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

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

- Sustained Control – where further spread onto uninfested properties is prevented, but the pest is allowed to increase in density on already infested areas.
- Progressive Containment – where the pest is reduced in extent or is contained within its existing infested area.
- Eradication – where the pest is removed from the region.
- Do Nothing – where the pest is allowed to continue to spread, and land holders undertake control as their own circumstances indicate.

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

is important to remember that those pests which rely on boundary control have only a limited chance of achieving anything different from the Do Nothing option.

Sustained Control pests with a negative quantified net benefit – Gorse and Broom in an urban setting, and ragwort produce a negative risk adjusted net benefit. Other non-monetised net benefits are therefore necessary to justify their inclusion in the plant.

Progressive Containment pests with a positive quantified net benefit – Wilding conifers produces a positive net benefit, with the analysis including indicative values for biodiversity benefit of $32.1/ha/annum. It should be noted that the control costs proposed are $20,000 per annum to inspect and control 345,000 ha, which impacts on the relative benefits and costs of the analysis.

Canada goose – does not show a net benefit to management by the council when the risk of not meeting the Eradication objective is taken into account.

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

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

Outcomes of funding analysis

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

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

For the pests where there is both a productive and biodiversity related benefit - the costs are apportioned between the General and Targeted rate depending on a qualitative assessment of the relative benefit to each party. 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 or Extreme proneness is not likely to be reasonable.

For possums a GNR is only likely to be close to reasonable when both the receptor and source are low prone land (e.g. pastoral land). In higher prone forested land the 500m buffer appears unlikely to make any difference to the costs experienced by neighbouring landholders because of the distances that possums move over. The costs of the GNR for possums would therefore be unreasonable.

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 the affected parties. However where other property types are affected the costs are not 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**
Canada geese	Eradication	-$0.145 to -$2.40	Do Nothing	-	-	100% (Sustained control)		100% (Sustained control)	100% (Eradication)	
Rabbits (feral)	Sustained Control with Boundary only	$3.38	Sustained Control with full control		-	-	100%			100%
Nodding Thistle	Sustained Control	$7.8	Sustained Control	-	-		100%			100%
Broom – Urban	Sustained Control	-$0.33	Sustained Control	-	-		100% urban land, or complainant charged			100% to prevent spread
Broom – Rural	Sustained Control	$13.9	Sustained Control	-	-	50% biodiversity-	50% biodiversity, 100% productive	50% biodiversity		50% biodiversity, 100% to prevent spread
Gorse – Urban	Sustained Control	-$0.33	Sustained Control	-	-		100% urban land, or complainant charged			100% to prevent spread
Gorse - Rural	Sustained Control	$10.6	Sustained Control	-	-		100%			100%
Wilding Conifers	Progressive Containment	$12.4	Progressive Containment	$41.5/ha/year[1]	-		100%	100% Initial		100% Ongoing
Ragwort	Sustained Control	-$1.6	Sustained Control			100%				100%
Exclusion Pests	Exclusion	Likely to be positive	Exclusion			100%		100%		
Site Led Pests	Site Led	Likely to be positive assuming land holder agreement	Site Led			100%		To be determined	To be determined	To be determined

[1] Assume a biodiversity benefit of $41.5/ha/annum based on a willingness to pay survey (Kerr, et al., 2007).

1 Background

Environment Southland 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. Environment Southland 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 4, 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 Canada Goose

2.1 Description

Canada goose (*Branta canadensis*) is a large waterfowl native to North America and parts of Europe. It was established in NZ in 1905, and has spread to large parts of the South Island and the North Island from 1970. In the South Island birds tend to breed in the high country near lakes and rivers, and travel to inland or coastal lakes and waterways from November (non-breeders) through to February (breeding birds), remaining there through the winter.

Population trends in New Zealand have been increasing since their introduction, with approximately 50,000 birds currently present. Trends from the mid 1980s – mid 2000s suggest that populations were stable in the South Island, although it should be noted that this stability was during periods of heavy culling and may have omitted expansion of habitat since aerial surveys were repeated over the same areas of established populations. Environment Southland suggest an estimate of 4500 – 5000 birds in Southland, with significant potential for population expansion into new habitat.

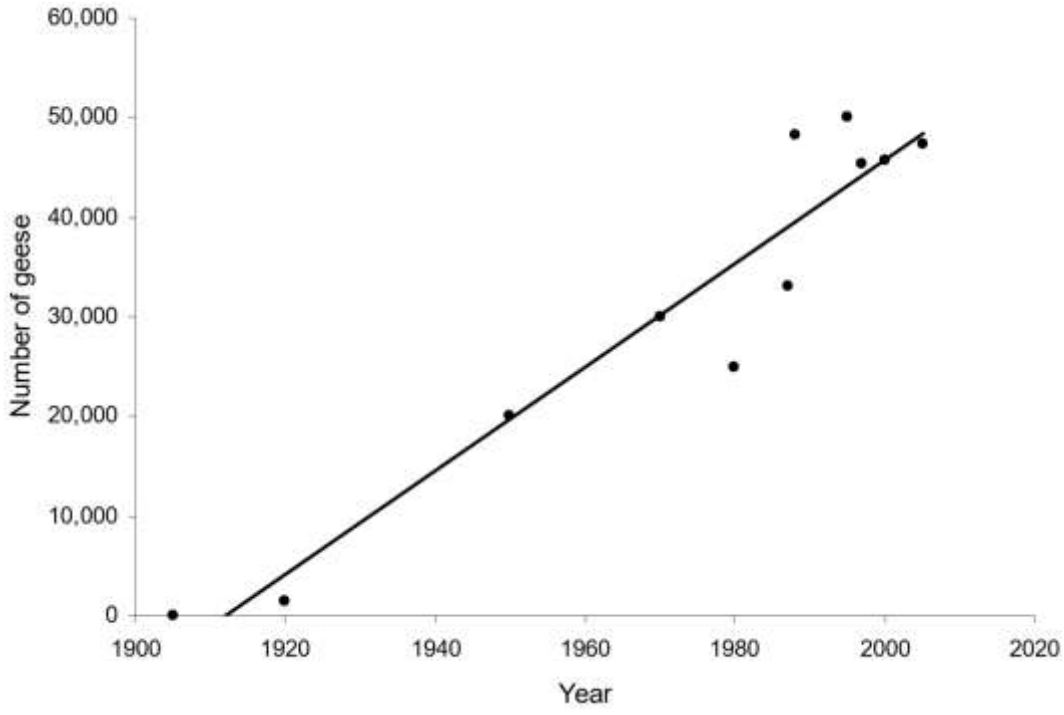

Figure 1: Canada goose population trend in New Zealand since establishment, based on anecdotal historical data (Spurr, et al., 2005)

