Waikato Regional Pest Management Plan 2014-2024

Appendix 1: Cost benefit analysis

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Introduction

This document contains the cost benefit analyses (CBA) that contributed to the decision making around which species to include in Waikato Regional Council's Regional Pest Management Plan (RPMP) for 2013-2023.

RPMPs are prepared under the Biosecurity Act (1993). The Act was reviewed in 2012 and the requirements for economic analysis adjusted. Section 70(2)(c)(vii) requires an analysis of the costs and benefits associated with each pest. Further detail on the requirements associated with each CBA is found primarily in section 71(e). Prior to the 2012 amendments, the cost benefit requirements of the Act were found primarily in section 72.

The amendments to the Biosecurity Act (BSA) also provided for a Proposed National Policy Direction for Pest Management Plans and Programmes that regional pest management plans are required to be not inconsistent with. As of the adoption of this plan, the national policy direction is in proposal form only. When the national policy direction is finalised, the council will have a period of time to determine whether the RPMP is inconsistent with it. Particularly relevant to this CBA analysis is section 7 of the national policy direction proposal. The current concepts and intent of section 7 have been part of the decision making for this RPMP and have been considered by council as part of the overall cost benefit analyses.

CBA background

For many pests, the cost/benefit situation has not changed significantly since the pests were first included in a regional pest management plan. For those pests, Waikato Regional Council has not repeated the CBA analysis. Waikato Regional Council uses the Harris model of cost benefit analysis, which was identified by the Biosecurity Generic Guidelines Group as meeting the requirements of the amended Act because it is well proven and robust. Because some of the CBA in this RPMP were done prior to the amendments to the Biosecurity Act, some of the analyses in reference section 72, which was the previous relevant section of the BSA.

Some pests are either new to this plan or have situations that have changed since the last CBA was done. In those cases, a new CBA has been completed, again using the Harris model. Pests with more complicated circumstances or with potentially large impacts on land occupiers were analysed by an outside consultant. More straightforward pests were analysed by Waikato Regional Council staff.

This scaleable approach reflects the intent of the proposed national policy direction which notes:

"When determining the appropriate level of analysis of the benefits and costs of the plan ... a proposer must consider ... the relative costs involved, for example, very low cost actions should not involve a high cost analysis."

For many pests in this RPMP, Waikato Regional Council concluded that an extensive (and expensive) CBA was not warranted. This determination included consideration of the impact of "good neighbour rules," which are the only RPMP rules with which Crown agencies must comply.

For all the pests identified in this plan, Waikato Regional Council was satisfied that the benefits outweigh the costs. The council notes that many of the costs and benefits associated with pests are not financial. There are environmental issues, as well as public health and general quality of life considerations. In fact, most of the impact of the non-agricultural pests is not directly related to monetary loss.

It is important to be aware that while non-monetary issues are often the key drivers behind the council's pest control operations, they are unfortunately difficult to quantify in cost benefit analyses. Waikato Regional Council took all factors into account when it made determinations about which pests to include in this RPMP.

1 Document structure

Section 1 of this document includes the new CBA done specifically for this RPMP by Harris Consulting – Resource Economists.

Section 2 includes CBA done specifically for this RPMP by Waikato Regional Council staff.

Section 3 includes CBA done for previous pest management plans. For these pests, Waikato Regional Council determined that there have been no changes substantive enough to warrant preparing a new CBA. Because these CBA were done in previous years, some terminology is not current. For example, "Environment Waikato" is used instead of the current "Waikato Regional Council." These CBAs also refer to section 72 of the BSA, whereas the current CBA requirements are in section 71 of the Act. However, the substantive pest issues that informed the original CBA are largely unchanged and the CBA conclusions remain valid.

2 CBA by Simon Harris

Summary

	Section 71(d)	Section 71(e)	Section 71(f)
Pest	*Is the pest a serious threat in relation to the region?*	*Do the benefits outweigh the costs?*	*Who receives benefits in excess of their costs, or are contributors/ exacerbators?*
Japanese cherry and rum cherry	Yes, part (ii) and (iv)	Yes if the costs of the strategy do not exceed $4,000/annum in perpetuity and the council is satisfied that 5% of the area will require control in the absence of intervention.	The wider regional community.
Chocolate vine	Yes, part (ii) and (iv)	Yes if the costs of the strategy do not exceed $10,000/annum and the council is satisfied that control will be undertaken on 5% of the land in the absence of a strategy.	Landholders and crown as contributors to the problem The wider regional community for conservation and biodiversity benefits.
Chilean rhubarb (*Gunnera spp.*)	Yes, part (ii) and (iv)	Yes if the costs of the strategy do not exceed $8,000/annum and the council is satisfied that control will be undertaken on 5% of the land in the absence of a strategy.	Landholders and crown as contributors to the problem. Note problems with strategy achievability if landholders are required to undertake control. The wider regional community for conservation and biodiversity benefits.
Velvet leaf	Yes, part (i)	Yes	Landholders as contributors. Arable land as beneficiaries.

	Section 71(d)	Section 71(e)	Section 71(f)
Pest	*Is the pest a serious threat in relation to the region?*	*Do the benefits outweigh the costs?*	*Who receives benefits in excess of their costs, or are contributors/ exacerbators?*
Tutsan	Yes, part (i)	Yes if control can be achieved on the 500 ha infested at a cost of $800/ha/annum. Note concerns about feasibility of achieving containment given increase from an area of 100ha over the period since the last review.	Landholders and Crown are contributors. Pastoral landholders without tutsan currently are beneficiaries and benefits exceed costs.
Woolly nightshade	Yes, part (i)	No, area infested too great and control costs too high. Note concerns about feasibility of containing a bird spread weed that is very widespread.	Landholders and Crown are contributors. Note the very high costs of control imposed on these parties if required on all land. Pastoral landholders not currently infested are beneficiaries.
Privet	Yes, part (vii)	No – costs of control and enforcement greatly outweigh very minor benefits.	Landholders and Crown are contributors. Beneficiaries are those parties with allergy to privet.

	Section 71(d)	Section 71(e)	Section 71(f)
Pest	*Is the pest a serious threat in relation to the region?*	*Do the benefits outweigh the costs?*	*Who receives benefits in excess of their costs, or are contributors/ exacerbators?*
Koi carp	Yes, part (ii) and (iv)	Yes if council considers benefits on area controlled exceeds an NPV of $78/ha of water body. This will need to be refined once costs and areas controlled have been better defined.	Community is beneficiary. No contributors.

Modelling containment and eradication of plant pests

In order to estimate the impact of the “do nothing” scenario, a model of plant growth and infestation is used to determine the outcome of no regional intervention. The model used for assessing the potential cost of unconstrained plant pests is based on a theta logistic growth curve for the pest increasing to saturation in its available habitat. A curve is fitted to the time between current and full infestation.

For the alternative management scenarios, an assumption is made that infestation and resulting costs change in a linear fashion between the initial (current) state and the final state to be achieved (containment, eradication, reduction etc).

All costs are then used in a cashflow analysis to produce an NPV of the costs using an 8 per cent discount rate.

2.1 Japanese cherry (*Prunus serrulata)* and rum cherry (*Prunus serotina*)

Description and background

Rum cherry (*Prunus serotina*), or black cherry as it is commonly known in its native North America, can grow to a height of 38 metres in the eastern US, but south-western US varieties typically are smaller. South-western black cherry (var. *rufula*) seldom grows taller than 9 metres, and escarpment black cherry (var. *exima*) no taller than 15 metres[1]. Whilst considered shade intolerant, seedlings are common under uncut stands and can survive for 3 to 5 years. The species is reported as readily sprouting from stumps with the sprouts able to grow rapidly, especially in full sunlight[2].

Japanese cherry (*P. serrulata)* is a small deciduous tree reaching 8-12 metres in height. It is native to Korea, Japan and China and is a noted ornamental. Japanese cherry is sold widely in root stock for ornamental cherry trees and is sold as a whole plant in nursery trade. It produces black fruit that are bird spread, and occurs in waste areas, reserves and forest margins. It has been reported (K. Loe, pers.comm) as occurring in native forest as an understorey plant, and thus has the potential to cause damage to environmental values by occupying native habitats.

There is a dearth of published information on its growth and habit in New Zealand, although it seems likely that *P. serotina* will behave in a similar manner to *P. campanulata,* which is reported by Auckland Regional Council as able to colonise bush margins, canopy gaps and clearings, where it competes with regenerating native plants.

Similarly, there is a paucity of information on the international experience of either species as a plant pest. Whilst *P. serotina* is considered by some to be a weed in parts of North America the species is not listed on federal or state noxious plant lists.

Rum cherry is included in the National Plant Pest Accord (NPPA), but Japanese cherry is not. Rum cherry is reported in the NPPA as

> *"..invading forests in Europe and dense stands of seedlings have been reported from open forest in New Zealand. The leaves contain toxins and are sometimes reported as causing livestock poisoning overseas."*

Japanese cherry is recorded as an environmental weed in the Department of Conservation's (DOC) consolidated list of environmental weeds[3]. Waikato Regional Council estimates 15ha of the Waikato region are currently infested by Japanese and rum cherry, with the majority of the area around Taupō. Council's estimate of the total potential area infested is 290,000ha, of which shrubland (180,000ha) is the largest vulnerable area, and indigenous forest margins, coastal cliffs and riparian margins significant potentially affected areas.

