land.
- Control costs – targeted rate on productive land.

20 Saffron Thistle

20.1 Description

Saffron Thistle (*Carthamus lanatus*) is an upright thistle that can grow up to 1m tall. It invades crop land, pasture, and non productive areas, and occurs in a number of locations in Canterbury. It prevents stock movement, competes with pasture species, causes injuries to the mouths and eyes of stock, and contaminates wool. The seed is windblown but it can also be spread by stock, water, vehicles, and in dirt.

20.2 Proposed Plan

ECan is proposing that Saffron Thistle is controlled through the Sustained Control objective described in Section 1(b) of the NPD.

20.3 NPD Section 6 Assessment

20.3.1 Level of analysis

The assessed level of analysis for Saffron Thistle under the requirements of the NPD and using the Guidance approach is Level 1. The detail of the requirement for assessment is shown in Appendix B.

20.3.2 Impacts of Saffron Thistle

Saffron Thistle has the potential to cause loss of production from pastoral agriculture in hill and high country.

20.3.3 Benefits for management of Saffron Thistle

Benefits from the management of Saffron Thistle accrue from the prevention of loss of production from pastoral agriculture in hill and high country. Cost of control and lost production if allowed to spread are NPV(6%) $14,000,000.

20.3.4 Costs of Saffron Thistle Plan

The plan will incur costs of control, inspection, and monitoring. These are $18,500 annually for the plan option. Costs for all three options considered are an NPV(6%) of $300,000 for Sustained Control, NPV(6%) $1,000,000 for Progressive Containment, and NPV(6%) $1,000,000 for Eradication (which has a shorter time frame).

20.3.5 Risks of Saffron Thistle Plan

Technical and operational risks: Sustained Control has relatively few risks, although Saffron Thistle has been under control for a long period with limited progress.

Implementation and compliance: Ensuring compliance with management regime will be difficult and will require education, inspection and potentially enforcement. These all carry risks.

Other legislative risks: None known

Public or political concerns: None known

Other risks: None known

20.3.6 Net Benefit and risk adjustment

The analysis produces an estimate of the total costs and benefits of the different options for the plan, as shown in Table 97 below. In terms of those alternatives considered, the Sustained Control option has the highest net value. The sensitivity of this conclusion to changes in various input parameters is shown in Table 98 below which suggests the conclusion is robust under changes to a range of assumptions, apart from a lower discount rate when Eradication produces higher net benefit, and a larger spread distance when Progressive Containment has the highest net benefit.

These factors suggest that the Sustained Control option has the highest net benefit if the assumptions made in this analysis are considered reasonable.

Table 97: Outcomes of analysis of costs and benefits for Saffron thistle.

Plan	Total control costs and lost production PV(6%)	Net Benefit of plan NPV(6%)	Risk adjusted net benefit of plan NPV(6%)
Do Nothing	$14,000,000		
Eradication	$1,000,000	$12,880,000	$8,720,000
Progressive containment	$1,000,000	$13,080 ,000	$8,820,000
Sustained Control	$400,000	$14,000,000	$8,990,000

Table 98: Impact of sensitivity testing on highest value option

Sensitivity test	Highest value option (risk adjusted)
Base net benefit	Sustained Control
Time to full occupation 50% of base	Sustained Control
Time to full occupation 150% of base	Sustained Control
Distance of spread 50% of base	Sustained Control
Distance of spread 200% of base	Progressive Containment
Cost of control +20% from base	Sustained Control
Cost of control -20% from base	Sustained Control
Loss of production impacts -20% from base	Sustained Control
Loss of production impacts +20% from base	Sustained Control
Discount rate 4%	Eradication
Discount rate 8%	Sustained Control

20.4 NPD Section 7 - Allocation of Costs and Benefits

20.4.1 Beneficiaries, exacerbators and costs of proposed plan for control of Saffron Thistle

The beneficiaries and exacerbators of the plan are:

- Beneficiaries: Rural community from prevention of spread and production benefits.
- Active exacerbators: Any persons transporting Saffron Thistle into or around the region.
- Passive exacerbators: Any persons with Saffron Thistle on their property not undertaking control.

The direct and indirect costs associated with the plan are shown below in Table 99 and Table 100.

Table 99: Direct and indirect costs of plan for Saffron Thistle

Plan option	Control costs land holders (PV (6%))	Inspection and monitoring costs (PV (6%))
Sustained Control	$60,000	$300,000
Progressive containment	$100,000	$1,000,000
Eradication	$200,000	$1,000,000

Table 100: Benefits and costs of plan for Saffron Thistle that accrue to different beneficiaries and exacerbators

Plan option	Benefits for those currently infested (PV (6%))	Benefits for those not currently infested (PV (6%))	Costs for exacerbators (PV (6%))
Sustained Control	$-6,700	$14,000,000	$60,000
Progressive containment	$-58,000	$14,000,000	$100,000
Eradication	$-156,000	$14,000,000	$200,000

20.4.2 Matters for consideration in allocation of costs

The matters for consideration are spelt out in Section 7(2)(d) of the NPD, and the analysis for each of these matters is shown in Table 101 below.

Table 101: Matters for consideration in allocating costs for proposed Saffron Thistle plan

Legislative rights and responsibilities	None known.
Management objectives	Sustained Control.
Stage of infestation	Early infestation with only 13 active sites in Canterbury.
Most effective control agents	Land holders are most effective because it requires control and measures to ensure that seed does not spread.
Urgency	Moderate urgency to prevent spread.
Efficiency and effectiveness	It is likely that requiring land holders to control will improve the efficiency of control measures as land will be managed to reduce infestation and spread.
Practicality of targeting beneficiaries	Beneficiaries are the wider rural community for prevention of spread onto productive land .
Practicality of targeting exacerbators	Locations are limited and known, and exacerbators can be targeted.
Administrative efficiency	Exacerbator control requires inspection and enforcement, while General Rate would have greater administrative efficiency.
Security	Rating mechanisms are most secure.
Fairness	Charges relate directly to benefits or exacerbators. Fairness is a politically determined judgement.
Reasonable	Costs are likely to be significant on some properties.
Parties bearing indirect costs	None likely.
Transitional cost allocation arrangements	None required as control has been required for Saffron thistle for some time.
Mechanisms available	General Rate, targeted rate (rural properties), and direct charges are the most readily available mechanisms. Levies are expensive to establish and administer.

20.4.3 Proposed allocation of costs

The recommended approach is for a mix of land holder control as exacerbators and a targeted rate for productive land in the wider community for inspection, monitoring, and enforcement costs.

- Inspection and monitoring costs: 100% targeted rate on productive rural land as beneficiaries
- Control costs: 100% land holders as exacerbators

21 Boneseed

21.1 Description

Boneseed (*Chrysanthemoides monolifera ssp monolifera*) is a shrub type weed typically reaching 1.3 to 1.5m in its native area of South Africa. The leaves are thick and leathery and palatable to stock. Boneseed occurs in coastal habitats throughout the North Island and in many parts of the South Island in more limited distribution. Boneseed occupies coastal cliffs, sand dunes, gardens, shrub land, and non-productive places. In Canterbury the major areas of infestation are in the Port Hills, where it has occupied coastal cliffs and ungrazed land set aside for development, and coastal sand dune areas to the north of the estuary where it has filled a niche created by the decline of the Tree Lupin (*Lupinus arboreus*). Boneseed is however found in other parts of Banks Peninsula, as far north as Kaikoura, and south to the Waitaki River. To date boneseed has occupied only coastal areas apart from areas of the Port Hills where it has spread as far inland as Evan's Pass. It has been thought that its inland spread is limited by frost, but studies in South Africa and Australia indicate that it may be frost tolerant and that this may not be a limiting factor.

Boneseed can grow on a variety of soil types although most infestations occur on sandy or low fertility soils. Boneseed also tolerates salinity and one of its alternate common names is Saltbush. Boneseed is spread by local seed drop and through its fruit which is attractive to birds which causes both local and more distant spread.

21.2 Proposed Plan

ECan is proposing that Boneseed is controlled through the Sustained Control objective described in Section 1(b) of the NPD.

21.3 NPD Section 6 Assessment

21.3.1 Level of analysis

The assessed level of analysis for Boneseed under the requirements of the NPD and using the Guidance approach is Level 2. The detail of the requirement for assessment is shown in Appendix B.

21.3.2 Impacts of Boneseed

Boneseed is palatable to stock and is typically controlled by grazing at early stages of growth. It appears to have only invaded ungrazed areas such as areas set aside for development and very lightly grazed, or inaccessible coastal and cliff-top areas. Therefore, while mature boneseed makes land unsuitable for pasture its opportunities to invade agricultural land are limited and it has a negligible economic impact

Ecologically, boneseed represents a major threat to coastal communities, including dunes, coastal cliffs, and upper salt marshes. Boneseed has demonstrated an ability to displace native species from these sites and alter the composition of these communities. Canterbury has an estimated 800 km of coastline, and 24,000 ha of coastal community that are considered at risk. Loss of ecosystems threatens biodiversity since the full species diversity of our flora and fauna has not been fully explored, and the only way of protecting it is therefore to retain ecosystems in close to their original condition.

Boneseed has the potential to cause loss of biodiversity in coastal areas, estuary margins, sand dunes, scrubland, and coastal cliffs.

21.3.3 Benefits for management of Boneseed

The benefits of the plan include preventing the loss of biodiversity in coastal areas, estuary margins, sand dunes, scrubland, and coastal cliffs on an area of 1,100 ha after 100 years if the pest is allowed to spread.

21.3.4 Costs of Boneseed Plan

The plan will incur costs of control, inspection, and monitoring. These are $70,000 annually for the plan option. Costs for all three options considered are an NPV(6%) of $1,000,000 for Sustained Control, NPV(6%) $23,000,000 for Progressive Containment, and NPV(6%) $55,000,000 for Eradication (which has a shorter time frame).

21.3.5 Risks of Boneseed Plan

Technical and operational risks: Containment is difficult to achieve given inaccessible locations which are preferred habitat.

Implementation and compliance: Potential for non compliance by land holders, mitigated by the inspection and enforcement regime.

Other legislative risks: None known

Public or political concerns: Acknowledged as a high risk weed.

Other risks: None known

21.3.6 Net Benefit and risk adjustment

The analysis produces an estimate of the total costs and benefits of the different options for the plan, as shown in Table 102 below. In terms of those alternatives considered, the Do Nothing option has the highest net value for matters quantified, which reflects the fact that there are no economic benefits associated with boneseed control. In addition to the quantified costs and benefits, there are potential benefits associated with preventing damage to biodiversity on 1,100 ha, and intergenerational implications that should be taken into account.

In order for the proposed plan to be worthwhile there would need to be a benefit associated with preventing damage to biodiversity of $1,100/ha in order for the benefits to outweigh the costs (see Table 103 below).

These factors suggest that either Do Nothing, or if there is a value exceeding $1,290/ha or $77/ha/year for prevented damage to biodiversity, the Sustained Control option produces the highest net benefit if the assumptions made in this analysis are considered reasonable.

Table 102: Outcomes of analysis of costs and benefits for Boneseed

Plan	Total control costs and lost production PV(6%)	Net Benefit of plan NPV(6%)	Risk adjusted net benefit of plan NPV(6%)
Do Nothing	$600,000		
Eradication	$68,000,000	$-66,960,000	$-55,420,000
Progressive containment	$28,000,000	$-27,660,000	$-23,520,000
Sustained Control	$2,000,000	$-1,370,000	$-1,440,000

Table 103: Value of biodiversity required for option to be positive (negative value shows that option is worthwhile even without biodiversity benefits)

Plan	Value of biodiversity needed for plan to be positive ($/ha)	Risk adjusted value of biodiversity for plan to be positive ($/ha)
Eradication	$60,000	$49,000
Progressive containment	$25,000	$21,000
Sustained Control	$1,220	$1,290

Table 104: Impact of sensitivity testing on highest value option

Sensitivity test	Highest value option (risk adjusted)
Base net benefit	Do Nothing
Time to full occupation 50% of base	Do Nothing
Time to full occupation 150% of base	Do Nothing
Distance of spread 50% of base	Do Nothing
Distance of spread 200% of base	Do Nothing
Cost of control +20% from base	Do Nothing
Cost of control -20% from base	Do Nothing
Loss of production impacts -20% from base	Do Nothing
Loss of production impacts +20% from base	Do Nothing
Discount rate 4%	Do Nothing
Discount rate 8%	Do Nothing

21.4 NPD Section 7 - Allocation of Costs and Benefits

21.4.1 Beneficiaries, exacerbators and costs of proposed plan for control of Boneseed

The beneficiaries and exacerbators of the plan are:

- Beneficiaries: Wider community from biodiversity benefits.
- Active exacerbators: Persons who plant boneseed in gardens, or dump boneseed containing material.
- Passive exacerbators: Any persons with boneseed on their property not undertaking control.

The direct and indirect costs associated with the plan are shown below in Table 105 and Table 106.

Table 105: Direct and indirect costs of plan for Boneseed

Plan option	Control costs land holders (PV (6%))	Inspection and monitoring costs (PV (6%))
Sustained Control	$800,000	$1,000,000
Progressive containment	$5,000,000	$23,000,000
Eradication	$12,000,000	$55,000,000

Table 106: Benefits and costs of plan for Boneseed that accrue to different beneficiaries and exacerbators

Plan option	Benefits for those currently infested (PV (6%))(cost of control)	Benefits for those not currently infested (PV (6%))(avoided cost of control)	Required benefit for community for biodiversity and ecological benefits in order for option to be positive	Costs for exacerbators (PV (6%))
Sustained Control	$-260,000	$50,000	$1,370,000	$800,000
Progressive containment	$-4,450,000	$50,000	$27,660,000	$5,000,000
Eradication	$-11,850,000	$50,000	$66,960,000	$12,000,000

21.4.2 Matters for consideration in allocation of costs

The matters for consideration are spelt out in Section 7(2)(d) of the NPD, and the analysis for each of these matters is shown in Table 107 below.

Table 107: Matters for consideration in allocating costs for proposed Boneseed plan

Legislative rights and responsibilities	None known.
Management objectives	Sustained Control.
Stage of infestation	Expanding but late in stage of expansion as it is present in a considerable part of its potential range.
Most effective control agents	Land holders, although some locations may require specialist control skills.
Urgency	Low - well established.
Efficiency and effectiveness	The efficacy of undertaking control on a widespread basis is potentially low. Site led control may be a more appropriate plan, particularly given the low effectiveness of previous attempts to contain boneseed.
Practicality of targeting beneficiaries	Beneficiaries are able to be targeted through the General Rate.
Practicality of targeting exacerbators	Location of boneseed can be established through an inspection programme. Therefore exacerbators are able to be targeted. Those planting or dumping boneseed are harder to identify and cannot be effectively targeted.
Administrative efficiency	General Rate is highly efficient for collecting community benefits related to biodiversity. Targeted rural rate is appropriate and efficient for benefits to pastoral agriculture.
Security	Rating mechanisms are generally secure.
Fairness	Charges relate directly to benefits or exacerbators. Fairness is a politically determined judgement
Reasonable	The costs of the programme are potentially high for some land holders with little benefit received.
Parties bearing indirect costs	No indirect costs are expected.
Transitional cost allocation arrangements	Programmes for Boneseed control have been established for a number of years. No transitional mechanisms are likely to be required.
Mechanisms available	General Rate, targeted rate (rural properties), and direct charges are the most readily available mechansisms. Levies are expensive to establish and administer.

21.4.3 Proposed allocation of costs

The benefits of boneseed accrue to the wider community, and therefore the General Rate should be used for the beneficiary share. Because it is susceptible to grazing pressure management will have an effect on the prevalence of boneseed and therefore there are likely to be some gains from exacerbator control. Given that the plan is to manage spread, the control required to prevent spread should be funded from land holders as exacerbators. The recommended approach therefore is:

- Cost of inspection and monitoring – General Rate
- Cost of control to prevent spread – Land holder control
- Cost of control in difficult to access areas or to reduce prevalence – General Rate.