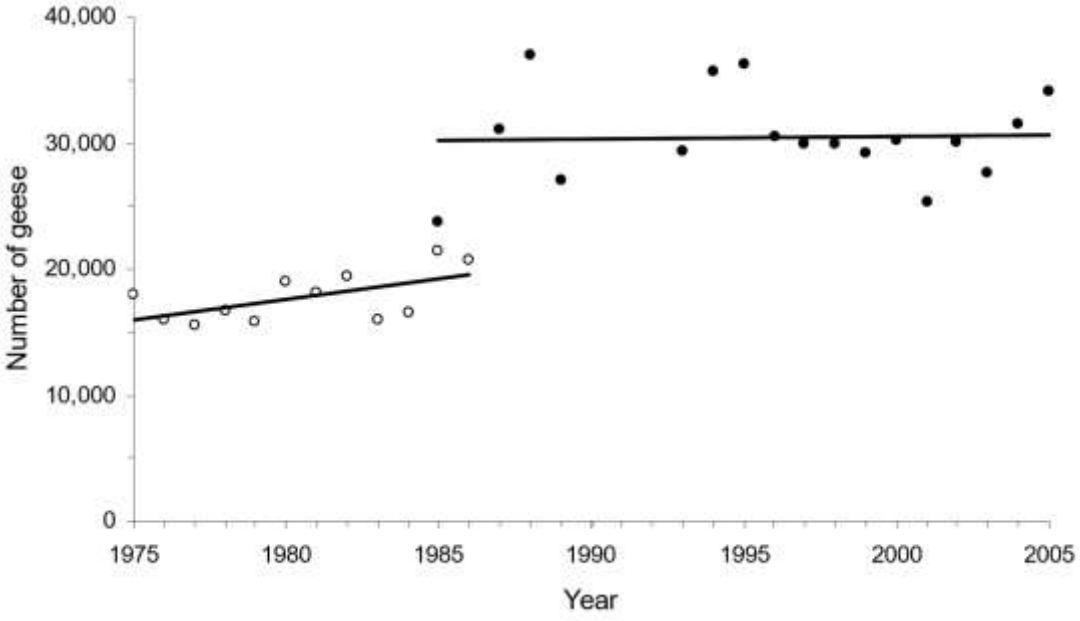

Figure 2: South Island Canada goose population trend from counts in April 1975–1986 (○), and June 1985–2005 (●) (from Potts 1984; Holloway et al. 1997; M. Webb, Fish & Game, unpubl. data 2005, cited in (Spurr, et al., 2005)).

Canada geese feed on pasture, particularly fields adjacent to lakes, irrigated pasture, and emergent re-sown pasture, and are most damaging on annual compared with perennial pasture ((Spurr, et al., 2005). The damage tends to be focused on specific properties rather than spread out, with farms in the high country and adjacent to lakes and lagoons most affected. Although geese will graze on crops, damage to arable cropping appears limited and this is not a major land use in Southland. Canada geese also foul pasture with droppings which may be avoided by stock, are a nuisance in urban areas. Their nuisance value can be particularly important in an airport setting where they represent a danger to aviation because of their size.

Canada geese do however represent a hunting resource and for a proportion of the hunting population they provide recreational benefits. They are also valued by some community members for their aesthetic appeal.

2.2 Proposed plan

ES are proposing an Eradication plan for Canada goose.

2.3 Level of analysis

The assessment of Canada geese is considered to require a Level 2 analysis under the guidelines of the NPD Guidance.

2.4 Method

Two models of linear population growth are used, with population maxima being reached in 50 or 100 years' time under each model. A linear model is determined to be appropriate based on historical increases in population from monitoring results between 1990 and 2012 (see Figure 3). The maximum population is unknown, so the analysis is undertaken by

assuming that the rate of increase occurs for either 50 or 100 years before maximum population is reached. No impact of control in the absence of regional intervention is assumed. Historically it was only necessary for Fish and Game to undertake culls on two occasions at specific locations in relation to excessive pasture grazing. However, this work did not necessarily prevent the spread of geese.

In the mid 2000s geese were actively hunted by only about 5% of licensed game bird hunters in the Wellington region and 10% of hunters in Central South Island region (Spurr, et al., 2005). However Fish and Game Southland note that of those hunters who specifically target geese, there are some extremely experienced groups in Southland, with the most successful group shooting 800 birds per year on average (Z Moss pers. comm.). In total, with Fish & Game's knowledge of those that hunt geese they estimate approximately 2640 birds are harvested by hunters annually.

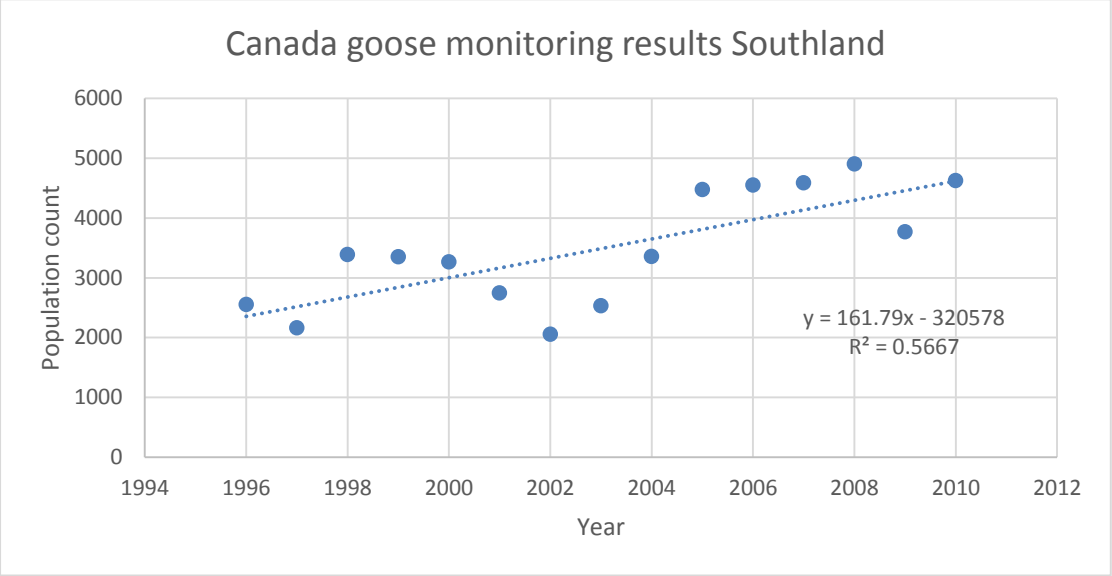

Figure 3: Southland Canada goose population trend from Fish and Game monitoring[2]

Canada geese were estimated to consume on average 0.35 kgDM/day from (White, 2006) based on 6 – 8% of body weight. Canada geese can cause significant differences in monthly dry-matter availability in goose-grazed pasture. Pasture consumption ranged from less than 100 kg/ha in winter to 900 kg/ha in late summer – early autumn, and was positively correlated with the number of geese present. Densities of grazing geese ranged from 3.7/ha in spring to 20.2/ha in autumn ((Win, 2001). The value of DM was estimated at $0.23/kgDM based on the standing costs of feed. If feed had to be imported to the property to replace that eaten by Canada goose, such as might occur for the replacement of autumn and winter feed, the costs would be higher at $0.4 - $0.5/kgDM.

Eradication is logistically very difficult due to their mobility, with movement of birds into the region, and redistribution of birds within the region following culling efforts. In order to achieve eradication, control would be required across the region across approximately 20

[2] Zane Moss, Southland Fish and Game, pers.comm.

key locations plus removal from all other locations almost simultaneously. There would be a need to prevent uncoordinated control in order to prevent disturbance of birds and a reduction in the efficacy of culling techniques. In order to achieve eradication therefore the control effort would need to control a large number of birds across a number of sites at the same time. Indicatively the analysis uses a doubling of the current estimated removal rate (from hunting) to 5300 birds per annum over a 10 or 20 year period. ES has estimated a cost of $40/bird for the removal cost , which results in a total cost of $216,000 per annum, plus an additional $19,000 per annum for monitoring, advice, etc. Sustained control would involve a lesser effort of 500 birds culled per annum in addition to the current hunting effort, with a cost of $20,000 per annum, with additional costs of $19,000 per annum.

A discount rate of 6% is used for the analysis (see Section 4.4).

2.5 NPD Section 6 Assessment

2.5.1 Impacts of Canada geese

Canada geese feed on pasture adjacent to water bodies. They can cause significant local loss of pasture, fouling of pasture, they are capable of causing a nuisance in urban settings (although this has only occurred in Te Anau to date in Southland) and pose a risk to aircraft in the vicinity of airports.

2.5.2 Options for response

The analysis considers three options for Canada geese:

1. Do Nothing
2. Sustained control
3. Eradication (fast and slow)

2.5.3 Benefits and costs of options for management of Canada geese

The benefits and costs of the three management options are shown in Table 2. Table 3 shows the net benefit of the plan relative to the Do Nothing, and suggests that in the absence of any risk to achievement of the objective there is a positive net benefit to both Sustained control and fast Eradication under a range of assumptions about rate of spread. Fast Eradication produces a higher net benefit than sustained control, but if Eradication were to take 20 years to achieve complete removal of Canada geese from Southland there would be a net negative outcome. However the risk of Eradication should be noted, given likely behavioural responses of geese, the need for repeated access at a large number of locations and the inherent logistical, public awareness and political challenges. These risks are discussed further below.