[1] U.S. Department of Agriculture Natural Resources Conservation Service http://plants.usda.gov/plantguide/doc/pg_prses.doc accessed 17 January 2007

[2] U.S. Department of Agriculture Forest Service http://www.na.fs.fed.us/pubs/silvics_manual/volume_2/prunus/serotina.htm accessed 17 January 2007

[3]

Table 1: Estimated potential habitat for Japanese and rum cherry

Habitat type	**Area potentially infested**
Roads	4,595ha
Railway	142ha
Indigenous forest (10m margin)	19,371ha
Plantation (planted forest) 10m margin	20,937ha
Shrubland/scrub (manuka, kanuka)	175,800ha
Coastal cliffs	1,250ha
Riparian margins (10m x length)	43,559ha
Urban (towns and cities)	22,400ha
Total potential range	**290,000ha**

While rum cherry is banned from sale through the NPPA, Japanese cherry continues to be sold through nurseries as rootstock and whole plants. Waikato Regional Council intends to prevent the sale and distribution of both cherry varieties, and undertake site specific control where biodiversity values are affected.

Analysis

Level of analysis

Considerations	**Assessment**	**Comment**
Certainty – data available	Moderate	Reasonable information on the costs of control. Data on current location of pest likely to be poor.
Certainty – impacts	Low	Some information on spread, but little documentation on impacts in NZ context.
Significance	High	Significant use as an amenity plant, but alternatives available.
Urgency	Moderate	Reasonably slow spread, and already reasonably widely distributed as amenity plantings.
Costs	Low	Low cost strategy.

Risks

National policy direction considerations	**Assessment**	**Comment**
Objective not being achieved	Moderate	
Management approach inadequately applied	Moderate	
Adverse impact on implementation	High	High amenity values may mean that growers and gardeners ignore restrictions on sale.
Unintended adverse effects	Low	
Public and political concerns	High	Amenity values.

Alternatives assessed

There are three alternate approaches assessed for managing Japanese cherry:

1. Do nothing – where the pest is allowed to continue to be sold and to spread unhindered.

2. Containment – where the pest is contained within its current range, with some site led control in areas where spread has occurred. No further sale of Japanese cherry will be allowed.
3. Eradication – where an intensive programme of control is undertaken to attempt to eradicate it from the region. No further sale of Japanese cherry will be allowed.

Costs and benefits

Costs

- Loss of amenity from preventing sale of these plants. Both species are highly prized for their ornamental value, and because the lifespan of these species is often reasonably short[4], the prevention of sale would result over time in the loss of these values. It may be that other species or non-fruiting cultivars are available to prevent this cost occurring.
- Control costs – where control is undertaken there will be costs incurred. Control is estimated to cost $1000/ha, although this is a broad estimate given that control has not yet been undertaken in the region and control costs are not available elsewhere. Waikato Regional Council is intending to undertake 1ha of site led control per year which would imply annual control costs of $1000/year. Because Japanese and rum cherry often occur in the same location, these costs apply to control of both weeds.
- Monitoring, enforcement, education – Waikato Regional Council estimates costs of $3000/annum for both weeds.

Benefits

The benefits of the strategy arise largely from prevention of harm to indigenous and conservation values:

- Where control is undertaken there will be a gain to conservation values and indigenous biodiversity. However this will be limited in scope and confined to high value sites.
- Prevention of sale will over time remove any planted seed sources, which will reduce the risk of escape and establishment of wild infestations in new locations. However, the risk from established wild infestations will continue, and this is unlikely to be greatly affected by the strategy other than a slowing in the rate at which they occupy their potential range.

The alternative scenario of eradication was also assessed. This had many of the same costs and benefits of the proposal, but had higher regional council costs associated with monitoring and searching for the pest (assumed at $50,000 per annum), and higher control costs to ensure that the plant was eliminated in areas where it was uncovered (assumed at $50,000 per annum). It was also assumed that the effort was required only for 10 years, and thereafter costs were reduced to $1000 per annum for ongoing surveillance.

Scenario outcomes

The outcomes for each alternative are expressed as the total losses occurring – ie the costs of control and the reduction in production as a result of infestation.

Table 2: NPV of costs and production losses for each alternative assessed (Japanese and rum cherry)

	No RPMP	Containment	Eradication
NPV outcome	**$752,726**	**$233,995**	**$752,828**

[4] http://www.ces.ncsu.edu/depts/hort/consumer/factsheets/trees-new/prunus_serrulata.html

The results suggest that the containment scenario has lower NPV of costs than either the do nothing approach or the eradication approach. This is because relative to the do nothing approach there is a reduction in control costs associated with Japanese and rum cherry once it spreads onto land with conservation and other regional values, but relative to the eradication scenario the high initial costs of achieving eradication are avoided.

Section 71(d)

Rum cherry appears capable of causing damage to the viability of indigenous species and ecosystems through invasion of habitat. While Japanese cherry is not recognised as a significant threat elsewhere in the world, it is listed as an environmental weed of conservation estate (Howell, 2008) and therefore ranks as a potential and actual threat to conservation values. On this basis both Japanese and rum cherry meet the requirements of section 71(d).

Section 71(e)

If the council considers that the assumptions are reasonable, and the loss of amenity from preventing plantings of the two cherry species are not significant, then the requirements of section 71(e) will have been met in relation to the proposal because it results in the lowest NPV cost for the region.

Funding assessment

Assessment of potential funders

Table 3: Assessment of exacerbators and beneficiaries for Japanese and rum cherry proposed strategy

		Ability to reduce costs through behaviour change	Able to determine whether benefits of control outweigh costs	Determine whether control is delivered in most cost effective manner
Exacerbators	Landholders with pest present	Yes	No	Yes
	Crown	Limited	No	Limited
Beneficiary	Community	No	Yes, through political process	Limited

Section 71(f) conclusion

The funding of the strategy is best placed to be sourced from the community as beneficiaries. Because control is site specific, requiring landholders and the Crown to pay as exacerbators is not appropriate. Because the conservation and biodiversity values accrue to the community, if the council considers that the requirements of section 71(e) have been met, then the requirements of section 71(f) will also be met.

2.2 Chocolate vine *(Akebia quinata)*

Description and background

Chocolate vine (*Akebia quinata*) grows as either a twining vine or vigorous groundcover (Photograph 2-1) that, if left unmanaged, has the potential to out-compete and kill existing ground level herbs and seedlings, understorey shrubs and young trees. Once established, its dense growth may prevent seed germination and establishment of seedlings of indigenous species. Waikato Regional Council is proposing that chocolate vine be included in its 2007 to 2012 RPMP as a 'potential' plant pest.

Chocolate vine is reported as being deciduous in cooler climates whilst it may remain evergreen in warmer regions. Flowers and fruits are uncommon. Native to a region extending from central China to Korea and Japan, it is reported as being naturalised in at least 19 states of the USA and also in southwest England[5].

Photograph 2-1: Chocolate vine grows as either a twining vine or vigorous groundcover

Source: Shep Zedaker, Virginia Polytechnic Institute and State University, www.forestryimages.org

Whilst its invasive nature and threat to native biodiversity is recognised by such authorities as the National Parks Service of the United States Department of the Interior[6], chocolate vine it is not listed on the Federal Noxious Plants List and does not appear to be classified as noxious or prohibited in any states of the USA. Although it is reported as being naturalised in southwest England,[6] references to its invasiveness there have proved elusive.

[5] Global Invasive Species Database, http://www.issg.org/database/species/ecology.asp?si=188&fr=1&sts=sss accessed 15 November 2012

[6] National Parks Service http://www.nps.gov/plants/alien/fact/akqu1.htm accessed 15 November 2012

There is a dearth of information on the extent and invasiveness of chocolate vine in a New Zealand context. The species is assigned a weediness score of 24[7] within DOC's weediness database. Chocolate vine has been recorded by DOC in Northland, Wanganui, Marlborough, Nelson and Banks Peninsula[8]. The species is not listed in the BSNZ's National Pest Plant Accord, but it is listed as a 'research organsim' in Auckland Council's 2007 to 2012 RPMP (ARC 2006), and also in Greater Wellington Regional Council's pest management review (GWR 2006).

Chocolate vine currently occurs on approximately 2ha in Waikato over 10 mainly urban sites, although it is possible there are more sites present. This has increased from 0.5ha at the last strategy review. The total potential habitat for chocolate vine is 295,000ha, although it is unlikely that all of this would be occupied.

Waikato Regional Council's strategy for chocolate vine is to require control on all sites where it is found, except for Crown land where a 150m margin is required to be controlled.

Table 4: Estimated potential habitat for chocolate vine

Habitat type	Area potentially infested (ha)
Roads	4,595
Railway	142
Indigenous forest (10m margin)	19,371
Plantation (planted forest) 10m margin	20,937
Shrubland/scrub (manuka, kanuka)	175,800
Coastal cliffs	43,559
Riparian margins (10m x length)	8,176
Urban (towns and cities)	
Total potential range	**295,000**

Waikato Regional Council estimates that the strategy will cost ~$5000/annum for monitoring and enforcement, and control costs are $2,500/ha/annum.

Analysis

Level of analysis

Considerations	Assessment	Comment
Certainty – data available	Moderate	Reasonable information on the costs of control. Data on current location of pest likely to be poor.
Certainty – impacts	Moderate	Established as a weed nationally and internationally.
Significance	Low	Few alternate uses, and control costs are limited.
Urgency	Moderate	
Costs	Moderate	Reasonably low cost strategy

[7] As a reference for chocolate vine's score (24), *Clematis vitalba* (old mans beard) has a DoC weediness score of 33.
[8] Pers. comm. Ian Popay, Department of Conservation, Hamilton.

Risks

National policy direction considerations	Assessment	Comment
Objective not being achieved	High	Appears to have spread since last strategy review despite control.
Management approach inadequately applied	Moderate	
Adverse impact on implementation	Low	Low with limited area of pest.
Unintended adverse effects	Low	
Public and political concerns	Low	

Alternatives assessed

There are three alternate approaches assessed for managing chocolate vine:

1. Do nothing – where the pest is allowed to continue to be sold and to spread unhindered.
2. Containment – where the pest is contained within its current range, with some site led control in areas where spread has occurred.
3. Eradication – where an intensive programme of control is undertaken to attempt to eradicate it from the region.

