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

Report prepared for Otago Regional Council as part of the preparation of a Regional Pest Management Plan

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Executive Summary

Approach

This report provides the information required for Otago Regional Council (ORC) 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 areas is prevented, but the pest can increase in density on already infested areas.
- Progressive Containment – where the pest is reduced in extent and density and is contained within its existing infested area.
- Eradication – where the pest is removed from the region.
- Do Nothing – where the pest can 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 Otago Regional Council 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.

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.

Sustained Control pests with a positive net benefit - Rabbits, Broom, Gorse, Nodding thistle and Ragwort. 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. In most cases the benefit accrues only on specific land types –hill and high country for rabbits, broom, gorse and nodding thistle, and dairy land for ragwort. The maximum net benefit can be achieved by constraining the plan to those areas, however a positive net benefit is still achieved region wide.

Progressive Containment pests with a positive quantified net benefit – African Love Grass, Bomarea, Bur Daisy, Cape Ivy, Old Man's Beard, Perennial nettle, and White Edged Nightshade all produce a positive net benefit taking into account production benefits and/or avoided costs of control in the future. Wilding conifers produces a positive net benefit, with the analysis including values for biodiversity benefit of $23.75/ha/annum.

Progressive Containment pests with a negative quantified net benefit, but which may be positive with biodiversity benefits included – these include Boneseed and Spartina. If the council considers that the biodiversity benefits exceed $370/ha for Boneseed and $8360/ha for Spartina the benefits will exceed the costs. Sustained Control may have a higher net benefit for these pests depending on the considered risks of further spread under that approach.

Progressive Containment pests with a negative quantified net benefit, which may be more appropriately Sustained Control pests – Nassella tussock and Lagarosiphon. Nassella tussock produces a positive net benefit under Progressive Containment, but a higher net benefit under Sustained Control. Data in Canterbury shows that many years of intensive control effort made little progress in reducing the incidence of the pest.

Lagaraosiphon produces a negative net benefit under all options, but the cost of Sustained Control is substantially lower, and requires a biodiversity benefit of only $19,000 per ha. Lagarosiphon is extremely difficult to control and reduce spread and preventing spread is in itself an ambitious objective. However the management of Lagarosiphon within Lake Wanaka and the Kawarau River, Lake Dunstan and Lake Wakatipu in accordance with Lagarosiphon Management Plans has been successful to date in controlling Lagarosiphon

The benefits and costs of Russell lupin have not been quantified because of a lack of data about the extent of the pest. The extent to which the benefits of the plan objectives for this pest exceed the costs will need to be assessed by decision makers.

Eradication pests – these include rooks, wallabies and spiny broom. The case for a positive net benefit is clear for rooks and spiny broom, but for wallabies it is only marginally better than Sustained Control. The justification for wallabies should be reviewed regularly to ensure Eradication is being achieved.

Exclusion pests – These are considered likely to be of net benefit because very little cost is involved and there are significant potential costs from establishment of the Exclusion pests in the region, which are known to have had impacts elsewhere.

The *Site led pest* programmes in Dunedin are considered likely to have a net benefit because they build on existing community initiatives and require land holder agreement, which suggests that the costs of control will be exceeded by the benefits to the parties involved.

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 and should not be seen as definitive. The funding recommendations 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.

For pests that are solely production related - the funding recommendations are for a targeted rate on productive land for plan related costs, and generally landholder (exacerbator) control depending on efficiency of the measure.

For pests that are solely biodiversity related – the funding recommendations are for funding of inspection and monitoring costs from the General rate as the most efficient means of targeting the wider community as beneficiaries. Control costs are split between exacerbator control and funding from the general rate depending on the extent of the pest and the efficiencies associated with exacerbator control.

For the pests where there is both a productive and biodiversity related benefit - the costs of inspection, monitoring and control are apportioned between the General and Targeted rate depending on a qualitative assessment of the relative benefit to each party. 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, broom, gorse, nodding thistle, ragwort 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 of a boundary on land where the source is High land type or the receptor is low land type is not likely to be reasonable, but in other situations is likely to be reasonable.

For light infestations of nodding thistle, gorse, broom, and wilding conifers in hill and high country 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, although only on certain land types. A GNR for these situations would be reasonable.

For dense infestations of broom and gorse the costs for the party required to control are 50% higher than for the neighbour. In these situations a judgement needs to be made by the council as to whether the costs of compliance are reasonable.

For dense infestations of wilding conifers the costs of control for the party required to control are 8 – 9 times the costs for the neighbour, and boundary control is not likely to meet the tests of reasonableness in the NPD.

For ragwort the costs are likely to be reasonable where dairy properties are both the source and the affected parties. This conclusion is likely to hold for other land use types such as deer and beef which are susceptible to ragwort infestation. However where other land uses are involved that are not greatly affected by ragwort the costs are not likely to be reasonable.

For GNRs the council may choose to apply the rule to all land and provide exemptions (such as under Biosecurity Act for situations where the costs are not reasonable, or may choose to apply the rule only to situations where it is likely to be reasonable.

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**
Exclusion Pests	Exclusion	Likely to be positive	Exclusion			100%		100%		
Bennetts Wallabies	Eradication	$26 - $97	Eradication	$17.6		60%	40%	60%	40%	
Rooks	Eradication	$0.36 - $0.68	Eradication	-	-	100%		100%		
Spiny Broom	Eradication	$12.8	Eradication			100%		100%		
African Love Grass	Progressive Containment	$18.4	Progressive Containment			50%	50%	50% (non-productive land)	50% (non-productive land)	100% (productive land)
Bomarea	Progressive Containment	$27.9	Progressive Containment			100%				100%
Boneseed	Progressive Containment	-$0.43	Sustained Control	$370/ha	$120/ha	100%		100% (reduce prevalence)		100% (prevent spread)
Bur Daisy	Progressive Containment	$1.7	Progressive Containment				100%		Some potential contribution	100%
Cape Ivy	Progressive Containment	$4.9	Progressive Containment			100%		100% (large infestations on private land)		100%
Lagarosiphon	Progressive Containment	-$160	Sustained Control	$31,000	19,000	100%		100%		LINZ for control work.
Nassella Tussock	Progressive Containment	$112	Sustained Control				100%			100%
Old Mans Beard	Progressive Containment	$10.2	Progressive Containment			100%		100% (large infestations on private land)		100%
Perennial Nettle	Progressive Containment	$8.3	Progressive Containment				100%			100%
Spartina	Progressive Containment	-$5.6	Sustained Control	$8630	$3270	100%		100%		
White-edged Nightshade	Progressive Containment	$0.05	Progressive Containment			50%	50%			100%

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**
Wilding Conifers	Progressive Containment	$226	Progressive Containment	$23.75/ha[1]	-	100%		100% Initial		100% Ongoing
Broom	Sustained Control	$59.3	Sustained Control	-	-	50% biodiversity-	50% biodiversity, 100% productive	50% biodiversity		50% biodiversity, 100% to prevent spread
Gorse	Sustained Control	$59.3	Sustained Control	-	-		100%			100%
Nodding Thistle	Sustained Control	$1.6	Sustained Control	-	-		100%			100%
Rabbits (feral)	Sustained Control	$149	Sustained Control		-	-	100%			100%
Ragwort	Sustained Control	$76.5	Sustained Control				100%			100%
Site Led Pests	Site Led	Likely to be positive assuming community and land holder agreement	Site Led			100%		To be determined	To be determined	To be determined

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[1] Assume a biodiversity benefit of $23.75/ha/annum based on a willingness to pay survey (Kerr, et al., 2007).

1 Background

Otago Regional Council 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. Otago Regional Council 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 Rabbits (Feral)

2.1 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. There has recently been a release of a new strain of the calicivirus that causes RHD, and it is expected that this will suppress rabbit numbers in areas where resistance to the original strain is present.

2.2 Proposed Plan

The proposed programme for rabbits is for Sustained Control, with a requirement that rabbits to be maintained at or below Maclean’s Scale 3.

2.3 Method for analysis of Rabbit options

The analysis undertaken here is Level 2 analysis under the NPD, and is based on information provided by ORC on the costs experienced in managing rabbits. This section details the background assumptions, the model used, the results, and the significance of the results.

ORC differentiates between different land types in determining rabbit proneness and costs of control. The three categories used are High country, Medium country and Low country. There are shown in Table 2 below.

Table 2: Area in each rabbit proneness class for Otago (ha)

Low	Moderate	High
200,000	400,000	800,000

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.

The costs of control with spillover between properties is likely to be higher because the immigration from neighbouring high populations densities will shorten the interval between control operations, and potentially increase the cost of those operations. The figures for Otago region were supplied by ORC and are shown in Table 3 below.

Table 3: Estimate of annual costs of control by rabbit proneness class

Land type	Total Operation cost/ha	Annual cost/ha without spillover	Annual cost/ha with spillover	Increase in cost/ha/year from spillover
Low	$120.00	$15.00	$30.00	$15.00
Moderate	$180.00	$30.00	$60.00	$30.00
High	$250.00	$50.00	$150.00	$100.00

The spread model assumes that increased costs of control as a result of spillover occur within 500m of a boundary. The boundary length affected is calculated using an assumed square shape for the property, which results in the smallest average boundary length and therefore is likely to be the most conservative.

The numbers of properties not controlling is estimated at 5%. At the height of rabbit infestations prior to RHD introduction non-control of rabbits reached as high as 70% in very rabbit prone parts of the country. However, it is expected that with better returns from high country farming, a better equity position, and the presence of a new strain 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 MPI Monitoring Farm data for 2011/12[2] updated using Statistics NZ producer price index series. These stocking rates and returns are shown in Table 4

Table 4: Stocking rates and returns per stock unit for rabbit prone land

Land type	Low	Moderate	High	Gross margin returns per su ($)
Otago Dry Hill	3	3	3	$100.96

Inspection and monitoring costs are estimated by ORC at $825,000 per annum, which is based on targeted monitoring on known prone properties.

2.4 NPD Section 6 Assessment

2.4.1 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.

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[2] https://www.mpi.govt.nz/news-and-resources/open-data-and-forecasting/agriculture/ .

2.4.2 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.

2.4.3 Options for response

Two options for a Sustained Control 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.

It is assumed that control is only undertaken on prone parts of Otago.

2.5 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 some of non-compliance in areas with high rabbit population numbers in rabbit prone areas, particularly given the relatively low return from grazing in very rabbit prone areas. This will be mitigated by the use of complaints and regular inspection of known prone locations to identify problem areas.

Other legislative risks: Risks arise to the availability of poisons through the Hazardous Substances and New Organisms (HSNO) Act.

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.

2.5.1 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 5 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 $124 million (NPV(6%)), compared with $149 million (NPV(6%)) for the Full Control plan that requires control on all rabbit infested land. The sensitivity analysis (Table 6) shows that the results are reasonably robust to the assumptions made about discount rate and proportion controlling.

In order for the options to be worthwhile there would need to be a greater than 45% for Boundary Control option and 35% for the Full Control option. There are also potentially biodiversity benefits on 30,000 ha for the Boundary Control option, and 40,000 ha for the Full Control option.

The analysis suggests that the Full Control has the highest net benefit of the options considered for those values quantified, and protects a greater area from damage to biodiversity values.

Table 5: 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	$37	$191	$0	$228	$0	
Boundary Control	$54	$36	$13	$104	$124	45%
Full Control	$66	$0	$13	$79	$149	35%

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

	Discount rate			**Proportion not controlling**		
Do Nothing	6%	4%	8%	Base	2X	4X
Boundary Control	$124	$170	$97	$124	$262	$536
Full Control	$149	$203	$116	$149	$311	$635

NPD Section 7 - Allocation of Costs and Benefits

2.5.2 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 7. The benefits and costs of the plan options, and the parties to whom they accrue, are shown in Table 8. They show that control costs for land holders are the largest cost for both the Boundary and the Full Control approaches. 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 7: Direct and indirect costs of plan for Rabbits (Feral) ($ million PV6%)

Plan option	Control costs on land holders	Inspection and monitoring costs
Boundary Control	$54.32	$13.00
Full Control	$66.20	$13.00

Table 8: 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**	$154.54	$37.16
	Full Control	$190.96	$37.16
Costs for exacerbators	**Boundary Control**	$54.32	$0.00
	Full Control	$66.20	$0.00

2.5.3 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 some 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 e.g. rural zones) is likely 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.

2.5.4 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.

3 Bennett's Wallabies.

3.1 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. Since that time landholder control has been required, but the spread of wallabies has increased significantly such that they are now established on the south side of the Waitaki river in low numbers.

3.2 Impacts of Wallabies

Wallabies cause losses in agricultural production from competition with sheep and some prevention of isolated damage to fodder crops, and impacts to young forestry seedlings during establishment (Warburton 1986[3]).

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

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

areas of high density and in their current state were readily reversed. Latham et al (2016[4]) undertook a wide review of literature related to wallaby impacts and the identified benefits 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 in other areas, but this is unlikely to be the case in Otago because numbers are too low.

3.3 Proposed plan

ORC is proposing an Eradication programme for Wallabies with the aim of removing them from within the Otago region.

3.4 Method

The analysis undertaken here is Level 2 under the NPD, and relies on Latham *et al.* (2016) to estimate the annual costs and benefits of wallaby control under the Do Nothing scenario – i.e. their spread if no intervention was undertaken. The Latham, et al. 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 9, Table 10, and Table 11.

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 Otago, 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 9. 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. These are referred to as follows:

- Spread rate Low: based on known distribution in 2015;
- Spread rate Medium: based on probable distribution in 2015; and
- Spread rate High: based on probable distribution with illegal liberations occurring.

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

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[4] 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.

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 9: 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	**Spread rate Low**	**Spread rate Medium**	**Spread rate High**
2015	667.18	667.18	667.18
2020	844.15	1119.26	2360.32
2025	1046.3	1638.77	3646.33
2035	1490.11	2649.56	6301.52
2065	2787.3	6874.12	12431.73

Table 10: 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	$24.59
Ecosystem benefit ($/ha)	$17.6	$17.6	$17.6
Post control wallaby stocking rate (su/ha)	0.2	0.2	0.2
Post control production losses ($/ha)	$3.0	$2.8	$2.5

Table 11: Assumptions for control costs by scenario

	Item
Control cost/ha Current	$15.5
Control costs/ha delayed	$15.5
Control costs buffer	$26
Control costs in absence of plan	$15
5km buffer area (km^2)	556

3.5 NPD Section 6 Assessment

3.5.1 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.

3.5.2 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.

3.5.3 Options for response

The analysis considers five options for Bennett’s Wallabies:

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

4. Eradication
5. Sustained Control with Buffer zone

3.5.4 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 12 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 12: Impacts of options for management of Bennet's Wallabies

Plan	Impact	Spread rate Low ($million PV(6%))	Spread rate Medium ($million PV(6%))	Spread rate High ($million PV(6%))
Do Nothing	**Lost production without control**	$21.12	$38.59	$81.46
	Control costs	$12.27	$22.46	$47.43
	Lost biodiversity without control	$48.16	$60.70	$128.18
	Total	**$81.55**	**$121.75**	**$257.07**
Sustained Control	**Lost production with control**	$4.17	$7.64	$16.12
	Control at current	$16.30	$16.30	$16.30
	Total	**$20.47**	**$23.94**	**$32.42**
Sustained Control delayed 10 years	**Lost production**	$9.43	$14.03	$27.91
	Lost biodiversity	$7.04	$6.47	$12.90
	Control	$18.03	$27.64	$60.48
	Total	**$34.50**	**$48.15**	**$101.28**
Eradication	**Lost production**	$0.00	$0.00	$0.00
	Cost of control inside buffer	$15.36	$15.36	$15.36
	Lost biodiversity	$0.00	$0.00	$0.00
	Control costs for buffer	$0.00	$0.00	$0.00
	Total	**$15.36**	**$15.36**	**$15.36**
Sustained Control with Buffer zone	**Lost production**	$11.67	$14.17	$25.41
	Cost of control inside buffer	$16.30	$16.30	$16.30
	Lost biodiversity	$13.70	$11.43	$20.50
	Control costs for buffer	$3.07	$3.07	$3.07
	Total	$21.12	$38.59	$81.46

3.5.5 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 a 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: Continued infestation of wallabies from Canterbury region.

3.5.6 Net benefit and risk adjustment

Table 13 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. The Eradication scenario, where control is undertaken across the known infestation area, produces the highest net benefit under the all scenarios. The analysis suggests that if Sustained Control were to be undertaken, it would be worth delaying until it was implemented, although it should be noted that this is based on relatively slow rates of spread and limited area currently infested, so may not work out in practice.

When the options are adjusted for the assessment of risk Eradication still produces the highest net benefit, although this is based on the assumption that the significantly higher spend on inspection and monitoring in the Eradication option reduces the risk of non-achievement to similar to the other options. Note that this assumes 30 years of ongoing spend to achieve Eradication, which is a reasonably conservative assumption. When the Buffer Zone is included alongside control in the current area this option produces a higher net benefit than Sustained Control at higher rates of spread, which may in fact be encountered.