22 Broom

22.1 Description

Broom is a woody weed with an almost leafless structure. The stems are green, and it produces seeds in a pod that bursts explosively to disperse the seeds. It forms dense stands that can exclude other plants. Broom causes loss of production by excluding stock and displacing pasture. Broom may also increase costs for establishment of forestry plantings, and tends to be a fire hazard. It is found throughout New Zealand is regarded as a pest in most areas.

22.2 Proposed Plan

ECan is proposing that Broom is controlled through the Sustained Control objective described in Section 1(b) of the NPD.

22.3 NPD Section 6 Assessment

22.3.1 Level of analysis

The assessed level of analysis for Broom under the requirements of the NPD and using the Guidance approach is Level 2. The detail of the requirement for assessment is shown in Appendix B.

22.3.2 Impacts of Broom

Broom has the potential to cause loss of production from pastoral agriculture in hill and high country. It also causes impacts to biodiversity in tussock landscapes, grasslands and riverbeds.

22.3.3 Benefits for management of Broom

The benefits of the management of Broom are prevention of loss of production from pastoral agriculture in hill and high country, and prevention of impacts to biodiversity in tussock landscapes, grasslands, and riverbeds. The benefits are NPV(6%) $946,250,000 by avoiding losses in pasture production and costs of control if Broom spreads to all its potential area. There is also the prevention of any impacts to biodiversity on an area of 496,250 ha after 100 years if the pest is allowed to spread.

22.3.4 Costs of Broom Plan

The plan will incur costs of control, inspection, and monitoring. These are $348,500 annually for the plan option. Costs for all three options considered are an NPV(6%) $6,000,000 for Sustained Control, NPV(6%) $116,000,000 for Progressive Containment, and NPV(6%) $275,000,000 for Eradication (which has a shorter time frame).

22.3.5 Risks of Broom Plan

Technical and operational risks: There is a long history of attempts to control Broom, with little evident impact on a widespread basis. The technical risks of preventing spread for a well established and widespread plant are considerable and there is a low probability of success.

Implementation and compliance: As noted there is a long history of regulated Broom control with widespread non-compliance. The implementation and compliance risks are substantial

and the likelihood of anything of significance beyond the Do Nothing scenario in areas where it is already present are minimal.

Other legislative risks: None known

Public or political concerns: High cost and widespread nature of Broom.

Other risks: None known

22.3.6 Net Benefit and risk adjustment

The analysis produces an estimate of the total costs and benefits of the different options for the plan, as shown in Table 108 below. In terms of those alternatives considered, the Sustained Control option has the highest net value. The sensitivity of this conclusion to changes in various input parameters is shown in Table 109 below which suggests that it is not affected by major changes in assumptions. In addition to the quantified costs and benefits, there are potential benefits associated with preventing damage to biodiversity on 496,000 ha, and intergenerational implications that should be taken into account.

These factors suggest that the Sustained Control option is favoured as producing the highest net benefit if the assumptions made in this analysis are considered reasonable. However, the conclusion is dependent on the ability of the Council to prevent spread into uninfested areas, and this is unproven at present.

Table 108: Outcomes of analysis of costs and benefits for Broom

Plan	Total control costs and lost production PV(6%)	Net Benefit of plan NPV(6%)	Risk adjusted net benefit of plan NPV(6%)
Do Nothing	$1,554,000,000		
Eradication	$3,534,000,000	$-1,980,160,000	$-226,940,000
Progressive containment	$1,433,000,000	$121,060,000	$-68,110,000
Sustained Control	$605,000,000	$948,430,000	$41,920,000

Table 109: Impact of sensitivity testing on highest value option

Sensitivity test	Highest value option (risk adjusted)
Base net benefit	Sustained Control
Time to full occupation 50% of base	Sustained Control
Time to full occupation 150% of base	Sustained Control
Distance of spread 50% of base	Sustained Control
Distance of spread 200% of base	Sustained Control
Cost of control +20% from base	Sustained Control
Cost of control -20% from base	Sustained Control
Loss of production impacts -20% from base	Sustained Control
Loss of production impacts +20% from base	Sustained Control
Discount rate 4%	Sustained Control
Discount rate 8%	Sustained Control

22.4 NPD Section 7 - Allocation of Costs and Benefits

22.4.1 Beneficiaries, exacerbators and costs of proposed plan for control of Broom

The beneficiaries and exacerbators of the plan are:

- Beneficiaries: Rural community from prevention of spread and production benefits.
- Active exacerbators: Any persons transporting Broom into or around the region.
- Passive exacerbators: Any persons with Broom on their property not undertaking control.

The direct and indirect costs associated with the plan are shown below in Table 110 and Table 111.

Table 110: Direct and indirect costs of plan for Broom

Plan option	Control costs land holders (PV (6%))	Inspection and monitoring costs (PV (6%))
Sustained Control	$345,000,000	$6,000,000
Progressive containment	$1,310,000,000	$116,000,000
Eradication	$3,259,000,000	$275,000,000

Table 111: Benefits and costs of plan for Broom that accrue to different beneficiaries and exacerbators

Plan option	Benefits for those currently infested (PV (6%))	Benefits for those not currently infested (PV (6%))	Required benefit for community for biodiversity and ecological benefits in order for option to be positive	Costs for exacerbators (PV (6%))
Sustained Control	$-18,008,981	$972,000,000		$345,000,000
Progressive containment	$-735,344,841	$972,000,000		$1,310,000,000
Eradication	$-2,677,746,967	$972,000,000	$1,980,160,000	$3,259,000,000

22.4.2 Matters for consideration in allocation of costs

The matters for consideration are spelt out in Section 7(2)(d) of the NPD, and the analysis for each of these matters is shown in Table 112 below.

Table 112: Matters for consideration in allocating costs for proposed Broom plan

Legislative rights and responsibilities	None known.
Management objectives	Sustained Control.
Stage of infestation	Widespread.
Most effective control agents	Land holders.
Urgency	Very low - well established and widespread.
Efficiency and effectiveness	The effectiveness of a Sustained Control plan is likely to be low, given that past intensive control efforts appear to have had little impact on spread. The efficiency of requiring land holders to control in uneconomic circumstances is also likely to be marginal.
Practicality of targeting beneficiaries	Beneficiaries are widespread throughout the region, although largely related to pastoral agriculture.
Practicality of targeting exacerbators	Location of Broom can be established through an inspection programme. Therefore exacerbators are able to be targeted.
Administrative efficiency	General Rate is highly efficient for collecting community benefits related to biodiversity. Targeted rural rate is appropriate and efficient for benefits to pastoral agriculture.
Security	Rating mechanisms are generally secure.
Fairness	Charges relate directly to benefits or exacerbators. Fairness is a politically determined judgement.
Reasonable	The costs of the programme are potentially high for some land holders with little benefit received.
Parties bearing indirect costs	No indirect costs are expected.
Transitional cost allocation arrangements	Programmes for Broom control have been established for a long period. No transitional mechanisms are likely to be required.
Mechanisms available	General Rate, targeted rate (rural properties), and direct charges are the most readily available mechanisms. Levies are expensive to establish and administer.

22.4.3 Proposed allocation of costs

The management of Broom potentially has very high costs associated with it. Care is therefore needed in terms of identifying who should pay for control. The benefits are largely associated with production, although there are benefits for biodiversity in parts of the landscape, particularly high country. The approach to funding recommended here separates out the requirements for funding dependent on where the control is required, and therefore to whom the benefits accrue.

- Inspection and monitoring in hill country and lowland where productive values are concerned – rate targeted at productive rural properties.
- Control in hill country and lowland s where productive values are concerned – 100% exacerbators control to prevent spread onto neighbouring properties.
- Inspection and monitoring in high country where biodiversity and productive values are concerned – 50% targeted rural rate, 50% General Rate.

- Control in high country where biodiversity and productive values area concerned – control initially funded 50% General Rate, 50% land holder.
- Ongoing control in high country to prevent recurrence and spread - land holder.

23 Darwin's Barberry

23.1 Description

Darwin's Barberry (*Berberis darwinii*) is a spiky evergreen shrub with purple – black, bird spread berries. It is a long lived plant which tolerates cold temperatures and both damp and dry conditions. It invades disturbed forest, scrubland, short tussock grassland, and bare land. It is widely spread in Canterbury but of limited area and is managed for biodiversity reasons.

23.2 Proposed Plan

ECan is proposing that Darwin's Barberry is controlled through the Sustained Control objective described in Section 1(b) of the NPD. Boundary control will be required where work is being undertaken in order to minimise spread into the cleared area.

23.3 NPD Section 6 Assessment

23.3.1 Level of analysis

The assessed level of analysis for Darwin's Barberry under the requirements of the NPD and using the Guidance approach is Level 1. The detail of the requirement for assessment is shown in Appendix B.

23.3.2 Impacts of Darwin's Barberry

Darwin's Barberry has the potential to cause loss of biodiversity in forest areas, scrubland, and coastal cliffs.

23.3.3 Benefits for management of Darwin's Barberry

Prevention of loss of biodiversity in forest areas, scrubland, and coastal cliffs. Cost of control if allowed to spread are NPV(6%) $9,170,000, and prevention of any impacts to biodiversity on an area of 14,370 ha after 100 years.

23.3.4 Costs of Darwin's Barberry Plan

The plan will incur costs of control, inspection, and monitoring. These are $25,000 annually for the plan option. Costs for all three options considered are an NPV(6%) of $400,000 for Sustained Control, NPV $8,000,000 for Progressive Containment, and NPV $20,000,000 for Eradication (which has a shorter time frame).

23.3.5 Risks of Darwin's Barberry Plan

Technical and operational risks: Darwin's Barberry can be difficult to identify in forest situations and because it is bird spread the prevention of spread particularly difficult.

Implementation and compliance: The widespread nature of Darwin's Barberry and the bird spread seed make compliance with the plan provisions challenging.

Other legislative risks: None known

Public or political concerns: None known

Other risks: None known

23.3.6 Net Benefit and risk adjustment

The analysis produces an estimate of the total costs and benefits of the different options for the plan, as shown in Table 113 below. In terms of those alternatives considered, the Sustained Control option has the highest net value. The sensitivity of this conclusion to changes in various input parameters is shown in Table 114 below and suggests that the conclusion is reasonably robust to changes in any of the assumptions tested, although a shorter distance of spread, an increased control cost or a higher control cost make the Do Nothing options higher value for the matters quantified. In addition to the quantified costs and benefits, there are potential benefits associated with preventing damage to biodiversity on 14,000 ha, and intergenerational implications that should be taken into account.

These factors suggest that the Sustained Control option is favoured as producing the highest net benefit if the assumptions made in this analysis are considered reasonable.

Table 113: Outcomes of analysis of costs and benefits for Darwin's Barberry

Plan	**Total control costs and lost production PV(6%)**	**Net Benefit of plan NPV(6%)**	**Risk adjusted net benefit of plan NPV(6%)**
Do Nothing	$11,000,000		
Eradication	$29,000,000	$-17,810,000	$-19,230,000
Progressive containment	$12,000,000	$-1,130,000	$-7,840,000
Sustained Control	$2,000,000	$8,940,000	$50,000

Table 114: Impact of sensitivity testing on highest value option

Sensitivity test	Highest value option (risk adjusted)
Base net benefit	Sustained Control
Time to full occupation 50% of base	Sustained Control
Time to full occupation 150% of base	Sustained Control
Distance of spread 50% of base	Do Nothing
Distance of spread 200% of base	Sustained Control
Cost of control +20% from base	Sustained Control
Cost of control -20% from base	Do Nothing
Loss of production impacts -20% from base	Sustained Control
Loss of production impacts +20% from base	Sustained Control
Discount rate 4%	Sustained Control
Discount rate 8%	Do Nothing

23.4 NPD Section 7 - Allocation of Costs and Benefits

23.4.1 Beneficiaries, exacerbators and costs of proposed plan for control of Darwin's Barberry

The beneficiaries and exacerbators of the plan are:

- Beneficiaries: Wider community from biodiversity benefits.
- Active exacerbators: Persons who plant Darwins Barberry in gardens or dump Darwins Barberry containing material.
- Passive exacerbators: Any persons with Darwins Barberry on their property not undertaking control.

The direct and indirect costs associated with the plan are shown below in Table 115 and Table 116.

Table 115: Direct and indirect costs of plan for Darwin's Barberry

Plan option	Control costs land holders (PV (6%))	Inspection and monitoring costs (PV (6%))
Sustained Control	$900,000	$400,000
Progressive containment	$4,000,000	$8,000,000
Eradication	$9,000,000	$20,000,000

Table 116: Benefits and costs of plan for Darwin's Barberry that accrue to different beneficiaries and exacerbators

Plan option	Benefits for those currently infested (PV (6%))	Benefits for those not currently infested (PV (6%))	Required benefit for community for biodiversity and ecological benefits in order for option to be positive	Costs for exacerbators (PV (6%))
Sustained Control	$-99,000	$9,000,000		$900,000
Progressive containment	$-2,280,000	$9,000,000	$7,800,000	$4,000,000
Eradication	$-7,560,000	$9,000,000	$19,200,000	$9,000,000

23.4.2 Matters for consideration in allocation of costs

The matters for consideration are spelt out in Section 7(2)(d) of the NPD, and the analysis for each of these matters is shown in Table 117 below.

Table 117: Matters for consideration in allocating costs for proposed Darwin's Barberry plan

Legislative rights and responsibilities	None known.
Management objectives	Sustained Control.
Stage of infestation	Expanding but late in stage of expansion as it is present in a considerable part of its potential range.
Most effective control agents	Council or other agencies with an interest in biodiversity protection.
Urgency	Low - well established.
Efficiency and effectiveness	The efficacy of undertaking control on a widespread basis is potentially low. Site led control may be a more appropriate plan, particularly given the low effectiveness of previous attempts to contain Darwin's Barberry.
Practicality of targeting beneficiaries	Beneficiaries are able to be targeted through the General Rate.
Practicality of targeting exacerbators	Location of Darwin's Barberry can be established through an inspection programme. Therefore exacerbators are able to be targeted. Those planting or dumping Darwin's Barberry are harder to identify and cannot be effectively targeted.
Administrative efficiency	General Rate is highly efficient for collecting community benefits related to biodiversity.
Security	Rating mechanisms are generally secure.
Fairness	Charges relate directly to benefits. Fairness is a politically determined judgement.
Reasonable	Costs of the programme would be high if universal control required. This suggests site led management is likely to be most appropriate.
Parties bearing indirect costs	No indirect costs are expected.
Transitional cost allocation arrangements	Programmes for Darwin's Barberry control have been established for a number of years. No transitional mechanisms are likely to be required.
Mechanisms available	General Rate, targeted rate (rural properties) and direct charges are the most readily available mechansisms. Levies are expensive to establish and administer.

23.4.3 Proposed allocation of costs

The primary beneficiaries of the management of Darwin's Barberry are the wider community. With very limited production benefits, the analysis suggests that the majority of the costs should be borne through the General Rate. The recommended funding therefore suggests that exacerbators should be targeted only to prevent spread where adjacent high value land is being kept clear. The recommended funding approach is:

- Inspection and monitoring costs – 100% General Rate
- Control in high value sites – 100% General Rate
- Control to prevent spread – 100% land holders as exacerbators where this is reasonable.

24 Gorse

24.1 Description

Gorse is an erect shrub growing to 5 m in height that was introduced to Canterbury for use as a fencing shrub and for shelter. Gorse is widespread in Canterbury, and causes loss of production by excluding stock and displacing pasture. Gorse may also increase costs for establishment of forestry plantings, and tends to be a fire hazard. Gorse is considered a good nursery plant for the regeneration of native forest where a suitable native seed source is available.