Costs and benefits

Costs

- Control costs – where control is undertaken there will be costs incurred. Control is estimated to cost $2,500/ha, and control on the 2ha currently occupied will cost in the order of $5000/annum for the 10 years of the strategy. However given the lack of success in containing the vine so far, this cost is likely to be ongoing, and so has been allowed for a further 15 years to ensure control and containment.
- Monitoring, enforcement, education – Waikato Regional Council estimates costs of $5000/annum for these activities.
- Eradication is assumed to cost twice as much for both management (regional council costs) and control to reflect the greater effort required to achieve eradication. All other assumptions are held constant.

Benefits

The benefits of the strategy arise largely from prevention of harm to indigenous and conservation values. This will occur through control on sites where chocolate vine currently occurs and prevention of spread to new areas. Because there is only very limited occurrence of the vine, the biodiversity gains from control efforts on currently affected land are limited.

However, there is a large area potentially affected by chocolate vine. The benefit of prevention of spread to new areas was tested by comparing the situation with the strategy against the situation without the strategy. The strategy was tested in two versions. In the first, eradication was achieved after 10 years at twice the cost of the containment strategy, and in the second, containment continued indefinitely.

The analysis of the ‘no regional pest management strategy’ assumes that:

- there are currently 2ha infested
- its subsequent spread infests 10 per cent of the potential area identified by Waikato Regional Council within 100 years
- 80 per cent of area affected possesses conservation values
- control is implemented voluntarily in 5 per cent of the area infested at a cost of $2 500/ha/annum; and
- no production losses are assumed.

Outcomes

Table 5: NPV of costs and production losses for each alternative assessed (chocolate vine)

	No RPMP	Containment	Eradication
NPV outcome	**$230,000**	**$129,000**	**$134,000**

- The outcome in the no RPMP scenario is a loss of $3,700,000 per annum in 100 years as a result of production losses and additional costs of control. This is equivalent to an NPV of approximately $230,000. In addition there are 20,000ha on which damages to regionally significant conservation values will occur.
- The outcome of the containment acenario is an NPV of $65,000 for administration, inspection, monitoring and enforcement, and an NPV of $65,000 for costs of control. This is a total cost in present day terms (NPV) of approximately $130,000 at a discount rate of 8 per cent. In addition there will be a total of 1.6ha on which damages to regionally significant conservation values will occur.
- The outcome of the eradication scenario is an NPV of $67,000 for administration, inspection, monitoring and enforcement, and an NPV of $67,000 for costs of control. This is a total cost in present day terms (NPV) of approximately $134,000 at a discount rate of 8 per cent. In addition there will be no damages to regionally significant conservation values from this pest once eradication has been achieved.
- The net outcome for containment when compared with the no RPMP approach produces a net positive benefit of $100,000 in NPV terms, because the costs of undertaking the strategy are less than the likely losses in production and control costs if the organisms were allowed to spread. For eradication, the net benefits when compared with the no RPMP scenario are $92,000 in NPV terms. Both options protect significant regional biodiversity values on 20,000ha through the prevention of spread of this organism.

Containment is preferred since it produces the highest net benefit, and best satisfies the requirements of section 71(e) of the BSA 1993, but the key issue for the chocolate vine strategy is whether containment is feasible. The expansion of the infested area since the last strategy review suggests that the current infested area is not well defined, and/or that the vine is not being contained. Either conclusion suggests containing or eradicating chocolate vine is going to be very difficult. Waikato Regional Council therefore needs to review whether the resourcing they are proposing for this strategy is appropriate.

It should be noted that this conclusion is very sensitive to the assumptions made. Table 6 shows that a 20 per cent increase in control costs results in the strategy producing negative values, which suggests that the ability to contain the pest for the assumed cost is the primary determinant of whether the strategy produces a net benefit.

Table 6: Sensitivity of chocolate Vine proposal outcome to changes in assumption ($NPV)

Outcome relative to do nothing ($million NPV)		Time to full infestation (proportion of base assumption)		
		80%	100%	120%
Control costs (proportion of base assumption)	120%	-$28,921	-$18,652	-$8,382
	100%	$63,208	$96,510	$129,812
	80%	$290,362	$380,452	$470,542

Section 71 (d)

Chocolate vine appears capable of causing damage to the viability of indigenous species and ecosystems through invasion of habitat. On this basis, a strategy to control chocolate vine meets the requirements of section 71(d) (ii) and (iv).

Section 71(e)

If the council considers that the assumptions made are reasonable, and that the risks of strategy non achievement can be managed, then the proposed containment approach meets the requirements of section 71(e) of the BSA.

Funding assessment

Assessment of potential funders

Table 7: Assessment of exacerbators and beneficiaries for chocolate vine proposed strategy

		Ability to reduce costs through behaviour change	Determine whether benefits of control outweigh costs	Determine whether control is delivered in most cost effective manner
Exacerbators	Landholders with pest present	Yes	No	Yes
	Crown	Limited	No	Limited
Beneficiary	Community	No	Yes, through political process	Limited

Section 71(f)

The funding of the strategy will come from the landholders for control on their land and from the Crown for control on its land. Occupiers and the Crown are funding control because they are contributing to the problem by allowing the pest to exist on their property and providing a source for further spread (exacerbator contribution).

The community will fund the monitoring and inspection of the strategy. Because the conservation and biodiversity values accrue to the community, if the council considers that the requirements of section 71(e) have been met, then the requirements of section 71(f) will also be met in respect of the community contribution.

2.3 Chilean rhubarb (*Gunnera tinctoria* and *G. manicata*)

Description and background

Chilean rhubarb (*G. tinctoria* and *G. manicata*) are native to South America. Chilean rhubarb's introduced range extends to the Australasia-Pacific region, Europe, and North America[9]. The literature on the invasiveness of *G. tinctoria* is almost wholly concerned with New Zealand, though it is reportedly recognised as a weed in Ireland (Williams et. al 2005).

Of the two species, *G. tinctoria* has been the more widely planted in New Zealand (Sykes 1969) where it is now widely recognised as invasive and a threat to indigenous ecosystems. It is listed under BSNZ's National Pest Plant Accord and by seven regional authorities under their regional pest management strategies. DOC has assigned it a weediness score of 30[10] with a relatively high 'biological success rating' component of eighteen.

Chilean rhubarb is a large clump-forming herbaceous plant which can grow up to 2m high. It has stout rhizomes, and massive umbrella-sized leaves which, along with the stems, are covered in rubbery prickles. In areas with harsh winter frosts, Chilean rhubarb is deciduous or semi-deciduous.

Once established, it is very invasive and forms dense colonies that shade-out or suppress desirable flora (Williams et. al 2005). The huge leaves of each plant can impact on a disproportionately large number of the comparatively small, native herbs. It is also capable of impeding drains and streams; and obstructing access to natural and recreational areas[11]. Areas that have been cleared of mature plants can become re-colonized with numerous seedlings from the original plants, and pieces of the rhizomes that may also re-grow.

Chilean rhubarb grows readily from stem fragments, and such fragments are common where bits of established plants break off and tumble down steep slopes or where floods carry fragments down streams. The stream-side distribution of Chilean rhubarb suggests that seeds are probably dispersed by water. Seeds are also spread by birds (Williams et. al 2005).

Williams et. al (2005) report that;

> *In New Zealand, Chilean rhubarb occupies mainly damp coastal bluffs, riparian zones and disturbed ground…,*
>
> *It threatens the integrity of indigenous communities such as coastal herbfields, including those containing threatened plant species.*

They conclude that:

> *Chilean rhubarb is at an early stage of invasion over much of New Zealand.*
>
> *…Chilean rhubarb presently occupies only a fraction of the areas suitable for it in New Zealand. It will continue to spread over wide areas of central New Zealand. Initially, this spread is likely to be relatively slow because many of the suitable sites are widely separated. The exception to this will be where Chilean rhubarb is growing along rivers, where it may spread downstream quite rapidly.*

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9 Global Invasive Species Database, http://www.issg.org/database/species/ecology.asp?si=836&fr=1&sts=sss accessed 16 January 2007

10 As a reference for Chilean rhubarb (DoC weediness score 30), horsetails, *Equisetum arvense* and *E. hyemale* have weediness scores of 21 and 23 respectively but possess relatively low biological success ratings. Purple loosestrife (*Lythrum salicaria*) scores 31.

11 Weedbusters http://www.weedbusters.co.nz/news/news_articles/news01.asp?NewsID=8 accessed 16 January 2007

Williams et. al. (2005) consider that the currently limited wild distribution makes the eradication or containment of Chilean rhubarb across a wide area a viable option. Chilean rhubarb can be controlled by mechanical means, but it is imperative to remove the entire rhizome because small pieces of live rhizome can re-sprout. Young Chilean rhubarb can readily be killed with chemicals.

Williams et. al report that herbicide trials on Chilean rhubarb have produced variable results. Where it has been possible to get to Chilean rhubarb on foot, cutting the leaves and flower stalks against the rhizomes and applying 25 per cent glyphosate by hand has been the most effective control method. Treated plants must be checked within a year to re-treat any surviving plants and to spray or remove seedlings. Seed appears to survive in the soil for no more than two years (ibid.).

Difficulties in reaching and working with Chilean rhubarb on very steep sites make control on such sites difficult and expensive to achieve. This is exacerbated by the need to conduct monitoring and undertake follow-up work on seedlings. Williams et. al. report that aerial spraying has had disappointing results and has been at the cost of non-target plants.

Chilean rhubarb has been widely planted throughout New Zealand because of its dramatic foliage. A critical part of any control programme will be increasing public awareness of the plants invasiveness and reducing its popularity as a garden plant.