Table 2: Benefits and Costs of Canada goose management options

Option	Rate of spread	Loss of pasture	Control costs (NPV)	Total costs
Do Nothing	*Fast spread (50 yrs. to max population)*	$3,066,453		$3,066,453
	Slow spread (100 years to max population)	$3,068,117		$3,068,117
Sustained control		$2,315,614	$653,713	$2,969,327
Eradication	*Fast eradication (10 years)*	$646,394	$1,931,180	$2,577,574
	Slow eradication (20 years)	$1,044,313	$2,880,552	$3,924,864

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

Net benefit ($million NPV (6%))	Sustained control	Eradication achieved in:	
		10 years	20 years
Short expansion (50 years to max population)	$0.10	$0.49	-$0.86
Long expansion (50 years to max population)	$0.10	$0.49	-$0.86

2.5.4 Risks of Canada geese Plan

Technical and operational risks: It is difficult to ensure eradication due to the mobility of the birds and their apparent (Spurr, et al., 2005) ability to learn and avoid control measures. Furthermore continued invasion from other regions in the South Island is likely if they also do not attempt to eradicate Canada geese. It seems highly unlikely that eradication could be achieved without significant resources and co-ordinated action across surrounding regions.

Sustained control is less risky since it requires culling of birds rather than complete control. However there are risks that poorly conducted control operations will fragment existing populations and lead to spread to new habitats, and a risk that birds become accustomed to control measures leading to avoidance and other changes in behaviour. Anecdotally this has already happened to a certain extent with helicopter hunting.

Implementation and compliance:

Requires expertise to control Canada geese due to specialised techniques and their mobility. Control in urban areas can be difficult.

Compliance risks are minimal as they are recognised as a pest by landholders in most situations. There may however be risks from operations being disrupted by disgruntled hunters.

Other legislative risks: None known

Public or political concerns: It is likely that there may be substantial opposition to eradication and control from hunters, given that some of them specialise in Canada goose hunting. There may be sections of the community that appreciate the presence of Canada goose for aesthetic reasons.

Other risks: The re-release or spread of birds by hunters or others is a possibility under an eradication approach.

Indicative estimates of the risk of non-achievement of the plan objectives are shown in Table 4 below. The table shows for example that if the plan objective is Sustained control, the analysis estimates that there is a 50% of having the same outcomes as Do Nothing, and 50% of the achieving the intended Sustained control objective. However for Eradication, there is a 45% chance of the outcomes being the same as Do Nothing, 50% chance of being the same as Sustained Control, and only a 5% chance of achieving Eradication in 20 years. This approach is indicative only, but allows the calculation of a risk adjusted Net Benefit as shown below in Table 5

Table 4: Risk of achievement of an objective for Canada Goose control

		Probability of achieving an objective (what was actually achieved)			
		Do Nothing	**Sustained control**	**Eradication in 10 years**	**Eradication in 20 years**
Plan Ojective (what was intended)	**Do Nothing**	100%	0%	0%	0%
	Sustained control	50%	50%	0%	0%
	Eradication	45%	50%	0%	5%

The risk adjusted net benefit as calculated using the adjustments in Table 4 shows that there is a net negative outcome when the probability of not achieving the objectives are taken into account. These figures reflect that fact that while Sustained control is more achievable than Eradication, the low net benefit associated with it means that only a small chance of non-achievement makes it not worthwhile. Eradication has a higher net benefit before risk is taken into account, but it is extremely difficult to achieve with a mobile and widespread pest. It is reasonable to conclude therefore that there is no net benefit associated with Canada goose control and control is likely to be best left to individuals affected.

Table 5: Risk adjusted net benefit of RPMP objectives for Canada goose control ($million NPV)

Net benefit ($million NPV (6%))	**Sustained control**	**Eradication achieved in:**	
		10 years	**20 years**
Short expansion (50 years to max population)	-$0.28	-$1.45	-$2.40
Long expansion (50 years to max population)	-$0.28	-$1.45	-$2.40

2.6 NPD Section 7 - Allocation of Costs and Benefits

2.6.1 Beneficiaries, exacerbators and costs of proposed plan for control of Canada geese

The beneficiaries and exacerbators of the plan are:

- Beneficiaries: Pastoral farmers adjacent to Canada goose habitat, general public.

- Active exacerbators: Any persons transporting Canada geese into the region
- Passive exacerbators: Any persons with Canada geese on their property not undertaking control.

The direct costs of Canada goose control are the inspection and control costs which are estimated at between $650,000 NPV (6%) for Sustained control, and between $660,000 and $990,000 NPV (6%) for Eradication. There are also some indirect costs associated with reduced hunting opportunities - these are likely to be greatest in the Eradication scenario but will still occur to some extent with the Sustained control scenario.

The benefits of the plan accrue to all arable and pastoral land holders for avoided losses of $0.8 million for Sustained control, and between $2.0 and 2.4 million for Eradication (NPV (6%)) (assuming the the outcomes are achieved). There are also some potential benefits to the wider community from the avoidance of impacts to biodiversity.

2.6.2 Matters for consideration in allocation of costs of Canada goose 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 Canada geese plan

Legislative rights and responsibilities	None known.
Management objectives	Eradication.
Stage of infestation	Medium – Canada geese have been present in New Zelaand for over a century, and in Southland for many decades. They are well established in the region.
Most effective control agents	Specialist Canada goose control agents (contractors and Council staff) required. Hunters appear to be moderately effective.
Urgency	Moderate – further expansion is possible but is not likely to occur in the near future given the length of time they have been present.
Efficiency and effectiveness	It is likely to be more efficient to eradicate than other options, but the low probabiliy of achievement means it is not a viable option. Management and control by the Council is likely to be the most effective due to specialist skills required to ensure long-term viability of control techniques. However it would be very difficult to prevent control being undertaken by hunters or landholders, so management and control by council would have limited additional value. Use of rates would also potentially reduce the incentive for landholders to work with hunters, increasing costs for the ratepayer.
Practicality of targeting beneficiaries	The main beneficiaries are limited in extent but there would need to be a specific and potentially non-objective classification system in order to target them. Furthermore the birds are mobile and have a range of alternate habitats, which means that more widespread benefits are also difficult to target.
Practicality of targeting exacerbators	Canada geese are very mobile so difficult to target exacerbators. Furthermore much of the Canada geese habitat is on public land.
Administrative efficiency	General Rate is efficient due to 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 difficulty in targeting exacerbators and beneficiaries and the habitat of Canada geese on public lands and waterways, the General Rate is a reasonable approach.
Parties bearing indirect costs	Hunters will bear some indirect costs, particularly with Eradication.
Transitional cost allocation arrangements	Not required.
Mechanisms available	General Rate, targeted rate (rural properties) and direct charges are the most readily available mechansisms. Levies are expensive to establish and administer.

2.6.3 Proposed allocation of costs

Targeting exacerbators is problematic because much of the Canada goose habitat is on public land. Targeting beneficiaries with a rating mechanism is similarly problematic because of the mobile nature of birds and it wide potential feeding opportunities. While the immediate beneficiaries are those adjacent to Canada geese habitat, a targeted rating mechanism would need to demonstrate it had covered all the Canada geese habitat but had not included non-Canada geese habitat, and it would also need to address issues around distance from habitat for benefits to occur. Administratively such a rating district would be difficult to define, expensive to establish, and subject to challenge.