It is likely therefore that when adjusted for risk the Eradication option has the highest net benefit for managing wallabies in the Otago region.

Table 13: Net Benefit for management intervention options ($ million NPV(6%))

	Spread rate Low ($million PV(6%))	**Spread rate Medium ($million PV(6%))**	**Spread rate High ($million PV(6%))**
Sustained Control	$61	$98	$225
Sustained Control delayed 10 Years	$47	$74	$156
Eradication	$66	$106	$242
Sustained Control with Buffer zone	$37	$77	$192

Table 14: Risk Adjusted Net Benefit for management intervention options ($million NPV(6%)))

	Spread rate Low ($million PV(6%))	Spread rate Medium ($million PV(6%))	Spread rate High ($million PV(6%))
Sustained Control	$24	$39	$90
Sustained Control delayed 10 Years	$19	$29	$62
Eradication	$26	$43	$97
Sustained Control with Buffer zone	$18	$38	$96

3.6 NPD Section 7 - Allocation of Costs and Benefits

3.6.1 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 15 and the size of the benefits and costs to different parties in relation to the plan options are shown in Table 16.

Table 15: 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%))
Sustained Control	$3.50	$0.53
Eradication	$11.20	$4.16
Sustained Control with Buffer zone	$17.96	$1.40

Table 16: 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	**Sustained Control**	$6.53	$32.06	$60.70
	Eradication	$6.53	$32.06	$60.70
	Sustained Control with Buffer zone	$6.53	$32.06	$60.70
Control costs for exacerbators	**Sustained Control**	$16.30	$0.00	$0.00
	Eradication	$15.36	$0.00	$0.00
	Sustained Control with Buffer zone	$16.30	$3.07	$0.00

3.6.2 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 17: 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 – have expanded into Otago over the last decade since control effort was eased in Canterbury.
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.
Efficiency and effectiveness	Efficiency and effectiveness maximised by focusing on removing wallabies from Otago and preventing further incursions.
Practicality of targeting beneficiaries	Beneficiaries are widespread throughout the region, although largely related to pastoral agriculture.
Practicality of targeting exacerbators	Bennetts wallabies are at low levels and it is difficult to directly identify their location. It is therefore difficult to target both passive exacerbators with wallabies on their property, and 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.

3.6.3 Proposed allocation of costs

Wallabies are at low numbers and very mobile It is therefore difficult to identify exacerbators and require control. It is also unlikely that eradication would be achieved with landholder control. Control effort is best funded from beneficiaries through rates rather than exacerbators from landholder control.

The benefits from the plan are approximately 60% to the wider community from prevention of damage to biodiversity values. The remainder of the benefit is to the wider rural community from prevention of damage to production values.

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, monitoring and control costs: 60% General Rate, 40% targeted rate on productive land.

4 Rooks

4.1 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 Otago. There are currently 3 areas where rooks occur, and an estimated population of 50 birds.

4.2 Proposed plan

ORC are proposing an Eradication plan for Rooks.

4.3 Level of analysis

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

4.4 Method

Two models of linear population expansion are used, with maximum areal extent being reached in 25 or 50 years' time under each model. These are based on the area of productive land (1.4 million ha) and the lower figures uses an annual spread rate of 1.3 km/year, while the upper figure simply doubles this as a conservative estimate. These population growth scenarios may overestimate the rate of growth of an undisturbed population because in the 30 years following their introduction to Canterbury in 1870s the rooks appeared to inhabit only a limited number of sites in the central city. Rooks did 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), and population increase rates of 20%/annum have been reported in Scotland and Hawke's Bay (NPCA, 2015). 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) using 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 90,000 birds in Otago over 10,700 km^2.

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)[5] 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). So if rooks eat 50% of the sown seed in a field, the gross margin is reduced by 50%. This is likely to underestimate the losses in some locations with heavy damage, as harvesting may not be economic.

Inspection and control costs are estimated by ORC at $8000 for inspection, monitoring and control. 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 10 or 20 years until Eradication can be deemed to have been achieved.

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

4.5 NPD Section 6 Assessment

4.5.1 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.

4.5.2 Options for response

The analysis considers two options for Rooks:

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[5] 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

1. Do Nothing
2. Eradication

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

4.5.3 Benefits and costs of options for management of Rooks

The benefits and costs of the two management options are shown in Table 18. 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 and time to achieve Eradication

Table 18: Benefits and Costs of Rook Management options

Option		**Losses for newly sown crops (PV)**	**Control costs (PV)**	
			Eradication achieved in:	
			10 years	**20 years**
Do Nothing	**25 yrs to max**	$680,681		
	50 yrs to max	$361,124		
Eradication		0	$41,699	$66,881

Table 19: Net Benefit of Eradication at two different rates of spread

	Eradication achieved in: (NPV(6%))	
Rate of spread	**10 years**	**20 years**
Linear - 25 yrs to max	$638,982	$613,800
Linear - 50 yrs to max	$361,124	$361,124

4.5.4 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 20. It shows that risks that the plan is not achieved would have to be a greater than

81% - 94% 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 20: Maximum risk of non-achievement for benefits of the Rook plan to still outweigh the costs

	Eradication achieved in :	
Rate of spread	**10 years**	**20 years**
Linear - 25 yrs to max	94%	90%
Linear - 50 yrs to max	88%	81%

4.6 NPD Section 7 - Allocation of Costs and Benefits

4.6.1 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 $40,000 and $70,000 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 $360,000 and $680,000 NPV(6%). There are also some potential benefits to the wider community from the avoidance of impacts to biodiversity.

4.6.2 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 (50 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.

4.6.3 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.

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 five year's reported farm budgets to 2015/16 from DairyNZ[6] 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[7]. It is higher than the 4% used by the Auckland 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

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[6] DairyNZ data for revenue and operating expenses at the Otago level is used, then adjusted using more detailed national data to estimate the proportion of fixed expenses.

[7] 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 54 to Table 56.

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 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 as 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 Containment/ Sustained Control**	**Eradication/ Sustained Control**
Spiny Broom	4	6
African Feather Grass	4	6
Chilean Needle Grass	4	6
Moth Plant	2	3
African Love Grass	4	6
Boneseed	4	6
Bur Daisy	4	6
Cape Ivy	4	6
Nassella Tussock	20	50
Old Man's Beard	20	50
Perennial Nettle	4	6
Spartina	4	6
White-edged nightshade	4	6
Wilding conifers	4	6
Bomarea	4	6
Lagarosiphon	4	6
Broom	20	50
Gorse	20	50
Nodding Thistle	20	50
Ragwort	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 Otago Regional Council 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 Spiny Broom

6.1 Description

Spiny Broom (Calicotome spinosa) is a spiny erect leguminous shrub. It prefers warm temperate conditions and dry acidic soils and moderate rainfall. As with common broom its seeds are ejected from pods during hot weather. Spiny broom can out-compete native plants and has an impact on native ecosystems, waterways, and agricultural land. It crowds out pasture and prevents grazing in dense patches.

6.2 Proposed Plan

ORC is proposing that Spiny Broom is controlled through the Eradication objective described in Section 1(b) of the NPD.

6.3 NPD Section 6 Assessment

6.3.1 Level of analysis

The assessed level of analysis for Spiny Broom 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.

6.3.2 Impacts of Spiny Broom

Spiny Broom has the potential to cause loss of production from pastoral agriculture in hill and high country, and damage to biodiversity values.

6.3.3 Benefits for management of Spiny Broom

Prevention of loss of production from pastoral agriculture in hill and high country and preventino of damage to biodiversity values. Net benefits are NPV $14,000,000 relative to the pest being kept at its current level. There is also the prevention of any impacts to biodiversity on an area of 34,330 ha after 100 years if the pest is allowed to spread.

6.3.4 Costs of Spiny Broom Plan

The plan will incur costs of control, inspection and monitoring. These are $1500 annually for the plan option. Costs for all three options considered are NPV(6%) $500 for Sustained Control, NPV(6%) $9,000 for Progressive Containment, and NPV(6%) $20,000 for Eradication (which has a shorter time frame).

6.3.5 Risks of Spiny Broom Plan

Technical and operational risks: Eradication is technically difficult to achieve, and requires consistent long term efforts.

Implementation and compliance: Work will be undertaken by ORC so implementation and compliance risks are low.

Other legislative risks: None known

Public or political concerns: None known

Other risks: None known

6.3.6 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 1 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 3 below. In addition to the quantified costs and benefits, there are potential benefits associated with preventing damage to biodiversity on 34330 ha that should be taken into account.

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

Table 1: Outcomes of analysis of costs and benefits for Spiny Broom

Plan	Total NPV	Net Benefit of plan	Risk adjusted net benefit
Do Nothing	$13,690,000		
Eradication	$50,000	$13,650,000	$12,790,000
Progressive Containment	$20,000	$13,670,000	$12,140,000
Sustained Control	$8,000	$13,690,000	$6,700,000

Table 3: Impact of sensitivity testing on highest value option

Sensitivity test	**Highest value option (risk adjusted)**
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

6.4 NPD Section 7 - Allocation of Costs and Benefits

6.4.1 Beneficiaries, exacerbators and costs of proposed plan for control of Spiny Broom

The beneficiaries and exacerbators of the plan are:

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

The direct and indirect costs associated with the plan are shown below in Table 4 and Table 5.

Table 4: Direct and indirect costs of plan for Spiny Broom

Plan option	Control costs landholders	Inspection and monitoring costs
Sustained Control	$7,000	$4,000
Progressive Containment	$30,000	$20,000
Eradication	$50,000	$20,000

Table 5: Benefits and costs of plan for Spiny Broom that accrue to different beneficiaries and exacerbators

Plan option	Benefits for those currently infested	Benefits for those not currently infested	Costs for exacerbators
Sustained Control	$-1,500	$14,000,000	$7,000
Progressive Containment	$-21,000	$14,000,000	$30,000
Eradication	$-44,000	$14,000,000	$50,000

6.4.2 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 6 below.

Table 6: Matters for consideration in allocating costs for proposed Spiny Broom plan

Legislative rights and responsibilities	None known
Management objectives	Eradication
Stage of infestation	Early infestation with only 3 sites in Otago.
Most effective control agents	Regional council agents will be most effective because control is required in a timely manner and all plants need to be removed.
Urgency	Moderate urgency to prevent spread
Efficiency and effectiveness	It is likely that requiring landholders 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 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.

6.4.3 Proposed allocation of costs

Because of the low level of Spiny Broom, and the widespread benefits to both landholders and the community, a General Rate is the most appropriate source for funding the Eradication objective. This will also ensure security of funding and management of the control effort.

7 African Love Grass

7.1 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.

7.2 Proposed Plan

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

7.3 NPD Section 6 Assessment

7.3.1 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.

7.3.2 Impacts of African Love Grass

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

7.3.3 Benefits for management of African Love Grass

Prevention of loss of production from pastoral agriculture in hill and high country. Net benefits are NPV $29 million relative to the pest being kept at its current level. There is also the prevention of any impacts to biodiversity on an area of 17,000 ha after 100 years if the pest is allowed to spread.

7.3.4 Costs of African Love Grass Plan

The plan will incur costs of control, inspection and monitoring. These are $4500 annually for the plan option. Costs for all three options considered are a NPV of NPV $20,000 for Sustained Control, NPV $70,000 for Progressive Containment, and NPV $80,000 for Eradication (which has a shorter time frame).

7.3.5 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.

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

7.3.6 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 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 3 below and shows that apart from the lower discount rate test the conclusion that Progressive Containment has a higher net benefit than other options is reasonably robust to a range of changes. In addition to the quantified costs and benefits, there are potential benefits associated with preventing damage to biodiversity on 17140 h 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 1: Outcomes of analysis of costs and benefits for African Love Grass

Plan	Total NPV	Net Benefit of plan	Risk adjusted net benefit
Do Nothing	$29000000		
Eradication	$100000	$28520000	$18,380,000
Progressive Containment	$100000	$28550000	$18,430,000
Sustained Control	$30000	$28560000	$17,100,000

Table 3: 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

7.4 NPD Section 7 - Allocation of Costs and Benefits

7.4.1 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. Wider community from prevention of damage to biodiversity values.
- 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 4 and Table 5.

Table 4: Direct and indirect costs of plan for African Love Grass

Plan option	**Control costs landholders**	**Inspection and monitoring costs**
Sustained Control	$10000	$20000
Progressive Containment	$30000	$70000
Eradication	$60000	$80000

Table 5: Benefits and costs of plan for African Love Grass that accrue to different beneficiaries and exacerbators

Plan option	**Benefits for those currently infested**	**Benefits for those not currently infested**	**Costs for exacerbators**
Sustained Control	$-404	$29000000	$10000
Progressive Containment	$-14034	$29000000	$30000
Eradication	$-39981	$29000000	$60000

7.4.2 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 6 below.

Table 6: 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	Early infestation with only twenty sites in Otago.
Most effective control agents	Landholders 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 landholders 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 Love Grass 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.

7.4.3 Proposed allocation of costs

The benefits of control of African Love Grass are primarily to the rural community, although 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.

8 Boneseed

8.1 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. 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.

8.2 Proposed Plan

ORC is proposing that Boneseed is controlled through the Progressive Containment 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 Boneseed 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 Boneseed

Boneseed has the potential to cause loss of biodiversity on coastal areas.

8.3.3 Benefits for management of Boneseed

Prevention of loss of biodiversity and additional control costs. Net benefits are NPV $40,000 relative to the pest being kept at its current level. There is also the prevention of any impacts to biodiversity on an area of 990 ha after 100 years if the pest is allowed to spread.

8.3.4 Costs of Boneseed Plan

The plan will incur costs of control, inspection and monitoring. These are $6,500 annually for the plan option. Costs for all three options considered are a NPV of NPV $30,000 for Sustained Control, NPV $100,000 for Progressive Containment, and NPV $100,000 for Eradication (which has a shorter time frame).

8.3.5 Risks of Boneseed Plan

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

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

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 1 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 3 below. In addition to the quantified costs and benefits, there are potential benefits associated with preventing damage to biodiversity on 990 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 $370/ha in order for the plan to be worthwhile (see Table 2 below).

Table 1: Outcomes of analysis of costs and benefits for Boneseed

Plan	Total NPV	Net Benefit of plan	Risk adjusted net benefit
Do Nothing	$90,000		
Eradication	$770,000	-$680,000	-$740,000
Progressive Containment	$410,000	-$320,000	-$430,000
Sustained Control	$200,000	-$110,000	-$140,000

Table 2: Minimum value of biodiversity protected if option is to be positive

Plan	Minimum value of biodiversity needed for plan to be positive ($/ha)	Minimum risk adjusted value of biodiversity for plan to be positive ($/ha)
Eradication	$690	$750
Progressive Containment	$320	$370
Sustained Control	$110	$120

Table 3: 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

8.4 NPD Section 7 - Allocation of Costs and Benefits

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

The beneficiaries and exacerbators of the plan are:

- Beneficiaries: Wider community from prevention of damage to biodiversity and amenity values.
- Active exacerbators: Any persons transporting Boneseed into or around the region
- 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 4 and Table 5.

Table 4: Direct and indirect costs of plan for Boneseed

Plan option	Control costs landholders	Inspection and monitoring costs
Sustained Control	$200,000	$30,000
Progressive Containment	$400,000	$100,000
Eradication	$800,000	$100,000

Table 5: Benefits and costs of plan for Boneseed that accrue to different beneficiaries and exacerbators

Plan option	Benefits for those currently infested	Benefits for those not currently infested	Required benefit for community for biodiversity and ecological benefits in order for option to be positive	Costs for exacerbators
Sustained Control	$-157,036	$40,000	$110,000	$200,000
Progressive Containment	$-358,032	$40,000	$320,000	$400,000
Eradication	$-708,306	$40,000	$680,000	$800,000

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 6 below.

Table 6: Matters for consideration in allocating costs for proposed Boneseed plan

Legislative rights and responsibilities	None known
Management objectives	Progressive Containment
Stage of infestation	Early infestation with only 48 sites in Otago.
Most effective control agents	Landholders 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 landholders 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. Can be targeted through general rate.
Practicality of targeting exacerbators	Locations are limited and know, and exacerbators can be targeted.
Administrative efficiency	Exacerbators 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 Boneseed 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.

8.4.3 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.

9 Bur Daisy

9.1 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. Bur daisy is present on only one site in Otogo, but has potential to occupy dry hill country across the region.

9.2 Proposed Plan

ORC is proposing that Bur Daisy is controlled through the Progressive Containment 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 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.

9.3.2 Impacts of Bur Daisy

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

9.3.3 Benefits for management of Bur Daisy

Prevention of loss of production from pastoral agriculture in hill and high country. Net benefits are NPV $3,000,000 relative to the pest being kept at its current level. There is also the prevention of any impacts to biodiversity on an area of 1750 ha after 100 years if the pest is allowed to spread.