24.2 Proposed Plan

ECan is proposing that Gorse is controlled through the Sustained Control objective described in Section 1(b) of the NPD.

24.3 NPD Section 6 Assessment

24.3.1 Level of analysis

The assessed level of analysis for Gorse under the requirements of the NPD and using the Guidance approach is Level 2. The detail of the requirement for assessment is shown in Appendix B.

24.3.2 Impacts of Gorse

Gorse has the potential to cause loss of production from pastoral agriculture in hill and high country.

24.3.3 Benefits for management of Gorse

The benefits from Gorse management are the prevention of loss of production from pastoral agriculture in hill country and prevention of control costs. The costs of lost production and control costs if allowed to spread are NPV(6%) $948,750,000.

24.3.4 Costs of Gorse Plan

The plan will incur costs of control, inspection, and monitoring. These are $348,500 annually for the plan option. Costs for all three options considered are an NPV(6%) of $6,000,000 for Sustained Control, NPV(6%) $116,000,000 for Progressive Containment, and NPV(6%) $275,000,000 for Eradication (which has a shorter time frame).

24.3.5 Risks of Gorse Plan

Technical and operational risks: There is a long history of attempts to control Gorse, with little evident impact on a widespread basis. The technical risks of preventing spread for a well established and widespread plant are considerable.

Implementation and compliance: There is a long history of regulated Gorse control with widespread non-compliance. The implementation and compliance risks are substantial and the likelihood of additional control beyond the Do Nothing scenario in areas where it is already present are low.

Other legislative risks: None known

Public or political concerns: High cost and widespread nature of Gorse.

Other risks: None known

24.3.6 Net Benefit and risk adjustment

The analysis produces an estimate of the total costs and benefits of the different options for the plan, as shown in Table 118 below. In terms of those alternatives considered, the Sustained Control option has the highest net value. The sensitivity of this conclusion to changes in various input parameters is shown in Table 119 below which suggests that the conclusion is robust to changes in single assumptions.

These factors suggest that the Sustained Control option is favoured as producing the highest net benefit if the assumptions made in this analysis are considered reasonable, provided the plan is able to prevent spread.

Table 118: Outcomes of analysis of costs and benefits for Gorse

Plan	Total control costs and lost production PV(6%)	Net Benefit of plan NPV(6%)	Risk adjusted net benefit of plan NPV(6%)
Do Nothing	$1,556,000,000		
Eradication	$3,534,000,000	$-1,977,660 ,000	$-226,810,000
Progressive containment	$1,433,000,000	$123,570,000	$-67,990,000
Sustained Control	$605,000,000	$950,940,000	$42,050,000

Table 119: Impact of sensitivity testing on highest value option

Sensitivity test	Highest value option (risk adjusted)
Base net benefit	Sustained Control
Time to full occupation 50% of base	Sustained Control
Time to full occupation 150% of base	Sustained Control
Distance of spread 50% of base	Sustained Control
Distance of spread 200% of base	Sustained Control
Cost of control +20% from base	Sustained Control
Cost of control -20% from base	Sustained Control
Loss of production impacts -20% from base	Sustained Control
Loss of production impacts +20% from base	Sustained Control
Discount rate 4%	Sustained Control
Discount rate 8%	Sustained Control

24.4 NPD Section 7 - Allocation of Costs and Benefits

24.4.1 Beneficiaries, exacerbators and costs of proposed plan for control of Gorse

The beneficiaries and exacerbators of the plan are:

- Beneficiaries: Rural community from prevention of spread and production benefits.
- Active exacerbators: Any persons transporting Gorse into or around the region.
- Passive exacerbators: Any persons with Gorse on their property not undertaking control.

The direct and indirect costs associated with the plan are shown below in Table 120 and Table 121.

Table 120: Direct and indirect costs of plan for Gorse

Plan option	Control costs land holders (PV (6%))	Inspection and monitoring costs (PV (6%))
Sustained Control	$345,000,000	$6,000,000
Progressive containment	$1,310,000,000	$116,000,000
Eradication	$3,259,000,000	$275,000,000

Table 121: Benefits and costs of plan for Gorse that accrue to different beneficiaries and exacerbators

Plan option	Benefits for those currently infested (PV (6%))	Benefits for those not currently infested (PV (6%))	Costs for exacerbators (PV (6%))
Sustained Control	$-18,000,000	$975,000,000	$345,000,000
Progressive containment	$-735,000,000	$975,000,000	$1,310,000,000
Eradication	$-2,680,000,000	$975,000,000	$3,259,000,000

24.4.2 Matters for consideration in allocation of costs

The matters for consideration are spelt out in Section 7(2)(d) of the NPD, and the analysis for each of these matters is shown in Table 32 below.

Table 122: Matters for consideration in allocating costs for proposed Gorse plan

Legislative rights and responsibilities	None known.
Management objectives	Sustained Control.
Stage of infestation	Widespread.
Most effective control agents	Land holders.
Urgency	Very low - well established and widespread.
Efficiency and effectiveness	The effectiveness of a Sustained Control plan is likely to be low, given that past intensive control efforts appear to have had little impact on spread. The efficiency of requiring land holders to control in uneconomic circumstances is also likely to be high.
Practicality of targeting beneficiaries	Beneficiaries are widespread throughout the region, although largely related to pastoral agriculture.
Practicality of targeting exacerbators	Location of gorse can be established through an inspection programme. Therefore exacerbators are able to be targeted.
Administrative efficiency	Targeted rural rate is appropriate and efficient for benefits to pastoral agriculture.
Security	Rating mechanisms are generally secure.
Fairness	Charges relate directly to benefits or exacerbators. Fairness is a politically determined judgement.
Reasonable	The costs of the programme are potentially high for some land holders with little benefit received.
Parties bearing indirect costs	No indirect costs are expected.
Transitional cost allocation arrangements	Programmes for gorse control have been established for a long period. No transitional mechanisms are likely to be required.
Mechanisms available	General Rate, targeted rate (rural properties) and direct charges are the most readily available mechanisms. Levies are expensive to establish and administer.

24.4.3 Proposed allocation of costs

The control of gorse primarily provides production benefits, and the prevention of any spread is of benefit to the rural land. Therefore, rural land holders should bear the majority of any costs. Because land holders are able to determine whether control is worthwhile on their own property, in the absence of any wider benefit the major gains will come from preventing spread. Therefore, the recommendations for funding are:

- Inspection and monitoring costs to prevent spread onto neighbouring properties – 100% targeted rate on productive land.
- Control costs to prevent spread – 100% land holders as exacerbators.

25 Nassella Tussock

25.1 Description

Nassella Tussock is a tall erect grass tussock, originally a native of South America, and probably introduced to New Zealand around the turn of the century. It grows to 1.5 - 2m tall and produces a large number of seeds from the first year of life. The seeds are spread by wind, animals, and water. Nassella Tussock is present in 400,000 ha of Canterbury distributed among 6 main areas including a large area (321,000 ha) in North Canterbury. Nassella Tussock is strongly invasive of most land at altitudes under 600m, although its invasiveness will be constrained by land use in the more productive land. It is estimated that 1.2 million ha in Canterbury could potentially be infested with Nassella Tussock. Nassella Tussock is strongly invasive of the semi-arid country and short tussock grasslands which will cause damage to conservation values in ecologically valuable areas.

25.2 Proposed Plan

ECan is proposing that Nassella Tussock is controlled through the Sustained Control objective described in Section 1(b) of the NPD.

25.3 NPD Section 6 Assessment

25.3.1 Level of analysis

The assessed level of analysis for Nassella Tussock under the requirements of the NPD and using the Guidance approach is Level 2. The detail of the requirement for assessment is shown in Appendix B.

25.3.2 Impacts of Nassella Tussock

Nassella Tussock has the potential to cause damage to pastoral agriculture through reduced pasture quality and animal intake, and damage to biodiversity through displacement of native tussock grassland.

25.3.3 Benefits for management of Nassella Tussock

The plan would prevent damage to pastoral agriculture through reduced pasture quality and animal intake, and damage to biodiversity through displacement of native tussock grassland. The costs of lost production and control costs if allowed to spread are NPV(6%) $263,000,000. There is also benefit from the prevention of any impacts to biodiversity on an area of 120,000 ha after 100 years if the pest is allowed to spread.

25.3.4 Costs of Nassella Tussock Plan

The plan will incur costs for inspection and monitoring. These are $767,583 annually for the plan option. Costs for all three options considered are an NPV of $13,000,000 for Sustained Control, NPV $242,000,000 for Progressive Containment, and NPV $605,000,000 for Eradication (which has a shorter time frame).

25.3.5 Risks of Nassella Tussock Plan

Technical and operational risks: Nassella Tussock has been controlled in Canterbury for over 30 years. The current programme appears to maintain populations at a stable level but is not making any gains in reducing population densities. It appears therefore that the technical risks of the proposed annual control are limited and it should maintain current

populations. The technical risks of attempting to reduce or eradicate populations are considerable given its widespread nature and lack of success in the past.

Implementation and compliance: The move from an eradication or reduction objective to Sustained Control brings risks of lower compliance if land holders no longer consider Nassella control to be a high priority. The risk is greatest with property management changes and will be mitigated by the Council undertaking education, inspeciton, and an enforcement regime.

Other legislative risks: None known

Public or political concerns: Some concern with the movement from eradication to Sustained Control as an objective.

Other risks: None known

25.3.6 Net Benefit and risk adjustment

The analysis produces an estimate of the total costs and benefits of the different options for the plan, as shown in Table 123 below. In terms of those alternatives considered, the Sustained Control option has the highest net value. The sensitivity of this conclusion to changes in various input parameters is shown in Table 124 below which suggests the analysis is robust to changes in single assumptions. In addition to the quantified costs and benefits there are potential benefits associated with preventing damage to biodiversity on 122,000 ha, and intergenerational implications that should be taken into account.

These factors suggest that the Sustained Control option is strongly favoured as producing the highest net benefit if the assumptions made in this analysis are considered reasonable.

Table 123: Outcomes of analysis of costs and benefits for Nassella Tussock

Plan	Total control costs and lost production PV(6%)	Net Benefit of plan NPV(6%)	Risk adjusted net benefit of plan NPV(6%)
Do Nothing	$263,000,000		
Eradication	$762,000,000	$-498,610,000	$-481,040,000
Progressive containment	$361,000,000	$-97,970,000	$-129,730,000
Sustained Control	$88,000,000	$175,670,000	$98,080,000

Table 124: Impact of sensitivity testing on highest value option

Sensitivity test	Highest value option (risk adjusted)
Base net benefit	Sustained Control
Time to full occupation 50% of base	Sustained Control
Time to full occupation 150% of base	Sustained Control
Distance of spread 50% of base	Sustained Control
Distance of spread 200% of base	Sustained Control
Cost of control +20% from base	Sustained Control
Cost of control -20% from base	Sustained Control
Loss of production impacts -20% from base	Sustained Control
Loss of production impacts +20% from base	Sustained Control
Discount rate 4%	Sustained Control
Discount rate 8%	Sustained Control

25.4 NPD Section 7 - Allocation of Costs and Benefits

25.4.1 Beneficiaries, exacerbators and costs of proposed plan for control of Nassella Tussock

The beneficiaries and exacerbators of the plan are:

- Beneficiaries: Rural community from prevention of spread and production benefits. Wider community for any biodiversity benefits from protecting tussock grasslands.
- Active exacerbators: Any persons transporting Nassella Tussock into or around the region.
- Passive exacerbators: Any persons with Nassella Tussock on their property not undertaking control.

The direct and indirect costs associated with the plan are shown below in Table 125 and Table 126.

Table 125: Direct and indirect costs of plan for Nassella Tussock

Plan option	Control costs land holders (PV (6%))	Inspection and monitoring costs (PV (6%))
Sustained Control	$60,000,000	$13,000,000
Progressive containment	$119,000,000	$242,000,000
Eradication	$157,000,000	$605,000,000

Table 126: Benefits and costs of plan for Nassella Tussock that accrue to different beneficiaries and exacerbators

Plan option	Benefits for those currently infested (PV (6%))	Benefits for those not currently infested (PV (6%))	Required benefit for community for biodiversity and ecological benefits in order for option to be positive	Costs for exacerbators (PV (6%))
Sustained Control	$8,490,000	$180,000,000		$60,000,000
Progressive containment	$-36,000,000	$180,000,000	$129,730,000	$119,000,000
Eradication	$-74,000,000	$180,000,000	$481,040,000	$157,000,000

25.4.2 Matters for consideration in allocation of costs

The matters for consideration are spelt out in Section 7(2)(d) of the NPD, and the analysis for each of these matters is shown in Table 127 below.

Table 127: Matters for consideration in allocating costs for proposed Nassella Tussock plan

Legislative rights and responsibilities	None known.
Management objectives	Sustained Control.
Stage of infestation	Expanding but stable under current control approaches.
Most effective control agents	Requires detailed inspection and grubbing to maintain populations at low levels. Nassella is very difficult to detect at a young stage and requires specialist expertise to identify it.
Urgency	Moderate, as it is already established and unlikely to be eradicated in the near future. However, it has not occupied its full habitat and is likely to spread further in the absence of control.
Efficiency and effectiveness	The efficiency of the programme has been demonstrated by detailed modelling (James et al 2011). Effectiveness of sustaining current population levels is evidenced by stable populations under current control approach.
Practicality of targeting beneficiaries	Beneficiaries are widespread throughout the region, although largely related to pastoral agriculture. Some benefits to the wider community from biodiversity gains.
Practicality of targeting exacerbators	Location of mature Nassella can be established through inspection although it can be difficult to identify immature plants. It can therefore be difficult to target exacerbators in a timely manner.
Administrative efficiency	A rating approach for inspection and monitoring is very efficient, and targeting exacerbators for control costs is likely to ensure greater effort in ensuring plants have been identified and are controlled.
Security	Rating mechanisms are generally secure.
Fairness	Charges relate directly to benefits or exacerbators. Fairness is a politically determined judgement.
Reasonable	The costs of the programme are reasonably high and ongoing for some land holders. However, some immediate benefit is received in terms of saved production losses.
Parties bearing indirect costs	No indirect costs are expected.
Transitional cost allocation arrangements	Programmes for Nassella control have been established for a long period. No transitional mechanisms are likely to be required.
Mechanisms available	General Rate, targeted rate (rural properties) and direct charges are the most readily available mechanisms. Levies are expensive to establish and administer.

25.4.3 Proposed allocation of costs

Nassella Tussock is a widespread plant pest with primarily production effects. However, there are some biodiversity effects as it is capable of displacing native vegetation. Land holder control is well established and the only feasible mechanism, and is one that is likely to result in efficiency gains. Therefore, the recommended funding approach is:

- Inspection and monitoring costs – targeted rural rate 75% on the benefiting area, General Rate 25% for biodiversity benefits.
- Control costs – 100% land holder control as exacerbators.

26 Purple Loosestrife

26.1 Description

Purple Loosestrife (*Lythrum salicaria*) is an erect herb that grows to 1-2 m. It invades damp ground and shallow water, and overtops native species in this habitat. It tolerates hot and cold conditions and its seed is spread by movement of water, livestock, and hay. It forms impenetrable stands and damages wetlands, marginal habitats and food sources, and causes blockages and flooding. It also excludes desirable species from a productive perspective. It is present in only limited areas (but in a large number of sites) in the wild in Canterbury, but is likely to be in a number of gardens as it was sold as a garden plant until recently.

26.2 Proposed Plan

ECan is proposing that Purple Loosestrife is controlled through the Sustained Control objective described in Section 1(b) of the NPD.