For Eradication because of the high level of costs, it may be necessary to develop a separate rating mechanism that targeted a mix of immediate (those with a Canada geese problem) and future beneficiaries (those protected from future spread and population growth). However it appears that Eradication produces a significant negative risk adjusted net benefit and is not a worthwhile option, and the next most appropriate option would be Sustained control. Because of the relatively low level of costs for this option, and the administrative costs of targeting beneficiaries or exacerbators, it is recommended that the costs for Sustained control of Canada geese, if undertaken as an option, be charged to the General Rate.

3 Rabbits (Feral)

3.1 Description

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

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

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

3.2 Proposed Plan

The proposed programme for rabbits is for Sustained Control, with intervention undertaken where rabbits are above Maclean's Scale 3.

3.3 Method for analysis of Rabbit options

The analysis undertaken here is based on information collected for a report prepared for Environment Canterbury in the 1994[3] - because rabbits have been at low levels since the introduction of RHD, there has been little new information collected since that time on which to base updated assessments. Therefore, most of the assumptions are derived from the experience of workers in the field or are extrapolated from this older data. This section details the background assumptions, the model used, the results, and the significance of the results.

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

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

Table 6: Estimate of annual costs of control by rabbit proneness class

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

The proportion of land in the different rabbit proneness classes is shown for Southland in Table 7.

Table 7: Area in each rabbit proneness class for Southland (ha)

Area of land in Rabbit Proneness Class (ha)				Total Area
Low	**Moderate**	**High**	**Extreme**	
41,750	110,000	49,100		200,850

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

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

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

The numbers of properties not controlling is estimated at 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 RHD, more control will be undertaken now than was the case at that time. Furthermore, the rabbit problem in Southland is not as severe as parts of Otago and Canterbury, and the returns from the predominantly moderately rabbit prone land in Southland are relatively high, so it is likely that an even lower proportion of farmers in Southland will not control rabbits. While it is possible to produce an extreme case where 50% of the land holders do not control rabbits, a lower limit is used in this paper so that the results are conservative with respect to the benefit which land holders gain from reducing spillover.

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

Production benefits are derived on a stock unit basis from work undertaken by Ogle Consulting for ES (Ogle, 2014). These stocking rates and returns are shown in Table 8.

Table 8: Stocking rates and returns per stock unit for rabbit prone land

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

Inspection and monitoring costs are estimated at $15,000 per annum, which is based on targeted monitoring on known prone properties.

3.4 NPD Section 6 Assessment

3.4.1 Level of analysis

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

3.4.2 Impacts of Rabbits (Feral)

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

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

3.4.3 Options for response

Two options for 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 very prone parts of Southland.

3.5 Risks of Rabbits (Feral) Plan

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

Implementation and compliance: There is a 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. There are also RMA requirements to be met in relation to poisoning operations.

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

Other risks: None known

Summary: There are risks associated with the rabbit plan although these are likely to be reasonably low as long as RHD has a reasonable level of effectiveness and returns for high country sheep and beef remain at a reasonable level.

3.5.1 Net Benefit and Risk Adjustment

The analysis produces an estimate of the total costs and benefits of the different options for the plan. These are shown in Table 9 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 $3.38 million (NPV(6%)), compared with $7.05 million (NPV(6%)) for the Full Control plan that requires control on all rabbit infested land. The sensitivity analysis (Table 10) shows that the results are reasonably robust to the assumptions made about discount rate, proportion controlling. However, if moderately prone land is excluded from the analysis, on the assumption that this land type is most likely to be controlled voluntarily and does not exhibit a significant rabbit problem with RHD, then the result is negative[7] for the Full Control option.

In order for the options to be worthwhile there would need to be a greater than 74% probability of success for the Boundary Control option, and 45% for the Full Control option. There are also potentially biodiversity benefits on 2,000 ha for the Boundary Control option, and 8,000 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 9: 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	$1.31	$11.53	$0.00	$12.84	$0.00	
Boundary Control	$0.68	$8.55	$0.24	$9.46	$3.38	74%
Full Control	$2.61	$0.00	$3.17	$5.79	$7.05	45%

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

Table 10: Assessment of sensitivity of results to assumptions for Rabbits (Feral) (NPV(6%) $million)

	Discount rate			Proportion not controlling			Moderate rabbit prone land included in the analysis	
Do Nothing	6%	4%	8%	10%	5%	20%	Yes	No
Boundary Control	$3.38	$4.61	$2.62	$3.38	$3.38	$14.23	$3.38	$0.76
Full Control	$7.05	$9.61	$5.47	$7.05	$7.05	$37.73	$7.05	-$1.20

NPD Section 7 - Allocation of Costs and Benefits

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

The beneficiaries and exacerbators of the plan are:

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

The direct and indirect costs associated with the plan are shown below in Table 11. The benefits and costs of the plan options, and the parties to whom they accrue, are shown in Table 12. 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 11: Direct and indirect costs of plan for Rabbits (Feral) ($ million PV6%)

Plan option	Control costs on land holders	Inspection and monitoring costs
Boundary Control	$0.68	$0.24
Full Control	$2.61	$3.17

Table 12: 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**	$2.98	$1.31
	Full Control	$11.53	$1.31
Costs for exacerbators	**Boundary Control**	$0.68	$0.00
	Full Control	$2.61	$0.00

3.5.3 Matters for consideration in allocation of costs

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

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

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

3.5.4 Proposed allocation of costs

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

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

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

4 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.

4.1 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.

4.2 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).

4.3 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 13. These are based on the last five year's reported farm budgets from DairyNZ[8] and Beef and Lamb NZ Table 13.

Table 13: 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

4.4 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[9]. It is higher than the 4% used by Auckland and Regional Council, but because most of the quantified benefit is associated with agricultural losses and control costs for land holders the 6% better reflects their cost of capital. Decision makers should note the impact of the higher and lower discount rates in the sensitivity testing when determining the best course of action.

The risks that the option will not meet the objective were identified for each pest and mitigation options considered where appropriate. The residual risk associated with the

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

different outcomes was estimated as a user input based on observation of success rates in similar 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 50 to Table 52 in Appendix C.

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.

4.5 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 14 below. The inspection costs should be seen as indicative only and are subject to change through the planning process.

Table 14: Ratio of inspection costs by objective for each scenario considered (base Sustained Control = 1)

	Ratio of inspection costs (Sustained Control = 1)	
Pest	**Progressive Control/ Sustained Control**	**Eradication/ Sustained Control**
Nodding Thistle	4	6
Broom	20	50
Gorse	20	50
Wilding conifers	20	50
Ragwort	20	50

4.6 Net Benefit analysis

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

4.6.1 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.

5 Nodding Thistle

5.1 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 Southland. 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.

5.2 Proposed Plan

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

5.3 NPD Section 6 Assessment

5.3.1 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.

5.3.2 Impacts of Nodding Thistle

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

5.3.3 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%) $159,000,000 for those not currently infested.

5.3.4 Costs of Nodding Thistle Plan

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

5.3.5 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

5.3.6 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 15 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 16 below which suggests the conclusion is robust under changes to a range of assumptions, apart from a lower discount rate when Eradication produces higher net benefit, and a larger spread distance when Progressive Containment has the highest net benefit.

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

Table 15: 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	$189,000,000		
Eradication	$39,000,000	$149,940,000	$-40,090,000
Progressive containment	$22,000,000	$166,800,000	$-1,170,000
Sustained Control	$27,000,000	$161,870,000	$7,800,000

Table 16: 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

5.4 NPD Section 7 - Allocation of Costs and Benefits

5.4.1 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 17 and Table 18.

Table 17: 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	$6,000,000	$300,000
Progressive containment	$20,000,000	$1000,000
Eradication	$38,000,000	$1000,000

Table 18: 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	$3,090,000	$159,000,000	$6,000,000
Progressive containment	$8,880,000	$159,000,000	$20,000,000
Eradication	$-7,869,281	$159,000,000	$38,000,000

5.4.2 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 19 below.

Table 19: 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 Southland
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 Southland.
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.