9.3.4 Costs of Bur Daisy Plan

The plan will incur costs of control, inspection and monitoring. These are $1800 annually for the plan option. Costs for all three options considered are a NPV of NPV $7,000 for Sustained Control, NPV $30,000 for Progressive Containment, and NPV $30,000 for Eradication (which has a shorter time frame).

9.3.5 Risks of Bur Daisy Plan

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

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

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 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 3 below, and suggests that either Progressive Containment or Eradication are likely to be the highest value options. In addition to the quantified costs and benefits, there are potential benefits associated with preventing damage to biodiversity on 1750 ha, and intergenerational implications that should be taken into account.

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

Table 1: Outcomes of analysis of costs and benefits for Bur Daisy

Plan	Total NPV	Net Benefit of plan	Risk adjusted net benefit
Do Nothing	$2,650,000		
Eradication	$7,000	$2,650,000	$1,660,000
Progressive Containment	$1,000	$2,650,000	$1,670,000
Sustained Control	$2,000	$2,650,000	$1,580,000

Table 3: 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%	Progressive Containment
Discount rate 8%	Progressive Containment

9.4 NPD Section 7 - Allocation of Costs and Benefits

9.4.1 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 4 and Table 5.

Table 4: Direct and indirect costs of plan for Bur Daisy

Plan option	**Control costs landholders**	**Inspection and monitoring costs**
Sustained Control	$1,000	$7,000
Progressive Containment	$3,000	$30,000
Eradication	$6,000	$30,000

Table 5: Benefits and costs of plan for Bur Daisy that accrue to different beneficiaries and exacerbators

Plan option	**Benefits for those currently infested**	**Benefits for those not currently infested**	**Costs for exacerbators**
Sustained Control	$100	$3,000,000	$1,000
Progressive Containment	$-1261	$3,000,000	$3,000
Eradication	$-3800	$3,000,000	$6,000

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 6 below.

Table 6: Matters for consideration in allocating costs for proposed Bur Daisy plan

Legislative rights and responsibilities	None known
Management objectives	Progressive Containment
Stage of infestation	Early infestation with only one site in Otago.
Most effective control agents	Landholders 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 landholders 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 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.

9.4.3 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 to have an effect, although a contribution from rates to assist with control may be appropriate to ensure that it is done well. 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 with some potential for contribution from the rural rate to ensure effective control.

10 Cape Ivy

10.1 Description

Cape Ivy (*Senecio angulatus*) is a scrambling perennial, often forming a dense tangled shrub to 2-3 m tall, with wiry to woody stems that are sparingly branched. It produces many long-lived seeds that are wind dispersed a long way from parent plants, and it tolerates salt, wind, drought, semi-shade and damage. It is found in coastal areas, rocky areas, cliffs, bush edges, regenerating lowland forests and smothers ground and low-growing plants to 3 m tall, forming dense, long-lived mats that prevent the establishment of native plant seedlings.

10.2 Proposed Plan

ORC is proposing that Cape Ivy is controlled through the Progressive Containment objective described in Section 1(b) of the NPD.

10.3 NPD Section 6 Assessment

10.3.1 Level of analysis

The assessed level of analysis for Cape Ivy 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.

10.3.2 Impacts of Cape Ivy

Cape Ivy has the potential to cause biodiversity in a range of habitats.

10.3.3 Benefits for management of Cape Ivy

The benefits of management of Cape Ivy is the prevention of any impacts to biodiversity on an area of 4650 ha after 100 years if the pest is allowed to spread.

10.3.4 Costs of Cape Ivy Plan

The plan will incur costs of control, inspection and monitoring. These are $4500 annually for the plan option. Costs for all three options considered are a NPV of NPV $20,000 for Sustained Control, NPV $70,000 for Progressive Containment, and NPV $80,000 for Eradication (which has a shorter time frame).

10.3.5 Risks of Cape Ivy Plan

Technical and operational risks: Progressive Containment is technically difficult to achieve, particularly with a wind dispersed plant.

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

10.3.6 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 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 3 below and suggests that it is relatively robust to changes in individual parameters. In addition to the quantified costs and benefits, there are potential benefits associated with preventing damage to biodiversity on 4650 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. Particularly important to this conclusion is the assumption that 10% of the area affected would be controlled in the absence of the plan.

Table 1: Outcomes of analysis of costs and benefits for Cape Ivy

Plan	Total NPV	Net Benefit of plan	Risk adjusted net benefit
Do Nothing	$7,830,000		
Eradication	$110,000	$7,720,000	$4,850,000
Progressive Containment	$60,000	$7,770,000	$4,930,000
Sustained Control	$9,000	$7,820,000	$2,310,000

Table 3: 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%	Progressive Containment
Discount rate 8%	Progressive Containment

10.4 NPD Section 7 - Allocation of Costs and Benefits

10.4.1 Beneficiaries, exacerbators and costs of proposed plan for control of Cape Ivy

The beneficiaries and exacerbators of the plan are:

- Beneficiaries: Community from prevention of damage to biodiversity values.
- Active exacerbators: Any persons transporting Cape Ivy into or around the region.
- Passive exacerbators: Any persons with Cape Ivy on their property not undertaking control.

The direct and indirect costs associated with the plan are shown below in Table 4 and Table 5.

Table 4: Direct and indirect costs of plan for Cape Ivy

Plan option	**Control costs landholders**	**Inspection and monitoring costs**
Sustained Control	$10,000	$20,000
Progressive Containment	$60,000	$70,000
Eradication	$100,000	$80,000

Table 5: Benefits and costs of plan for Cape Ivy that accrue to different beneficiaries and exacerbators

Plan option	**Benefits for those currently infested**	**Benefits for those not currently infested**	**Costs for exacerbators**
Sustained Control	$-6,647	$8,000,000	$10,000
Progressive Containment	$-56,365	$8,000,000	$60,000
Eradication	$-108,257	$8,000,000	$100,000

10.4.2 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 6 below.

Table 6: Matters for consideration in allocating costs for proposed Cape Ivy plan

Legislative rights and responsibilities	None known
Management objectives	Progressive Containment
Stage of infestation	Well established with 60 sites in Otago.
Most effective control agents	Landholders 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 landholders 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 exacerbators can be targeted.
Administrative efficiency	Exacerbators 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 Cape Ivy 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.

10.4.3 Proposed allocation of costs

Cape Ivy is sufficiently widespread for council control to no longer be cost effective, and it is likely that landholder control as exacerbators will be most efficient. This will ensure that landholders manage land, particularly in the city, to minimise the risk of Cape Ivy infestations. For large infestations on private land council should fund initial control costs through general rate because the costs to landholders would not be reasonable.

The benefits from the management of Cape Ivy accrue to the general community from prevention of damage to biodiversity values and reduced future control costs. It is therefore appropriate that the inspection and monitoring costs be funded through General Rate.

11 Nassella Tussock

11.1 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 100,000 ha of Canterbury distributed among 3 main areas. 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 1.5 million ha could potentially be infested with Nassella Tussock in Otago. 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.

11.2 Proposed Plan

ORC is proposing that Nassella Tussock is controlled through the Progressive Containment 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 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.

11.3.2 Impacts of Nassella Tussock

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

11.3.3 Benefits for management of Nassella Tussock

Prevention of loss of production from pastoral agriculture in hill and high country. Net benefits are NPV $228,000,000 relative to the pest being kept at its current level. There is also the prevention of any impacts to biodiversity on an area of 146,150 ha after 100 years if the pest is allowed to spread.

11.3.4 Costs of Nassella Tussock Plan

The plan will incur costs of control, inspection and monitoring. These are $45,000 annually for the plan option. Costs for all three options considered are a NPV $40,000 for Sustained Control, NPV $700,000 for Progressive Containment, and NPV $2,000,000 for Eradication (which has a shorter time frame).

11.3.5 Risks of Nassella Tussock Plan

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

11.3.6 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 23 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 26 below which suggests that the Sustained Control remains the highest value option with changes to single assumptions. In addition to the quantified costs and benefits, there are potential benefits associated with preventing damage to biodiversity on 140,000 ha that should be taken into account.

Progressive Containment would be justified as higher value if the risks of non-achievement were considered to be lower than have been assumed for this analysis. However it should be noted that work undertaken by AgResearch in Canterbury showed that even with intensive inspection and annual control a number of plants were missed and set seed every year, and there was no overall trend in Nassella occurrence based on transects through infested areas.

Table 23: Outcomes of analysis of costs and benefits for Nassella Tussock

Plan	Total NPV	Net Benefit of plan	Risk adjusted net benefit
Do Nothing	$264,140,000		
Eradication	$77,210,000	$186,930,000	$87,680,000
Progressive Containment	$29,550,000	$234,590,000	$111,970,000
Sustained Control	$22,710,000	$241,430,000	$119,670,000

Table 24: 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

11.4 NPD Section 7 - Allocation of Costs and Benefits

11.4.1 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.
- 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 4 and Table 5.

Table 4: Direct and indirect costs of plan for Nassella Tussock

Plan option	Control costs landholders	Inspection and monitoring costs
Sustained Control	$15,000,000	$400,000
Progressive Containment	$29,000,000	$700,000
Eradication	$77,000,000	$2,000,000

Table 5: Benefits and costs of plan for Nassella Tussock that accrue to different beneficiaries and exacerbators

Plan option	Benefits for those currently infested	Benefits for those not currently infested	Required benefit for community for biodiversity and ecological benefits in order for option to be positive	Costs for exacerbators
Sustained Control	$6,350,000	$235,000,000	$-241,430,000	$15,000,000
Progressive Containment	$-448,880	$235,000,000	$-234,590,000	$29,000,000
Eradication	$-48,350,736	$235,000,000	$-186,930,000	$77,000,000

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 6 below.

Table 6: Matters for consideration in allocating costs for proposed Nassella Tussock plan

Legislative rights and responsibilities	None known
Management objectives	Progressive Containment
Stage of infestation	Early infestation with four areas of infestation in Otago.
Most effective control agents	Landholders are most effective because it requires control and measures to ensure that seed does not spread.
Urgency	Moderate urgency to prevent further spread outside current sites.
Efficiency and effectiveness	It is likely that requiring landholders 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 known, and exacerbators can be targeted.
Administrative efficiency	Exacerbators 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.

11.4.3 Proposed allocation of costs

The benefits of the plan are largely to the rural community that is not currently affected. However the pest is widespread and control being undertaken by landholders will encourage improved management of land to prevent infestations and spread. The proposed allocation of costs is therefore:

- Control costs – landholders with nassella tussock on their property as exacerbators.
- Inspection and monitoring costs – rural landholders for prevention of spread of nassella tussock onto uninfested land.

12 Old Mans Beard

12.1 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.

12.2 Proposed Plan

ORC is proposing that Old Mans Beard is controlled through the Progressive Containment 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 Old Mans Beard 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.

12.3.2 Impacts of Old Mans Beard

Old Mans Beard has the potential to cause loss of biodiversity through smothering and displacing native vegetation.

12.3.3 Benefits for management of Old Mans Beard

Prevention of loss biodiversity. Net benefits are NPV $35,000,000 relative to the pest being kept at its current level through prevented control action. There is also the prevention of any impacts to biodiversity on an area of 68,000 ha after 100 years if the pest is allowed to spread.

12.3.4 Costs of Old Mans Beard Plan

The plan will incur costs of control, inspection and monitoring. These are $130,000 annually for the plan option. Costs for all three options considered are a NPV of NPV $100,000 for Sustained Control, NPV $2,000,000 for Progressive Containment, and NPV $5,000,000 for Eradication (which has a shorter time frame).

12.3.5 Risks of Old Mans Beard Plan

Technical and operational risks: Progressive Containment is technically difficult to achieve, and requires adaptation of management techniques by farmers. Old Mans Beard 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

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 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 3 below. In addition to the quantified costs and benefits, there are potential benefits associated with preventing damage to biodiversity on 68,000 ha 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 1: Outcomes of analysis of costs and benefits for Old Mans Beard

Plan	Total NPV	Net Benefit of plan	Risk adjusted net benefit
Do Nothing	$36,100,000		
Eradication	$35,460,000	$630,000	-$5,170,000
Progressive Containment	$14,370,000	$21,730,000	$10,150,000
Sustained Control	$3,750,000	$32,350,000	$8,270,000

Table 3: 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%	Progressive Containment
Discount rate 8%	Progressive Containment

12.4 NPD Section 7 - Allocation of Costs and Benefits

12.4.1 Beneficiaries, exacerbators and costs of proposed plan for control of Old Mans Beard

The beneficiaries and exacerbators of the plan are:

- Beneficiaries: Wider community from prevention of impacts on biodiversity and amenity values.
- 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 plan are shown below in Table 4 and Table 5.

Table 4: Direct and indirect costs of plan for Old Mans Beard

Plan option	Control costs landholders	Inspection and monitoring costs
Sustained Control	$4,000,000	$100,000
Progressive Containment	$14,000,000	$2,000,000
Eradication	$35,000,000	$5,000,000

Table 5: Benefits and costs of plan for Old Mans Beard that accrue to different beneficiaries and exacerbators

Plan option	**Benefits for those currently infested**	**Benefits for those not currently infested**	**Costs for exacerbators**
Sustained Control	$-2,991,158	$35,000,000	$4,000,000
Progressive Containment	$-13,460,212	$35,000,000	$14,000,000
Eradication	$-34,594,248	$35,000,000	$35,000,000

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 6 below.

Table 6: Matters for consideration in allocating costs for proposed Old Mans Beard plan

Legislative rights and responsibilities	None known
Management objectives	Progressive Containment
Stage of infestation	Well established with 120 sites in Otago.
Most effective control agents	Landholders 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 landholders 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.
Practicality of targeting exacerbators	Locations are limited and know, and exacerbators can be targeted.
Administrative efficiency	Exacerbators 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 Old Man's Beard for some time. Assistance may be required for large infestations on private land as control costs may be unreasonably high.
Mechanisms available	General rate, targeted rate (rural properties) and direct charges are the most readily available mechansisms. Levies are expensive to establish and administer.

12.4.3 Proposed allocation of costs

The benefits of the plan are largely to the wider community for prevention of damage to biodiversity. The pest is widespread and control being undertaken by landholders will encourage better identification and control of the pest. The proposed allocation of costs is therefore:

- Control costs – landholders with old man's beard on their property as exacerbators. For large infestations on private land council should fund initial control costs through general rate because the costs to landholders would not be reasonable.
- Inspection and monitoring costs – wider community through general rate for prevention of damage to biodiversity values and saved future control costs.

13 Perennial Nettle

13.1 Description

Perennial nettle can grow up to 1.5 metres high. Its stems are woody, its flowers are green and its leaf is a lighter colour green than common stinging nettle (*Urtica urens*). It grows taller than common stinging nettle and it has an extensive system of underground rhizomes, whereas common nettle does not have rhizomes. The seeds are 1 to 1.5mm long, flat, oval and yellow to greyish in colour. Its underground rhizomes can spread 2.5m in a season.

It is a particular problem in South Otago mainly Balclutha, Lawrence and Clydevale (along the Clutha River).

The sting causes itching and burning which may last for several days. Animals shy away from the plant because of its stinging hairs. The pollen from this plant may cause hay fever.

Perennial Nettle's extensive system of underground rhizomes, and its ability to form tall dense stands means it can easily invade paddocks and dominate good pasture. It tolerates a wide range of conditions, soil types and localities from shade and damp, to very dry. It can be found in pastures, in areas where stock shelter or congregate, waste areas, river banks, roadsides and old house sites.

13.2 Proposed Plan

ORC is proposing that Perennial Nettle 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 Perennial Nettle 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 Perennial Nettle

Perennial Nettle has the potential to cause loss of production from pastoral agriculture.

13.3.3 Benefits for management of Perennial Nettle

Prevention of loss of production from pastoral agriculture. Net benefits are NPV $13,000,000 relative to the pest being kept at its current level. There is also the prevention of any impacts to biodiversity on an area of 21,000 ha after 100 years if the pest is allowed to spread.

13.3.4 Costs of Perennial Nettle Plan

The plan will incur costs of control, inspection and monitoring. These are $2500 annually for the plan option. Costs for all three options considered are a NPV of NPV $10,000 for Sustained Control, NPV $40,000 for Progressive Containment, and NPV $60,000 for Eradication.

13.3.5 Risks of Perennial Nettle Plan

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

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 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 3 below and the analysis suggests that the conclusion is robust to changes in a number of single assumptions. In addition to the quantified costs and benefits, there are potential benefits associated with preventing damage to biodiversity on 21350 ha 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 1: Outcomes of analysis of costs and benefits for Perennial Nettle

Plan	Total NPV	Net Benefit of plan	Risk adjusted net benefit
Do Nothing	$13,360,000		
Eradication	$1,180,000	$12,190,000	$7,910,000
Progressive Containment	$480,000	$12,890,000	$8,300,000
Sustained Control	$130,000	$13,230,000	$3,940,000

Table 3: 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%	Progressive Containment
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 Perennial Nettle

The beneficiaries and exacerbators of the plan are:

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

The direct and indirect costs associated with the plan are shown below in Table 4 and Table 5.