There are currently approximately 4ha of Chilean rhubarb in the Waikato region, with 21 sites located. However staff are not confident that all sites have been located. Waikato Regional Council estimates the potential habitat for Chilean rhubarb to be approximately 50,000ha, the majority of which is riparian margins.

Table 8: Estimated potential habitat for Chilean rhubarb

Habitat type	**Area potentially infested (ha)**
Coastal cliffs	1,250
Riparian margins (10m x length)	43,559
Wetlands	8,176
Total potential range	**50,000**

Waikato Regional Council is proposing a strategy of progressive containment, with total occupier control for Chilean rhubarb. Measures will include prevention of sale. The strategy requires landholders and the Crown to undertake control of Chilean rhubarb on their properties. Waikato Regional Council is not proposing to undertake any control itself.

Analysis

Level of analysis

Considerations	**Assessment**	**Comment**
Certainty – data available	Low	Poor information on the costs of control. Data on current location of pest is also poor.
Certainty – impacts	High	Well established as a weed nationally and internationally
Significance	Moderate	Does have some amenity values as plantings.
Urgency	Moderate	
Costs	Moderate	Reasonably low cost strategy.

Risks

National policy direction considerations	Assessment	Comment
Objective not being achieved	Medium	Difficult to control.
Management approach inadequately applied	Medium	Difficult to control, and often in inaccessible locations.
Adverse impact on implementation	Medium	
Unintended adverse effects	Low	
Public and political concerns	Medium	

Alternatives assessed

There are three alternate approaches assessed for managing Chilean rhubarb:

1. Do nothing – where the pest is allowed to continue to be sold and to spread unhindered.
2. Containment – where the pest is contained within its current range, with some site led control in areas where spread has occurred.
3. Eradication – where an intensive programme of control is undertaken to attempt to eradicate it from the region.

Costs and benefits

Costs

- Control costs – where control is undertaken there will be costs incurred. Control is estimated to cost $470/ha, and control on the 4ha currently occupied will cost in the order of $2,000/annum for the 10 years of the strategy.
- Monitoring, enforcement, education – Waikato Regional Council estimates costs of $6000/annum for these activities.

Benefits

The benefits of the strategy arise largely from prevention of harm to indigenous and conservation values in coastal cliffs, riparian margins and wetlands.

The benefit of prevention of spread to new areas was tested by comparing the situation with the containment strategy against the situation without the strategy.

The analysis of the 'no regional pest management strategy' assumes that:

- there are currently 4ha infested
- its subsequent spread infests 20 per cent of the potential area identified by Waikato Regional Council within 50 years
- 50 per cent of area affected possesses conservation values
- control is implemented voluntarily in 5 per cent of the area infested at a cost of $470/ha/annum; and
- no production losses are assumed.

The alternative scenario of eradication was also assessed. This had many of the same costs and benefits of the proposal, but had higher regional council costs associated with monitoring and searching for the pest (assumed at $30,000 per annum), and higher control costs to ensure that the plant was eliminated in areas where it was uncovered (assumed at $10,000 per annum).

The magnitude of these costs reflects the very great difficulty in eradicating a pest such as Chilean rhubarb. However it was also assumed that the effort was required only for 10 years, and thereafter costs were reduced to $1000 per annum for ongoing surveillance.

Outcomes

The outcomes for each alternative are expressed as the total losses occurring – ie the costs of control and the reduction in production as a result of infestation.

Table 9: NPV of costs and production losses for each alternative assessed (Chilean rhubarb)

	No RPMP	Containment	Eradication
NPV outcome	**$183,858**	**$103,999**	**$348,029**

- The outcome in the no RPMP Scenario is a loss of $240,000 per annum in 50 years as a result of production losses and additional costs of control. This is equivalent to an NPV of approximately $180,000. In addition there is 10,000ha on which damages to regionally significant (conservation, recreation/ amenity/Māori/ soil and water) values will occur.
- The outcome of the containment scenario is an NPV of $78,000 for administration, inspection, monitoring and enforcement, and an NPV of $26,000 for costs of control. This is a total cost in present day terms (NPV) of approximately $100,000 at a discount rate of 8 per cent.
- The outcome for the eradication scenario is an NPV of $280,000 for regional council costs and an NPV $70,000 for control, for a total cost of NPV $350,000 at 8 per cent discount rate.
- The net outcome for containment when compared with the no RPMP approach produces a net positive benefit of $80,000 in NPV terms, because the costs of undertaking the strategy are less than the likely losses in production and control costs if the organisms were allowed to spread. It also protects significant regional biodiversity values on 10,000ha through the prevention of spread of this organism. Containment is preferred to no action since it produces the highest net benefit, and best satisfies the requirements of section 71(a) of the BSA 1993. This result is relatively insensitive to changes in the control costs or time for the pest to infest its full habitat (see Table 10).

Feasibility is a major concern for the Chilean rhubarb strategy. Control of Chilean rhubarb is difficult to achieve and expensive, and landholder control is unlikely to be very successful and will require and intensive inspection and enforcement effort. Waikato Regional Council should consider whether landholder control is an appropriate and feasible means of containing this pest in the region.

Table 10: Sensitivity of progressive containment of Chilean rhubarb outcome to changes in assumption ($NPV)

Outcome relative to do nothing ($million NPV)		Time to full infestation (proportion of base assumption)		
Control costs (proportion of base assumption)		80%	80%	120
	120%	$17,076	$8,036	-$2,923
	100%	$88,899	$79,859	$68,900
	80%	$209,005	$199,965	$189,006

Section 71 (d) conclusion

Chilean rhubarb appears capable of causing damage to the viability of indigenous species and ecosystems through invasion of habitat. On this basis a strategy to control Chilean rhubarb meets the requirements of section 71(d).

Section 71(e) conclusion

If the council considers that the assumptions made are reasonable, then the proposal for progressive containment meets the requirements of section 71(e).

Funding assessment

Assessment of potential funders

Table 11: Assessment of exacerbators and beneficiaries for Chilean rhubarb proposed strategy

National policy direction considerations		Ability to reduce costs through behaviour change	Determine whether benefits of control outweigh costs	Determine whether control is delivered in most cost effective manner
Exacerbators	Landholders with pest present	Yes	No	Yes
	Crown	Limited	No	Limited
Beneficiary	Community	No	Yes, through political process	Limited

Section 71(f)

It is proposed that the funding for the progressive containment strategy will come from the landholders for control on their land and from the Crown for control on its land.

Occupiers and the Crown should fund control because they are contributing to the problem by allowing the pest to exist on their property and providing a source for further spread (exacerbator contribution). They both have some ability to change their behaviour to reduce the potential for Chilean rhubarb to affect other parties.

The community will fund the monitoring and inspection of the strategy. Because the conservation and biodiversity values accrue to the community, if the council considers that the requirements of section 71(e) have been met, then the requirements of section 71(f) will also be met in respect of the community contribution.

2.4 Velvet leaf (*Abutilon theophastri*)

Description and background

Velvet leaf is an annual plant native to East Europe, North Africa and Asia, but now a major crop pest in the USA. It has a deep taproot and is capable of growing over 1m tall. The plant has velvety, hairy leaves and produces 30 – 50 seeds per plant under competition, and 90 – 200 with no competition. The seeds are capable of long dormancy – up to 50 years - making control very difficult.

Velvet leaf is considered a significant weed of cropping areas, and competes with crops for light, nutrients and water. It contains allelopathic chemicals that inhibit water uptake and chlorophyll uptake in soybeans and other crops[12]. Because it is capable of late emergence and is shade tolerant, it is capable of producing seed under the crop canopy. This can result in huge seed loads in the soil – a study in Nebraska found 51 million viable seeds/ha under continuous corn cultivation. The long dormancy and potential for shade tolerance means that once velvet leaf becomes established in a field, even intensive efforts cannot eradicate it[13].

Velvet leaf appears to spread primarily through contaminated seed and through animal feed. Because the seed remains viable in animal faeces, the manure of both chicken and cattle fed on contaminated seed will contain velvet leaf. In the Waikato this raises the potential for the spread of velvet leaf onto dairy land, although it is not likely to compete strongly in a grazed environment.

Velvet leaf is known to affect soybean, sweetcorn, maize, and cotton, and is likely to be mainly a pest of maize and corn in New Zealand. Studies in the US have shown yield reduction of 15 - 25 per cent (depending on emergence time). In the US, 1982 control costs of velvet leaf in North America were estimated at $343 million per year[14]. Reductions in yield in NZ are not considered likely to be as great because it is not considered to be as aggressive here. Using an assumption of 10 per cent yield loss, the reduction in gross margin is likely to be in the order of $310/ha (gross margins from Booker 2009)[15].

There are currently approximately 10 sites in Waikato with velvet leaf, with about ~2ha of area where it is present. The total arable area, and therefore potential area affected, in Waikato is estimated differently by a number of sources:

- Waikato Regional Council estimate the area from GIS at 10,000ha
- Statistics NZ estimates maize grain production at 3700ha[16] and wheat/barley an additional 0 – 600ha in the region.
- Booker (2009) uses a range of industry and government statistics to estimate the area of maize silage and grain, and using the midpoint of his estimates gives a total of 50,000ha of maize silage and 6200ha of maize grain in 2008/09.

The Booker estimate is probably the most accurate representation of the total infestable area given that there are only very minor areas of other crops.

Waikato Regional Council is considering making velvet leaf a progressive containment pest. This will involve landholders controlling all velvet leaf on their property, and prevention of sale and transport of velvet leaf.

[12] http://extension.psu.edu/weeds/extension-info/facts/velvetleaf.pdf Accessed 20 November 2011
[13] http://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=2495&context=extensionhist Accessed 20 November 2011.
[14] Spencer, N.R. 1984. Velvetleaf, *Abutilon theophrasti* (Malvaceae), History and Economic Impact in the United States. Econ. Bot. 38(4):407-416
[15] Booker, J.W. Production, distribution and utilisation of maize in NZ. M.Appl.Sc. dissertation, Lincoln University.
[16] Statistics NZ, 2010.