5.4.3 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

6 Broom - Urban

6.1 Description

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

6.2 Proposed Plan

ES is proposing that Broom is controlled through the Sustained Control 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 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.

6.3.2 Impacts of Broom in urban area

Broom has the potential to cause damage to amenity values and increased fire risk in urban settings.

6.3.3 Benefits for management of Broom

The benefits of the management of Broom in an urban setting are prevention of damage to amenity values and potentially some reduction in risk of fire. There are no quantified benefits associated with its control.

6.3.4 Costs of Broom Plan

The plan will incur costs of control, inspection, and monitoring. These are $33,730 annually for the strategy option. Costs for all three options considered are a NPV of NPV $600,000 for Sustained Control, NPV $11,000,000 for Progressive Containment, and NPV $27,000,000 for Eradication (which has a shorter time frame).

6.3.5 Risks of Broom Plan

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

Implementation and compliance: As noted there is a long history of regulated Broom control with widespread non-compliance. The implementation and compliance risks are substantial and the likelihood of anything of significance beyond the Do Nothing scenario in areas where it is already present are minimal.

Other legislative risks: None known

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

Other risks: None known

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 20 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 21 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 amenity values. However these values could only be achieved be complete control of broom on sections, and a control strategy that only targeted boundaries would not have any substantive benefits.

These factors suggest that the control of Broom in urban settings will not produce a positive net benefit.

Table 20: 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	$6,000,000		
Eradication	$34,000,000	$-28,300,000	$-26,350,000
Progressive containment	$14,000,000	$-8,280,000	$-10,980,000
Sustained Control	$2,000,000	$4,090,000	$-330,000

Table 21: 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

6.3.7 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 22 below.

Table 22: Matters for consideration in allocating costs for proposed Broom (urban) plan

Legislative rights and responsibilities	None known.
Management objectives	Sustained Control.
Stage of infestation	Widespread.
Most effective control agents	Land holders.
Urgency	Very low - well established and widespread.
Efficiency and effectiveness	The effectiveness of a Sustained Control plan is likely to be low, given that past intensive control efforts appear to have had little impact on spread. The efficiency of requiring land holders to control in uneconomic circumstances is also likely to be marginal.
Practicality of targeting beneficiaries	Beneficiaries are confined to urban areas.
Practicality of targeting exacerbators	Location of Broom can be established through an inspection programme. Therefore exacerbators are able to be targeted.
Administrative efficiency	A targeted rate on urban areas would be reasonably efficient.
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 (urban properties), and direct charges are the most readily available mechanisms. Levies are expensive to establish and administer.

6.3.8 Proposed allocation of costs

The management of Broom in an urban setting 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 amenity values in an urban setting. The approach to funding recommended here targets the beneficiaries and exacerbators.

- Inspection and monitoring in urban areas – direct charge to complainant or targeted urban rate.
- Control - land holder.

7 Broom - Rural

7.1 Proposed Plan

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

7.2 NPD Section 6 Assessment

7.2.1 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.

7.2.2 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. Broom causes increased costs for the management of river berms.

7.2.3 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 $289,760,000 relative to the pest being kept at its current level for those not currently infested.

7.2.4 Costs of Broom Plan

The plan will incur costs of control, inspection and monitoring. These are $34,440 annually for the strategy option. Costs for all three options considered are a NPV of NPV $600,000 for Sustained Control, NPV $11,000,000 for Progressive Containment, and NPV $27,000,000 for Eradication (which has a shorter time frame).

7.2.5 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

7.2.6 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 20 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 21 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, and intergenerational implications that should be taken into account.

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

Table 23: 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	$353,000,000		
Eradication	$370,000,000	$-16,390,000	$-12,630,000
Progressive containment	$150,000,000	$203,480,000	$3,070,000
Sustained Control	$64,000,000	$289,760,000	$13,940,000

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

7.3 NPD Section 7 - Allocation of Costs and Benefits

7.3.1 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.
- 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 25 and Table 26.

Table 25: Direct and indirect costs of plan for Broom

Plan option	Control costs land holders (PV (6%))	Inspection and monitoring costs (PV (6%))
Sustained Control	$36,000,000	$600,000
Progressive containment	$138,000,000	$11,000,000
Eradication	$343,000,000	$27,000,000

Table 26: 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	$-1,892,983	$292,000,000	$-289,760,000	$36,000,000
Progressive containment	$-77,294,488	$292,000,000	$-203,480,000	$138,000,000
Eradication	$-281,466,695	$292,000,000	$16,390,000	$343,000,000

7.3.2 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 22 below.

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

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

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

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

8 Gorse - urban

8.1 Description

Gorse is an erect shrub growing to 5 m in height that was introduced to Southland for use as a fencing shrub and for shelter. Gorse is widespread in Southland, 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.

8.2 Proposed Plan

ES 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.

8.3 NPD Section 6 Assessment

8.3.1 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.

8.3.2 Impacts of Gorse - urban

Gorse in an urban setting it causes primarily loss of amenity but in some situations may represent a potential fire risk.

8.3.3 Benefits for management of Gorse - urban

There are no quantified benefits from the management of gorse in an urban setting, apart from the reduction in costs of control for landholders to whom it may spread in the absence of a strategy. There may be benefits in terms of improved amenity values.

8.3.4 Costs of Gorse - urban Plan

The plan will incur costs of control, inspection and monitoring. These are $33,680 annually for the strategy option. Costs for all three options considered are a NPV of NPV $600,000 for Sustained Control, NPV $11,000,000 for Progressive Containment, and NPV $27,000,000 for Eradication (which has a shorter time frame).

8.3.5 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

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 31 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 32 below which suggests that the conclusion is robust to changes in single assumptions. There are some amenity benefits that may accrue if land is kept clear of gorse in urban settings, but these benefits would not exist if a boundary control approach were the only option used.

These factors suggest that the management of gorse in an urban setting is not likely to be worthwhile.

Table 28: Outcomes of analysis of costs and benefits for Gorse - urban

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	$6,000,000		
Eradication	$34,000,000	$-28,260,000	$-26,310,000
Progressive containment	$14,000,000	$-8,260,000	$-10,960,000
Sustained Control	$2,000,000	$4,090,000	$-330,000

Table 29: 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

8.3.7 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 30.

Table 30: Matters for consideration in allocating costs for proposed Gorse - urban

Legislative rights and responsibilities	None known.
Management objectives	Sustained Control.
Stage of infestation	Widespread.
Most effective control agents	Land holders.
Urgency	Very low - well established and widespread.
Efficiency and effectiveness	The effectiveness of a Sustained Control plan is likely to be low, given that past intensive control efforts appear to have had little impact on spread. The efficiency of requiring land holders to control in uneconomic circumstances is also likely to be high.
Practicality of targeting beneficiaries	Beneficiaries are located in urban areas and readily targeted.
Practicality of targeting exacerbators	Location of gorse can be established through an inspection programme. Therefore exacerbators are able to be targeted.
Administrative efficiency	Targeted urban rate is appropriate and efficient for benefits to urban area.
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 (urban properties) and direct charges are the most readily available mechanisms. Levies are expensive to establish and administer.

8.3.8 Proposed allocation of costs

The management of Broom in an urban setting 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 amenity values in an urban setting. The approach to funding recommended here targets the beneficiaries and exacerbators.

- Inspection and monitoring in urban areas – direct charge to complainant or targeted urban rate.
- Control - land holder.

9 Gorse - rural

9.1 Description

Gorse is an erect shrub growing to 5 m in height that was introduced to Southland for use as a fencing shrub and for shelter. Gorse is widespread in Southland, 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.

9.2 Proposed Plan

ES 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.

9.3 NPD Section 6 Assessment

9.3.1 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.

9.3.2 Impacts of Gorse

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

9.3.3 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%) $217 million for landholders currently not infested.

9.3.4 Costs of Gorse Plan

The plan will incur costs of control, inspection and monitoring. These are $19,180 annually for the strategy option. Costs for all three options considered are a NPV of NPV $300,000 for Sustained Control, NPV $6,000,000 for Progressive Containment, and NPV $15,000,000 for Eradication (which has a shorter time frame).