Table 4: Direct and indirect costs of plan for Perennial Nettle

Plan option	Control costs landholders	Inspection and monitoring costs
Sustained Control	$100,000	$10,000
Progressive Containment	$500,000	$40,000
Eradication	$1,000,000	$60,000

Table 5: Benefits and costs of plan for Perennial Nettle that accrue to different beneficiaries and exacerbators

Plan option	Benefits for those currently infested	Benefits for those not currently infested	Costs for exacerbators
Sustained Control	$-23,898	$13,000,000	$100,000
Progressive Containment	$-367,721	$13,000,000	$500,000
Eradication	$-1,072,189	$13,000,000	$1,000,000

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 6 below.

Table 6: Matters for consideration in allocating costs for proposed Perennial Nettle plan

Legislative rights and responsibilities	None known
Management objectives	Progressive Containment
Stage of infestation	Well established with 15 sites in Otago.
Most effective control agents	Landholders 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 landholders 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 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 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.

13.4.3 Proposed allocation of costs

The benefits of the plan are largely to the rural community that is not currently affected. However the pest is moderately widespread and control being undertaken by landholders will encourage improved management of land to prevent infestations and spread. The proposed allocation of costs is therefore:

- Control costs – landholders with perennial nettle on their property as exacerbators.
- Inspection and monitoring costs – rural landholders for prevention of spread of perennial nettle tussock onto uninfested land.

14 Spartina

14.1 Description

Spartina is a perennial estuarine sward grass, commonly one metre tall and growing in shallow saltwater. It has stiff, upright stems, originating from thick rhizomes. The stems have broad, pointed leaves from their base to the top, where several long fingers contain the seed. New growth occurs from either root pieces or seed. Shoots rapidly sprout from belowground rhizomes, while the seed falls into the water and floats away.

Scattered infestations occur in Pleasant River Estuary, Karitane Estuary, the Lower Taieri Gorge and Catlins lake.

Colonies of spartina form dense grassy clumps, and these can spread laterally from underground rhizomes, or by over ground side shoots (tillers). Within the estuarine area, vast meadows can form causing a build-up of sediment. This can increase the risk of flooding and also alter the habitat for wading bird species and other estuarine flora and fauna

14.2 Proposed Plan

ORC is proposing that Spartina 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 Spartina 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 Spartina

Spartina has the potential to cause loss of biodiversity in estuarine ecosystems and increase the potential for flooding.

14.3.3 Benefits for management of Spartina

Prevention of loss of biodiveristy on an area of 630 ha after 100 years if the pest is allowed to spread.

14.3.4 Costs of Spartina Plan

The plan will incur costs of control, inspection and monitoring. These are $17,660 annually for the plan option. Costs for all three options considered are a NPV $70,000 for Sustained Control, NPV $300,000 for Progressive Containment, and NPV $400,000 for Eradication (which has a shorter time frame).

14.3.5 Risks of Spartina Plan

Technical and operational risks: Spartina has been under control for a long period with limited progress.

Implementation and compliance: Control will be undertaken by public agencies so minimal compliance 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 1 below. In terms of those alternatives considered, the Do Nothing option has the highest net value before biodiversity values are taken into account. The sensitivity of this conclusion to changes in various input parameters is shown in Table 3 below. In addition to the quantified costs and benefits, there are potential benefits associated with preventing damage to biodiversity on 630 ha 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 $6430/ha in order for the plan to be worthwhile (see Table 2 below). If Sustained Control were the option, the value assigned to biodiversity would be only $3,270/ha assuming that spread could be prevented through this option.

These factors suggest that the Sustained Control is likely to be the preferred option if a value in excess of NPV $3270 or $200/ha/year is assigned to estuarine biodiversity values. Progressive Containment would be considered higher value if the risks of further spread were too high under Sustained Control.

Table 1: Outcomes of analysis of costs and benefits for Spartina

Plan	Total NPV	Net Benefit of plan	Risk adjusted net benefit
Do Nothing	$980,000		
Eradication	$19,650,000	-$18,670,000	-$11,750,000
Progressive Containment	$7,890,000	-$6,900,000	-$5,580,000
Sustained Control	$3,740,000	-$2,760,000	-$2,090,000

Table 2: Minimum value of biodiversity protected if option is to be positive

Plan	Minimum value of biodiversity needed for plan to be positive ($/ha)	Minimum risk adjusted value of biodiversity for plan to be positive ($/ha)
Eradication	$29,630	$22,330
Progressive Containment	$10,950	$8,630
Sustained Control	$4,380	$3,270

Table 3: 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

14.4 NPD Section 7 - Allocation of Costs and Benefits

14.4.1 Beneficiaries, exacerbators and costs of proposed plan for control of Spartina

The beneficiaries and exacerbators of the plan are:

- Beneficiaries: Wider community from prevention of damage to estuarine biodiversity values.
- Active exacerbators: Any persons transporting Spartina into or around the region
- Passive exacerbators: Any persons with Spartina on their property not undertaking control.

The direct and indirect costs associated with the plan are shown below in Table 4 and Table 5.

Table 4: Direct and indirect costs of plan for Spartina

Plan option	Control costs landholders	Inspection and monitoring costs
Sustained Control	$4,000,000	$70,000
Progressive Containment	$8,000,000	$300,000
Eradication	$20,000,000	$400,000

Table 5: Benefits and costs of plan for Spartina that accrue to different beneficiaries and exacerbators

Plan option	Benefits for those currently infested	Benefits for those not currently infested	Required benefit for community for biodiversity and ecological benefits in order for option to be positive	Costs for exacerbators
Sustained Control	$-3,323,509	$600,000	$2,760,000	$4,000,000
Progressive Containment	$-7,476,496	$600,000	$6,900,000	$8,000,000
Eradication	$-19,219,026	$600,000	$18,670,000	$20,000,000

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 6 below.

Table 6: Matters for consideration in allocating costs for proposed Spartina plan

Legislative rights and responsibilities	None known
Management objectives	Progressive Containment
Stage of infestation	Well established but limited number of sites.
Most effective control agents	Land is not privately owned so public agencies most effective for control.
Urgency	Moderate urgency to prevent spread
Efficiency and effectiveness	There are few alternative options for effective control to public agencies. Voluntary action is unlikely to be effective.
Practicality of targeting beneficiaries	Beneficiaries are the wider community for biodiversity values.
Practicality of targeting exacerbators	No specific exacerbators as no private land.
Administrative efficiency	General rate would have greater administrative efficiency.
Security	Rating mechanisms are most secure.
Fairness	Benefits accrue to the wider community, and there are no targetable exacerbators.
Reasonable	Costs may be high in some areas.
Parties bearing indirect costs	None likely.
Transitional cost allocation arrangements	None required as spartina has been under control 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.

14.4.3 Proposed allocation of costs

The benefits of the control of Spartina accrue to the wider community, and there are no targetable exacerbators. Control and inspection should be funded from the general rate.

15 White-edged nightshade

15.1 Description

White-edged nightshade is a quick growing perennial shrub that can grow up to 5 metres tall. The large woody stems and green oak-shaped leaves are covered in sharp spines. Its leaves have white veins on the upper surface and dense chalky-white hairs on the underside. In summer white or pale mauve flowers bloom in clusters at the end of branches. Green-yellow tomato-shaped berries grow on the ends of prickly stalks.

It is confined to one site near Hampden, but is also known to have existed on Quarantine Island in the Otago harbour.

The shrub is well adapted to dry areas. Once established, it forms dense thickets that are impenetrable to stock. It also prevents the establishment of native understory on margins of native bush.

15.2 Proposed Plan

ORC is proposing that White-edged nightshade is controlled through the Progressive Containment 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 White-edged nightshade 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 White-edged nightshade

White-edged nightshade has the potential to cause damage to biodiversity values and loss of production from pastoral agriculture in hill and high country.

15.3.3 Benefits for management of White-edged nightshade

Prevention of any impacts to biodiversity on an area of 16,000 ha after 100 years if the pest is allowed to spread. Prevention of loss of production from pastoral agriculture in hill and high country. Net benefits are NPV $50000 relative to the pest being kept at its current level.

15.3.4 Costs of White-edged nightshade Plan

The plan will incur costs of control, inspection and monitoring. These are $500 annually for the plan option. Costs for all three options considered are a NPV of NPV $2,000 for Sustained Control, NPV $8,000 for Progressive Containment, and NPV $9,000 for Eradication (which has a shorter time frame).

15.3.5 Risks of White-edged nightshade Plan

Technical and operational risks: None known.

Implementation and compliance: Ensuring compliance with management regime 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

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 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 3 below and is sensitive to a variety of assumptions with both Eradication and Sustained Control being the preferred option under different sets of assumptions. In addition to the quantified costs and benefits, there are potential benefits associated with preventing damage to biodiversity on 16,000 ha that should be taken into account.

These factors suggest that the Progressive Containment option is favoured as the producing the highest net benefit if the assumptions made in this analysis are considered reasonable, although the decision makers may wish to consider the outcomes under alternative assumptions.

Table 1: Outcomes of analysis of costs and benefits for White-edged nightshade

Plan	Total NPV	Net Benefit of plan	Risk adjusted net benefit
Do Nothing	$110,000		
Eradication	$10,000	$90,000	$40,000
Progressive Containment	$6,000	$100,000	$50,000
Sustained Control	$3,000	$100,000	$30,000

Table 3: 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%	Progressive Containment
Discount rate 8%	Progressive Containment

15.4 NPD Section 7 - Allocation of Costs and Benefits

15.4.1 Beneficiaries, exacerbators and costs of proposed plan for control of White-edged nightshade

The beneficiaries and exacerbators of the plan are:

- Beneficiaries: Wider community from prevention of damage to biodiversity values, and rural community from prevention of spread and production benefits.
- Active exacerbators: Any persons transporting White-edged nightshade into or around the region
- Passive exacerbators: Any persons with White-edged nightshade on their property not undertaking control.

The direct and indirect costs associated with the plan are shown below in Table 4 and Table 5.

Table 4: Direct and indirect costs of plan for White-edged nightshade

Plan option	Control costs landholders	Inspection and monitoring costs
Sustained Control	$3,000	$2,000
Progressive Containment	$6,000	$8,000
Eradication	$10,000	$9,000

Table 5: Benefits and costs of plan for White-edged nightshade that accrue to different beneficiaries and exacerbators

Plan option	Benefits for those currently infested	Benefits for those not currently infested	Costs for exacerbators
Sustained Control	$-3,000	$100,000	$3,000
Progressive Containment	$-6,000	$100,000	$6,000
Eradication	$-11,000	$100,000	$10,000

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 6 below.

Table 6: Matters for consideration in allocating costs for proposed White-edged nightshade plan

Legislative rights and responsibilities	None known
Management objectives	Progressive Containment
Stage of infestation	Early infestation with only one site in Otago.
Most effective control agents	Landholders are most effective because it requires integration with land management.
Urgency	Moderate urgency to prevent spread
Efficiency and effectiveness	It is likely that requiring landholders 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 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 White edged nightshade 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.

15.4.3 Proposed allocation of costs

The benefits of the plan are largely to the wider community for prevention of damage to biodiversity, but also to the rural community for prevention of damage to production values.

Control being undertaken by landholders will encourage improved management of land to prevent infestations and spread. The proposed allocation of costs is therefore:

- Control costs – landholders with white edged nightshade on their property as exacerbators.
- Inspection and monitoring costs
    - 50% wider community through general rate for prevention of damage to biodiversity values and saved future control costs.
    - 50% rural community for prevention of damage to production values through a targeted rural rate.

16 Wilding Conifers

Wilding conifers and the associated analysis refers to plants that have spread naturally, with low economic benefits and with potential to spread further in an uncontrolled manner. It is appropriate to group these species because they behave similarly, occupy similar habitat, and in some cases occur as mixed stands that must be controlled together. In addition to naturally spread species it covers all occurrences of the following conifer species:

Contorta (lodgepole) pine	*Pinus contorta*
Corsican pine	*Pinus nigra*
Larch	*Larix decidua*
Mountain pine and dwarf mountain pine	*Pinus mugo and P.uncinata*
Scots pine	*Pinus sylvestris*

16.1 Proposed programme

ORC is proposing that Wilding Conifers are controlled through a Progressive Containment regime. It may be that differential levels of effort will be applied to different areas depending on the risk of spread and damage to biodiversity values.

16.2 NPD Section 6 Assessment

16.2.1 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.

16.2.2 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 Otago (42,188 ha[8]). 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 150m/year. This approach allows the model to replicate the approach taken by

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[8] From Wildlands 2016

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 that was productive 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 which was used directly as an estimate of productive land.

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 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 Otago. It also ensures that the estimate is conservative in relation to the impacts on irrigation. The assumption is that there is a linear relationship between the reduction in water yield and irrigation impacts. Hydro impacts are not considered likely to be major in Otago because the major hydro resource in Lake Manapouri is currently forested and therefore not particularly vulnerable to impacts from wilding invasion.

Hydro impacts are calculated for the Clutha catchment which is the largest hydro scheme in the region comprising the Clyde dam (2100GWh) and Roxburgh dam (1650GWh). There is also the Waipori scheme near Dunedin which has an annual capacity of 192GWh and although this is also potentially affected by wildings it is relatively minor part of the region's generation capacity. The hydro impact in the Clutha is estimated by calculating the share of the catchment that is vulnerable to wilding pines (55%) and multiplying this proportion by the total estimated gross revenue of the catchment (less an allowance for 6% spillage). This gives an estimate of $66.34/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 Clutha share of wilding prone land (36% of Class 6 and 7 land is in the Clutha), giving an average loss per ha occupied by wildings in Otago of $23.75/ha/annum.

The impact on irrigation for the catchment is estimated using the irrigated and dryland figures for an assessment of wilding impacts in Canterbury (Harris, 2016). The irrigated areas in Otago are estimated from Statistics NZ (2017) data as 92,080 ha. The impact of wildings is assumed to occur only on Class 6 and 7 land and only in proportion to the land potentially occupied by wildings (55%) which is $19.08 /ha infested by wildings. This likely overestimates the total impact because a proportion of the irrigated area in Otago will source water from the Waitaki, which lies outside the region's boundaries. Nevertheless it provides an adequate estimate for the purposes of this study.

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 81,000 estimated households in Otago (Statistics NZ privately occupied dwellings) this gives an annual cost of $26.7 million per annum. It is assumed that this benefit is all lost when wildings occupy their full potential habitat which gives an average biodiversity value of $36.95/ha/annum for land currently unaffected.

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 likely to be affected in Otago. Carbon sequestration values are potentially quantifiable based on the value of carbon (~$18/NZU August 2016) and estimates are available 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.

16.2.3 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. They may also cause impacts for irrigators and other water users through reduced water availability, honey production, and landscape and amenity values.

16.2.4 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%) $290 million in costs for control, lost production, reduced irrigation, and loss of biodiversity.

16.2.5 Costs of Wilding Conifers Programme

The plan will incur costs of control, inspection, and monitoring. These are $120,000 annually for the Progressive Containment option. Costs for all three options considered are an NPV(6%) of $500,000 for Sustained Control, NPV $2,000,000 for Progressive Containment, and NPV $3,000,000 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.

16.2.6 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. The low level of costs allowed to inspect and manage wildings increases the risk of non-achievement.

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

16.2.7 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 25, Table 26 and Table 27 below. In terms of those alternatives considered, the Progressive Containment option has the net benefit and the highest risk adjusted net value when risks associated with achievement of the objectives are taken into account. The sensitivity analysis in Table 28 shows that the conclusion that Progressive Containment has the highest risk adjusted net benefit is robust to a range of changes in the assumptions. The potential benefits associated with preventing damage to biodiversity on 300,000 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.

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 may also be an input of national funding into reduction of areas infested by wilding conifers that will reduce the regional costs.

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 16.2.4 and 16.2.5. 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 Progressive Containment 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 low level of inspection and monitoring costs assumed as required to achieve the outcomes, and 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 25: Scenario outcomes by item for Wilding Conifers

	Scenario outcome ($ million NPV)			
Item	**Do Nothing**	**Sustained Control**	**Progressive Containment**	**Eradication**
Cost of control	$35.9	$83.1	$315.7	$785.4
Cost of lost production	$246.2	$149.5	$3.2	$0.0
Inspection, monitoring etc.	$0.0	$0.5	$2.0	$2.8
Hydro losses	$178.2	$107.3	$0.0	$0.0
Irrigation losses	$143.2	$86.3	$0.0	$0.0
Biodiversity losses	$277.3	$167.0	-$0.1	$0.0
Total	**$880.9**	**$593.6**	**$320.7**	**$788.2**

Table 26: Net benefit for plan option by item for Wilding Conifers

	Net Benefit ($ million NPV)		
Item	**Sustained Control**	**Progressive Containment**	**Eradication**
Cost of control	-$47.1	-$279.8	-$749.4
Cost of lost production	$96.8	$243.0	$246.2
Inspection, monitoring etc.	-$0.5	-$2.0	-$2.8
Hydro benefits	$70.9	$178.3	$178.2
Irrigation benefits	$57.0	$143.3	$143.2
Biodiversity benefits	$110.3	$277.4	$277.3
Total	**$287.3**	**$560.2**	**$92.7**

Table 27: Outcomes of analysis of costs and benefits for Wilding Conifers

Programme	**Risk adjusted net benefit (NPV(6%) $ million**
Eradication	-$15
Progressive Containment	$226
Sustained Control	$89

Table 28: 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%	Progressive Containment
Discount rate 8%	Progressive Containment

16.3 NPD Section 7 - Allocation of Costs and Benefits

16.3.1 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, or persons with plantation forestry which is spreading seeds onto neighbouring properties.