Analysis

Level of analysis required

National policy direction considerations	Assessment	Comment
Certainty – data available	High	Reasonable information on the costs of control. Not currently in region.
Certainty – impacts	Medium	Reasonable information on impacts, although not extensive in NZ context.
Significance	Low	Reasonably small arable area in Waikato
Urgency	High	Present in NZ and potential to arrive in Waikato imminently
Costs	Low	Low cost strategy.

Risks

National policy direction considerations	Assessment	Comment
Objective not being achieved	Moderate	Difficult to contain and eradicate once established.
Management approach inadequately applied	Moderate	Lack of knowledge regarding velvet leaf and its impacts among growers.
Adverse impact on implementation	Moderate	May be some resistance to measures among growers if costs imposed are significant
Unintended adverse effects	Low	
Public and political concerns	Low	

Alternatives assessed

There are two alternate approaches assessed for managing velvet leaf:

1. Do nothing – where the pest is allowed to continue to be sold and to spread unhindered.
2. Containment – where the pest is contained within its current range, with some site led control in areas where spread has occurred.
3. Eradication – where velvet leaf is eliminated from the region through greater monitoring and control effort.

Costs and benefits

Costs

- Control costs – where control is undertaken there will be costs incurred. Control is estimated to cost $180/ha, and control on the 2ha currently occupied will cost in the order of $400/annum for the 10 years of the strategy.
- Monitoring, enforcement, education – Waikato Regional Council estimates costs of $20,000/annum for these activities.
- For the eradication alternative, the costs for both control and monitoring and enforcement were assumed to double on the basis that significantly greater effort would be required.

Benefits

The benefits of the strategy arise largely from prevention of yield loss on maize land in the Waikato.

The benefit of prevention of spread to new areas was tested by comparing the situation with the strategy against the situation without the strategy. The strategy was tested in two versions. It is assumed that containment will indefinitely because there is a likelihood with the very long lived seed that eradication will not be achieved within the foreseeable future.

The analysis of the 'no regional pest management strategy' assumes that:

- there are currently 2 ha infested
- tts subsequent spread infests 80 per cent of the potential area within 35 years. This matches rates of spread seen in Ontario, Canada, where velvet leaf spread from a small isolated weed to a weed of cultivated land throughout the state between 1950 and 1985.
- none of the area affected possesses conservation values
- control is implemented voluntarily in 80 per cent of the area infested at a cost of $470/ha/annum; and
- production losses are assumed to be $310/ha/year in uncontrolled land.

The benefits of the eradication alternative strategy are assumed to be the same as for the containment strategy.

Scenario outcomes

The outcomes for each alternative are expressed as the total losses occurring – ie the costs of control and the reduction in production as a result of infestation.

Table 12: NPV of costs and production losses for each alternative assessed (velvet leaf)

	No RPMP	Containment	Eradication
NPV outcome	**$13,493,904**	**$265,195**	**$275,263**

- The outcome in the no RPMP scenario is a loss of $0.9 million per annum in 35 years as a result of production losses and additional costs of control. This is equivalent to an NPV of approximately $13.5 million.
- The outcome of the containment scenario is an NPV of $260,000 for administration, inspection, monitoring and enforcement, an NPV of $10,000 for costs of control, with no effective production losses. This is a total cost in present day terms (NPV) of approximately $270,000 at a discount rate of 8 per cent.
- The outcome of the containment scenario is an NPV of $270,000 for administration, inspection, monitoring and enforcement, an NPV of $10,000 for costs of control, with no effective production losses. This is a total cost in present day terms (NPV) of approximately $280,000 at a discount rate of 8 per cent.
- The net outcome for containment when compared with the no RPMP approach produces a net positive benefit of $13.2 million in NPV terms. This is because the costs of undertaking the strategy are less than the likely losses in production and control costs if the organisms were allowed to spread. The positive result is relatively robust under 20 per cent changes to assumptions regarding control costs and time to for it to occupy its full habitat (see Table 13). The outcome for containment is slightly better than for eradication, and has lower risks of non-achievement, and is therefore preferred.

Containment is likely to be highly beneficial if it can be achieved. However, it is worth noting that the ability to achieve containment through control only may be limited, as the spread of velvet leaf from contaminated properties will occur through sale of the maize to animal feed, and because it is not possible to eliminate 100 per cent of velvet leaf every year. It may therefore be necessary to place controls on the use of maize silage and grain from contaminated properties if the strategy is to be effective.

Table 13: Sensitivity of velvet leaf outcome to changes in assumption ($NPV)

Outcome relative to do nothing ($million NPV)		Time to full infestation (proportion of base assumption)		
		80%	100%	120%
Control costs (proportion of base assumption)	120%	$7,332,153	$8,564,760	$9,796,951
	100%	$11,344,055	$13,228,709	$15,112,947
	80%	$17,139,935	$19,966,584	$22,792,816

Section 71(d) conclusion

Velvet leaf appears capable of causing damage to the agricultural production and it is well established as a problem in other parts of the world. On this basis a strategy to control velvet leaf meets the requirements of section 71(d) (i).

Section 71(e) conclusion

If the council considers that the assumptions made are reasonable, then the proposal for progressive containment meets the requirements of section 71(e).

Funding assessment

Assessment of potential funders

Table 14: Assessment of exacerbators and beneficiaries for velvet leaf proposed strategy

National policy direction considerations		**Ability to reduce costs through behaviour change**	**Determine whether benefits of control outweigh costs**	**Determine whether control is delivered in most cost effective manner**
Exacerbators	Landholders with pest present	Yes	No	Yes
Beneficiary	Growers	No	Yes	Yes

Section 71(f)

Growers are likely to be both beneficiaries and exacerbators in respect of velvet leaf. The funding of the strategy will come from the landholders for control on their land. Occupiers should fund control because they are contributing to the problem by allowing the pest to exist on their property and providing a source for further spread (exacerbator contribution). It is particularly true in this situation because growers are able to alter their behaviour to reduce spread of velvet leaf.

Because the production benefits accrue primarily to arable land in the region, arable and maize silage farmers should fund the costs of monitoring and inspection to ensure that the strategy is achieved. This will ensure that the benefits of administering and achieving the strategy exceed the costs.

2.5 Tutsan (*Hypericum androsaemum)*

Description and background

Tutsan is a semi-woody perennial shrub that grows to approximately 1.5m in height. It is capable of forming dense stands that can compromise biodiversity and conservation values as well as production values.

Johns (1967) reports that tutsan was not noticed in New Zealand until 1920. By 1967 tutsan was considered a serious weed in Taumarunui 'County' where it was estimated to cover 5000 acres (ibid).

Johns reports that in most locations it was confined to sheep farms and that, apart from the young seedling stage, it is unpalatable to stock. Maintenance of a dense pasture sward prevents rapid establishment following control of mature stands (ibid). Cultivation followed by good pasture management is reported as giving satisfactory control, but was considered by Johns (1967) as being of little practical significance at that date as the majority of serious infestations were on steep, unploughable hill country.

MAF's 2006 farm monitoring report for central North Island sheep and beef farms notes that the "weed tutsan has become particularly prevalent in the northern areas, and is proving to be a very difficult weed to control, generally spreading along roadways, riverbanks and in areas not grazed by cattle" (MAF 2006). This comment has not been repeated in the monitoring reports since that time.

More recently, tutsan is reported as invading regenerating sites, disturbed land, tussock land, riparian areas, farmland and roadsides. In the Waikato region it appears to be spread via the roadsides due to mowing[17]. Dispersal is also reported as being by birds, wind and soil disturbances[18].

Tutsan is known mainly on roadsides in the Waitomo and Ōtorohanga districts, with a small amount known to be spreading from there onto farmland. It is also reported at a few sites along stream margins. It has been recorded in the Waipā district and is known at two sites in the Wider regional community district. Waikato Regional Council believe that tutsan may still be in the 'lag phase' in the Waikato region, and there is an opportunity to prevent it progressing.

Tutsan is assigned a weediness score of 27 within DOC's weediness database. It is listed in BSNZ's National Pest Plant Accord where its invasiveness and impact on indigenous biota is described as follows:

> *Tutsan invades regenerating sites, forms dense stands and prevents the establishment of native plant seedlings. It is usually succeeded by taller vegetation, but is persistent in shorter habitats.*

Bay of Plenty Regional Council[19] describes tutsan as being fairly common on roadsides, banks and disturbed areas, and as being locally abundant. They also describe it has having the:

> *Capacity to form extensive patches exceeding 1 ha in size. Dense cover of branches and rotting leaves can smother existing low growing plant communities and seriously inhibit regeneration (a semi-matting effect). May hold back successional forest communities. Is seen to infest forest communities under light shade. Plant species of rocklands and steep banks e.g. kowhai may be heavily impacted.*

[17] Pers. com. Peter Russell, Environment Waikato, 31 May 2007
[18] http://www.nzpcn.org.nz/exotic_plant_life_and_weeds/detail.asp?WeedID=1718 (accessed 31 May 2007)
[19] http://www.ebop.govt.nz/weeds/Weed214.asp (accessed 31 May 2007)

Tutsan is listed for inclusion in the RPMPs of Auckland Council (surveillance) and Environment Southland (eradication on Stewart Island). It is also recognised as a pest in Victoria and West Australia in Australia, where it affects mainly wetter areas.

Waikato Regional Council estimates that tutsan current infests approximately 500ha, which is an increase from 100ha at the time of the last review (2007). They estimate the potential range of tutsan as the entire region, although this is likely to be an overestimate because it is unlikely to occupy all these sites. The range has been estimated at 360,000ha, with the majority of area in extensive pastoral land (land use capability classes 4 – 6). It is not considered likely to be a major pest of intensively farmed land.