9.3.5 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

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 31 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 32 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 31: 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	$297,000,000		
Eradication	$442,000,000	$-145,550,000	$-4,220,000
Progressive containment	$179,000,000	$117,630,000	$4,520,000
Sustained Control	$79,000,000	$217,640,000	$10,580,000

Table 32: 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

9.4 NPD Section 7 - Allocation of Costs and Benefits

9.4.1 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 33 and Table 34.

Table 33: Direct and indirect costs of plan for Gorse

Plan option	Control costs land holders (PV (6%))	Inspection and monitoring costs (PV (6%))
Sustained Control	$45,000,000	$300,000
Progressive containment	$172,000,000	$6,000,000
Eradication	$427,000,000	$15,000,000

Table 34: 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	$-2,358,960	$220,000,000	$-217,640,000
Progressive containment	$-96,321,314	$220,000,000	$-117,630,000
Eradication	$-350,752,590	$220,000,000	$145,550,000

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 Table 35.

Table 35: 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 be low, given that past intensive control efforts appear to have had little impact on spread. The efficiency of requiring land holders to control in uneconomic circumstances is also likely to be 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.

9.4.3 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.

10 Wilding Conifers

Wilding conifers and the associated analysis shown here covers the following confier species:

- Lodgepole or contorta pine
- Dwarf mountain pine
- Bishop or muricata pine
- Corsican pine
- Maritime pine
- Ponderosa pine
- Radiata pine
- Scots pine

The term 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.

10.1 Proposed programme

ES 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.

10.2 NPD Section 6 Assessment

10.2.1 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.

10.2.2 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 4 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 Southland (42,188 ha[10]). This gave a formula of:

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

[10] From Wildlands 2016

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 the Velarde *et al.*(2015) paper of increasing each infestation in concentric circles with a given distance of spread. The approach here is likely to produce a lower estimate of spread because a mathematical rather than GIS based approach is used in the model, which means that interaction between different infestations sites is not taken into account. However, because the year in which the full habitat is infested is unaltered, the difference in costs should not be significant and will be within the error bounds for the study.

Estimate of productive land affected – an estimate of the proportion of land affected was made based on the proportion of Land use Capability (LUC) Class 6 and 7 land that is in grassland of some sort (85%), and comparing this with the proportion of affected land in private ownership in 2025 (75%). Because a proportion of short and tall tussock grassland will be in public ownership, the lower proportion of 75% of potentially affected land being productive is used for the purposes of this analysis.

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 Southland. 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 Southland because the major hydro resource in Lake Manapouri is currently forested and therefore not particularly vulnerable to impacts from wilding invasion.

Table 36: Estimated proportion of wilding prone land in productive land use

LUC class	Grassland (ha)	Other vulnerable (ha)	Not vulnerable (ha)	Total (ha)
6	234,000	42,000	234,000	510,000
7	100,000	14,689	248,000	362,000
Total	**334,000**	**57,000**	**482,000**	**872,000**
Proportion	**85%**	**15%**	**NA**	

Any impacts on irrigation are likely to occur primarily in the upper part of the Mataura catchment where the majority of irrigation takes place. 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 Southland are estimated from Statistics NZ 2012 Agricultural Census data as 17,200 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 (13%) which is $1.12/ha infested by wildings.

Biodiversity benefits - There are very few studies on the biodiversity values of tussock grasslands, and none specifically for species that occur primarily in the Southland region. Benefit transfer from a study to a similar habitat is an accepted practice if used cautiously and with caveats, and that is considered the most appropriate approach in this situation. The biodiversity benefits in Velarde et al. (2015) 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 38,000 estimated households in Southland (Statistics NZ privately occupied dwellings) this gives an annual cost of $12.5 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 $41.5/ha/annum for land currently unaffected. Caution should be used with these estimates of the biodiversity benefits because the species and situations may differ from those in Southland. They should be considered indicative rather than definitive estimates of biodiversity benefits.

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 Southland. 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.

10.2.3 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.

10.2.4 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%) $30 million in costs for control, lost production, reduced irrigation, and loss of biodiversity.

10.2.5 Costs of Wilding Conifers Programme

The plan will incur costs of control, inspection, and monitoring. These are $20,000 annually for the Progressive Containment option. Costs for all three options considered are an NPV(6%) of $200,000 for Sustained Control, NPV $600,000 for Progressive Containment, and NPV $2,000,000 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.

10.2.6 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

10.2.7 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 37, Table 38 and Table 39 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 40 shows that the conclusion that Progressive Containment has the highest risk adjusted net benefit is robust to a range of changes in the assumptions used apart from a higher rate of spread and a lower discount rate where Eradication is favoured. The potential benefits associated with preventing damage to biodiversity on 220,000 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, and because they are based on benefit transfer should be considered indicative rather than definitive.

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 10.2.4 and 10.2.5. 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 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 37: Scenario outcomes by item for Wilding Conifers

	Scenario outcome ($ million NPV)			
Item	**Do Nothing**	**Sustained Control**	**Progressive containment**	**Eradication**
Cost of control	$0.2	$0.2	$0.6	$1.6
Cost of lost production	$23.0	$10.6	$0.0	$0.0
Inspection, monitoring etc.	$0.0	$0.0	$0.3	$0.8
Hydro losses	$0.0	$0.0	$0.0	$0.0
Irrigation losses	$0.6	$0.2	$0.0	$0.0
Biodiversity losses	$22.4	$7.6	$0.0	$0.0
Total	**$46.1**	**$18.6**	**$1.0**	**$2.4**

Table 38: Net benefit for plan option by item for Wilding Conifers

	Net Benefit ($ million NPV)		
Item	**Sustained Control**	**Progressive containment**	**Eradication**
Cost of control	$0.0	-$0.4	-$1.4
Cost of lost production	$12.4	$23.0	$23.0
Inspection, monitoring etc.	$0.0	-$0.3	-$0.8
Hydro benefits	$0.0	$0.0	$0.0
Irrigation benefits	$0.4	$0.6	$0.6
Biodiversity benefits	$14.7	$22.4	$22.4
Total	**$27.6**	**$45.2**	**$43.8**

Table 39: Outcomes of analysis of costs and benefits for Wilding Conifers

Programme	**Risk adjusted net benefit (NPV(6%) $ million**
Eradication	$4.20
Progressive Containment	$12.4
Sustained Control	$12.0

Table 40: 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	Eradication
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

10.3 NPD Section 7 - Allocation of Costs and Benefits

10.3.1 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 41 and Table 42.

Table 41: 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	$200,000	$20,000
Progressive Containment	$600,000	$300,000
Eradication	$2,000,000	$800,000

Table 42: 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	$29,000,000	$6,240,000	$200,000
Progressive Containment	$29,000,000	$16,320,000	$600,000
Eradication	$29,000,000	$15,400,000	$2,000,000

Table 43: Estimate of share of net benefit by benefit type for Sustained Control option (% of total net benefit)

Item	Share of net benefit for Progressive containment
Cost of control	0%
Cost of lost production	45%
Inspection, monitoring etc.	0%
Hydro benefits	0%
Irrigation benefits	1%
Biodiversity benefits	53%
Total	100%

10.3.2 Matters for consideration in allocation of costs

The matters for consideration are spelt out in Section 7(2)(d) of the NPD, and the analysis for each of these matters is shown in Table 44 below.

Table 44: 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 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 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.

10.3.3 Proposed allocation of costs

The analysis in Table 43 suggests that the biodiversity benefits and lost production benefits both amount to ~50% each 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. 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: General Rate.
- Ongoing control following initial control: 100% landholder

11 Ragwort

11.1 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.

11.2 Proposed Strategy

ES is proposing that Ragwort is controlled through the Sustained Control 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 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.

11.3.2 Impacts of Ragwort

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

11.3.3 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.