The direct and indirect costs associated with the programme are shown below in Table 29 and Table 30.

Table 29: 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	$83,000,000	$500,000
Progressive Containment	$316,000,000	$2,000,000
Eradication	$785,000,000	$3,000,000

Table 30: 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	$39,820,000	$609,000,000	$83,000,000
Progressive Containment	$-46,547,600	$609,000,000	$316,000,000
Eradication	$-513,015,374	$609,000,000	$785,000,000

Table 31: Estimate of share of net benefit by benefit type for Progressive Containment option (% of total net benefit)

Item	Share of net benefit for Progressive Containment
Cost of control	-50%
Cost of lost production	43%
Inspection, monitoring etc.	0%
Hydro benefits	32%
Irrigation benefits	26%
Biodiversity benefits	50%
Total	**100%**

16.3.2 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 32: 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 of 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 irrigated properties and hydro assets potentially affected the reduction in water associated with 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 irrigated properties and hydro assets 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.

16.3.3 Proposed allocation of costs

The analysis in Table 31 suggests that cost of control is approximately equal to the production benefits, although the benefits and costs are not equally shared with those currently infested experiencing the costs of control, while those not currently infested would receive benefits from both control costs saved and reduced production losses. The hydro and irrigation benefits are both substantial, and the biodiversity benefits are all a substantial part of the net benefit from the Progressive Containment option. Other benefits are negligible.

The analysis therefore suggests that the cost of the programme should be spread between the landholders who benefit, including those protected from spread, and the wider regional community.

Landholder 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 for reasons of practicality and efficiency. This would target all parties receiving production, hydro, irrigation and biodiversity benefits. Ongoing removal of wildings following effective control should be the role of landholder as exacerbators.

The recommendation for funding is therefore:

- Inspection and monitoring costs: 100% General Rate.
- Initial large scale control: 100% General Rate.
- Ongoing control following initial control: 100% landholder

17 Bomarea

17.1 Description

Bomarea is a shade tolerant, multi-stemmed vine that arises from short underground rhizomes, which bear numerous tubers. It invades alongside streams and river banks, shrublands, forest edges, forest remnants and intact low canopy forest. The vines grow into the forest canopy, forming large masses, which overtop and smother supporting trees. Large infestations can alter light levels in forests, kill mature trees and prevent seedlings from establishing. Bomarea produces bright fleshy orange seeds, which can be dispersed over long distances by birds.

Bomarea is known to be present, or has been present, across 870 properties in Otago, primarily in Dunedin City, Otago Peninsula, and West Harbour areas.

17.2 Proposed Plan

ORC is proposing that Bomarea is controlled through the Progressive Containment 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 Bomarea 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.

17.3.2 Impacts of Bomarea

Bomarea has the potential to cause damage to biodiversity values on stream and river banks, shrublands, forest edges, forest remnants and intact low canopy forest.

17.3.3 Benefits for management of Bomarea

Prevention of damage to biodiversity on an area of 9850 ha after 100 years if the pest is allowed to spread and prevention of future control costs.

17.3.4 Costs of Bomarea Plan

The plan will incur costs of control, inspection and monitoring. These are $36,000 annually for the plan option. Costs for all three options considered are a NPV of NPV $100,,000 for Sustained Control, NPV $600000 for Progressive Containment, and NPV $900,000 for Eradication (which has a shorter time frame).

17.3.5 Risks of Bomarea Plan

Technical and operational risks: Progressive Containment is technically difficult to achieve, particularly with bird spread seeds.

Implementation and compliance: Ensuring compliance with management regime will be difficult when so many properties are affected 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

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 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 3 below which suggests that the conclusions are robust to changes in individual parameters. In addition to the quantified costs and benefits, there are potential benefits associated with preventing damage to biodiversity on 9850 ha 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 1: Outcomes of analysis of costs and benefits for Bomarea

Plan	Total NPV	Net Benefit of plan	Risk adjusted net benefit
Do Nothing	$57,730,000		
Eradication	$31,370,000	$26,360,000	$17,870,000
Progressive Containment	$12,630,000	$45,100,000	$27,920,000
Sustained Control	$2,040,000	$55,680,000	$15,810,000

Table 3: 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%	Progressive Containment
Discount rate 8%	Progressive Containment

17.4 NPD Section 7 - Allocation of Costs and Benefits

17.4.1 Beneficiaries, exacerbators and costs of proposed plan for control of Bomarea

The beneficiaries and exacerbators of the plan are:

- Beneficiaries: Wider community from prevention of damage to biodiversity values and future control costs.
- Active exacerbators: Any persons transporting Bomarea into or around the region
- Passive exacerbators: Any persons with Bomarea on their property not undertaking control.

The direct and indirect costs associated with the plan are shown below in Table 4 and Table 5.

Table 4: Direct and indirect costs of plan for Bomarea

Plan option	**Control costs landholders**	**Inspection and monitoring costs**
Sustained Control	$2,000,000	$100,000
Progressive Containment	$13,000,000	$600,000
Eradication	$31,000,000	$900,000

Table 5: Benefits and costs of plan for Bomarea that accrue to different beneficiaries and exacerbators

Plan option	**Benefits for those currently infested**	**Benefits for those not currently infested**	**Costs for exacerbators**
Sustained Control	$-1,330,000	$57,000,000	$2,000,000
Progressive Containment	$-12,000,000	$57,000,000	$13,000,000
Eradication	$-31,000,000	$57,000,000	$31,000,000

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 6 below.

Table 6: Matters for consideration in allocating costs for proposed Bomarea plan

Legislative rights and responsibilities	None known
Management objectives	Progressive Containment
Stage of infestation	Well established with 870 sites, but mainly in Dunedin and surrounding area..
Most effective control agents	Landholders are most effective because it is too widespread for agency control over the whole affected area.
Urgency	Moderate urgency to prevent spread outside its current main infestation areas.
Efficiency and effectiveness	Across the affected area landholder control is likely to be more effective than the agency attempting to identify and control all sites. However it may require significant inspection and enforcement efforts.
Practicality of targeting beneficiaries	Beneficiaries are the wider community for biodiversity values.
Practicality of targeting exacerbators	Exacerbators can be targeted through inspections, although not all sites may be known.
Administrative efficiency	Exacerbators 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	For major infestations on private land assistance may be required from the council as costs would be large and significant resistance would be encountered.
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

The benefits of the plan are largely to the wider community for prevention of damage to biodiversity. The pest is widespread and control being undertaken by landholders will encourage better identification and control of the pest. The proposed allocation of costs is therefore:

- Control costs – landholders with Bomarea on their property as exacerbators. For large infestations on private land council should fund initial control costs through general rate.
- Inspection and monitoring costs – wider community through general rate for prevention of damage to biodiversity values and saved future control costs.

18 Lagarosiphon

18.1 Description

Lagarosiphon is a vigorous submerged bottom rooting aquatic perennial reaching depths of 6.5m. It has slender stems slender, that are brittle and much branched. It occupies and displaces biodiversity in moderately fast flowing to still water bodies of low fertility and high clarity. Only female plants have been collected in New Zealand, so no seed dispersal occurs here. However spreading is through stem fragments that are easily dispersed within catchments by water flow. New catchments are colonised by contaminated boats and trailers (occasionally motor cooling water), eel nets, diggers, people liberating fish, and emptying aquaria.

18.2 Proposed Plan

ORC is proposing that Lagarosiphon is controlled through a Site Led Programme objective described in Section 1(b) of the NPD. The majority of the control work will be undertaken by, and costs will be incurred by, LINZ.

18.3 NPD Section 6 Assessment

18.3.1 Level of analysis

The assessed level of analysis for Lagarosiphon 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.

18.3.2 Impacts of Lagarosiphon

Lagarosiphon has the potential to cause damage to biodiversity, recreational activity and amenity values.

18.3.3 Benefits for management of Lagarosiphon

Prevention impacts on biodiversity, recreation and amenity values, on an area of 1150 ha after 100 years if the pest is allowed to spread. Management at current levels will also reduce future control costs.

18.3.4 Costs of Lagarosiphon Plan

The plan will incur costs of control, inspection and monitoring. These are $32,000 annually for the plan option. Costs for all three options considered are a NPV of NPV $500,000 for Sustained Control, NPV $2,000,000 for Progressive Containment, and NPV $3,000,000 for Eradication.

18.3.5 Risks of Lagarosiphon Plan

Technical and operational risks: Containment and control of Lagarosiphon is difficult, and because of the potential for spread through a number of mechanisms has high risk of non-avhievement. Lagarosiphon has been under control around NZ for a long period with limited progress, but has been succesfully managed by LINZ in Otago for a number of years.

Implementation and compliance: Ensuring compliance with management regime to prevent spread is difficult because exacerbators who move weed between lakes are difficult to identify.

However LINZ undertakes and funds control work so no compliance problems are expected in that regard.

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 1 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 3 below. In addition to the quantified costs and benefits, there are potential benefits associated with preventing damage to biodiversity, recreational and amenity values on 1150 ha of lakes and waterways 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, recreational, and amenity values of $19,000/ha in order for the Site Led Programme option to be worthwhile (see Table 2 below).

These factors suggest that either Do Nothing or the Site Led Programme option are favoured as the producing the highest net benefit depending on the value assigned to biodiversity, recreational and amenity values of any water bodies affected by Lagarosiphon.

Table 1: Outcomes of analysis of costs and benefits for Lagarosiphon

Plan	Total NPV	Net Benefit of plan	Risk adjusted net benefit
Do Nothing	$19,110,000		
Eradication	$955,530,000	-$936,420,000	-$423,470,000
Progressive Containment	$363,220,000	-$344,110,000	-$159,610,000
Site Led Programme	$57,360,000	-$38,250,000	-$21,980,000

Table 2: 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	$181,000	$82,000
Progressive Containment	$67,000	$31,000
Site Led Programme	$33,000	$19,000

Table 3: 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

18.4 NPD Section 7 - Allocation of Costs and Benefits

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

The beneficiaries and exacerbators of the plan are:

- Beneficiaries: Wider community from prevention of damage to biodiversity, recreational and amenity values.
- Active exacerbators: Any persons transporting Lagarosiphon into or around the region
- Passive exacerbators: Any persons with Lagarosiphon on their property not undertaking control.

The direct and indirect costs associated with the plan are shown below in Table 4 and Table 5.

Table 4: Direct and indirect costs of plan for Lagarosiphon

Plan option	Control costs landholders	Inspection and monitoring costs
Site Led Programme	$57,000,000	$500,000
Progressive Containment	$363,000,000	$2,000,000
Eradication	$955,000,000	$3,000,000

Table 5: Benefits and costs of plan for Lagarosiphon that accrue to different beneficiaries and exacerbators

Plan option	**Benefits for those currently infested**	**Benefits for those not currently infested**	**Required benefit for community for biodiversity and ecological benefits in order for option to be positive**	**Costs for exacerbators**
Site Led Programme	$-38,000,000	$0	$38,250,000	$57,000,000
Progressive Containment	$-343,000,000	$0	$344,110,000	$363,000,000
Eradication	$-936,000,000	$0	$936,420,000	$955,000,000

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 6 below.

Table 6: Matters for consideration in allocating costs for proposed Lagarosiphon plan

Legislative rights and responsibilities	None known
Management objectives	Site Led Programme
Stage of infestation	Is present in 3 main water bodies in Otago but covers a large area.
Most effective control agents	Requires control by council and Crown agencies as public land. Private control is infeasible.
Urgency	Low as has been present for a long time
Efficiency and effectiveness	Council or crown agency will be most effective as control is difficult and requires a range of techniques depending on the situation. Control is currently undertaken by LINZ and this is expected to continue.
Practicality of targeting beneficiaries	Wider community beneficiaries can be targeted through General Rate. LINZ voluntarily undertakes and funds control work.
Practicality of targeting exacerbators	Exacerbators are very difficult to identify as spread is through a variety of mechanisms, and is often unknowningly moved by to the individual transporting it.
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	It would be unreasonable to charge any party other than council or LINZ. Even if exacerbators could be identified the costs of clean-up could potentially be very high.
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 mechansisms.

18.4.3 Proposed allocation of costs

Lagarosiphon occurs in public space, the benefits are to the wider community for prevention of damage to biodiversity, recreation and amenity values, and exacerbators are difficult to identify. It is most appropriate that the costs of inspection, monitoring and control should continue to be funded by LINZ with any additional funding sourced from General rate.

19 Broom - Rural

19.1 Proposed Plan

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

19.2 NPD Section 6 Assessment

19.2.1 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.

19.2.2 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.

19.2.3 Benefits for management of Broom

Prevention of loss of production from pastoral agriculture in hill and high country. Impacts to biodiversity in tussock landscapes, grasslands and riverbeds. Net benefits are NPV $450,000,000 relative to the pest being kept at its current level for those not currently infested.

19.2.4 Costs of Broom 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 a NPV of NPV $700,000 for Sustained Control, NPV $13,000,000 for Progressive Containment, and NPV $33,000,000 for Eradication.

19.2.5 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

19.2.6 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 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 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 302,000 ha 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 33: 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	$1,112,560,000		
Eradication	$4,153,880,000	-$3,041,330,000	-$1,643,440,000
Progressive Containment	$1,587,940,000	-$475,380,000	-$473,790,000
Sustained Control	$663,450,000	$449,110,000	$59,310,000

Table 34: 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

19.3 NPD Section 7 - Allocation of Costs and Benefits

19.3.1 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. Wider community for biodiversity 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 35 and Table 36.

Table 35: Direct and indirect costs of plan for Broom

Plan option	Control costs land holders (PV (6%))	Inspection and monitoring costs (PV (6%))
Sustained Control	$415,000,000	$700,000
Progressive Containment	$1,579,000,000	$13,000,000
Eradication	$4,154,000,000	$33,000,000

Table 36: 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	$-33,000,000	$483,000,000		$415,000,000
Progressive Containment	$-957,000,000	$483,000,000	$475,380,000	$1,579,000,000
Eradication	$-3,523,000,000	$483,000,000	$3,041,330,000	$4,154,000,000

19.3.2 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 37 below.

Table 37: 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 moderate, given that past intensive control efforts appear to have had some impact on spread. The efficiency of requiring land holders to control in uneconomic circumstances is 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.

19.3.3 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 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.
- Initial control in high country where biodiversity and productive values area concerned – control funded 50% General Rate, 50% land holder.
- Ongoing control in high country to prevent recurrence and spread - land holder.

20 Gorse - rural

20.1 Description

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

20.2 Proposed Plan

ORC is proposing that Gorse is controlled through the Sustained Control objective described in Section 1(b) of the NPD. This analysis assesses the benefits and costs of Gorse control in an urban and rural setting.

20.3 NPD Section 6 Assessment

20.3.1 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.

20.3.2 Impacts of Gorse

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

20.3.3 Benefits for management of Gorse

The quantified 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%) $438 million for landholders currently not infested.

20.3.4 Costs of Gorse Plan

The plan will incur costs of inspection and monitoring as well as landholder control. Inspection costs are $40,000 annually for the plan option. Costs for inspection in all three options considered are a NPV of NPV $700,000 for Sustained Control, NPV $13,000,000 for Progressive Containment, and NPV $33,000,000 for Eradication.

20.3.5 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

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 38 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 39 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 38: Outcomes of analysis of costs and benefits for Gorse (rural)

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	$1,112,560,000		
Eradication	$4,153,880,000	-$3,041,330,000	-$1,643,440,000
Progressive Containment	$1,587,940,000	-$475,380,000	-$473,790,000
Sustained Control	$663,450,000	$449,110,000	$59,310,000

Table 39: 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

20.4 NPD Section 7 - Allocation of Costs and Benefits

20.4.1 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 40 and Table 41.

Table 40: Direct and indirect costs of plan for Gorse

Plan option	**Control costs land holders (PV (6%))**	**Inspection and monitoring costs (PV (6%))**
Sustained Control	$415,000,000	$700,000
Progressive Containment	$1,579,000,000	$13,000,000
Eradication	$4,154,000,000	$33,000,000

Table 41: 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	$-33,000,000	$483,000,000	$415,000,000
Progressive Containment	$-958,000,000	$483,000,000	$1,579,000,000
Eradication	$-3,520,000,000	$483,000,000	$4,154,000,000

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 Table 42.