Table 15: Estimated potential habitat of tutsan in the Waikato region (ha)

Habitat type	Area potentially infested (ha)
Roads	4,595
Railway	142
Indigenous forest (10m margin)	19,371
Plantation (planted forest) 10m margin	20,937
Coastal cliffs	43,559
Riparian margins (10m x length)	8,176
Pastoral land (20% LUC classes 4 – 6)	260,000
Total potential range	**360,000**

Waikato Regional Council is proposing that tutsan will become a progressive control pest in the RPMP.

Analysis

Level of analysis required

National policy direction considerations	Assessment	Comment
Certainty – data available	Moderate	Reasonable information on the costs of control and current location of pest. Understanding of total potential habitat only moderately understood.
Certainty – impacts	High	Impacts well understood in the Waikato context.
Significance	Low	Reasonable acceptance among landholders of the need for control.
Urgency	High	Tutsan is at a size where if action is not taken then spread will not be controllable.
Costs	Medium	The control of tutsan is high cost, but it is not yet extensive in the region so the costs are limited to a small group of landholders.

Risks

National policy direction considerations	Assessment	Comment
Objective not being achieved	High	Tutsan is widespread and because it is potentially wind and bird spread, halting further spread is difficult.
Management approach inadequately applied	Moderate	Ensuring control over 500ha is difficult.
Adverse impact on implementation	Medium	Control costs for individual landholders may be very significant, resulting in adverse reaction.
Unintended adverse effects	Low	
Public and political concerns	Low	

Alternatives assessed

There are two alternate approaches assessed for managing tutsan:

1. Do nothing – where the pest is allowed to continue to be sold and to spread unhindered.
2. Containment – where the pest is contained within its current range, with some site led control in areas where spread has occurred.
3. Reduction – where a more intensive programme of control is undertaken to attempt to reduce the current area infested.

Costs and benefits

Costs

- Control costs – where control is undertaken there will be costs incurred. Control is estimated by Waikato Regional Council to cost $800/ha/annum, and control on the 500ha currently occupied will cost in the order of $400,000/annum for the 10 years of the strategy. Of this, Waikato Regional Council control costs are estimated at $4,000 per annum.
- Monitoring, enforcement, education – Waikato Regional Council estimates costs of $15,000/annum for these activities.
- Reduction is assumed to require approximately four times the effort being undertaken in monitoring to reflect the additional intensity required to reduce the extent of the pest, and an additional 50 per cent in control costs to ensure that any follow up control is undertaken.

Benefits

- Prevention of production loss on grazed pasture. The value of production was derived from the MPI Farm Monitoring Report central North Island hill country model for the period 2009 – 2011 (3 years). The assumption is that revenue and variable expenses decrease in proportion to the tutsan infestation, but fixed expenses are not altered. This results in a net cost of $380/ha occupied, with this loss occurring on 25 per cent of the land where tutsan invades.
- Prevention of damage to conservation values.Approximately 20 per cent of the land at risk has conservation values that may be affected by tutsan.

The benefit of prevention of spread to new areas was tested by comparing the situation with the strategy against the situation without the strategy.

The analysis of the 'no regional pest management strategy' assumes that:

- there is currently 500 ha infested

- subsequent spread infests all of the potential area within the next 50 years, assuming that it is in a phase of rapid expansion at present.
- 20 per cent of the area affected possesses conservation values
- control is implemented voluntarily in 10 per cent of the area infested at a cost of $800/ha/annum, and
- production losses are assumed to be $380/ha/year on 25 per cent of land infested.

The reduction scenario was assessed on the assumption that it results in 50 per cent less area infested after 50 years, with all other assumptions (other than management and control costs) held constant. Regional council and control costs are set as per the description in the assumption.

Scenario outcomes

The outcomes for each alternative are expressed as the total losses occurring – ie the costs of control and the reduction in production as a result of infestation.

Table 16: NPV of costs and production losses for each alternative assessed (tutsan)

	No RPMP	Containment	Reduction
NPV outcome	**$56,350,828**	**$5,959,210**	**$9,089,941**

- The outcome in the no RPMP scenario is a loss of $60,000,000 per annum in 50 years as a result of production losses and additional costs of control. This is equivalent to an NPV of approximately $56,000,000. In addition there is 60000ha on which damages to regionally significant conservation and amenity values will occur.
- The outcome of the containment scenario is an NPV of $190,000 for administration, inspection, monitoring and enforcement, an NPV of $5.2 million for costs of control, and loss of $38,000 per annum in 50 years as a result of production losses. This is a total cost in present day terms (NPV) of approximately $6 million at a discount rate of 8 per cent.
- The outcome of the reduction scenario is an NPV of $780,000 for administration, inspection, monitoring and enforcement, an NPV of $7.8 million for costs of control, and loss of $19,000 per annum in 50 years as a result of production losses. This is a total cost in present day terms (NPV) of approximately $9 million at a discount rate of 8 per cent.
- The net outcome for containment when compared with the no RPMP approach produces a net positive benefit of $50 million in NPV terms because the costs of undertaking the strategy are less than the likely losses in production and control costs if the organisms were allowed to spread. It also protects significant regional biodiversity values on 60,000ha through the prevention of spread of this organism. This is a higher NPV relative to the do nothing scenario than the reduction alternative, which arises because the control and management costs are lower, while the benefits in terms of reducing lost production are relatively minor.
- Containment satisfies the requirements of section 71(e) of the BSA 1993. The conclusion of a positive outcome is robust under changes of 20 per cent in control costs and time for tutsan to occupy its full habitat (see Table 17).

Table 17: Sensitivity of tutsan outcome to changes in assumption ($NPV)

Net outcome relative to do nothing ($million NPV)		Time to full infestation (proportion of base assumption)		
		80%	100%	120
Control costs (proportion of base assumption)	120%	$30,889,087	$32,760,410	$34,215,740
	100%	$46,815,768	$50,391,618	$53,551,476
	80%	$75,397,722	$82,032,510	$88,251,307

Section 71(d)

Tutsan appears capable of causing damage to the agricultural production, and it is well established as a problem in Australia,South Africa and New Zealand. On this basis a strategy to control tutsan meets the requirements of section 71(d)(i).

Section 71(e)

The proposal for containment satisfies the requirements of section 71(e) of the BSA 1993. The conclusion of a positive outcome is robust under changes of 20 per cent in control costs and time for tutsan to occupy its full habitat (see Table 17), but the risks of non-achievement of the containment objective should be noted.

Funding assessment

Assessment of potential funders

Table 18: Assessment of exacerbators and beneficiaries for tutsan proposed strategy

National policy direction considerations		**Ability to reduce costs through behaviour change**	**Determine whether benefits of control outweigh costs**	**Determine whether control is delivered in most cost effective manner**
Exacerbators	Landholders with pest present	Yes	No	Yes
	Crown	Yes	No	Limited
Beneficiary	Pastoral landholders	No	Yes	Yes
	Community	No	Yes, through political process	No

Section 71(f)

In order to meet the requirements of 71(f), funding for control could come from either landholders (including the Crown) because they are contributing to the problem by allowing the pest to exist on their property and providing a source for further spread (exacerbator contribution), or from the pastoral community as beneficiaries.

The benefits from the strategy accrue to extensive pastoral land in the region not currently infested for prevention of future lost production, and to the community for protection of conservation and biodiversity values. Therefore these parties should fund the costs of monitoring and inspection to ensure that the strategy is achieved.

Division between these two parties is not straightforward, since there is a different type of benefit involved in each case. However it is noted that the pastoral land potentially occupied amounts to 70 per cent of the total land potentially infested, and this may be an appropriate mechanism for dividing the costs.

If the conclusions of section 71(e) are accepted, then the benefits to pastoral landholders will exceed the costs of monitoring and enforcement. Depending on the level of charge to the community, the benefits of preventing tutsan effects on 60,000ha would need to exceed up to NPV of $190,000 ($3.20/ha affected) in order for section 71(f) requirements to be met.

2.6 Woolly nightshade (*Solanum mauritianum)*

Description and background

Woolly nightshade is a fast growing tree up to 9m tall that has large leaves with furry hair covering. It seeds prolifically, and is capable of producing 10,000 seeds per plant. The seeds are largely bird spread, and remain viable in the soil after 20 – 30 years. It is capable of forming dense stands that exclude other vegetation, and is particularly a threat in open areas and forest margins.

Woolly nightshade was introduced as a garden plant[20], with an unreferenced source noting that this occurred 1880[21]. It is considered rare for it to invade intact habitats.

Woolly nightshade is listed as a pest in DOC's list of consolidated weeds, and has been a feature of their lists since the first report in 1983 (Timmins, 1983). Woolly nightshade is listed in the Auckland Council RPMP as a containment plant.

Woolly nightshade does not appear to invade intensive pastures, but is capable of occupying more extensive grazed land. Waikato Regional Council estimates that typical full occupation would not exceed 40 per cent in grazed pasture, and it may exceed this in areas where no grazing occurs.

Woolly nightshade is common in northern parts of the region, particularly Port Waikato and Coromandel Peninsula, where it forms dense stands that exclude other plants. Waikato Regional Council estimates that there are currently ~380,000ha infested, with 5200 sites recorded on the biosecurity database. It is highly likely that there is greater area and more sites than this affected.

The maximum potential range is 2.3 million hectares, because it is theoretically capable of infesting the entire region. However, because it only affects open areas, the range is likely to be restricted to roads, open spaces forestry margins, scrubland and coastal cliffs.