26.3 NPD Section 6 Assessment

26.3.1 Level of analysis

The assessed level of analysis for Purple Loosestrife under the requirements of the NPD and using the Guidance approach is Level 1. The detail of the requirement for assessment is shown in Appendix B.

26.3.2 Impacts of Purple Loosestrife

Purple Loosestrife has the potential to cause damage to pastoral production and impacts on biodiversity.

26.3.3 Benefits for management of Purple Loosestrife

Prevention of damage to biodiversity and damage to production values. The costs of lost production and control costs if allowed to spread are NPV(6%) $3,220,000. There is also the prevention of any impacts to biodiversity on an area of 22,500 ha after 100 years if the pest is allowed to spread which would cost $22,500,000 to return to the current state.

26.3.4 Costs of Purple Loosestrife Plan

The plan will incur costs of inspection and monitoring. These are $10,000 annually for the plan option. Costs for all three options considered are an NPV of $200,000 for Sustained Control, NPV $3,000,000 for Progressive Containment, and NPV $8,000,000 for Eradication (which has a shorter time frame).

26.3.5 Risks of Purple Loosestrife Plan

Technical and operational risks: Containment and control of any pest is difficult, but assisted by its limited occurrence in Canterbury.

Implementation and compliance: Purple Loosestrife is an ornamental garden plant and there are risks associated with escape or dumping from gardens.

Other legislative risks: None known

Public or political concerns: None known

Other risks: None known

Other risks: None known.

26.3.6 Net Benefit and risk adjustment

The analysis produces an estimate of the total costs and benefits of the different options for the plan, as shown in Table 128 below. In terms of those alternatives considered, the Sustained Control option has the highest net value. The sensitivity of this conclusion to changes in various input parameters is shown in Table 129 below which suggests that it is robust to changes in a number of single parameters. In addition to the quantified costs and benefits there are potential benefits associated with preventing damage to biodiversity on 22,500 ha, and intergenerational implications that should be taken into account.

These factors suggest that the Sustained Control option is favoured as producing the highest net benefit if the assumptions made in this analysis are considered reasonable.

Table 128: Outcomes of analysis of costs and benefits for Purple Loosestrife

Plan	Total control costs and lost production PV(6%)	Net Benefit of plan NPV(6%)	Risk adjusted net benefit of plan NPV(6%)
Do Nothing	$3,000,000		
Eradication	$8,000,000	$-4,500,000	$-7,710,000
Progressive containment	$3,000,000	$60,000	$-960,000
Sustained Control	$200,000	$3,220,000	$1,860,000

Table 129: Impact of sensitivity testing on highest value option

Sensitivity test	Highest value option (risk adjusted)
Base net benefit	Sustained Control
Time to full occupation 50% of base	Sustained Control
Time to full occupation 150% of base	Sustained Control
Distance of spread 50% of base	Sustained Control
Distance of spread 200% of base	Sustained Control
Cost of control +20% from base	Sustained Control
Cost of control -20% from base	Sustained Control
Loss of production impacts -20% from base	Sustained Control
Loss of production impacts +20% from base	Sustained Control
Discount rate 4%	Sustained Control
Discount rate 8%	Sustained Control

26.4 NPD Section 7 - Allocation of Costs and Benefits

26.4.1 Beneficiaries, exacerbators and costs of proposed plan for control of Purple Loosestrife

The beneficiaries and exacerbators of the plan are:

- Beneficiaries: Wider community from biodiversity benefits.
- Active exacerbators: Any persons transporting Purple Loosestrife into or around the region, or selling it for garden plants.
- Passive exacerbators: Any persons with Purple Loosestrife on their property not undertaking control.

The direct and indirect costs associated with the plan are shown below in Table 130 and Table 131.

Table 130: Direct and indirect costs of plan for Purple Loosestrife

Plan option	Control costs land holders (PV (6%))	Inspection and monitoring costs (PV (6%))
Sustained Control	$100	$200,000
Progressive containment	$300	$3,000,000
Eradication	$700	$8,000,000

Table 131: Benefits and costs of plan for Purple Loosestrife that accrue to different beneficiaries and exacerbators

Plan option	Benefits for those currently infested (PV (6%))	Benefits for those not currently infested (PV (6%))	Costs for exacerbators (PV (6%))
Sustained Control	$-129	$3,000,000	$100
Progressive containment	$-286	$3,000,000	$300
Eradication	$-703	$3,000,000	$700

26.4.2 Matters for consideration in allocation of costs

The matters for consideration are spelt out in Section 7(2)(d) of the NPD, and the analysis for each of these matters is shown in Table 132 below.

Table 132: Matters for consideration in allocating costs for proposed Purple Loosestrife plan

Legislative rights and responsibilities	None known.
Management objectives	Sustained Control.
Stage of infestation	Early.
Most effective control agents	Control is likely best underaken by the Council in order to prevent spread, and the location of Purple Loosestrife in waterways means that land holders may not always be identifiable.
Urgency	Reasonable urgency if spread is to be prevented.
Efficiency and effectiveness	Control at an early stage is likely to be more efficient than when it is better established.
Practicality of targeting beneficiaries	Wider community can be targeted through General Rate for biodiversity benefits and through a rate on productive land for agricultural benefits.
Practicality of targeting exacerbators	Locations are limited and known and exacerbators can be targeted.
Administrative efficiency	Exacerbator control requires inspection and enforcement, while General Rate would have greater administrative efficiency.
Security	Exacerbator control is difficult with a small scale pest that is intended to be contained, because highly effective control is required. Rating mechanisms are generally very secure.
Fairness	Charges relate directly to benefits or exacerbators. Fairness is a politically determined judgement.
Reasonable	Costs are likely to be significant on some properties if eradication is to be achieved.
Parties bearing indirect costs	None known.
Transitional cost allocation arrangements	None required.
Mechanisms available	General Rate, targeted rate (rural properties) and direct charges are the most readily available mechanisms. Levies are expensive to establish and administer.

26.4.3 Proposed allocation of costs

The small scale nature of the pest and the need to contain its spread mean that rate funding for control and inspection is likely to be required. The recommended approach for funding therefore is:

- Inspection and monitoring costs – General Rate 75%, targeted rate on productive land 25%.
- Control costs – General Rate 75%, targeted rate on productive land 25%.

27 Wilding Conifers

27.1 Proposed programme

ECan is proposing that Wilding Conifers are controlled through the site led objective described in Section 1(b) the NPD. This analysis treats them as though they were managed under a Sustained Control regime. The specific species to be controlled have not been identified at the time of this analysis.

27.2 NPD Section 6 Assessment

27.2.1 Level of analysis

The assessed level of analysis for Wilding Conifers under the requirements of the NPD and using the Guidance approach is Level 3. The detail of the requirement for assessment is shown in Appendix B.

27.2.2 Method

The method is adapted from Velarde, Paul, Monge, & Yao, (2015) with that publication providing assumptions and other information. This information was combined with the plant pest spread model to estimate a combination of area infested and occupation, which was not estimated directly by Velarde et al. (2015) paper. This section should be read in conjunction with Section 5 which describes the plant pest model in greater detail. Key assumptions are detailed below.

Rate of spread – the rate of spread for Wilding Conifers was adapted from Velarde *et al.* (2015) by converting the formula they used for estimating the national rate of spread to account for the estimated current area infested in Canterbury (466,000 ha). This gave a formula of:

$$Area_t = 6.6262E - 10 \times t^{7.192}$$

Where Area = area in ha, t = time since 1900 when it is assumed that wildings first occurred in the region.

This formula was then used to estimate the time since 1900 when the full habitat was occupied, which is the year 2045, or approximately 30 years from now. The annual distance of spread was then adjusted in the pest spread model through trial and error so that the year when the full habitat was infested with some level of wildings occurred in 2045, which is a spread distance of 340m/year. This approach allows the model to replicate the approach taken by the Velarde *et al.*(2015) paper of increasing each infestation in concentric circles with a given distance of spread. The approach here is likely to produce a lower estimate of spread because a mathematical rather than GIS based approach is used in the model, which means that interaction between different infestations sites is not taken into account. However, because the year in which the full habitat is infested is unaltered, the difference in costs should not be significant and will be within the error bounds for the study.

Estimate of productive land affected – an estimate of the proportion of land affected was made based on the proportion of infested land in public and private ownership currently from Velarde *et al.*(2015). This gave an estimate of 46% of land in private ownership, and this was

cross checked by estimating the proportion of Class 6 and 7 in sheep and beef or deer farming from ECan data on Land use Capability (LUC) and Agribase data on land use, which gave an estimate of 54% of land in sheep and beef or other similar productive land use. The figure of 46% was considered adequate for the purposes of the study.

Estimating the impact on water yield – the Velarde *et al.*(2015) report uses an estimate of 46% reduction on water yield from wilding infested catchments with complete cover. They multiply this by the proportion of the region in wildings, and use GDP as a proxy for the impact on irrigation. It is likely that the impacts on water yield, hydro generation, and irrigation in Canterbury are highly complex because the impacts will depend on the source catchment (alpine river, foothills river, lowland streams, and groundwater), since each of these has different susceptibility to wildings. They will also be affected by the timing of the water yield reduction and the location of the wilding populations.

Nevertheless the approach adopted in Velarde *et al.*(2015) is considered sufficient for the purposes of this study. The reduction in water yield is, however, assumed to be 20%, which is less than half the assumption used in the Velarde *et al.* (2015) report. This is to allow for potential differences in land type and climatic patterns between the study sites where the yield measurements were made and the situation that exists in Canterbury. It also ensures that the estimate is conservative in relation to the impacts on electricity and irrigation. The assumption is that there is a linear relationship between the reduction in water yield and both hydro and irrigation impacts.

Table 133: Estimated area of land in wilding prone land

	LUC Class 6 and 7 (ha)	All land (ha)	Proportion Class 6 and 7
Canterbury area	1,613,328	3,672,136	44%
Mackenzie/Waitaki	577,461	997,988	58%
Proportion	36%	27%	

Hydro impacts are only calculated for the Waitaki catchment which is the largest hydro scheme in the region and is the only one where all of the catchment water is directed through the hydro scheme. This provides a greater degree of certainty that the reduction in water will cause a reduction in hydro generation. The hydro impact in the Waitaki is estimated by calculating the share of the catchment that is vulnerable to wilding pines (58%, see Table 133), and multiplying this proportion by the total estimated gross revenue of the catchment (less spillage) from Taylor *et al.* (2015) of $660 million per annum (allowing for 6% spillage and $85/MWh). This gives an estimate of $66.28/ha/annum of wilding prone land that is occupied. The hydro impacts for land occupied in the model are assumed to occur in proportion to the Waitaki share of wilding prone land (36% of Class 6 and 7 land is in the Waitaki), giving an average loss per ha occupied by wildings in Canterbury of $23.73/ha/annum.

The impact on irrigation for the catchment is estimated based on the returns for irrigation in the Waitaki catchment (Harris, 2014) and the Beef and Lamb NZ Class 6 land as an estimate of the dryland returns. The irrigated areas in Waitaki were estimated from the PC3 hearing data, and in the rest of Canterbury from Dommisse (2005), adjusted for known irrigation scheme development since that time. The impact of wildings is assumed to occur only on Class 6 and 7 land and only in proportion to the land occupied by wildings. The irrigation

impact is applied to the Waitaki and the rest of Canterbury separately, with the total impact estimated as a weighted average of the two at $20.34/ha occupied by wildings.

Biodiversity benefits - the biodiversity benefits in the Velarde et al. (2015) paper were estimated using a choice modelling experiment for three native species – *Hebe cupressoides*, *Brachasips robustus*, and *Galaxias macronasus* (Kerr & Sharp, 2007). In a study of household preferences on the impact of wilding pines, they suggest reasonable mid-range values for protection of these species are of $70/household per annum, $120/household per annum and $140/household per annum, giving an aggregate $330/household/annum. Multiplied by the 208,000 estimated households in Canterbury (Statistics NZ privately occupied dwellings) this gives an annual cost of $69 million per annum. It is assumed that this benefit is all lost when wildings occupy their full potential habitat which gives an average cost of $35.5/ha/annum of occupied land .

Non quantified costs. There are a range of costs that have not been quantified here. These include:

- Reduction in tourist visits from reduced amenity values.
- Impact on recreational use of water, through reduction in amenity values and desirability of lcoations.
- Drinking water supply from reduction in available water.
- Landscape values, although this is dependent on the location, scale and density of wilding infestations.
- Cultural and historic values by impact on historic buildings and structures, and earthworks and *urupa and* grave sites from conifer trees and their roots.
- Increased fire risk from longer lasting fires and fires that are more expensive to control from the need for chemicals, heavier equipment, and the more frequent need for the use of aircraft. They may also increase insurance premiums and require maintenance in the form of firebreaks and access control.
- Honey production from the replacement of manuka shrublands and shading of flowering species. These impacts have not been costed.
- Carbon sequestration – the Wilding Conifers accumulate significant levels of carbon which potentially has a market value depending on their status and tradeability.
- Erosion control in unstable land.

Many of these are not realistically quantifiable within the scope of this study. The Valerde *et al.*(2015) report estimates the impact on international tourism, but this is not considered appropriate for a regional scale study due to a lack of any detailed information on tourism sites liekly to be affected in Canterbury. Carbon sequestration values are potentially quantifiable based on the value of carbon (~$18/NZU August 2016) and estimates of the amount of carbon sequestered per ha at maturity for plantation forestry. However, this report follows the guidance of Valerde *et al.*(2015) who consider the impacts are not able to be quantified because of uncertainty about the status of wilding forests in the Emissions Trading Scheme. It should be noted that at current carbon prices the gains from carbon sequestration are

potentially very significant if the full potentially habitable area were infested with dense stands of wildings.

27.2.3 Impacts of Wilding Conifers

Wilding Conifers have the potential to cause loss of production on high country properties, and significant impacts on biodiversity in tussock grasslands.

27.2.4 Benefits for management of Wilding Conifers

Prevention of loss of production on high country properties, and significant impacts on biodiversity in tussock grasslands. Wildings also cause losses for:

- Indigenous biodiversity from replacement of habitat and shading.
- Hydro generation through reduction of available water.
- Irrigation through a reduction in available water.
- Reduction in tourist visits from reduced amenity values.
- Impact on recreational use of water, through reduction in amenity values and desirability of lcoations.
- Drinking water supply from reduction in available water.
- Landscape values, although this is dependent on the location, scale and density of wilding infestations.
- Cultural and historic values by impact on historic buildings and structures, and earthworks and urupa and grave sites from conifer trees and their roots.
- Increased fire risk from longer lasting fires and fires that are more expensive to control from the need for chemicals, heavier equipment, and the more frequent need for the use of aircraft. They may also increase insurance premiums and require maintenance in the form of firebreaks and access control.
- Honey production from replacement of manuka shrublands and shading of flowering species. These impacts have not been costed.

Allowing wilding pines to spread will cause an additional NPV(6%) $326.2 million in costs for control, lost production, reduced hydrogeneration, reduced irrigation, and loss of biodiversity.

27.2.5 Costs of Wilding Conifers Programme

The plan will incur costs of control, inspection, and monitoring. These are $350,000 annually for the plan option. Costs for all three options considered are an NPV(6%) of $6,000,000 for Sustained Control, NPV $116,000,000 for Progressive Containment, and NPV $276,000,000 for Eradication. In addition, the removal of wildings will incur costs from reduced:

- Carbon sequestration – the Wilding Conifers accumulate significant levels of carbon which potentially has a market value depending on their status and tradeability.
- Erosion control in unstable land.

27.2.6 Risks of Wilding Conifers Programme

Technical and operational risks: There are significant technical and operational risks with the control of wildings. They tend to occur across large areas of the landscape, and require individual control of scattered plants in order to halt spread. Wildings can occur in difficult to access locations and there are no reliable chemical control agents.