11.3.4 Costs of Ragwort Strategy

The plan will incur costs of control, inspection and monitoring. These are $27,460 annually for the strategy option. Costs for all three options considered are a NPV of NPV $500,000 for Sustained Control, NPV $900,0000 for Progressive Containment, and NPV $22,000,000 for Eradication.

11.3.5 Risks of Ragwort Strategy

Technical and operational risks: Ragwort has been present in New Zealand for many years, and it likely to have occupied most habitats in Southland. 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, athough its efficacy in Southland does not appear to have been as good as in other parts of the country. 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.

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 strategy, 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, which suggests that Sustained Control may be of a higher net benefit with a lower discount rate or higher rates of spread.

These factors suggest that a strategy 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

Strategy	Total NPV	Net Benefit of strategy	Risk adjusted net benefit
Do Nothing	$679,000,000		
Eradication	$610,000,000	$69,430,000	$-2,1640,000
Progressive reduction	$257,000,000	$421,920,000	$-9,130,000
Sustained control	$703,000,000	$-23,780,000	$-1,620,000

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	Sustained control
Time to full occupation 150% of base	Do Nothing
Distance of spread 50% of base	Do Nothing
Distance of spread 200% of base	Sustained control
Cost of control +20% from base	Do Nothing
Cost of control -20% from base	Do Nothing
Loss of production impacts -20% from base	Do Nothing
Loss of production impacts +20% from base	Do Nothing
Discount rate 4%	Sustained control
Discount rate 8%	Do Nothing

11.4 NPD Section 7 - Allocation of Costs and Benefits

11.4.1 Beneficiaries, exacerbators and costs of proposed strategy for control of Ragwort

The beneficiaries and exacerbators of the strategy 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 strategy are shown below in Table 4 and Table 5.

Table 4: Direct and indirect costs of strategy for Ragwort

Plan option	Control costs landholders	Inspection and monitoring costs
Sustained control	$62,000,000	$500,000
Progressive reduction	$246,000,000	$9,000,000
Eradication	$588,000,000	$22,000,000

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

Strategy 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	$300,600,000	$-323,924,241	$23,780,000	$62,000,000
Progressive reduction	$754,970,000	$-323,924,241	$-421,920,000	$246,000,000
Eradication	$415,000,000	,$-323,924,241	$-69,430,000	$588,000,000

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 45 below.

Table 45: 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 Southland
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 judgenemtn
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.

11.4.3 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

12 Exclusion Pests

Exclusion pests include :

Table 46: Pests to be included in an exclusion programmes

Common names	Scientific name	Area	Page
Plants			
Boneseed	*Chrysanthemoides monilifera*	All Southland	
Chilean needle grass*	*Nassella neesiana*	All Southland	
Nassella tussock*	*Nassella trichotoma*	All Southland	
Animals			
Rook	*Corvus frugilegus*	All Southland	
Wallaby - Bennett's, Dama, Parma, Brushtail Rock and Swamp	*Macropus rufogriseus rufogriseus, M. eugenii, M. parma, Petrogale penicillata, Wallibia bicolour*	All Southland	
Marine			
Asian paddle crab	*Charybdis japonica*	All Southland	
Sabella (Mediterranean fanworm)**	*Sabella spallanzanii*	All Southland	
Sea squirts (clubbed tunicate, Australian droplet tunicate, pyura & didemnum)	*Styela clava Eudistoma elongatum, Pyura doppelgangera and Didemnum vexillum*	All Southland	

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

12.1 NPD Section 6 Assessment

The analysis for these pests is undertaken at Level 1 because they are not present in the region, there is no opposition to their management, and the management costs are relatively low.

The objectives for exclusion pests will meet the requirements of Section 6 if the Council considers that the benefits of reducing the risks of these pests being introduced to the region and causing damage to biodiversity, conservation, amenity, and production values exceeds the expenditure of $xx,000 per annum.

12.2 NPD Section 7 Assessment for Exclusion Pests

Because these pests are not present there are no exacerbators, and therefore the most appropriate source of funding is from the beneficiaries. Rating is the most efficient and secure source of funding. The majority of the pests are biodiversity related, for which funding from the General Rate is most appropriate. There is unlikely to be major efficiency benefits from targeting production beneficiaries, given the diffuse and uncertain nature of the benefits, and therefore the recommendation is that all the funding for Exclusion pests be sourced from General Rate.

13 Site Led Pests

The group of pests included in Site Led programmes are:

Table 47: Pests included in site-led programmes

Common names	Scientific name	Area
Plants		
African club moss	*Selaginella kraussiana*	Zone 1
Gunnera	*Gunnera tinctoria*	Zone 1
Hawthorn	*Crataegus monogyna*	Zone 1
Heather	*Calluna vulgaris*	Zone 1
Knotweed	*Fallopia japonica, F. sachalinensis and Persicaria wallichii* (syn *Polygonum polystachyum*)	Zone 1
Spanish heath	*Erica lusitanica*	Zone 1
Willow (Crack, Grey)*	*Salix fragilis*, *S. cinerea*	Zone 1
Any other pest plant in RPMP		Any Zone as required
Animals		
Feral cat	*Felix catus*	Zone 1 & 2
Feral goat	*Capra hircus*	Zone 1 & 2
Feral pig	*Sus scrofa*	Zone 1
Hedgehog	*Erinaceous europaeus*	Zone 1 & 2
House mouse	*Mus musculus*	Zone 1
Mustelids (ferret, stoat, weasel	*Mustelo furo, M. ermine, M. nivalis*	Zone 1 & 2
Possum	*Trichosurus vulpecula*	Zone 1
Rat (Norway, ship and Kiore)	*Rattus norvegicus, R. rattus R. exulans*	Zone 1 & 2
Any other pest animal in RPMP		Any Zone as required

Zone 1: Rakiura/Stewart Island
Zone 2: Omaui

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.

13.1 Section 6 Assessment

The level of analysis for Site led Pests is 1, because the expenditure on any single site will be limited, and because the programme will only be undertaken where feasible and in conjunction with the land holder.

The proposed costs for the Site Led pests are shown in the qualitative cost benefit analysis, although it should be noted that these will be finalised once the locations are known and agreed. The agreement of the land holder signals that for them the benefits of the programme are likely to exceed the costs they will incur. Therefore, as long as the Council is

satisfied that the benefits of the site led programme exceed the costs, the requirements of Section 6 of the NPD will have been met.

13.2 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.

14 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.

14.1 Feral rabbits

The analysis for feral rabbits in Section 3 is based on boundary control, and it shows that overall there is likely to be a net benefit from a boundary control regime. In terms of reasonableness the analysis suggests that the costs are likely to be similar or lower for the source landholder as opposed to the receptor landholder where the rabbit proneness is moderate or low and the receptor is of a higher proneness class. Requiring control on land where the source is High or Extreme proneness will result in the costs of the source being between 1.7 and 7.7 times the additional costs of control for the receptor landholder. Costs are unlikely to be reasonable in any situations where the receptor is Low proneness because rabbits are generally maintained at low levels on these land types without control being undertaken.

14.2 Possums

Possums are controlled under the site led programme in Possum Control Areas. The assessment of their ability to meet the tests for GNR therefore assumes that the overall costs and benefits of the site led programme are established.

The good neighbour rule does not appear to meet the tests of reasonableness in the NPD, because the boundary control distance of 500m provides no benefit in terms of control costs for recipient landholders. The only situation which comes close is when both the source and receptor landholder are low prone land (pasture and open country), where the costs of the source landholder are approximately 50% more than the savings in costs for the receptor landholder.

14.3 Nodding thistle

For light infestations of nodding thistle on hill and high country properties the 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.

14.4 Gorse

For light infestations of Gorse in the source property, the costs of control for the source and receptor land holders are likely to be similar. For dense infestations the cost of control for source land holders exceeds the costs for the receptor landholder by more than 50%. For broom in urban settings the costs for the source land generally exceeds that for the receptor by a significant margin and the GNR inclusion is not likely to meet the reasonableness tests of the NPD.