In pastoral land it is not likely to affect high productivity land due to the level of grazing, weed control and pasture renewal. However for less intensive land uses there is greater potential for infestation and the habitat has been estimated at 40 per cent of these land classes (LUC 4 – 6).

Table 19: Estimated potential habitat for woolly nightshade in the Waikato region (ha)

Habitat type	**Area potentially infested (ha)**
Roads	4,595
Railway	142
Indigenous forest (10m margin)	19,371
Native scrub	175,800
Plantation (planted forest) 10m margin	341,985
Coastal cliffs	43,559
Riparian margins (10m x length)	8,176
Pastoral land (40% LUC classes 4 – 6)	520,000
Total potential range	**1,110,000**

[20] http://www.issg.org/database/species/ecology.asp?si=209&fr=1&sts=&lang=EN accessed 30 November 2011
[21] http://en.wikipedia.org/wiki/Solanum_mauritianum

Analysis

Level of analysis

National policy direction considerations	Assessment	Comment
Certainty – data available	High	Reasonable information on the costs of control. Data on current location of pest likely to be poor.
Certainty – impacts	High	Well known in Waikato context.
Significance	High	Costs associated with control requirements likely to be significant
Urgency	Low	Well established in the region and ability to slow spread limited.
Costs	High	Very high cost strategy.

Risks

National policy direction considerations	Assessment	Comment
Objective not being achieved	High	Ability to manage widespread pests limited.
Management approach inadequately applied	High	High control costs will place pressure on those managing the strategy and those undertaking inspections and enforcement.
Adverse impact on implementation	High	High costs will create significant potential for adverse reaction.
Unintended adverse effects	Low	
Public and political concerns	High	High cost of control will create political pressure on implementation.

Alternatives assessed

There are three alternate approaches assessed for managing woolly nightshade:

1. Do nothing – where the pest is allowed to continue to be sold and to spread unhindered.
2. Containment – where the pest is contained within its current range, with some site led control in areas where spread has occurred.
3. Control on non-infested land – where control is undertaken on land where woolly nightshade is not currently established as it arrives, with the aim being to reduce the costs of the strategy and slow the spread.

Costs and benefits

Costs

- Control costs – where control is undertaken there will be costs incurred. Control is estimated by Waikato Regional Council to cost $1000/ha/annum, and control on the 380,000ha currently occupied will cost in the order of $380,000,000/annum for the 10 years of the strategy. Of this, Waikato Regional Council control costs are estimated at $50,000 per annum.
- Monitoring, enforcement, education – Waikato Regional Council estimates costs of $120,000/annum for these activities.

Benefits

- Prevention of production loss on grazed pasture. The value of production was derived from the MPI Farm Monitoring Report central North Island hill country model for the period 2009 – 2011 (3 years). The assumption is that revenue and variable expenses

decrease in proportion to the woolly nightshade infestation, but fixed expenses are not altered. This results in a net cost of $380/ha occupied, with this loss occurring on 40 per cent of the productive land that woolly nightshade invades.
- Prevention of damage to conservation values Approximately 20 per cent of the land at risk has conservation values that may be affected by woolly nightshade.

The benefit of prevention of spread to new areas was tested by comparing the situation with the strategy against the situation without the strategy. It is assumed that containment will indefinitely because of the extensive nature of the woolly nightshade occurrence.

The analysis of the 'no regional pest management strategy' assumes that:
- there are currently 380,000 ha infested
- subsequent spread infests all of the potential area within the next 50 years, assuming that it is in a phase of rapid expansion at present
- 20 per cent of the area affected possesses conservation values.
- control is implemented voluntarily in 50 per cent of the productive area infested at a cost of $1000/ha/annum, and
- production losses are assumed to be $380/ha/year on 40 per cent of the productive land infested.

The control on non-infested land scenario was assessed using the same assumptions as the containment scenario. However, it assumes that control is undertaken on 10 per cent of the land currently not infested to reduce the speed of spread, and that after 80 years only 50 per cent of that land is affected by woolly nightshade. The monitoring and control costs are assumed to be $120,000 per annum as per the containment strategy, and control costs are estimated at $24 million per annum for landholders.

Scenario outcomes

The outcomes for each alternative are expressed as the total losses occurring – ie the costs of control and the reduction in production as a result of infestation.

Table 20: NPV of costs and production losses for each alternative assessed (woolly nightshade)

	No RPMP	Containment	Control on non-infested land
NPV outcome	**$1,169,556,365**	**$5,257,110,194**	**$1,317,812,825**

The strategy set out by Waikato Regional Council for containment requires control of all woolly nightshade on an individual's property, as well as control by the Crown within 150m of a boundary. If this strategy were to be enforced, the cost of control on the containment land is likely to be in the order of $380 million per annum.

The costs and benefits of the containment strategy have been modelled, but the results are not presented here because:
- the costs are many billions of dollars in present value terms. The cost is reasonably insensitive to changes in the input assumptions tested (Table 21).
- the benefits are substantially outweighed by the costs, again by many billions of dollars
- the requirements of the strategy are unrealistic in terms of the potential costs imposed on landholders
- containment of a weed which has an extent of many hundreds of thousands of hectares, and which is present on thousands of sites, is unrealistic and unlikely to be

achieved. Therefore the benefits of the strategy in terms of preventing spread are unlikely to be attained.

It is highly unlikely given the areas infested and control costs estimated that a strategy for control of woolly nightshade on all land where it occurs would meet the requirements of the Biosecurity Act. It may be that a strategy which was able to achieve containment, but with a lesser area controlled, would meet the requirements of the Act, but because it is bird spread it is difficult to see how containment could be achieved without controlling all occurrences.

Table 21: Sensitivity of woolly nightshade outcome to changes in assumption ($NPV) (Containment scenarios)

Net outcome relative to do nothing ($million NPV)		Time to full infestation (proportion of base assumption)		
		80%	100%	120
Control costs (proportion of base assumption)	120%	-$3,292,226,763	-$4,144,608,400	-$4,996,990,038
	100%	-$3,242,126,399	-$4,087,553,829	-$4,932,981,260
	80%	-$3,152,871,601	-$3,985,909,972	-$4,818,948,343

The alternative strategy of control on non-infested land has significantly lower costs than the containment option, but still involves an NPV of $1.3 billion in costs and annual control costs of $73 million. This still has a higher NPV of costs than do nothing with a net outcome of $-148 million, and also is dependent on the assumption that it can slow or prevent spread onto new land. The negative outcome is insensitive to changes in the input assumptions (Table 22). There is a very high risk of non-achievement for this alternate option.

Table 22: Sensitivity of woolly nightshade outcome to changes in assumption ($NPV) (Slow spread scenarios)

Net outcome relative to do nothing ($million NPV)		Time to full infestation (proportion of base assumption)		
		80%	100%	120
Control costs (proportion of base assumption)	120%	-$151,114,107	-$205,311,031	-$259,507,955
	100%	-$101,013,743	-$148,256,460	-$195,499,177
	80%	-$11,758,945	-$46,612,603	-$81,466,260

Section 71 (d)

Woolly nightshade appears capable of causing damage to the agricultural production and it is well established as a problem in Australia, South Africa and New Zealand. On this basis a strategy to control woolly nightshade meets the requirements of section 71(d)(i).

Section 71(e)

It is unlikely that either the proposed containment strategy or the alternate slowing of spread strategy would meet the requirements of section 71(f).

Section 71(f)

Because the requirements of section 71(e) have not been met, it would be difficult to meet the requirements of section 71(f) for the containment strategy.

It may be appropriate to require landholders and the Crown to control woolly nightshade as contributors, but it should be noted that, if applied as indicated in the proposed strategy, this would result in a huge financial burden to landholders for little gain.

Monitoring, inspection and enforcement can be charged to the beneficiaries of the strategy. These will be either the community in respect of conservation and biodiversity values, or the pastoral sector in respect of preventing the spread of woolly nightshade onto uninfested land.

Because over 80 per cent of the land affected by woolly nightshade, and all of the financial benefits (NPV of approximately $130 million on land not currently affected) accrue to the pastoral sector, it would seem appropriate that they pay the majority of the costs associated with the inspection, monitoring and enforcement. The benefits for the currently unaffected land ($130 million) will exceed the inspection, monitoring and enforcement costs of NPV $1.6 million.

2.7 Privet (*Ligustrum spp.)*

Description and background

The genus *Ligustrum* comprises approximately 20 species that variously native to India, Europe, Asia and North Africa. Plants are deciduous or semi evergreen, and grow to between 3 – 5 m in height typically. They have irregular branches and stiff stems with dark green to purplish leaves. Privet flowers in December to January, and is insect pollinated so it contains relatively large pollen. Privet is used extensively as an ornamental in gardens.

Privet is not considered a threat to production land, and although it is an environmental pest it has a short-lived seedbank that is amenable to control. However, there is a section of the community that considers it to be a significant allergen. For this reason it has been included in the previous RPMP as a control plant, with control required where a complainant is living within 50m of a privet plant and on presentation of a doctor's certificate supporting the claim of allergic reaction.

Privet is not generally considered a significant allergen overseas[22]. It is considered to comprise only a small proportion of pollen in the air and, because it is insect pollinated and has relatively heavy pollen, it does not tend to be carried in the wind as easily.

However a three year study[23] in Sydney did find substantial numbers of privet (*Ligustrum lucidum* and *Ligustrum sinense*) pollen in the air. Privet is also cross-reactive with other more common allergy causing species, notably olives (*Olea*), ash (*Fraxinus*) and lilac (*Syringa*), with which it shares a common allergen (Ole e 1). These genera are all part of the *Oleaceae* family, which formed 30 per cent of the tree species and 13 per cent of the pollen in the Sydney study sample. Privet's flowering season overlaps with that of the olive, which may accentuate the cross reactivity. Privet is listed in Allergy New Zealand's pollen calendar as producing pollen from late October to the end of February.