Implementation and compliance: There are significant risks to compliance with the plan because of the substantial costs that can be involved, coupled with the low productive value of the land. Furthermore, conifers are also planted for production purposes, and plantation forests do not always have associated plans for the management of wilding spread. This has created some opposition amongst land holders to requirements to manage wildings that impose costs on their operations.

Other legislative risks: Some parties will have a consented right to grow conifer species, which may conflict with the requirements of the management plan. The status of wildings within the Emissions Trading Scheme may create risks for removing pre 1990s wilding stands, or by creating benefit from increasing infestations of wildings.

Public or political concerns: Wilding control in the high country is an emotive subject, with potentially high costs for land holders and iconic landscape values.

Other risks: None known

27.2.7 Net Benefit and risk adjustment

The analysis produces an estimate of the total costs and benefits of the different options for the programme, as shown in Table 134, Table 135 and Table 136 below. In terms of those alternatives considered, the Progressive Containment option has the highest net benefit, but the Sustained Control option has the highest risk adjusted net value. The potential benefits associated with preventing damage to biodiversity on 1,349,400 ha of land are included in this analysis based on a non-market valuation study of endangered species in the high country. It should be noted that the non-market values estimated in that study may not cover the full range of values that are associated with biodiversity.

The difference negative risk adjusted value associated with the Progressive Containment strategy is equivalent to a NPV of $64/ha. Therefore if the council believes that the other non quantified benefits associated with wilding conifer control described in Section 27.2.2 exceed the risk adjusted NPV of $64/ha (~$4/ha/annum) then the Progressive control option may result in a positive net benefit. In order for the Progressive Control option to be preferred over the Sustained control option in risk adjusted terms the value would need to exceed $560/ha or $34/ha/annum, which is approximately the value ($35/ha/annum) that was applied to biodiversity benefits in the analysis. Because the analysis only takes a regional viewpoint, national benefits and costs have been excluded. However there are additional national benefits that will arise from Wilding Conifer control, and there will also be an input of national funding into reduction of areas infested by wilding conifers that will reduce the regional costs. These factors makes it likely that the benefits of the Progressive Containment strategy would exceed those of Sustained Control were these national implications included.

There are a range of other values that have not been covered by this study, including landscape values, impacts on rural firefighting costs etc., as detailed in Section 27.2.4 and 27.2.5. There are also intergenerational implications that should be taken into account because of the enormous cost of returning any infested land to the current state.

These factors suggest that the Sustained Control option is favoured as producing the highest net benefit if the assumptions made in this analysis are considered reasonable and if the Council is satisfied about the value of biodiversity. However, it should be noted that the conclusion should have a disclaimer regarding the non-inclusion of other non-market benefits and costs, because, for example: the returns from carbon sequestration could readily outweigh the net benefits calculated here.

Table 134: Scenario outcomes by item for Wilding Conifers

	Scenario outcome ($ million NPV)			
Item	**Do Nothing**	**Sustained Control**	**Progressive containment**	**Eradication**
Cost of control	$40.5	$38.8	$147.3	$366.4
Cost of lost production	$150.8	$116.8	$0.2	$0.0
Inspection, monitoring etc.	$0.0	$5.8	$116.3	$275.8
Hydro losses	$136.6	$48.3	$0.0	$0.0
Irrigation losses	$117.1	$41.4	$0.0	$0.0
Biodiversity losses	$204.4	$72.2	$0.0	$0.0
Total	**$649.4**	**$323.3**	**$263.8**	**$642.2**

Table 135: Net benefit for plan option by item for Wilding Conifers

	Net Benefit ($ million NPV)		
Item	**Sustained Control**	**Progressive containment**	**Eradication**
Cost of control	$1.8	-$106.8	-$325.8
Cost of lost production	$34.0	$150.6	$150.8
Inspection, monitoring etc.	-$5.8	-$116.3	-$275.8
Hydro benefits	$88.3	$136.6	$136.6
Irrigation benefits	$75.7	$117.1	$117.1
Biodiversity benefits	$132.1	$204.4	$204.4
Total	**$326.2**	**$385.6**	**$7.2**

Table 136: Outcomes of analysis of costs and benefits for Wilding Conifers

Programme	**Risk adjusted net benefit (NPV(6%) $ million**
Eradication	$-257.11
Progressive Containment	$-98.99
Sustained Control	$5.32

27.3 NPD Section 7 - Allocation of Costs and Benefits

27.3.1 Beneficiaries, exacerbators and costs of proposed programme for control of Wilding Conifers

The beneficiaries and exacerbators of the programme are:

- Beneficiaries: Wider community from prevention of impacts to biodiversity. Land holders from protection of production values.
- Active exacerbators: Any persons transporting Wilding Conifers into or around the region.
- Passive exacerbators: Any persons with Wilding Conifers on their property not undertaking control.

The direct and indirect costs associated with the programme are shown below in Table 137 and Table 138.

Table 137: Direct and indirect costs of programme for Wilding Conifers

Plan option	Control costs land holders (PV (6%))	Inspection and monitoring costs (PV (6%))
Sustained Control	$39,000,000	$6,000,000
Progressive Containment	$147,000,000	$116,000,000
Eradication	$366,000,000	$276,000,000

Table 138: Benefits and costs of programme for Wilding Conifers that accrue to different beneficiaries and exacerbators

Programme option	Benefits for those currently infested (PV (6%))	Benefits for those not currently infested (PV (6%))	Costs for exacerbators (PV (6%))
Sustained Control	$46,830,000	$447,000,000	$39,000,000
Progressive Containment	$54,900,000	$447,000,000	$147,000,000
Eradication	$-164,000,000	$447,000,000	$366,000,000

Table 139: Estimate of share of net benefit by benefit type for Sustained Control option (% of total net benefit)

Item	Share of net benefit for Sustained Control
Cost of control	1%
Cost of lost production	10%

Inspection, monitoring etc.	-2%
Hydro benefits	27%
Irrigation benefits	23%
Biodiversity benefits	41%
Total	100%

27.3.2 Matters for consideration in allocation of costs

The matters for consideration are spelt out in Section 7(2)(d) of the NPD, and the analysis for each of these matters is shown in Table 140 below.

Table 140: Matters for consideration in allocating costs for proposed Wilding Conifers programme

Legislative rights and responsibilities	None known.
Management objectives	Sustained Control.
Stage of infestation	Widespread but continuing to expand in suitable habitats in the high country.
Most effective control agents	The areas that wildings occupy are generally either not grazed, or grazed at low densities. The most effective control agents will depend on the circumstances but will involve a mixture and land holder and external agency control.
Urgency	There is moderate urgency to control wildings as the opportunity to prevent widespread occupation of high country habitats is limited.
Efficiency and effectiveness	The most efficient approach is likely to be requiring land holder control since they have management control over the land being infested. However, this is not always effective if the control required is widespread, diffficult, and expensive. In those situations it may be more effective to undertake control directly, and require land holders to maintain the pest infestations at low levels. This also ensures an incentive to control seed sources within the property.
Practicality of targeting beneficiaries	The main beneficiaries are the wider community for biodiversity benefits and this group can be readily target through the General Rate. Land holder benefits can be targeted through direct charges, and the rural community through a targeted rural rate. Levies or rates could be charged against hydro stations and for irrigated properties potentially affected by wilding spread.
Practicality of targeting exacerbators	Location of wildings can be established through an inspection programme or remote monitoring. Therefore exacerbators are able to be targeted.
Administrative efficiency	General Rate is highly efficient for collecting community benefits related to biodiversity. Rural rate can be targeted to collect benefits from preventing spread and damage to productive values. Targeting hyrdo generators and irrigated properties would be more problematic that a targeted rural rate and would require a higher standard of consultation and establishment of benefits.
Security	Rating mechanisms are generally secure.
Fairness	Charges relate directly to benefits or exacerbators. Fairness is a politically determined judgement.
Reasonable	The costs for wilding control can be extremely high for dense infestations, and typically the cost of control greatly outweighs any production benefits.
Parties bearing indirect costs	Wilding control can cause erosion and landscape impacts.
Transitional cost allocation arrangements	If land holder control is to be required then some transitional mechanisms will be required to ensure that the ongoing costs of control are manageable.
Mechanisms available	General Rate, targeted rate (rural properties) and direct charges are the most readily available mechansisms. Levies are expensive to establish and administer.

27.3.3 Proposed allocation of costs

The analysis in Table 139 suggests that the biodiversity benefits amount to 40% of the net benefit from the Sustained Control option, while lost production from wildings only represents 10% of the net benefit. Hydro benefits and benefits for irrigated land amount to 50% collectively.

The analysis therefore suggests that the cost of the programme should generally fall on parties other than the land holders with wildings and those protected from the spread of wildings. It may be possible to target hydro and irrigators separately, but from an administrative point of view it is likely to be simplest to source the benefits not directly related to production loss from the General Rate on capital value across all assets. Because both hydro and irrigation have greater assets values, they would pay a greater share of the General Rate than other asset classes, and the biodiversity benefits and other non-quantified benefits would be accounted for.

Land holder control (as exacerbators) has the potential to increase the effectiveness of control but it should be kept in mind that for large infestations on high country properties the costs of doing so would be unreasonably large. It is therefore recommended that the costs of large scale control programmes should be funded mostly from the General Rate in proportion to the relative share of the quantified benefits (90% non-productive, 10% productive).

The recommendation for funding is therefore:

- Inspection and monitoring costs: 100% General Rate.
- Control: General Rate 90%, 10% land holder contribution or direct control.

28 Knotweed

28.1 Description

Japanese Knotweed grows rapidly from an extensive fleshy underground root system, forming dense, long-lived thickets. It excludes other species and is spread through the movement of roots and shoots. It grows primarily in disturbed areas, roadsides and river banks. It can be difficult to eradicate

28.2 Proposed Programme

ECan is proposing that Knotweed is controlled through the Eradication objective described in Section 1(b) the NPD.

28.3 NPD Section 6 Assessment

28.3.1 Level of analysis

The assessed level of analysis for Knotweed under the requirements of the NPD and using the Guidance approach is Level 3. The detail of the requirement for assessment is shown in Appendix B.

28.3.2 Impacts of Knotweed

Knotweed has the potential to cause loss of amenity and biodiversity values in riparian margins and other disturbed areas.

28.3.3 Benefits for management of Knotweed

Prevention of damage to biodiversity and amenity values. Net benefits are NPV(6%) $6 million relative to the pest being kept at its current level from prevented cost of control. There is also the prevention of any impacts to biodiversity on an area of 30,000 ha after 100 years if the pest is allowed to spread.

28.3.4 Costs of Knotweed Programme

The plan will incur costs of control and monitoring. These are $12,000 annually for the programme option initially. Costs for all three options considered are an NPV(6%) of $70,000 for Sustained Control, NPV $100,000 for Progressive Containment, and NPV(6%) $100,000 for Eradication (which has a shorter time frame).

28.3.5 Risks of Knotweed Programme

Technical and operational risks: Control of Knotweed is very difficult, and requires intensive monitoring and management. The limited number of sites mitigates this risk.

Implementation and compliance: No implementation and compliance risks are expected given the limited number of sites and the fact that the Council will be undertaking control.

Other legislative risks: None known.

Public or political concerns: None known.

Other risks: None known.

28.3.6 Net Benefit and risk adjustment

The analysis produces an estimate of the total costs and benefits of the different options for the programme, as shown in Table 141 below. In terms of those alternatives considered, the Progressive Containment option has the highest net value. The sensitivity of this conclusion to changes in various input parameters is shown in Table 142 below, suggesting that either Progressive Containment or Eradication will produce a positive net benefit. Given that these two are likely to require similar actions on the ground, there is little practical difference. In addition to the positive quantified costs and benefits, there are potential benefits associated with preventing damage to biodiversity on 280 ha, and intergenerational implications that should be taken into account.

These factors suggest that the Progressive Containment option is strongly favoured as the producing the highest net benefit if the assumptions made in this analysis are considered reasonable.

Table 141: Outcomes of analysis of costs and benefits for Knotweed

Programme	Total NPV	Net Benefit of programme	Risk adjusted net benefit of plan NPV(6%)
Do Nothing	$6,220,000	$0	
Eradication	$70,000	$6,150,000	$2,980,000
Progressive Containment	$130,000	$6,090,000	$5,720,000
Sustained Control	$140,000	$6,080,000	$5,700,000

Table 142: Impact of sensitivity testing on highest value option

Sensitivity test	Highest value option (risk adjusted)
Base net benefit	Progressive Containment
Time to full occupation 50% of base	Progressive Containment
Time to full occupation 150% of base	Progressive Containment
Distance of spread 50% of base	Progressive Containment
Distance of spread 200% of base	Progressive Containment
Cost of control +20% from base	Progressive Containment
Cost of control -20% from base	Progressive Containment
Loss of production impacts -20% from base	Progressive Containment
Loss of production impacts +20% from base	Progressive Containment
Discount rate 4%	Eradication
Discount rate 8%	Progressive Containment

28.4 NPD Section 7 – Allocation of Costs and Benefits

28.4.1 Beneficiaries, exacerbators and costs of proposed programme for control of Knotweed

The beneficiaries and exacerbators of the programme are:

- Beneficiaries: Wider regional community from biodiversity and amenity benefits associated with the prevention of spread of Knotweed.
- Active exacerbators: Any persons transporting Knotweed into or around the region.
- Passive exacerbators: Any persons with Knotweed on their property not undertaking control.

The direct and indirect costs associated with the programme are shown below in Table 143 and Table 144.

Table 143: Direct and indirect costs of programme for Knotweed

Plan option	Control costs land holders (PV (6%))	Inspection and monitoring costs (PV (6%))
Sustained Control	$300	$70,000
Progressive Containment	$500	$100,000
Eradication	$900	$100,000

Table 144: Benefits and costs of programme for Knotweed that accrue to different beneficiaries and exacerbators

Programme option	Benefits for those currently infested (PV (6%))	Benefits for those not currently infested (PV (6%))	Costs for exacerbators (PV (6%))
Sustained Control	$-223	$6,000,000	$300
Progressive Containment	$-473	$6,000,000	$500
Eradication	$-909	$6,000,000	$900

28.4.2 Matters for consideration in allocation of costs

The matters for consideration are spelt out in Section 7(2)(d) of the NPD, and the analysis for each of these matters is shown in Table 145 below.

Table 145: Matters for consideration in allocating costs for proposed Knotweed programme

Legislative rights and responsibilities	None known.
Management objectives	Eradication.
Stage of infestation	Low infestation – there are only three known active sites in Canterbury.
Most effective control agents	It is likely that Council control will be required because of the technical difficulty of undertaking control.
Urgency	Very high if spread is to be prevented
Efficiency and effectiveness	Control at an early stage is likely to be more efficient than when it is better established.
Practicality of targeting beneficiaries	Wider community beneficiaries can be targeted through General Rate.
Practicality of targeting exacerbators	Exacerbators difficult to identify and target.
Administrative efficiency	General Rate is highly efficient for collecting community benefits related to biodiversity.
Security	Rating mechanisms are generally secure.
Fairness	Charges relate directly to benefits or exacerbators. Fairness is a politically determined judgement.
Reasonable	The costs for Council are not large compared with the overall budget for pest management.
Parties bearing indirect costs	There are potentially some costs for other parties associated with control being undertaken on properties – but these are not likely to be significant and no opposition from land holders has been experienced.
Transitional cost allocation arrangements	None required.
Mechanisms available	General Rate, targeted rate (rural properties) and direct charges are the most readily available mechanisms. Levies are expensive to establish and administer.

28.4.3 Proposed allocation of costs

General Rate is the most appropriate source of funds for control and inspection/monitoring, because the benefits are related to biodiversity and amenity values which are widespread across the community. There is no likely efficiency gain from targeting exacerbators.