Table 42: Matters for consideration in allocating costs for proposed Gorse (rural) 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 bemoderate, given that past intensive control efforts appear to have had some impact on spread. The efficiency of requiring land holders to control in uneconomic circumstances is likely to be low.
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.

20.4.3 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 rural productive land.
- Control costs to prevent spread – 100% land holders as exacerbators.

21 Nodding Thistle

21.1 Description

Nodding Thistle (*Carduus nutans*) is an upright thistle. It invades crop land, pasture, and non-productive areas, and occurs in a number of locations in Otago. 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.

21.2 Proposed Plan

ORC is proposing that Nodding Thistle 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 Nodding Thistle 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. Note that this analysis tests a plan that prevents the further spread of Nodding thistle through boundary control.

21.3.2 Impacts of Nodding Thistle

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

21.3.3 Benefits for management of Nodding Thistle

Benefits from the management of Nodding 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%) $22,000,000 for those not currently infested.

21.3.4 Costs of Nodding Thistle Plan

The plan will incur costs of inspection, and monitoring. These are $7500 annually for the plan option. Costs for all three options considered are an NPV(6%) of $100,000 for Sustained Control, NPV(6%) $2,000,000 for Progressive Containment, and NPV(6%) $6,000,000 for Eradication.

21.3.5 Risks of Nodding Thistle Plan

Technical and operational risks: Sustained Control has relatively few risks, although Nodding Thistle has been under control for a long period with limited progress and the likelihood of having any significant impact appears limited.

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: Spread of Nodding thistle on riverbeds is a public concern.

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 43 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 44 below which suggests the conclusion is reasonably robust under changes to a range of assumptions, although it is sensitive to no longer being worthwhile to undertake under assumptions of a lower distance of spread, lower costs of control, and a high discount rate.

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

Table 43: Outcomes of analysis of costs and benefits for Nodding 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	$116,690,000		
Eradication	$415,600,000	-$298,900,000	-$172,580,000
Progressive Containment	$152,370,000	-$35,680,000	-$52,840,000
Sustained Control	$93,010,000	$23,680,000	$1,630,000

Table 44: 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

21.4 NPD Section 7 - Allocation of Costs and Benefits

21.4.1 Beneficiaries, exacerbators and costs of proposed plan for control of Nodding Thistle

The beneficiaries and exacerbators of the plan are:

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

The direct and indirect costs associated with the plan are shown below in Table 45 and Table 46.

Table 45: Direct and indirect costs of plan for Nodding Thistle

Plan option	**Control costs land holders (PV (6%))**	**Inspection and monitoring costs (PV (6%))**
Sustained Control	$42,000,000	$100,000
Progressive Containment	$149,000,000	$2,000,000
Eradication	$415,000,000	$6,000,000

Table 46: Benefits and costs of plan for Nodding 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	$1,980,000	$22,000,000	$42,000,000
Progressive Containment	$-57,000,000	$22,000,000	$149,000,000
Eradication	$-320,000,000	$22,000,000	$415,000,000

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 47 below.

Table 47: Matters for consideration in allocating costs for proposed Nodding Thistle plan

Legislative rights and responsibilities	None known
Management objectives	Sustained Control
Stage of infestation	Late stage – nodding thistle is throughout Otago
Most effective control agents	Landholders are most effective because it requires control and measures to ensure that seed does not spread.
Urgency	Low urgency as it has been present for a long time and has liklely reached most of Otago.
Efficiency and effectiveness	It is likely that requiring landholders 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	Nodding thistle is easily seen 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 Nodding thistle 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.

21.4.3 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

22 Ragwort

22.1 Description

Ragwort (*Jacobaea vulgarisis*) is a biennial or perennial herb that grows 30 – 120cm tall, with an erect rigid stem and yellow daisy like flowers. It is wind spread and produces a very large number of long lived seed that can colonise bare ground rapidly. Ragwort invades disturbed forest and shrubland, short tussockland, fernland, herbfield, wetlands and coastal areas throughout New Zealand. In a productive setting it is usually considered a pest only of dairying because it is palatable to sheep. It taints milk if eaten by lactating cows.

22.2 Proposed Plan

ORC is proposing that Ragwort 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 Ragwort 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 Ragwort

Ragwort has the potential to cause loss of production on dairy farms as its major impact.

22.3.3 Benefits for management of Ragwort

Prevention of loss of production on dairy farms. There is a negative net benefit relative to the pest being kept at its current level, primarily because effective control will require its removal on properties where it is not currently a major pest.

22.3.4 Costs of Ragwort 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 of NPV $80,000 for Sustained Control, NPV $2,000,0000 for Progressive Containment, and NPV $4,000,000 for Eradication.

22.3.5 Risks of Ragwort Plan

Technical and operational risks: Ragwort has been present in New Zealand for many years, and it likely to have occupied most habitats in Otago. No progress has been made in reducing ragwort infestations anywhere in New Zealand under a RPMP, and given the number of viable seeds produces and its wide potential dispersal it is unlikely that intervention by the regional council will make any difference to the infestation on individual properties.

Implementation and compliance: Because of the widespread nature of ragwort in order to achieve uniform compliance there would need to be a very large inspection programme, with regular follow ups through the season.

Other legislative risks: None known.

Public or political concerns: Ragwort is highly visible in flower and can be the cause of concern for those landholders who consider they are affected by infestations on a neighbouring property.

Other risks: There is a biocontrol agent released for ragwort. Care should be taken to ensure that any control requirements do not interfere with establishment and spread of other biocontrol agents that may be released in the future.

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 1 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 3 below, which suggests that Do Nothing may be of a higher net benefit with a lower discount rate or higher rates of spread.

These factors suggest that a plan for control of ragwort is unlikely to meet the tests of the Biosecurity Act if the assumptions made in this analysis are considered reasonable.

Table 1: Outcomes of analysis of costs and benefits for Ragwort

Plan	Total NPV	Net Benefit of plan	Risk adjusted net benefit
Do Nothing	$754,680,000		
Eradication	$997,030,000	-$242,350,000	-$344,290,000
Progressive Containment	$381,210,000	$373,480,000	-$67,390,000
Sustained Control	$332,370,000	$422,310,000	$76,540,000

Table 3: 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	Do Nothing
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 Ragwort

The beneficiaries and exacerbators of the plan are:

- Beneficiaries:
- Active exacerbators: Any persons transporting Ragwort into or around the region
- Passive exacerbators: Any persons with Ragwort on their property not undertaking control.

The direct and indirect costs associated with the plan are shown below in Table 4 and Table 5.

Table 4: Direct and indirect costs of plan for Ragwort

Plan option	Control costs landholders	Inspection and monitoring costs
Sustained Control	$60,000,000	$80,000
Progressive Containment	$379,000,000	$2,000,000
Eradication	$997,000,000	$4,000,000

Table 5: Benefits and costs of plan for Ragwort that accrue to different beneficiaries and exacerbators

Plan option	Benefits for those currently infested	Benefits for those not currently infested	Required benefit for community for biodiversity and ecological benefits in order for option to be positive	Costs for exacerbators
Sustained Control	$20950000	$401000000	$-422310000	$60000000
Progressive Containment	$-28228271	$401000000	$-373480000	$379000000
Eradication	$-643559162	$401000000	$242350000	$997000000

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 48 below.

Table 48: Matters for consideration in allocating costs for proposed Ragwort plan

Legislative rights and responsibilities	None known
Management objectives	Sustained Control
Stage of infestation	Late stage – ragwort is throughout Otago
Most effective control agents	Landholders are most effective because it requires control and measures to ensure that seed does not spread.
Urgency	Low urgency as it has been present for a long time and has liklely reached its full habitat
Efficiency and effectiveness	It is likely that requiring landholders 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	Ragwort in flower is easily seen 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 ragwort 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.

22.4.3 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. A levy on dairy properties could be considered, although this is not likely to be an efficient mechanism for collection of funding requirements.
- Control costs: 100% land holders as exacerbators

23 Russell Lupin

23.1 Description

Russell lupin (*Lupinus polyphyllus*) is a biennial or perennial herb that produces an erect 15 – 60cm long flowerhead spike. It tolerates wind, warm to cold, damage and grazing (not readily eaten), flooding and drought, poor soils, low fertility (fixes nitrogen), and fire, but is intolerant of moderate shade. Russell lupin invades shingly braided river systems and provides hiding places for predators of the birds that would usually nest safely on these bare islands. It produces large amounts of seed that are spread mainly by water, and also by humans distributing them along roadsides. Russell lupin is cropped for animal feed in drier high country parts of the region, and is considered a good alternative to lucerne because of its greater tolerance of aluminium toxicity.

23.2 Proposed Plan

ORC is proposing that Russell lupin is controlled through the Sustained Control objective described in Section 1(b) of the NPD. This will involve prevention of planting and occupation by Russell lupin within:

- 200 metres of the outer gravel margin of a braided river;
- 50 metres from any non-braided river;
- 10 metres from any artificial watercourse; or
- 10 metres from an adjoining property boundary.

23.3 NPD Section 6 Assessment

23.3.1 Level of analysis

The assessed level of analysis for Russell lupin 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 Russell lupin

Russell lupin has the potential to cause damage to biodiversity values in braided riverbeds, and to impact on flow in waterways with dense infestations.

23.3.3 Benefits for management of Russell lupin

Prevention of loss of biodiversity damage on braided riverbeds and maintaining flows in waterways.

23.3.4 Costs of Russell lupin Plan

The plan will incur costs of control, inspection and monitoring. These are $10,000 annually for the plan option.

23.3.5 Risks of Russell lupin Plan

Technical and operational risks: Russell lupin is present in many parts of the region and would be difficult to eradicate or remove. Prevention of spread into waterways will be difficult.

Implementation and compliance: Because Russell lupin has productive benefits it is likely to be difficult to completely eliminate it from risk areas. There would be significant effort in inspecting all properties to ensure compliance with the planting prohibitions in the plan, and there will therefore need to be some reliance on voluntary compliance and complaints.

Other legislative risks: None known.

Public or political concerns: Russell lupin is highly visible and considered attractive in flower and can be seen as having amenity values, particularly along roadsides.

Other risks: None known.

23.3.6 Net Benefit

Data is not available on the extent of planting of Russell lupin and how significant the costs of preventing planting and requiring control adjacent to waterways could be. There are likely to be some costs associated with the unavailability of land adjacent to waterways for planting, particularly with the large setbacks for braided riverbeds and non-braided rivers (50m). For example a 10ha paddock with a non-braided river adjacent to it would lose 15% of the plantable area, and 75% of the plantable area if it was adjacent to a braided river.

However it is likely that on larger high country properties where Russell lupin cropping is most common there are generally a number of paddocks available which have no permanent waterways adjacent and which are suitable for cropping with Russell lupins. For these properties the plan rules will impose some inconvenience in terms of selecting paddocks for cropping with Russell lupins, but will not impose significant costs overall. However for properties with limited land available for planting and only adjacent to waterways, the costs could be significant. However there are other feed crops available to plant, and these alternatives will mean that costs are not prohibitive.

The costs of control however are likely to be more significant and ongoing. Because of the unknown extent of Russell lupin, it is not possible to calculate a cost for this. Costs are unlikely to be major in grazed areas, because Russell lupin is palatable to animals. However in retired land and waste areas the costs may be significant.

The costs of inspection and monitoring will amount to $10,000 per annum or NPV (6%) of $160,000.

It is not possible to provide a definitive answer on whether the benefits outweigh the costs because neither the benefits nor the costs can be accurately specified. If the council considers that the benefits of preventing damage to biodiversity values on riverbeds from Russell lupin exceeds the costs of $160,000 plus the costs to landholders from reduced availability of land for cropping of this species and costs of control on non-productive land adjacent to waterways, then the benefits will outweigh the costs.

23.4 NPD Section 7 - Allocation of Costs and Benefits

23.4.1 Beneficiaries, exacerbators and costs of proposed plan for control of Russell lupin

The beneficiaries and exacerbators of the plan are:

- Beneficiaries: wider community from prevention of damage to biodiversity values.

- Active exacerbators: persons planting Russell lupin.
- Passive exacerbators: persons not undertaking control of Russell lupins on land adjacent to waterways.

The direct costs of the plan are inspection and monitoring costs of NPV (6%) $160,000 and costs for unavailability of land for planting.

The benefits are from prevention of damage to biodiversity values and maintenance of waterways, which accrue to the wider community.

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 50 below.

Table 49: Matters for consideration in allocating costs for proposed Russel lupin plan

Legislative rights and responsibilities	None known
Management objectives	Sustained Control
Stage of infestation	Late stage – Russell lupin is throughout Otago
Most effective control agents	Landholders are most effective because it requires measures to ensure that seed does not spread.
Urgency	Low urgency as it has been present for a long time
Efficiency and effectiveness	Landholders are the only party able to prevent planting on their land and likely to be most efficient in ensuring Russell lupin does not become established on their land.
Practicality of targeting beneficiaries	Beneficiaries are the wider rural community for prevention of damage to biodiversity values
Practicality of targeting exacerbators	Russell lupin in flower is easily seen and exacerbators can be targeted.
Administrative efficiency	Exacerbators are the only party able to prevent planting and can be targeted.
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 low overall but may be significant on some properties.
Parties bearing indirect costs	None likely
Transitional cost allocation arrangements	None required in relation to planting as costs are experienced from unavailability of land for planting. However some assistnace with control on non-productive land may be appropriate.
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 recommended approach is for funding of the inspection and monitoring costs from general rate to reflect the benefits for biodiversity values. Costs of control on productive land are most appropriately targeted at exacerbators. For non-productive land additional funding from the wider community may be appropriate to reflect the benefits from prevention of damage to biodiversity.

24 Exclusion Pests

Exclusion pests include :

Table 50: Pests to be included in an exclusion programme

Common names	**Scientific name**
African feather grass	*Pennisetum macrourum*
Chilean needle grass	*Nassella neesiana*
False tamarisk	*Myricaria germanica*
Moth plant	*Araujia hortorum*

24.1 The total expenditure on these pests is expected to be $10,000 per annum. 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 low.

The objectives for exclusion pests will meet the requirements of Section 6 if the Council considers that there are benefits of reducing the risks of these pests being introduced to the region and causing damage to biodiversity, conservation, amenity, and production values (because no costs are anticipated).

24.2 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 pests are a mix of production and biodiversity pests. However funding from the General Rate is most appropriate because of the low level of costs involved, and the difficulty of dividing into the expenditure on different pests. 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.

25 Site Led Pests

The group of pests included in Site Led programmes are:

*Table 51**:** Pests included in site-led programmes*

Common name	***Scientific name***	**Otago Peninsula**	**Orokonui Halo**	**Quarantine and Goat Islands**	**Lagarosiphon Management Areas**
Plants					
Banana passionfruit	*Passiflora tripartita var mollissima* *P. tripartita var azuayansis* *P. tarminiana* *P. pinnatistipula* *Passiflora x rosea* *P. caerulea*	*	*		
Chilean flame creeper	*Tropaeolum speciosum*	*	*		
Darwin's barberry	*Berberis darwinii*	*	*		
Gunnera	*Gunnera tinctoria*	*			
Sycamore	*Acer pseudoplatanus*	*	*		
Tradescantia (wandering willie)	*Tradescantia fluminensis*	*	*		
Lagarosiphon	*Lagarosiphon major*				*
Animals					
Bennett's wallaby	*Macropus rufogriseus*	*	*	*	
Feral cat	*Felis catus*	*	*	*	
Feral deer (incl. hybrids)	*Cervus elaphus, C. nippon, C. dama*	*	*	*	
Feral goat	*Capra aegagrus hircus*	*	*	*	
Feral pig	*Sus scrofa*	*	*	*	
Hedgehog	*Erinaceous europaeus*	*	*	*	
Mustelids (ferret, stoat, weasel)	*Mustelo furo, M. ermine, M. nivalis*	*	*	*	
Possum	*Trichosurus vulpecula*	*	*	*	
Rat (Norway, ship and Kiore)	*Rattus norvegicus, R. rattus R. exulans*			*	

The Site Led status is 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.

25.1 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 Programme pests are approximately $95,000. The Site-Led Programmes are undertaken in a collaborative nature and intended to support and build on momentum from existing efforts to manage pests for biodiversity protection. The exact nature of the work is to be determined in association with community groups and landholders, and that agreement will include cost sharing arrangements. The agreement of the community groups and landholders 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 to the council and the wider community of the site led programme exceed the costs, the requirements of Section 6 of the NPD will have been met.

25.2 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.

26 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, gorse, broom, nodding thistle, ragwort 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 in Appendix D 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.