14.5 Broom

For light infestations of Broom in the source property, the costs of control for the source and receptor land holders are likely to be similar. For dense infestations the cost of control for source land holders exceeds the costs from spread for the receptor landholder by more than 50%. For broom in urban settings the costs for the source land generally exceeds that for the receptor by a significant margin and the GNR inclusion is not likely to meet the reasonableness tests of the NPD.

14.6 Wilding conifers

Wilding conifers refer to a range of species which are yet to be defined. The assumed boundary distance is 200 m. For light infestations of wilding conifers the source property, the costs of control for the source and receptor land holders are likely to be similar. For dense infestations on the source property the costs of control for the source are 8 – 9 times the additional cost caused by the spread to the adjacent receiving landholder and the GNR inclusion is not likely to meet the reasonableness tests of the NPD.

14.7 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.

15 References

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16 Appendices

Appendix A Assumptions used in plant pest modelling

Table 48: Assumptions for Plant Pest Spread Model (PPSM) Part A

Pest	Programme	Current Area infested (ha)	Number of active sites (locations)	Largest area of a location	Potential habitat/area (ha)	Current densities (%)	Density at full occupancy (%)	Time of first arrival at a site to 90% occupancy at a site/to all of Southland	Low distance of spread (Min)	High distance of spread (Max)	How often is it likely to generate new foci of infestation	Cost of control low density ($/ha/annum)	Cost of control high density ($/ha)	Inspection costs ($/annum)
Nodding Thistle	Sustained Control	67462	1532	1240	872000	10	20	5	50	200	3	$10	$45	$18,500
Broom Urban	Sustained Control	994	3373	15	5945	10	50	15	10	50	1	$100	$1,000	$33,730
Broom Rural	Sustained Control	43622	1722	22443	1042817	10	50	15	10	50	1	$100	$1,000	$34,440
Gorse Urban	Sustained Control	993	3368	15	5945	10	50	15	10	50	1	$100	$1,000	$33,680
Gorse Rural	Sustained Control	54360	959	22443	1042817	10	50	15	10	50	1	$100	$1,000	$19,180
Wilding conifers	Progressive containment	42188	3	14062.6667	345311	1	80	20	150	150	3	$0.47	$2,200	$20,000
Ragwort	Sustained Control	62402	2746	2897	875988	10	80	5	1	20	3	$120	$150	$27,460

Table 49: Assumptions for Plant Pest Spread Model (PPSM) Part B

Pest	Density of new infestations (%)	Proportion productive land	Years to establishment of new sites to significant seed spread	Number of new foci established each time	Proportion controlled Sustained	Proportion controlled progressive	Proportion controlled Do Nothing	Years to progressive	Years to eradication	Production model type	Inspection cost ratio strategy/sustained	Inspection cost ratio Progressive/Sustained	Inspection cost ratio Eradication/sustained	Distance to North Boundary (km)	Distance to East Boundary (km)	Distance to South Boundary (km)	Distance to West Boundary (km)
Nodding Thistle	0.125	0.75	2	3	0.5	0.95	0.4	50	20	Hill country	1	4	6	200	200	200	200
Broom Urban	2	0.75	2	1	0.5	0.95	0.4	1000	50	Hill country	1	20	50	200	200	200	200
Broom Rural	2	0.75	2	1	0.5	0.95	0.4	1000	50	Hill country	1	20	50	200	200	200	200
Gorse Urban	2	0.75	2	1	0.5	0.95	0.4	1000	50	Hill country	1	20	50	200	200	200	200
Gorse Rural	2	0.75	2	1	0.5	0.95	0.4	1000	50	Hill country	1	20	50	200	200	200	200
Wilding conifers	0.0005	0.75	2	3	0.5	0.95	0.2	1000	50	High country	1	20	50	200	200	200	200
Ragwort	0.125	0.23623383	2	3	0.5	0.99	0.4	1000	50	Dairy	1	20	50	200	200	200	200

Appendix B Assessment of level of analysis under the NPD Guidance

Organism	Criteria 1	Criteria 2	Criteria 3	Criteria 4	Comments	Analysis Intensity
Nodding thistle	H	M	M	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**
Wilding Conifers	H	M	M	H	Some in community oppose management, overall costs are high, benefits exceed costs, impacts are known to occur, control measures are available and quality data exists.	**3**
Broom	M	M	L	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**
Gorse	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**
Ragwort	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**
Feral rabbit	M	M	L	H	Some in community oppose management, overall costs are high, benefits exceed costs, impacts are known to occur, control measures are available and quality data exists.	**2**
Canada Goose	M	M	L	M	Control supported by community, overall costs are moderate - high, benefits may not exceed costs, impacts are known to occur, control measures are available and limited data exists.	**2**
Possum	M	M	L	M	Control supported by community, overall costs are moderate - high, benefits may not exceed costs, impacts are known to occur, control measures are available and some data exists.	**2**

Appendix C Risk adjustment for net benefit calculation of Plant Pests

Table 50: 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 51: 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**	80%	20%	0%	0%
	Sustained Control	75%	25%	0%	0%
	Progressive containment	75%	25%	0%	0%
	Eradication	75%	25%	0%	0%

Table 52: 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	10%	50%	35%	5%
	Eradication	5%	60%	30%	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 53: Good Neighbour Rule Model outcomes for Feral Rabbits

Feral rabbits NPD Section 8(e)(ii) - Ratio of costs for Source land holder to the costs for the Receiving land holder

Land use for the Source of infestation	Land holder who receives the infestation			
	Low	Moderate	High	Extreme
Low	No costs	0.29	0.13	0.11
Moderate	No costs	2.33	1.06	0.91
High	No costs	4.40	2.00	1.72
Extreme	No costs	7.68	3.49	3.00

Table 54: Good Neighbour Rule Model outcomes for Possums

Possums NPD Section 8(e)(ii) - Ratio of costs for Source land holder to the costs for the Receiving land holder

Land use for the Source of infestation	Land holder who receives the infestation			
	Low	Moderate	High	Extreme
Low	1.52	No effect[11]	No effect	No effect
Moderate	4.12	No effect	No effect	No effect
High	4.12	No effect	No effect	No effect
Extreme	4.12	No effect	No effect	No effect

[11] No effect means the boundary control has no effect on the costs of the receptor landholder, and therefore it is not a reasonable requirement.

Table 55: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 56: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 57:Good Neighbour Rule Model outcomes for Broom: Scattered infestation on Source property

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

Receptor land use

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

Table 58: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

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	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 59: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

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	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 60: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 61:Good Neighbour Rule Model outcomes for Wilding pines (various species): Scattered infestation on Source property

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

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

Table 62:Good Neighbour Rule Model outcomes for Wilding pines (various species): Dense infestation on Source property

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

Source Landuse	Receptor Landuse: Dairy	Sheep and beef Intensive	Arable	Horticulture	Hill country	High country	Conservation	Forestry	Non Productive
Dairy	No costs	No costs	No costs	No costs	8.89	8.89	8.89	No costs	No costs
Sheep and beef Intensive	No costs	No costs	No costs	No costs	8.89	8.89	8.89	No costs	No costs
Arable	No costs	No costs	No costs	No costs	8.89	8.89	8.89	No costs	No costs
Horticulture	No costs	No costs	No costs	No costs	8.89	8.89	8.89	No costs	No costs
Hill country	No costs	No costs	No costs	No costs	8.89	8.89	8.89	No costs	No costs
High country	No costs	No costs	No costs	No costs	8.89	8.89	8.89	No costs	No costs
Conservation	No costs	No costs	No costs	No costs	8.89	8.89	8.89	No costs	No costs
Forestry	No costs	No costs	No costs	No costs	8.89	8.89	8.89	No costs	No costs
Non Productive	No costs	No costs	No costs	No costs	8.89	8.89	8.89	No costs	No costs