29 Old Mans Beard

29.1 Description

Old Man's Beard (*Clematis vitalba)* is a climbing and creeping vine which is considered a danger because of its potential to smother trees and scrub. The major habitats of concern are regenerating native forest and forest remnants, river and amenity plantings, and shelterbelts. *Clematis vitalba* seeds mostly during the winter months although seed can fall all year round in some habitats. The seed remains viable for 5 – 10 years and plant growth can be extremely fast – up to 4m in one growing season. The seed is spread by rivers and wind, with some bird and human spread. *C.vitalba* requires well drained and fertile soils, and is susceptible to grazing.

The main means of control for Old Man's Beard is chemical and mechanical – cutting of vines in winter and application of chemicals to the stumps. Due to buried seed, a control programme for up to 10 years is required to ensure that the plant does not reoccur at the site.

29.2 Proposed Programme

ECan is proposing that Old Man's Beard is controlled through the Sustained Control objective described in Section 1(b) of the NPD.

29.3 NPD Section 6 Assessment

29.3.1 Level of analysis

The assessed level of analysis for Old Man's Beard under the requirements of the NPD and using the Guidance approach is Level 1. The detail of the requirement for assessment is shown in Appendix B.

29.3.2 Impacts of Old Mans Beard

Old Man's Beard has the potential to cause impacts on forest and scrub biodiversity and amenity values.

29.3.3 Benefits for management of Old Mans Beard

Prevention of impacts on forest and scrub biodiversity and amenity values. Net benefits are NPV $85,810,000 relative to the pest being kept at its current level. There is also the prevention of any impacts to biodiversity on an area of 187,500 ha after 100 years if the pest is allowed to spread which would cost $189,000,000 to return to the current state.

29.3.4 Costs of Old Mans Beard Programme

The plan will incur costs of control, inspection, and monitoring. These are $210,000 annually for the programme option. Costs for all three options considered are an NPV(6%) of $3,000,000 for Sustained Control, NPV $70,000,000 for Progressive Containment, and NPV $165,000,000 for Eradication (which has a shorter time frame).

29.3.5 Risks of Old Mans Beard Programme

Technical and operational risks: Old Mans Beard is difficult to control because all shoots need to be removed, and because the seed is prolific and wind spread.

Implementation and compliance: Old Mans Beard has been under control for a significant period with little progress.

Other legislative risks: None known

Public or political concerns: None known

Other risks: None known

29.3.6 Net Benefit and risk adjustment

The analysis produces an estimate of the total costs and benefits of the different options for the programme, as shown in Table 146 below. In terms of the alternatives considered, the Sustained Control option has the highest net value. The sensitivity of this conclusion to changes in various input parameters is shown in Table 147 below and it suggests that the conclusion is not sensitive to changes in any of the parameters tested. In addition to the quantified costs and benefits, there are potential benefits associated with preventing damage to biodiversity on 187,000 ha, and intergenerational implications that should be taken into account.

These factors suggest that the Sustained Control option is strongly favoured as the producing the highest net benefit if the assumptions made in this analysis are considered reasonable.

Table 146: Outcomes of analysis of costs and benefits for Old Mans Beard

Programme	Total NPV	Net Benefit of programme	Risk adjusted net benefit of plan NPV(6%)
Do Nothing	$97,000,000		
Eradication	$236,000,000	$-139,400,000	$-161,030,000
Progressive reduction	$98,000,000	$-1,430,000	$-65,330,000
Sustained Control	$11,000,000	$85,810,000	$980,000

Table 147: Impact of sensitivity testing on highest value option

Sensitivity test	Highest value option (risk adjusted)
Base net benefit	Sustained Control
Time to full occupation 50% of base	Sustained Control
Time to full occupation 150% of base	Sustained Control
Distance of spread 50% of base	Sustained Control
Distance of spread 200% of base	Sustained Control
Cost of control +20% from base	Sustained Control
Cost of control -20% from base	Sustained Control
Loss of production impacts -20% from base	Sustained Control
Loss of production impacts +20% from base	Sustained Control
Discount rate 4%	Sustained Control
Discount rate 8%	Sustained Control

29.4 NPD Section 7 – Allocation of Costs and Benefits

29.4.1 Beneficiaries, exacerbators and costs of proposed programme for control of Old Mans Beard

The beneficiaries and exacerbators of the programme are:

- Beneficiaries: Wider community from prevention of impacts to biodiversity.
- Active exacerbators: Any persons transporting Old Mans Beard into or around the region.
- Passive exacerbators: Any persons with Old Mans Beard on their property not undertaking control.

The direct and indirect costs associated with the programme are shown below in Table 148 and Table 149.

Table 148: Direct and indirect costs of programme for Old Mans Beard

Plan option	Control costs land holders (PV (6%))	Inspection and monitoring costs (PV (6%))
Sustained Control	$7,000,000	$3,000,000
Progressive reduction	$28,000,000	$70,000,000
Eradication	$71,000,000	$165,000,000

Table 149: Benefits and costs of programme for Old Mans Beard that accrue to different beneficiaries and exacerbators

Programme option	Benefits for those currently infested (PV (6%))	Benefits for those not currently infested (PV (6%))	Required benefit for community for biodiversity and ecological benefits in order for option to be positive	Costs for exacerbators (PV (6%))
Sustained Control	$-5,982,317	$95,000,000		$7,000,000
Progressive reduction	$-26,920,425	$95,000,000	$1,430,000	$28,000,000
Eradication	$-69,188,496	$95,000,000	$139,400,000	$71,000,000

29.4.2 Matters for consideration in allocation of costs

The matters for consideration are spelt out in Section 7(2)(d) of the NPD, and the analysis for each of these matters is shown in Table 150 below.

Table 150: Matters for consideration in allocating costs for proposed Old Mans Beard programme

Legislative rights and responsibilities	There are no known issues with legislative rights and responsibilities.
Management objectives	Sustained Control.
Stage of infestation	Old Mans Beard is widespread in Canterbury.
Most effective control agents	Old Mans Beard is often found in non productive areas and scrub. It is difficult for land holders to ensure effective control, and it is often overlooked.
Urgency	Low – has been present for some time and is widespread.
Efficiency and effectiveness	The most efficient approach is likely to be requiring land holder control since they have management control over the land being infested. However, this is not always effective if the control required is widespread, diffficult and expensive. In these situations Council control is likely to be more effective.
Practicality of targeting beneficiaries	The main beneficiaries are the wider community for biodiversity benefits and this group can be readily target through the General Rate.
Practicality of targeting exacerbators	Location of Old Mans Beard can be difficult to establish and requires intensive inspection programme.
Administrative efficiency	General Rate is highly efficient for collecting community benefits related to biodiversity.
Security	Rating mechanisms are generally secure.
Fairness	Charges relate directly to benefits or exacerbators. Fairness is a politically determined judgement
Reasonable	The costs for wilding control can be extremely high for dense infestations.
Parties bearing indirect costs	None known.
Transitional cost allocation arrangements	It is likely that if land holder control is to be required then some transitional mechanisms will be required to ensure that the ongoing costs of control are manageable.
Mechanisms available	General Rate, targeted rate (rural properties), and direct charges are the most readily available mechanisms. Levies are expensive to establish and administer.

29.4.3 Proposed allocation of costs

The primary beneficiaries of the management of Old Man's Beard are the wider community. There are no production benefits and the analysis suggests that the majority of the costs should be borne through the General Rate. The recommended funding therefore suggests

that exacerbators should be targeted only to prevent spread where adjacent high value land is being kept clear. The recommended funding approach is:

- Inspection and monitoring costs – 100% General Rate
- Control in high value sites – 100% General Rate
- Control to prevent spread – 100% land holders as exacerbators where this is reasonable.

30 Exclusion Pests

Exclusion pests include :

- Australian Sedge
- Broom Sedge
- Hornwort
- Kangaroo Grass
- Koi Carp
- Noogoora Bur
- Nutgrass
- Oxylobium
- Spiny Broom
- Woolly Nightshade
- Palm Grass

The total expenditure on these pests is expected to be $75,000 per annum.

30.1 NPD Section 6 Assessment

The analysis for these pests is undertaken at Level 1 because they are not present in the region, there is no opposition to their management, and the management costs are relatively low.

The objectives for exclusion pests will meet the requirements of Section 6 if the Council considers that the benefits of reducing the risks of these pests being introduced to the region and causing damage to biodiversity, conservation, amenity, and production values exceeds the expenditure of $75,000 per annum.

30.2 NPD Section 7 Assessment for Exclusion Pests

Because these pests are not present there are no exacerbators, and therefore the most appropriate source of funding is from the beneficiaries. Rating is the most efficient and secure source of funding. The majority of the pests are biodiversity related, for which funding from the General Rate is most appropriate. There is unlikely to be major efficiency benefits from targeting production beneficiaries, given the diffuse and uncertain nature of the benefits, and therefore the recommendation is that all the funding for Exclusion pests be sourced from General Rate.

31 Site Led Pests

The group of pests included in Site Led programmes are:

- Banana Passionfruit
- Spartina
- Feral Goats
- Old Man's Beard
- Possum
- Wild Russell Lupin
- Lagarosiphon
- Broom
- Gorse
- White Edge Nightshade
- Wilding Conifers
- Wild Thyme
- Cathedral Bells

Separate analyses have been undertaken for Broom, Gorse, Wilding Conifers, and Old Man's Beard as Sustained Control pests. The additional Site Led status for these pests relates to specific areas where conservation and biodiversity objectives are targeted.

Site led programmes will only be undertaken where there is land holder agreement. Any cost sharing arrangements and ongoing obligations for land holders will be part of the agreement.

31.1 Section 6 Assessment

The level of analysis for Site led Pests is 1, because the expenditure on any single site will be limited, and because the programme will only be undertaken where feasible and in conjunction with the land holder.

The proposed costs for the Site Led pests are shown in Proposed costs for Site Led Pests Appendix D, although it should be noted that these will be finalised once the locations are known and agreed. The agreement of the land holder signals that for them the benefits of the programme are likely to exceed the costs they will incur. Therefore, as long as the Council is satisfied that the benefits of the site led programme exceed the costs, the requirements of Section 6 of the NPD will have been met.

31.2 Section 7 Assessment

The cost sharing arrangements will be agreed at the time when specific sites are identified. However, because the benefits for the Councils are primarily to biodiversity, it is appropriate that the Council's contribution be covered from the General Rate which reflects the community nature of the benefits.

32 Good Neighbour Rules (GNR)

The good neighbour rule is covered by Section 8 of the NPD. These require that the:

- Pest would spread onto adjacent land;
- That the pest would cause unreasonable costs for the adjacent land holder (receptor);
- The receptor land holder is controlling the pest;
- The requirement on the land holder from whence the pest (source) is spreading is not more than is required to prevent the pest spreading;
- The costs of compliance for the source land holder are reasonable relative to the cost that the receptor land holder would incur from the pest spreading.

The first two of these are covered by the plan requirements and identification of the biology of the pest species, which all spread naturally in the absence of intervention and cause control costs. For each of the pests for which a GNR rule would apply a primary analysis of costs and benefits has already been undertaken. This GNR analysis therefore focuses on whether the costs for the source land holder are reasonable relative to the costs caused by the spread of the pest in the absence of the rule. These GNRs apply in addition to the rules for management in the proposed programmes for feral rabbits, Bennetts wallabies, gorse, broom, old man's beard, Nassella tussock and wilding conifers.

The GNR analysis is undertaken using the model developed for the joint Biosecurity Managers Group as described by Harris, Hutchison, Sullivan, and Bourdot (2016). The model provides a tabular output describing the boundary distance required before the benefits outweigh the costs, and the relationship between the costs for the source and receptor land holders. These are given to assist and inform any decisions as to whether the rule is reasonable as per the requirements of clause 8(1)(e)(ii) of the NPD.

32.1 Feral rabbits

The analysis for feral rabbits in Section 3 is based on boundary control, and it shows that overall there is likely to be a net benefit from a boundary control regime. In terms of reasonableness the analysis suggests that the costs are likely to be similar or lower for the source landholder as opposed to the receptor landholder where the rabbit proneness is moderate or low and the receptor is of a higher proneness class. Requiring control on land where the source is High or Extreme proneness will result in the costs of the source being between 1.7 and 7.7 times the additional costs of control for the receptor landholder. Costs are unlikely to be reasonable in any situations where the receptor is Low proneness because rabbits are generally maintained at low levels on these land types without control being undertaken.

32.2 Wallabies

The boundary control rule for wallabies is set at 1km, but it is not clear what implications this distance would have for reduction in costs for receptor landholders given wallaby mobility. Assuming a 20% reduction in wallaby control costs with prevention of immigration from a 100m boundary clearance distance would result in the costs for the source landholder being 5 times the additional cost for the receptor. The prevention of immigration from the boundary control

clearance of 1000m would need to reduce the control costs for the receptor landholder by ~85% in order for the source costs to be no more than 20% greater than the additional costs for the receptor landholder in the absence of the rule. This conclusion also requires an assumption that the receptor landholder has a similar 1000m of land that can be affected by wallabies, which may not be appropriate where two different land types abut.

32.3 Gorse

For light infestations of Gorse in the source property, the costs of control for the source and receptor land holders are likely to be similar. For dense infestations the cost of control for source land holders exceeds the costs for the receptor landholder by more than 50%.

32.4 Broom

For light infestations of Broom in the source property, the costs of control for the source and receptor land holders are likely to be similar. For dense infestations the cost of control for source land holders exceeds the costs from spread for the receptor landholder by more than 50%.

32.5 Old Man's Beard

For light infestations of Old Man's Beard in the source property, the costs of control for the source and receptor land holders are likely to be similar. For dense infestations the cost of control for source land holders are 2.3 times the additional cost caused by the spread to the adjacent receiving landholder.

32.6 Nassella tussock

It is assumed that only light infestations of Nassella tussock are likely to occur in Canterbury given the long history of intense control. For light infestations of Nassella tussock in the source property and where the receptor is Hill country, High country, or conservation land, the costs of control for the source and receptor land holders are likely to be similar.

32.7 Wilding pines

Wilding pines refer to a range of species which are yet to be defined. The assumed boundary distance is 200 m. For light infestations of wilding pines the source property, the costs of control for the source and receptor land holders are likely to be similar. For dense infestations on the source property the costs of control for the source are 8 – 9 times the additional cost caused by the spread to the adjacent receiving landholder.