26.1 Feral rabbits

The analysis for feral rabbits in Section 2 is shows that overall there is likely to be a net benefit from control of rabbits at or below Maclean’s Scale 3. 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 proneness will result in the costs of the source being between 1.5 and 10 times the additional costs of control for the receptor landholder. Costs are unlikely to be reasonable in any situations where the receptor is Low country because the costs for managing rabbits with spillover is lower on that land type than it is on other steeper land, and because the removal of spillover does not completely remove costs for the receptor landholders. Thus the costs for the source landholder are generally significantly greater than any savings made on low country from preventing spillover.

26.2 Nodding thistle

For light infestations of nodding thistle on hill and high country sheep and beef properties the costs of control for the source and receptor land holders are likely to be similar. The requirement for a GNR is therefore likely to meet the reasonable tests of the NPD. Very dense infestations on boundaries are relatively rare and have not been tested here.

26.3 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 hill and high country sheep and beef. For dense infestations the cost of control for source land holders exceeds the costs for the receptor landholder by more than 50%. Decision makers will need to determine whether this is reasonable in the context of the requirements of the NPD.

26.4 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 hill and high country sheep and beef. For dense infestations the cost of control for source land holders exceeds the costs from spread for the receptor landholder by more than 50%. Decision makers will need to determine whether this is reasonable in the context of the requirements of the NPD.

26.5 Wilding conifers

Wilding conifers refer to a range of species. For light infestations of wilding conifers on the source property, the costs of control for the source and receptor land holders are likely to be similar for hill and high country sheep and beef, and for conservation land. In these situations the GNR rule will meet the reasonableness test of the NPD. 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 and the GNR inclusion is not likely to meet the reasonableness tests of the NPD.

26.6 Ragwort

For light infestations and where the receptor land use is dairy, the costs of control of ragwort are likely to be similar on both the receptor and source properties, and the GNR would meet the reasonableness test of the NPD. However where the receptor is other land use types these tests are not likely to be met. Very dense infestations of ragwort are rare and have not been tested here.

27 References

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28 Appendices

Appendix A Assumptions used in plant pest modelling

Table 52: 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	Low distance of spread (Min)	High distance of spread (Max)	How often is it likely to generate new foci of	Cost of control low density ($/ha/annum)	Cost of control high density ($/ha)	Inspection costs ($/annum)
Spiny Broom	Eradication	9	3	5	381,424	0.001	15	15	15	50	15	$100	$1,000	$1,500
African Feather Grass	Eradication	0.0001	1	0.0001	342948	0.0001	25	30	500	1500	2	$5	$15	$0
Chilean needle grass	Eradication	0.0001	1	0.0001	342948	0.0001	50	30	15	30	1.2	$140	$1,000	$0
Moth Plant	Eradication	0.0001	1	0.0001	342948	0.0001	50.00	15	1	100	1	$23	$45	$0
African Love Grass	Progressive Containment	200	20	40	342948	0.001	25	30	500	1500	3	$5	$15	$4,500
Boneseed	Progressive Containment	300	48	12	313244	5	50	30	1	2	10	$45	$1,000	$6,500
Bur Daisy	Progressive Containment	10	1	10	50000	5	5.835	30	500	1500	1	$10	$45	$1,800
Cape Ivy	Progressive Containment	20	60	1	51724	0.001	10	30	20	2000	3	100	750	4500
Nassella Tussock	Progressive Containment	98600	3	64000	1461492	1	50	30	1000	10000	10	$10	$45	$45,000
Old Man's Beard	Progressive Containment	10000	2410	120	511204	5	15	30	20	2000	10	45	1000	130000
Perennial Nettle	Progressive Containment	150	15	25	335220	0.001	25	50	1	50	20	100	1000	2500
Spartina	Progressive Containment	1000	6	700	2448	10	30	3	1	3000	1	250	2000	17660
White-edged nightshade	Progressive Containment	20	1	20	333600	0.001	24.25	15	10	50	5	$10	$45	$500

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**	**Low distance of spread (Min)**	**High distance of spread (Max)**	**How often is it likely to generate new foci of**	**Cost of control low density ($/ha/annum)**	**Cost of control high density ($/ha)**	**Inspection costs ($/annum)**
Wilding conifers	Progressive Containment	1000000	7	240000	1091212	15	80	20	340	340	3	$10	$2,200	$120,000
Bomarea	Progressive Containment	800	870	131	73612	5	15	30	1	5000	2	500	1000	36000
Lagarosiphon	Sustained Control	11500	3	3500	7980	5	50	30	1	300000	1	1000	10000	32000
Broom Rural	Sustained Control	500000	50000	400000	1029444	15	50	15	10	50	1	$100	$1,000	$40,000
Broom Urban	Sustained Control	994	3373	15	5945	10	50	15	10	50	1	$100	$1,000	$33,730
Gorse Rural	Sustained Control	500000	50000	400000	1029444	15	50	15	10	50	1	$100	$1,000	$40,000
Gorse Urban	Sustained Control	993	3368	15	5945	10	50	15	10	50	1	$100	$1,000	$33,680
Nodding Thistle	Sustained Control	500000	4	359045	1224656	5	6.44	5	50	200	3	$10	$45	$7,500
Ragwort	Sustained Control	100000	3750	250	465092	10	80	5	1	20	3	$120	$150	$5,000

Table 53: 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	Number of new foci established each time	Proportion controlled Sustained	Proportion controlled progressive	Proportion controlled Do Nothing	Years to progressive	Years to Eradication	Production model type	Inspection cost ratio plan/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)
Spiny Broom	0.01	1%	2	1	0.5	0.95	0.4	50	20	Hill country	1	4	6	200	200	200	200
African Feather Grass	0.02	10%	2	2.0	90%	95%	80%	50	20	Hill country	1	4	6	200	90	200	90
Chilean needle grass	0.5	100%	2	1.2	90%	95%	80%	50	20	Hill country	1	4	6	200	90	200	90
Moth Plant	0.125	0%	2	1.0	90%	95%	10%	50	20	None	1	2	3	200	90	200	90
African Love Grass	0.125	100%	2	3.0	90%	95%	80%	50	20	Hill country	1	4	6	200	90	200	90
Boneseed	0.1	0%	2	10.0	90%	95%	20%	50	20	None	1	4	6	100	20	20	20
Bur Daisy	0.0005	50%	2	1.0	90%	95%	40%	50	20	Hill country	1	4	6	200	90	200	90
Cape Ivy	2	1%	2	3	30%	95%	10%	50	20	None	1	4	6	200	90	200	90
Nassella Tussock	0.02	100%	2	10.0	90%	95%	80%	50	50	Hill country	10	20	50	500	500	500	500
Old Man's Beard	2	75%	2	10.0	50%	95%	10%	1000	50	None	1	20	50	500	500	500	500
Perennial Nettle	0.001	100%	3	3	0.5	0.95	0.4	1000	50	Hill country	1	4	6	500	500	500	500
Spartina	1	5%	1	1	90%	95%	10%	100	50	None	1	4	6	500	500	500	500
White-edged nightshade	0.01	50%	2	5.0	90%	95%	10%	50	20	None	1	4	6	500	500	500	500
Wilding conifers	0.0005	46%	2	3.0	0.5	0.95	0.2	1000	50	High country	1	4	6	500	500	500	500
Bomarea	2	5%	2	3	30%	95%	10%	100	50	None	1	4	6	500	500	500	500

Pest	Density of new infestations (%)	Proportion productive land	Years to establishment of new sites to significant	Number of new foci established each time	Proportion controlled Sustained	Proportion controlled progressive	Proportion controlled Do Nothing	Years to progressive	Years to Eradication	Production model type	Inspection cost ratio plan/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)
Lagarosiphon	1	0%	2	2	30%	95%	10%	1000	100	None	1	4	6	500	500	500	500
Broom Rural	2	75%	2	1.0	0.5	0.95	0.4	1000	100	Hill country	1	20	50	500	500	500	500
Broom Urban	2	0.75	2	1	0.5	0.95	0.4	1000	100	Hill country	1	20	50	500	500	500	500
Gorse Rural	2	75%	2	1.0	0.5	0.95	0.4	1000	100	Hill country	1	20	50	500	500	500	500
Gorse Urban	2	0.75	2	1	0.5	0.95	0.4	1000	100	Hill country	1	20	50	500	500	500	500
Nodding Thistle	0.125	100%	2	3.0	0.5	0.95	0.4	50	100	Hill country	1	20	50	500	500	500	500
Ragwort	0.125	19%	2	3	0.3	0.95	0.0948651	1000	100	Dairy	1	20	50	500	500	500	500

Appendix B Assessment of level of analysis under the NPD Guidance

Organism	Criteria 1	Criteria 2	Criteria 3	Criteria 4	Comments	Analysis Intensity
African feather grass	L	L	L	L	Not currently present, high impacts, unlikely to be opposition to exclusion	**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**
Banana passion fruit	L	L	L	L	Control generally supported by community, overall costs are moderate, benefits exceed costs, impacts well understood and poor data.	**1**
Bennett's Wallaby	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**
Bennett’s Wallaby site led	L	L	L	L	Site led control generally supported by community, overall costs are low, benefits exceed costs, impacts well understood and poor data.	**1**
Bomarea	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**
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**
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**
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**
Cape Ivy	L	L	L	L	Control generally supported by community, overall costs are moderate, benefits exceed costs, impacts well understood and poor data.	**1**
Chilean flame creeper	L	L	L	L	Control generally supported by community, overall costs are low, benefits exceed costs, impacts well understood and poor data.	**1**
Chilean needle grass	L	L	L	L	Not currently present, high impacts, unlikely to be opposition to exclusion	**1**
Darwin's barberry	L	L	L	L	Control generally supported by community, overall costs are moderate, benefits exceed costs, impacts well understood and poor data.	**1**

False tamarisk	L	L	L	L	Not currently present, high impacts, unlikely to be opposition to exclusion	**1**
Feral cat	L	L	L	L	Site led control generally supported by community, overall costs are low, benefits exceed costs, impacts well understood and poor data.	**1**
Feral deer (incl. hybrids)	L	L	L	L	Site led control generally supported by community, overall costs are low, benefits exceed costs, impacts well understood and poor data.	**1**
Feral goat	L	L	L	L	Site led control generally supported by community, overall costs are low, benefits exceed costs, impacts well understood and poor data.	**1**
Feral pig	L	L	L	L	Site led control generally supported by community, overall costs are low, benefits exceed costs, impacts well understood and poor data.	**1**
Feral rabbit	M	H	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**
Gunnera	L	L	L	L	Control generally supported by community, overall costs are low, benefits exceed costs, impacts well understood and poor data.	**1**
Hedgehog	L	L	L	L	Site led control generally supported by community, overall costs are low, benefits exceed costs, impacts well understood and poor data.	**1**
Lagarosiphon	M	M	L	L	Control generally supported by community, overall costs are high, benefits exceed costs, impacts well understood and moderate data.	**2**
Moth plant	L	L	L	L	Not currently present, high impacts, unlikely to be opposition to exclusion	**1**
Mustelids (ferret, stoat, weasel)	L	L	L	L	Control generally supported by community, overall costs are low, benefits exceed costs, impacts well understood and poor data.	**1**
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**
Nodding thistle	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 some data exists.	**2**

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 moderate data exists.	**2**
Perennial nettle	L	M	M	M	Some in community oppose management, overall costs are low, benefits exceed costs, impacts are known to occur, control measures are available and moderate data exists.	**1**
Possum	L	L	L	L	Control generally supported by community, overall site led costs are low, benefits exceed costs, impacts well understood and moderate data.	**2**
Ragwort	H	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 some data exists.	**3**
Rat (Norway, ship and Kiore)	L	L	L	L	Control generally supported by community, overall costs are low, benefits exceed costs, impacts well understood and poor data.	**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**
Russell lupin	M	L	L	L	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**
Spartina	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**
Spiny broom	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**
Sycamore	L	L	L	L	Control supported by community, overall costs are low, benefits exceed costs, impacts well understood and poor data.	**1**
Tradescantia (wandering willie)	L	L	L	L	Control generally supported by community, overall costs are moderate, benefits exceed costs, impacts well understood and poor data.	**1**
White-edged nightshade	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**
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**

Appendix C Risk adjustment for net benefit calculation of Plant Pests

Table 54: Assumptions for risk adjustment of net benefit for Nodding thistle and Ragwort pests

	Matrix of risk	Outcomes actually achieved			
		Do Nothing	Sustained Control	Progressive Containment	Eradication
Plan undertaken	**Do Nothing**	80%	20%	0%	0%
	Sustained Control	80%	20%	0%	0%
	Progressive Containment	80%	20%	0%	0%
	Eradication	80%	20%	0%	0%

Table 55: Assumptions for risk adjustment of net benefit for Gorse and Broom

	Matrix of risk	Outcomes actually achieved			
		Do Nothing	Sustained Control	Progressive Containment	Eradication
Plan undertaken	**Do Nothing**	90%	10%	0%	0%
	Sustained Control	70%	30%	0%	0%
	Progressive Containment	70%	30%	0%	0%
	Eradication	70%	40%	0%	0%

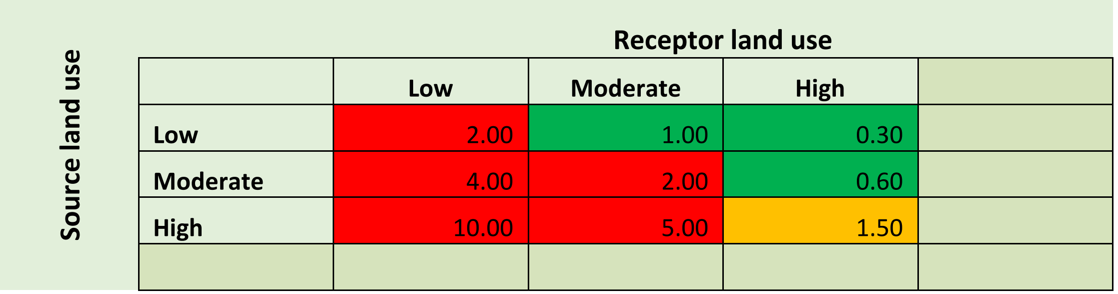
Table 56: Assumptions for risk adjustment of net benefit for Wilding Conifers

	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	15%	45%	40%	0%
	Eradication	15%	45%	35%	5%

Appendix D GNR result tables

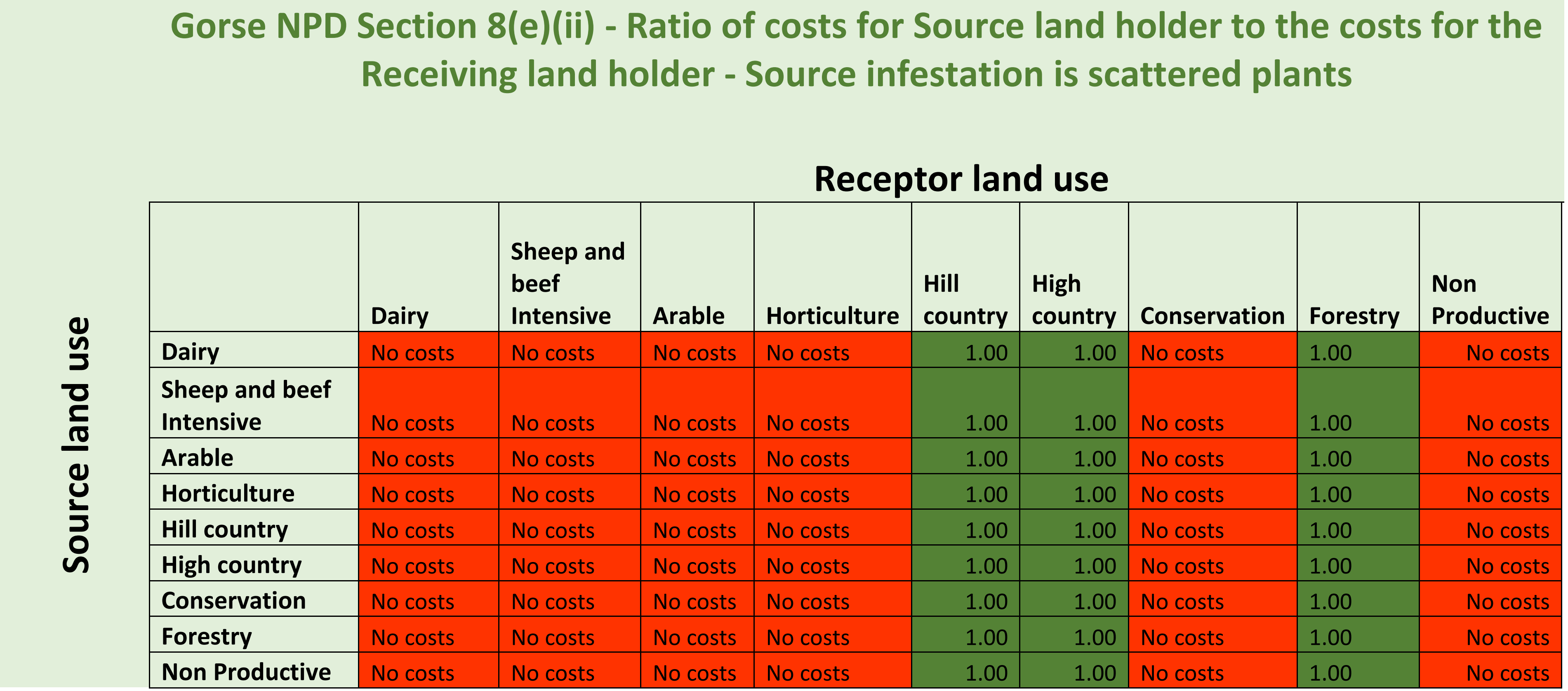
Note: green = ratio source/additional receptor costs <1.2, orange = 1.2 – 1.5, red = >1.5 or No costs incurred by receptor landholder.