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34 Appendices

Appendix A Assumptions used in plant pest modelling

Table 151: Assumptions for Plant Pest Spread Model (PPSM) Part A

Pest	Programme	Current Area infested (ha)	Number of active sites (locations)	Largest area of a location	Potential habitat/area (ha)	Current densities (%)	Density at full occupancy (%)	Time of first arrival at a site to 90% occupancy at a site/to all of Canterbury	Low distance of spread (Min)	High distance of spread (Max)	How often is it likely to generate new foci of infestation	Cost of control low density ($/ha/annum)	Cost of control high density ($/ha)	Inspection costs ($/annum)	Monitoring costs ($/annum)	Enforcement costs ($/annum)
Baccharis	Progressive Containment	3.5	16[13]	3.5	303241	0.125	50	15	250	750	1.0	$5	$15	$5,000	$500	
Egeria	Eradication	4.5	2	4	50,000	0.5	1	15	250	750	1.0	$1,000	$3,000	$2,000	$500	
Entire Marshwort	Eradication	1	1	0.063	50,000	0.4	1	8	1	100	1.0	$2	$8	$2,000	$500	
Moth Plant	Eradication	1	8	0.0001	50,000	0.0001	50.00	15	1	100	1.0	$23	$45	$2,500	$500	
Phragmites	Eradication	1.1	10	1	50,000	0.001	1	8	1	5	1.0	$250	$500	$5,000	$500	
Yellow Bristle Grass	Eradication	0.011	2	0.01	1500,000	0.002	40	10	15	30	1.2	$140	$1,000	$2,500	$500	$0
Yellow water lily	Eradication	6	1	6	50,000	0.5	40	30	250	750	1.0	$5,000	$20,000	$1,000	$500	
African Feather Grass	Progressive Containment	132	113	50	2170,000	0.02	25	30	500	1500	2.0	$5	$15	$20,000	$500	
African Love Grass	Progressive Containment	107	3	106	2170,000	0.125	25	30	500	1500	3.0	$5	$15	$20,000	$500	
Bell Heather	Sustained Control	375	1[14]	375	100,0,000	0.1	20	30	10	50	1.0	$45	$200	$50,000	$3,000	
Bur Daisy	Sustained Control	235	34	10	1080,000	0.02	5.835	30	500	1500	1.0	$10	$45	$20,000	$500	
Chilean Needle Grass	Sustained Control	325	17	160	1,168,000	2	50	30	15	30	1.2	$140	$1,000	$130,000	$5,000	$5,000
Coltsfoot	Sustained Control	1118	27	286	453000	0.02	20%	50	1	50	1.0	$10	$45	$20,000	$500	
Puna Grass	Progressive Containment	60	2	50	1218878	0.02	50	30	5	10	10.0	$10	$45	$5,000	$500	
Saffron Thistle	Sustained Control	378	13	15	1334000	0.02	6.44	5	50	200	3.0	$10	$45	$15,000	$500	

[13] Amalgamated to 1 site for the modelling.
[14] Amalgamated into 1 site for the modelling

Pest	Programme	Current Area infested (ha)	Number of active sites (locations)	Largest area of a location	Potential habitat/area (ha)	Current densities (%)	Density at full occupancy (%)	Time of first arrival at a site to 90% occupancy at a site/to all of Canterbury	Low distance of spread (Min)	High distance of spread (Max)	How often is it likely to generate new foci of infestation	Cost of control low density ($/ha/annum)	Cost of control high density ($/ha)	Inspection costs ($/annum)	Monitoring costs ($/annum)	Enforcement costs ($/annum)
White-edged nightshade	Site led	259	5	10	75400	1	24.25	15	10	50	5.0	$10	$45	$10,000	$500	
Boneseed	Sustained Control	3500	15	2000	24000	10	50	30	1	2	10.0	$45	$1,000	$50,000	$5,000	
Broom	Sustained Control	415000	10,000	10,000	200,0,000	10	50	15	10	50	1.0	$100	$1,000	$420,000	$35,000	$25,000
Darwin's Barberry	Sustained Control	2500	254	100	50,000	0.02	50.00	15	1	100	1.0	$45	$1,000	$10,000	$1,000	
Gorse	Sustained Control	415000	10,000	1000	200,0,000	10	50	15	10	50	1.0	$100	$1,000	$420,000	$35,000	$25,000
Nassella Tussock	Sustained Control	400,000	6	321,000	1218878	0.02	50	30	1000	10,000	10.0	$10	$45	$635,000	$60,000	$60,000
Wild Thyme	Site led	70	9	50	1218878	0.05	20	60	250	750	1.0	$10	$45	$10,000	$500	
Wilding Conifers	Site led	466492	17	5000	2400,000	1	80	20	340	340	3.0	$10	$2,200	$300,000	$2,000	$5,000
Purple Loosestrife	Sustained Control	0.2031	177	0.2	50,000	0.0001	50	60	250	750	1.0	$45	$1,000	$5,000	$500	
Knotweed	Eradication	0.007	6	0.0035	78126	70	100	15	1	50	1	2400	1600	0	12000	0
Old Man's Beard	Site led	20,000	2000	50	1400000	10	15	30	20	2000	10	45	1000	200000	5000	5000

Table 152: Assumptions for Plant Pest Spread Model (PPSM) Part B

Pest	Density of new infestations (%)	Proportion productive land	Years to establishment of new sites to significant seed spread	Number of new foci established each time	Proportion controlled Sustained	Proportion controlled progressive	Proportion controlled Do Nothing	Years to progressive	Years to eradication	Proportion controlling	Production model type	Inspection cost ratio strategy/sustained	Inspection cost ratio Progressive/Sustained	Inspection cost ratio Eradication/sustained	Distance to North Boundary (km)	Distance to East Boundary (km)	Distance to South Boundary (km)	Distance to West Boundary (km)
Baccharis	0.125	100%	2	1.0	90%	95%	40%	50	20	40%	Hill country	1	2	3	200	90	200	90
Egeria	0.125	0%	2	1.0	90%	95%	10%	50	20	10%	None	1	2	3	200	90	200	90
Entire Marshwort	0.125	0%	2	1.0	90%	95%	10%	50	20	10%	None	1	2	3	200	90	200	90
Moth Plant	0.125	0%	2	1.0	90%	95%	10%	50	20	10%	None	1	2	3	200	90	200	90
Phragmites	0.125	0%	2	1.0	90%	95%	10%	50	20	10%	None	1	2	3	200	90	200	90
Yellow Bristle Grass	0.125	100%	2	1.2	90%	95%	80%	50	20	80%	Intensive pasture	1	2	3	200	90	200	90
Yellow water lily	0.125	0%	2	1.0	90%	95%	10%	50	20	10%	None	1	2	3	200	90	200	90
African Feather Grass	0.02	10%	2	2.0	90%	95%	80%	50	20	80%	Hill country	1	4	6	200	90	200	90
African Love Grass	0.125	100%	2	3.0	90%	95%	80%	50	20	80%	Hill country	1	4	6	200	90	200	90
Bell Heather	0.0005	50%	2	1.0	90%	95%	40%	50	20	40%	High country	1	4	6	200	90	200	90
Bur Daisy	0.0005	50%	2	1.0	90%	95%	40%	50	20	40%	Hill country	1	4	6	200	90	200	90
Chilean Needle Grass	0.5	100%	2	1.2	90%	95%	80%	50	20	80%	Hill country	1	4	6	200	90	200	90
Coltsfoot	0.0005	100%	2	1.0	90%	95%	40%	50	20	40%	Hill country	1	4	6	200	90	200	90
Puna Grass	0.125	100%	2	10.0	90%	95%	40%	50	20	40%	Hill country	1	4	6	200	90	200	90
Saffron Thistle	0.125	100%	2	3.0	90%	95%	40%	50	20	40%	Hill country	1	4	6	200	90	200	90
White-edged nightshade	0.01	50%	2	5.0	90%	95%	10%	50	20	10%	None	1	4	6	200	-	200	180
Boneseed	0.1	0%	2	10.0	30%	95%	20%	100	50	20%	None	1	20	50	100	20	20	20

Pest	Density of new infestations (%)	Proportion productive land	Years to establishment of new sites to significant seed spread	Number of new foci established each time	Proportion controlled Sustained	Proportion controlled progressive	Proportion controlled Do Nothing	Years to progressive	Years to eradication	Proportion controlling	Production model type	Inspection cost ratio strategy/sustained	Inspection cost ratio Progressive/Sustained	Inspection cost ratio Eradication/sustained	Distance to North Boundary (km)	Distance to East Boundary (km)	Distance to South Boundary (km)	Distance to West Boundary (km)
Broom	2	75%	2	1.0	50%	95%	40%	1000	50	40%	Hill country	1	20	50	200	90	200	90
Darwin's Barberry	2	5%	2	1.0	50%	95%	40%	1000	50	40%	Hill country	1	20	50	200	90	200	90
Gorse	2	75%	2	1.0	50%	95%	40%	1000	50	40%	Hill country	1	20	50	200	90	200	90
Nassella Tussock	0.02	100%	2	10.0	90%	95%	80%	50	50	80%	Hill country	1	20	50	-	90	400	90
Wild Thyme	0.0005	50%	2	1.0	90%	95%	40%	100	50	40%	High country	1	20	50	200	90	200	90
Wilding Conifers	0.0005	46%	2	3.0	50%	95%	20%	1000	50	20%	High country	1	20	50	200	90	200	90
Purple Loosestrife	0.0005	0	2	1.0	95%	99%	10%	1000	50	10%	None	1	20	50	200	90	200	90
Knotweed	0.125	0	2	1	90%	95%	10%	50	20	10%	None	1	2	3	10%	None	1	2
Old Man's Beard	2	75%	2	10.0	50%	95%	10%	1000	50	10%	None	1	20	50	10%	None	1	20

Appendix B Assessment of level of analysis under the NPD Guidance

Organism	Criteria 1	Criteria 2	Criteria 3	Criteria 4	Comments	Analysis Intensity
Australian sedge	L	L	L	H	Control supported by community, overall costs are low, benefits exceed costs, impacts are known to occur, control measures are available and some data exists.	**1**
Broomsedge	L	L	L	H	Control supported by community, overall costs are low, benefits exceed costs, impacts are known to occur, control measures are available and some data exists.	**1**
Hornwort	L	L	L	H	Control supported by community, overall costs are low, benefits exceed costs, impacts are known to occur, control measures are available and some data exists.	**1**
Kangaroo grass	L	L	L	H	Control supported by community, overall costs are low, benefits exceed costs, impacts are known to occur, control measures are available and some data exists.	**1**
Noogora bur	L	L	L	H	Control supported by community, overall costs are low, benefits exceed costs, impacts are known to occur, control measures are available and some data exists.	**1**
Nutgrass	L	L	L	H	Control supported by community, overall costs are low, benefits exceed costs, impacts are known to occur, control measures are available and some data exists.	**1**
Oxylobium	L	L	L	H	Control supported by community, overall costs are low, benefits exceed costs, impacts are known to occur, control measures are available and some data exists.	**1**
Palm grass	L	L	L	H	Control supported by community, overall costs are low, benefits exceed costs, impacts are known to occur, control measures are available and some data exists.	**1**

Organism	Criteria 1	Criteria 2	Criteria 3	Criteria 4	Comments	Analysis Intensity
Spiny Broom	L	L	L	H	Control supported by community, overall costs are low, benefits exceed costs, impacts are known to occur, control measures are available and some data exists.	**1**
Woolly nightshade	L	L	L	H	Control supported by community, overall costs are low, benefits exceed costs, impacts are known to occur, control measures are available and some data exists.	**1**
Yellow Bristle Grass	L	L	L	H	Control supported by community, overall costs are low, benefits exceed costs, impacts are known to occur, control measures are available and some data exists.	**1**
Rook	L	L	L	H	Control well supported by community, overall costs are low, benefits substantially exceed costs, impacts well understood and quality data exists.	**1**
Baccharis	L	L	L	H	Control supported by community, overall costs are low, benefits exceed costs, impacts are known to occur, control measures are available and some data exists.	**1**
Egeria	L	M	M	H	Control supported by community, overall costs are low, benefits substantially exceed costs, impacts well understood and quality data exists.	**1**
Entire marshwort	L	L	L	M	Control supported by community, overall costs are low, benefits exceed costs, impacts are known to occur, control measures are available and some data exists.	**1**
Phragmites	L	M	L	H	Control supported by community, overall costs are low, benefits exceed costs, impacts are known to occur, control measures are available and extensive data exists.	**1**
Coltsfoot	L	M	M	H	Control supported by community, overall costs are low, benefits substantially exceed costs, impacts well understood and quality data exists.	**1**

Organism	Criteria 1	Criteria 2	Criteria 3	Criteria 4	Comments	Analysis Intensity
African feather grass	L	M	L	M	Control supported by community, overall costs are low, benefits exceed costs, impacts are known to occur, control measures are available and some data exists.	**1**
African Love Grass	M	M	L	M	Control supported by community, overall costs are low, benefits exceed costs, impacts are known to occur, control measures are available and some data exists.	**1**
Bell Heather	M	M	L	M	Control supported by community, overall costs are low, benefits exceed costs, impacts are known to occur, control measures are available and some data exists.	**1**
Bur Daisy	M	M	L	M	Control supported by community, overall costs are low, benefits exceed costs, impacts are known to occur, control measures are available and some data exists.	**1**
Saffron Thistle	M	M	L	M	Control supported by community, overall costs are low, benefits exceed costs, impacts are known to occur, control measures are available and some data exists.	**1**
White-edged nightshade	M	M	L	M	Some in community may oppose LO responsibility?, overall costs are low, benefits exceed costs, impacts are known to occur, control measures are available and some data exists.	**1**
Bennett's Wallaby	M	M	L	H	Some in community oppose management, overall costs are high, benefits exceed costs, impacts are known to occur, control measures are available and quality data exists.	**2**
Boneseed	M	M	M	H	Control generally supported by community, overall costs are moderate, benefits exceed costs, impacts well understood and quality data exists.	**2**
Darwin's Barberry	M	M	M	M	Control generally supported by community, overall costs are moderate, benefits exceed costs, impacts well understood and quality data exists.	**2**

Organism	Criteria 1	Criteria 2	Criteria 3	Criteria 4	Comments	Analysis Intensity
Wild thyme	M	M	L	M	Some in community oppose management, overall costs are high, benefits exceed costs, impacts are known to occur, control measures are available and quality data exists.	**2**
Chilean Needle Grass	H	M	M	H	Some in community oppose management, overall costs are high, benefits exceed costs, impacts are known to occur, control measures are available and quality data exists.	**2**
Wilding Conifers	H	M	M	H	Some in community oppose management, overall costs are high, benefits exceed costs, impacts are known to occur, control measures are available and quality data exists.	**3**
Broom	M	M	L	H	Some in community oppose management, overall costs are high, benefits exceed costs, impacts are known to occur, control measures are available and quality data exists.	**2**
Gorse	M	M	L	H	Some in community oppose management?, overall costs are high, benefits exceed costs, impacts are known to occur, control measures are available and quality data exists.	**2**
Feral rabbit	M	M	L	H	Some in community oppose management, overall costs are high, benefits exceed costs, impacts are known to occur, control measures are available and quality data exists.	**2**
Nassella Tussock	M	M	L	H	Some in community oppose management, overall costs are high, benefits exceed costs, impacts are known to occur, control measures are available and quality data exists.	**2**
Banana passion fruit	M	M	L	M	Control supported by community, overall costs are low, benefits exceed costs, impacts are known to occur, control measures are available and some data exists.	**1**
Darwin's Barberry	L	M	L	M	Control supported by community, overall costs are low, benefits exceed costs, impacts are known to occur, control measures are available and some data exists.	**1**

Organism	Criteria 1	Criteria 2	Criteria 3	Criteria 4	Comments	Analysis Intensity
Feral cat	M	M	L	M	Some in community oppose management, overall costs are high, benefits exceed costs, impacts are known to occur, control measures are available and quality data exists.	**1**
Feral goat	L	M	L	M	Control supported by community, overall costs are low, benefits exceed costs, impacts are known to occur, control measures are available and some data exists.	**1**
Wasps	L	M	L	M	Control supported by community, overall costs are low, benefits exceed costs, impacts are known to occur, control measures are available and some data exists.	**1**
Lagarosiphon	L	M	L	M	Control supported by community, overall costs are low, benefits exceed costs, impacts are known to occur, control measures are available and some data exists.	**1**
Moth Plant	L	L	L	H	Control supported by community, overall costs are low, benefits exceed costs, impacts are known to occur, control measures are available and some data exists.	**1**
Mustelids	L	L	L	M	Control supported by community, overall costs are low, benefits well exceed costs, impacts are known to occur, control measures are available and some data exists.	**1**
Old man's beard	M	M	L	M	Some in community oppose management, overall costs are low, benefits exceed costs, impacts are known to occur, control measures are available and quality data exists.	**1**
Possum	L	M	L	M	Control supported by community, overall costs are low, benefits exceed costs, impacts are known to occur, control measures are available and some data exists.	**1**
Puna Grass	L	M	L	M	Control supported by community, overall costs are low, benefits exceed costs, impacts are known to occur, control measures are available and some data exists.	**1**

Organism	Criteria 1	Criteria 2	Criteria 3	Criteria 4	Comments	Analysis Intensity
Russell lupin	M	M	L	M	Some in community oppose management, overall costs are low, benefits exceed costs, impacts are known to occur, control measures are available and quality data exists.	**1**
Wild cotoneaster	L	M	L	M	Control supported by community, overall costs are low, benefits exceed costs, impacts are known to occur, control measures are available and some data exists.	**1**
Yellow water lily	L	L	L	M	Control supported by community, overall costs are low, benefits well exceed costs, impacts are known to occur, control measures are available and some data exists.	**1**

Appendix C Risk adjustment for net benefit calculation of Plant Pests

Table 153: Assumptions for risk adjustment of net benefit for Eradication pests

	Matrix of risk	Outcomes actually achieved			
		Do Nothing	Sustained Control	Progressive containment	Eradication
Plan undertaken	**Do nothing**	99%	1%	0%	0%
	Sustained Control	50%	45%	5%	0%
	Progressive containment	10%	50%	35%	5%
	Eradication	5%	50%	25%	20%

Table 154: Assumptions for risk adjustment of net benefit for Progressive Containment pests

	Matrix of risk	Outcomes actually achieved			
		Do Nothing	Sustained Control	Progressive containment	Eradication
Plan undertaken	**Do nothing**	99%	1%	0%	0%
	Sustained Control	50%	45%	5%	0%
	Progressive containment	5%	50%	35%	10%
	Eradication	5%	50%	35%	10%

Table 155: Assumptions for risk adjustment of net benefit for Sustained Control pests excluding Nassella Tussock

	Matrix of risk	Outcomes actually achieved			
		Do Nothing	Sustained Control	Progressive containment	Eradication
Plan undertaken	**Do nothing**	80%	20%	0%	0%
	Sustained Control	75%	25%	0%	0%
	Progressive containment	75%	25%	0%	0%
	Eradication	75%	25%	0%	0%

Table 156: Assumptions for risk adjustment of net benefit for Nassella Tussock and Wilding Conifers

	Matrix of risk	Outcomes actually achieved			
		Do Nothing	Sustained Control	Progressive containment	Eradication
Plan undertaken	**Do nothing**	80%	20%	0%	0%
	Sustained Control	50%	45%	5%	0%
	Progressive containment	10%	50%	35%	5%
	Eradication	5%	60%	30%	5%

Appendix D Proposed costs for Site Led Pests

Site Led	Council estimated costs ($/annum
Banana passionfruit	$15,000
Spartina	$6,000
Feral goats	$20,000
Old man's beard	$100,000
Possum	$110,000
Wild Russell lupin	$25,000
Lagarosiphon	$25,000
Broom	$50000
Gorse	$50000
White edge nightshade	$17000
Wilding Conifers	$350,000
Wild thyme	$15,000
Total	**$783,000**

Appendix E GNR result tables

Note: green = ratio source/additional receptor costs <1.2, orange = 1.2 – 1.5, red = >1.5 or No costs incurred by receptor landholder.

Table 157: Good Neighbour Rule Model outcomes for Feral Rabbits

Feral rabbits NPD Section 8(e)(ii) - Ratio of costs for Source land holder to the costs for the Receiving land holder

Land use for the Source of infestation	Land holder who receives the infestation				
	Low	Moderate	High	Extreme
Low	No costs	0.29	0.13	0.11
Moderate	No costs	2.33	1.06	0.91
High	No costs	4.40	2.00	1.72
Extreme	No costs	7.68	3.49	3.00

Table 158: Good Neighbour Rule Model outcomes for Bennett's Wallaby.

Wallabies NPD Section 8(e)(ii) - Ratio of costs for Source Landholder to the costs for the Receiving landholder

Source land use	Receptor land use			
	Low	Moderate	High	Extreme
Low	No costs	5.00	5.00	5.00
Moderate	No costs	5.00	5.00	5.00
High	No costs	5.00	5.00	5.00
Extreme	No costs	5.00	5.00	5.00

Table 159:Good Neighbour Rule Model outcomes for Gorse: Dense infestation on Source property

Gorse NPD Section 8(e)(ii) - Ratio of costs for Source land holder to the costs for the Receiving land holder - Source infestation is scattered plants

Receptor land use

Source land use	Dairy	Sheep and beef Intensive	Arable	Horticulture	Hill country	High country	Conservation	Forestry	Non Productive
Dairy	No costs	No costs	No costs	No costs	1.00	1.00	No costs	1.00	No costs
Sheep and beef Intensive	No costs	No costs	No costs	No costs	1.00	1.00	No costs	1.00	No costs
Arable	No costs	No costs	No costs	No costs	1.00	1.00	No costs	1.00	No costs
Horticulture	No costs	No costs	No costs	No costs	1.00	1.00	No costs	1.00	No costs
Hill country	No costs	No costs	No costs	No costs	1.00	1.00	No costs	1.00	No costs
High country	No costs	No costs	No costs	No costs	1.00	1.00	No costs	1.00	No costs
Conservation	No costs	No costs	No costs	No costs	1.00	1.00	No costs	1.00	No costs
Forestry	No costs	No costs	No costs	No costs	1.00	1.00	No costs	1.00	No costs
Non Productive	No costs	No costs	No costs	No costs	1.00	1.00	No costs	1.00	No costs

Table 160:Good Neighbour Rule Model outcomes for Gorse: Dense infestation on Source property

Gorse NPD Section 8(e)(ii) - Ratio of costs for Source land holder to the costs for the Receiving land holder - Source infestation is dense

Receptor land use

Source land use	Dairy	Sheep and beef Intensive	Arable	Horticulture	Hill country	High country	Conservation	Forestry	Non Productive
Dairy	No costs	No costs	No costs	No costs	1.54	1.54	No costs	1.54	No costs
Sheep and beef Intensive	No costs	No costs	No costs	No costs	1.54	1.54	No costs	1.54	No costs
Arable	No costs	No costs	No costs	No costs	1.54	1.54	No costs	1.54	No costs
Horticulture	No costs	No costs	No costs	No costs	1.54	1.54	No costs	1.54	No costs
Hill country	No costs	No costs	No costs	No costs	1.54	1.54	No costs	1.54	No costs
High country	No costs	No costs	No costs	No costs	1.54	1.54	No costs	1.54	No costs
Conservation	No costs	No costs	No costs	No costs	1.54	1.54	No costs	1.54	No costs
Forestry	No costs	No costs	No costs	No costs	1.54	1.54	No costs	1.54	No costs
Non Productive	No costs	No costs	No costs	No costs	1.54	1.54	No costs	1.54	No costs

Table 161:Good Neighbour Rule Model outcomes for Broom: Scattered infestation on Source property

Broom NPD Section 8(e)(ii) - Ratio of costs for Source land holder to the costs for the Receiving land holder - Source infestation is scattered plants

Receptor land use

Source land use	Dairy	Sheep and beef Intensive	Arable	Horticulture	Hill country	High country	Conservation	Forestry	Non Productive
Dairy	No costs	No costs	No costs	No costs	1.00	1.00	1.00	1.00	No costs
Sheep and beef Intensive	No costs	No costs	No costs	No costs	1.00	1.00	1.00	1.00	No costs
Arable	No costs	No costs	No costs	No costs	1.00	1.00	1.00	1.00	No costs
Horticulture	No costs	No costs	No costs	No costs	1.00	1.00	1.00	1.00	No costs
Hill country	No costs	No costs	No costs	No costs	1.00	1.00	1.00	1.00	No costs
High country	No costs	No costs	No costs	No costs	1.00	1.00	1.00	1.00	No costs
Conservation	No costs	No costs	No costs	No costs	1.00	1.00	1.00	1.00	No costs
Forestry	No costs	No costs	No costs	No costs	1.00	1.00	1.00	1.00	No costs
Non Productive	No costs	No costs	No costs	No costs	1.00	1.00	1.00	1.00	No costs

Table 162:Good Neighbour Rule Model outcomes for Broom: Dense infestation on Source property

Broom NPD Section 8(e)(ii) - Ratio of costs for Source land holder to the costs for the Receiving land holder - Source infestation is dense

Source land use \ Receptor land use	Dairy	Sheep and beef Intensive	Arable	Horticulture	Hill country	High country	Conservation	Forestry	Non Productive
Dairy	No costs	No costs	No costs	No costs	1.54	1.54	1.54	1.54	No costs
Sheep and beef Intensive	No costs	No costs	No costs	No costs	1.54	1.54	1.54	1.54	No costs
Arable	No costs	No costs	No costs	No costs	1.54	1.54	1.54	1.54	No costs
Horticulture	No costs	No costs	No costs	No costs	1.54	1.54	1.54	1.54	No costs
Hill country	No costs	No costs	No costs	No costs	1.54	1.54	1.54	1.54	No costs
High country	No costs	No costs	No costs	No costs	1.54	1.54	1.54	1.54	No costs
Conservation	No costs	No costs	No costs	No costs	1.54	1.54	1.54	1.54	No costs
Forestry	No costs	No costs	No costs	No costs	1.54	1.54	1.54	1.54	No costs
Non Productive	No costs	No costs	No costs	No costs	1.54	1.54	1.54	1.54	No costs

Table 163:Good Neighbour Rule Model outcomes for Old Man's Beard: Scattered infestation on Source property

Old Man's Beard NPD Section 8(e)(ii) - Ratio of costs for Source land holder to the costs for the Receiving land holder - Source infestation is scattered plants

Receptor land use

Source land use	Dairy	Sheep and beef Intensive	Arable	Horticulture	Hill country	High country	Conservation	Forestry	Non Productive
Dairy	No costs	No costs	No costs	No costs	No costs	No costs	1.00	No costs	1.00
Sheep and beef Intensive	No costs	No costs	No costs	No costs	No costs	No costs	1.00	No costs	1.00
Arable	No costs	No costs	No costs	No costs	No costs	No costs	1.00	No costs	1.00
Horticulture	No costs	No costs	No costs	No costs	No costs	No costs	1.00	No costs	1.00
Hill country	No costs	No costs	No costs	No costs	No costs	No costs	1.00	No costs	1.00
High country	No costs	No costs	No costs	No costs	No costs	No costs	1.00	No costs	1.00
Conservation	No costs	No costs	No costs	No costs	No costs	No costs	1.00	No costs	1.00
Forestry	No costs	No costs	No costs	No costs	No costs	No costs	1.00	No costs	1.00
Non Productive	No costs	No costs	No costs	No costs	No costs	No costs	1.00	No costs	1.00

Table 164:Good Neighbour Rule Model outcomes for Old Man's Beard: Dense infestation on Source property

Old Man's Beard NPD Section 8(e)(ii) - Ratio of costs for Source land holder to the costs for the Receiving land holder - Source infestation is dense

Receptor land use

Source land use	Dairy	Sheep and beef Intensive	Arable	Horticulture	Hill country	High country	Conservation	Forestry	Non Productive
Dairy	No costs	No costs	No costs	No costs	No costs	No costs	2.27	No costs	2.27
Sheep and beef Intensive	No costs	No costs	No costs	No costs	No costs	No costs	2.27	No costs	2.27
Arable	No costs	No costs	No costs	No costs	No costs	No costs	2.27	No costs	2.27
Horticulture	No costs	No costs	No costs	No costs	No costs	No costs	2.27	No costs	2.27
Hill country	No costs	No costs	No costs	No costs	No costs	No costs	2.27	No costs	2.27
High country	No costs	No costs	No costs	No costs	No costs	No costs	2.27	No costs	2.27
Conservation	No costs	No costs	No costs	No costs	No costs	No costs	2.27	No costs	2.27
Forestry	No costs	No costs	No costs	No costs	No costs	No costs	2.27	No costs	2.27
Non Productive	No costs	No costs	No costs	No costs	No costs	No costs	2.27	No costs	2.27

Table 165:Good Neighbour Rule Model outcomes for Nassella tussock: scattered infestation on Source property

Nassella tussock NPD Section 8(e)(ii) - Ratio of costs for Source land holder to the costs for the Receiving land holder - Source infestation is scattered plants

Receptor land use

Source land use	Dairy	Sheep and beef Intensive	Arable	Horticulture	Hill country	High country	Conservation	Forestry	Non Productive
Dairy	No costs	No costs	No costs	No costs	1.00	1.00	1.00	No costs	No costs
Sheep and beef Intensive	No costs	No costs	No costs	No costs	1.00	1.00	1.00	No costs	No costs
Arable	No costs	No costs	No costs	No costs	1.00	1.00	1.00	No costs	No costs
Horticulture	No costs	No costs	No costs	No costs	1.00	1.00	1.00	No costs	No costs
Hill country	No costs	No costs	No costs	No costs	1.00	1.00	1.00	No costs	No costs
High country	No costs	No costs	No costs	No costs	1.00	1.00	1.00	No costs	No costs
Conservation	No costs	No costs	No costs	No costs	1.00	1.00	1.00	No costs	No costs
Forestry	No costs	No costs	No costs	No costs	1.00	1.00	1.00	No costs	No costs
Non Productive	No costs	No costs	No costs	No costs	1.00	1.00	1.00	No costs	No costs

Table 166:Good Neighbour Rule Model outcomes for Wilding pines (various species): Scattered infestation on Source property

Lodgepole or contorta pine NPD Section 8(e)(ii) - Ratio of costs for Source Landholder to the costs for the Receiving landholder - Source infestation is scattered plants

Source Landuse	Receptor Landuse: Dairy	Sheep and beef Intensive	Arable	Horticulture	Hill country	High country	Conservation	Forestry	Non Productive
Dairy	No costs	No costs	No costs	No costs	1.00	1.00	1.00	No costs	No costs
Sheep and beef Intensive	No costs	No costs	No costs	No costs	1.00	1.00	1.00	No costs	No costs
Arable	No costs	No costs	No costs	No costs	1.00	1.00	1.00	No costs	No costs
Horticulture	No costs	No costs	No costs	No costs	1.00	1.00	1.00	No costs	No costs
Hill country	No costs	No costs	No costs	No costs	1.00	1.00	1.00	No costs	No costs
High country	No costs	No costs	No costs	No costs	1.00	1.00	1.00	No costs	No costs
Conservation	No costs	No costs	No costs	No costs	1.00	1.00	1.00	No costs	No costs
Forestry	No costs	No costs	No costs	No costs	1.00	1.00	1.00	No costs	No costs
Non Productive	No costs	No costs	No costs	No costs	1.00	1.00	1.00	No costs	No costs

Table 167:Good Neighbour Rule Model outcomes for Wilding pines (various species): Dense infestation on Source property

Lodgepole or contorta pine NPD Section 8(e)(ii) - Ratio of costs for Source Landholder to the costs for the Receiving landholder - Source infestation is dense

Source Landuse	Receptor Landuse: Dairy	Sheep and beef Intensive	Arable	Horticulture	Hill country	High country	Conservation	Forestry	Non Productive
Dairy	No costs	No costs	No costs	No costs	8.89	8.89	8.89	No costs	No costs
Sheep and beef Intensive	No costs	No costs	No costs	No costs	8.89	8.89	8.89	No costs	No costs
Arable	No costs	No costs	No costs	No costs	8.89	8.89	8.89	No costs	No costs
Horticulture	No costs	No costs	No costs	No costs	8.89	8.89	8.89	No costs	No costs
Hill country	No costs	No costs	No costs	No costs	8.89	8.89	8.89	No costs	No costs
High country	No costs	No costs	No costs	No costs	8.89	8.89	8.89	No costs	No costs
Conservation	No costs	No costs	No costs	No costs	8.89	8.89	8.89	No costs	No costs
Forestry	No costs	No costs	No costs	No costs	8.89	8.89	8.89	No costs	No costs
Non Productive	No costs	No costs	No costs	No costs	8.89	8.89	8.89	No costs	No costs