Table 57: Good Neighbour Rule Model outcomes for Feral Rabbits



		Receptor land use			
		Low	**Moderate**	**High**	
Source land use	**Low**	2.00	1.00	0.30	
	Moderate	4.00	2.00	0.60	
	High	10.00	5.00	1.50	

Table 58:Good Neighbour Rule Model outcomes for Gorse: Dense infestation on Source property



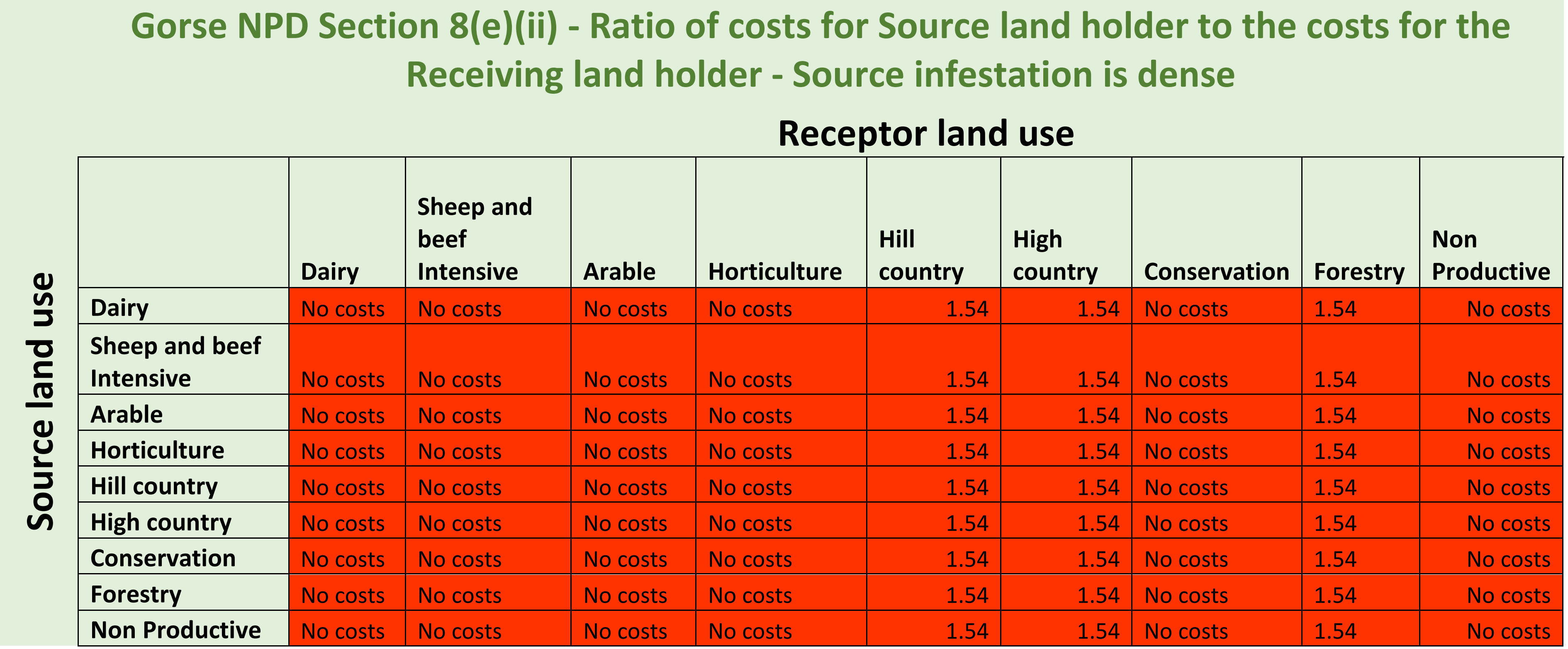
Gorse NPD Section 8(e)(ii) - Ratio of costs for Source land holder to the costs for the Receiving land holder - Source infestation is scattered plants

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 59: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 60:Good Neighbour Rule Model outcomes for Gorse: 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

		Dairy	Sheep and beef Intensive	Arable	Horticulture	Hill country	High country	Conservation	Forestry	Non Productive
Source land use	**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 61: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

Receptor land use

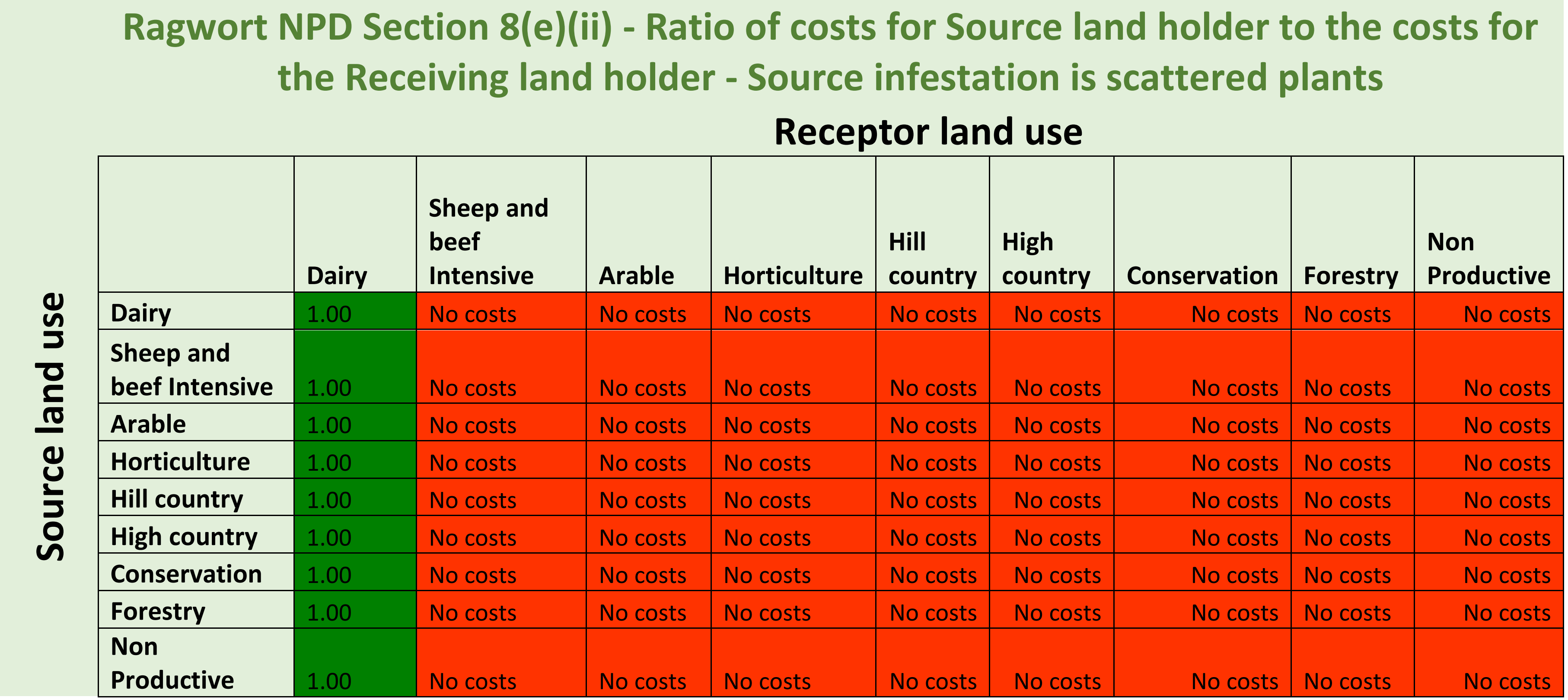
		Dairy	Sheep and beef Intensive	Arable	Horticulture	Hill country	High country	Conservation	Forestry	Non Productive
Source land use	**Dairy**	No costs	No costs	No costs	No costs	1.54	1.54	1.54	1.54	No costs
	Sheep and beef Intensive	No costs	No costs	No costs	No costs	1.54	1.54	1.54	1.54	No costs
	Arable	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 62:Good Neighbour Rule Model outcomes for Nodding thistle tussock: scattered infestation on Source property

Nodding thistle 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								
		Dairy	**Sheep and beef Intensive**	**Arable**	**Horticulture**	**Hill country**	**High country**	**Conservation**	**Forestry**	**Non Productive**
Source land use	**Dairy**	No costs	No costs	No costs	No costs	1.00	1.00	No costs	No costs	No costs
	Sheep and beef Intensive	No costs	No costs	No costs	No costs	1.00	1.00	No costs	No costs	No costs
	Arable	No costs	No costs	No costs	No costs	1.00	1.00	No costs	No costs	No costs
	Horticulture	No costs	No costs	No costs	No costs	1.00	1.00	No costs	No costs	No costs
	Hill country	No costs	No costs	No costs	No costs	1.00	1.00	No costs	No costs	No costs
	High country	No costs	No costs	No costs	No costs	1.00	1.00	No costs	No costs	No costs
	Conservation	No costs	No costs	No costs	No costs	1.00	1.00	No costs	No costs	No costs
	Forestry	No costs	No costs	No costs	No costs	1.00	1.00	No costs	No costs	No costs
	Non Productive	No costs	No costs	No costs	No costs	1.00	1.00	No costs	No costs	No costs

Table 63:Good Neighbour Rule Model outcomes for Ragwort: Scattered infestation on Source property



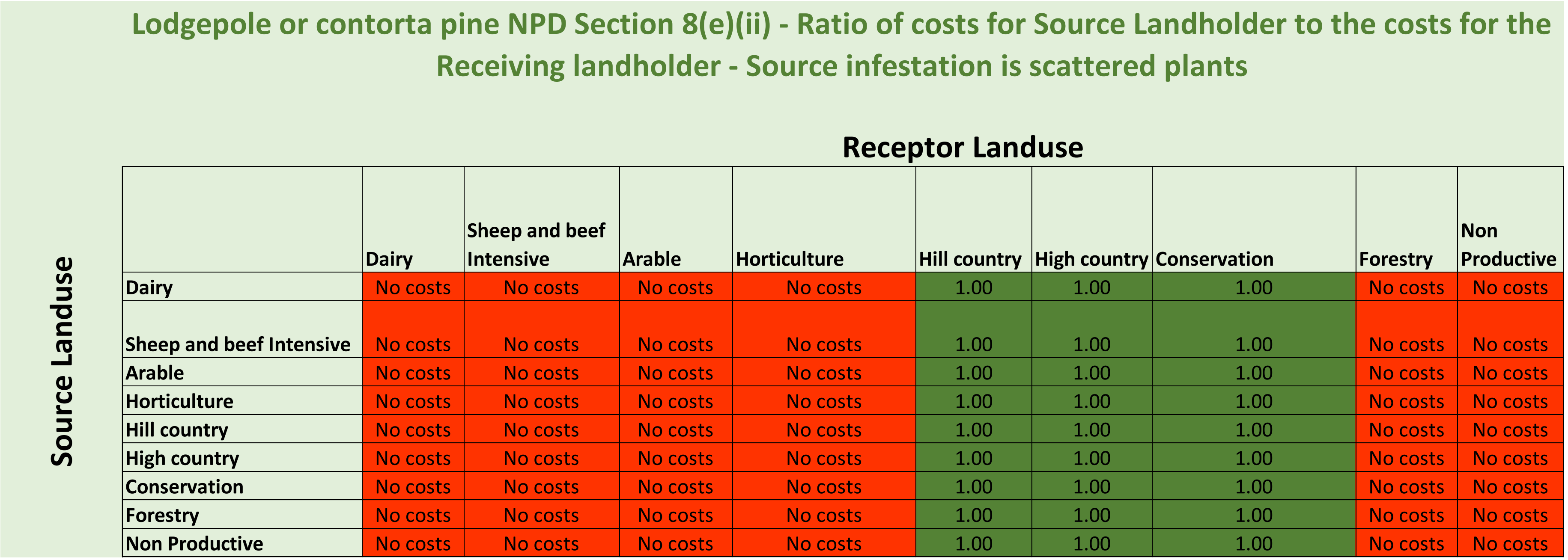
Ragwort NPD Section 8(e)(ii) - Ratio of costs for Source land holder to the costs for the Receiving land holder - Source infestation is scattered plants

Receptor land use

Source land use

	Dairy	Sheep and beef Intensive	Arable	Horticulture	Hill country	High country	Conservation	Forestry	Non Productive
Dairy	1.00	No costs	No costs	No costs	No costs	No costs	No costs	No costs	No costs
Sheep and beef Intensive	1.00	No costs	No costs	No costs	No costs	No costs	No costs	No costs	No costs
Arable	1.00	No costs	No costs	No costs	No costs	No costs	No costs	No costs	No costs
Horticulture	1.00	No costs	No costs	No costs	No costs	No costs	No costs	No costs	No costs
Hill country	1.00	No costs	No costs	No costs	No costs	No costs	No costs	No costs	No costs
High country	1.00	No costs	No costs	No costs	No costs	No costs	No costs	No costs	No costs
Conservation	1.00	No costs	No costs	No costs	No costs	No costs	No costs	No costs	No costs
Forestry	1.00	No costs	No costs	No costs	No costs	No costs	No costs	No costs	No costs
Non Productive	1.00	No costs	No costs	No costs	No costs	No costs	No costs	No costs	No costs

Table 64:Good Neighbour Rule Model outcomes for Wilding pines (various species): Scattered infestation on Source property



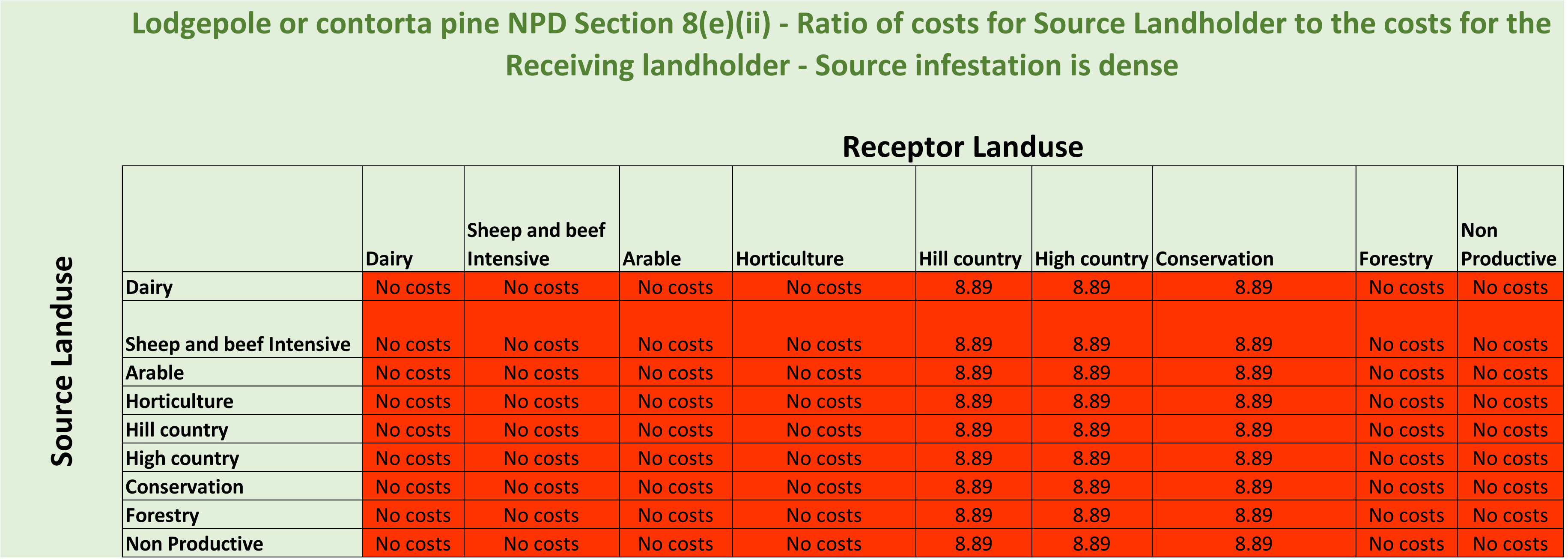
Lodgepole or contorta pine NPD Section 8(e)(ii) - Ratio of costs for Source Landholder to the costs for the Receiving landholder - Source infestation is scattered plants

Receptor Landuse

Source 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 65: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

Receptor Landuse

Source 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