In the only study of privet sensitivity in NZ, Richards et al (1995)[24] demonstrated enhanced airway responsiveness during privet flowering season among 20 severely asthmatic subjects, but no statistically significant symptoms. Direct challenge produced no early asthmatic response, but late response in 6 out of the 20 subjects. It should be noted that these individuals were all asthma sufferers, and considered atopic (predisposed to developing hypersensitivity reactions). These authors concluded:

> "*Privet exposure may cause bronchoconstriction in certain individuals, but it is unlikely to be responsible for a large proportion of asthma morbidity in New Zealand."*

While privet has been singled out as an allergenic plant for the RPMP, it is merely one of 23 trees considered allergenic, many of which are more common. It is also not considered the most allergenic tree in NZ (this is identified as white birch which produces a higher number of wind dispersed pollen). Allergy NZ[25] notes that grass is considered a worse problem than tree pollen:

> *Tree pollen is, therefore, less of an issue compared with grass pollen. Grass allergy is a severe problem because its season goes from August/September through to March. This makes New Zealand's pollen season a nine-month nasal marathon! Many people allergic to grass are allergic to more than one species creating a long protracted suffering period.*

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[22] Carinanos, P., Alcazar, P., and Dominguez, E. 2002. Privet pollen (Ligustrum spp.) as a potential cause of pollinosis in the city of Cordoba, south-west Spain. Allergy, 2002 Feb. 57(2) 92 – 97.

[23] Bass, G and Morgan, D. 1997. A three year (1995 – 97) study of pollen and Alternaria mould in the atmosphere of south western Sydney. Grana 36(5) 293-300

[24] Richards G, Kolbe J, Fenwick J, Rea H. The effects of Privet exposure on asthma morbidity. N Z Med J 1995;108(996):96-9

[25] http://www.allergy.org.nz/allergy+help/a-z+allergies/pollen+allergy.html Accessed 28 November 2012.

Other local sources are somewhat dismissive of the link between privet and allergies. The Allergy Clinic notes[26]:

> *Privet produces a highly scented flower, which is an irritant to most allergy sufferers, but is not a strong allergen. In doing skin prick tests in patients with allergic rhinitis it is very rare to get positive reactions to privet. Most people who think they are allergic to privet are actually allergic to ryegrass, which is not as visible as privet.*

Waikato Regional Council is proposing that privet be subject to control subject to complaint and the provision of an allergen sensitivity test. It is also proposing that in areas where community initiatives are in place that all privet be either removed or trimmed so it does not flower.

Analysis

Level of analysis required

National policy direction considerations	Assessment	Comment
Certainty – data available	Moderate	Reasonable information on the costs of control. Data on current location of pest likely to be poor.
Certainty – impacts	Low	Considerable difference of opinion regarding impact of privet.
Significance	High	High level of interest in privet in the Waikato region.
Urgency	Low	Privet well established and common in the region.
Costs	High	Considerable costs imposed on individuals required to remove or control privet.

Risks

National policy direction considerations	Assessment	Comment
Objective not being achieved	High	Relationship between privet and allergies suffered by individuals not well established, and there are a large number of other potential allergens not controlled in the RPMP so the potential to reduce the overall allergenic load is low.
Management approach inadequately applied	Low	Strategy is currently in place
Adverse impact on implementation	Medium	Control on roadsides may be problematic
Unintended adverse effects	Low	
Public and political concerns	High	

Alternatives assessed

There are two alternate approaches assessed for managing privet:

1. Do nothing – where the pest is allowed to continue to be sold and to spread unhindered.

[26] http://www.allergyclinic.co.nz/guides/26.html Accessed 28 November 2012

2. Removal of individual plants under complaint where allergic reaction is established. Removal of all privet in areas where community programmes are in place.

Costs and benefits

Costs

- Allergy test – complainants would need to undertake an allergy test at a cost of $60 - $100 per test to determine whether they are allergic to privet pollen. Assuming 50 per cent of current complaints (75 total) would get an allergy test, this would result in a cost of $6000/annum[27], with only a relatively small proportion proving allergic (assume 5 per cent based on the Allergy Clinic comment).
- Monitoring, enforcement, education – Waikato Regional Council intends to take no action in respect of privet, other than in response to complaints. Historically there have been 1500 complaints per annum, of which approximately 10 per cent lead to formal control action, with half requiring only a phone call and half requiring an inspection and letter. On this basis the requirement for a positive allergy test would result in only 4 successful complaints per year. Assuming an average cost of $51/complaint, the total costs for enforcement would be approximately $200/annum[28].
- Control costs – where control is undertaken there will be costs incurred. Control costs will depend on the extent and nature of the privet occurrence. For individual plants this cost is likely to be less than $80 - $400/plant depending on its size. Trimming hedges is likely to cost in the order of $150/trim[29], but for large hedges and clumps of privet the costs could increase significantly. Assuming $200/control required, the total cost for 4 successful complaints would be $800/year.
- Loss of amenity value – the privet presumably provides some amenity value where it is located. However it is likely that similar species or forms of plants can be planted instead to provide the same value.
- On this basis total annual costs would be $7,000 per annum, or an NPV of $50,000 over the 10 years of the strategy, plus some loss of amenity value.
- The community initiative requires control of all privet, not just those forwhich complaints are received. This will mean that while there will be savings for those who are not required to undergo an allergy test, the control costs will be much higher. If we assume that all complaints involved a requirement for control, and the complaints are proportionate to population, then there would be 123 control actions required annually in the community initiative areas[30]. This would cost $24,000/annum or an NPV of $160,000 over the 10 years of the strategy.

Benefits

The benefits of the strategy arise largely from prevention of allergic reactions to privet.

The estimated annual cost of treating this reaction is $40/annum[31] per individual affected. Assuming one individual affected per complaint followed up, the total benefit of the strategy is likely to be in the order of $160 per annum accumulating over the 10 year period, which is an NPV of $1,000. In addition there will be intangible costs for individuals associated with the side effects of taking antihistamines, and there would be an additional benefit for a proportion whose symptoms are not controlled by medication .

The probability of achieving this benefit may be limited. If the privet is replaced by another allergenic tree the expected gains may not occur, unless the complainant is allergic to only privet species. It should also be noted that those allergic to privet are known to be potentially cross reactive with olive, ash and lilac genera, and given that there are a large number of

[27] Assuming $80/test.
[28] $88/hour, with 1 hour per inspection and letter for 50% of complaints.
[29] All costs from Tree Menders Ltd (pers.comm. 28 November 2012). Trimming costs are $150/trim, with trimming twice per year. However it is assumed that only one trim is required for control during flowering.
[30] 1500 complaints per annum, and 8% of the region's population in the community initiative area.
[31] Based on purchase of long acting antihistamine tablets taken daily for one month to cover the flowering period of any nearby privet.

other pollen allergens around, the likelihood is that removal of privet will provide little or no improvement.

The benefits of universal control in areas of community initiatives are very unclear, because there is only a very small link between privet and general allergic symptoms in susceptible individuals. Because the populations of the areas where total control is required are small, the number of people who are solely allergic to privet will be small. There are approximately 30,000 people living in the areas of current community initiatives, which is 8 per cent of the Waikato population. If the benefit for the whole region of a complaint driven regime is $160/annum, the benefit for the community initiative areas is likely to be ~$10 – $20/annum or an NPV of $90.

Outcome
It appears unlikely that the benefits of privet control as set out in the strategy will outweigh the costs :

- For complaint driven control, the costs of NPV $50,000 outweigh the benefits of NPV $1000.
- For universal control, the costs of NPV $160,000 outweigh the benefits of NPV $90.

In addition, the benefits are not well established because for individual complaints the complainant would need to prove not only that they were allergic to privet pollen, but that they were not allergic to other species, particularly grasses, flowering at the same time of year. Without this there will be considerable expenditure without any benefit in terms of reduced allergic reaction.

Section 71 (d)

Privet appears capable of causing damage to human health. On this basis a strategy to control privet meets the requirements of section 71(d).

Section 71(e)

It is unlikely that a strategy for the control of privet will meet the requirements of section 71(e) because of the low likelihood that significant benefits will be achieved and because the costs are high relative to any potential benefits.

Funding Assessment

Assessment of potential funders

Table 23: Assessment of exacerbators and beneficiaries for woolly nightshade proposed strategy

National policy direction considerations		Ability to reduce costs through behaviour change	Determine whether benefits of control outweigh costs	Determine whether control is delivered in most cost effective manner
Exacerbators	Landholders with privet	Yes	No	Yes
	Crown	Limited	No	Limited
Beneficiary	Allergy sufferers	No	Yes, although costs potentially not experienced if exacerbators pay.	No

Section 71(f)

The funding for control of privet could be sourced either from contributors (those with privet causing a problem) or beneficiaries (individuals affected by privet).

Either of these would be appropriate and would meet the tests of section 71(f), with the advantages of landholders with privet paying being a potential reduction in costs, and also a reduced potential for planting of privet.

The advantage of those affected by privet paying would be that these people are best placed to determine whether the benefits outweigh the costs of control – and in some cases the costs of control could be very significant.

The benefits of the strategy accrue to the community, but to a very specific sector of the community. The most likely way of ensuring that the benefits of inspection and enforcement of the strategy exceed the cost would be for those affected by privet to pay the costs of inspection and enforcement associated with removing any problem plant. This would ensure that the health benefits to the community exceed the costs of inspection and enforcement, thus allowing the requirements of section 71(f) to be met.

2.8 Koi carp (*Cyprinus carpio*)

Description and Background

Carp are an exotic fish originating from Europe and Asia. They grow to over 5kg and 60mm in length. Koi are an ornamental strain of common carp, originating in Japan, and are capable of interbreeding with common carp and goldfish. Koi in the Waikato are generally gold/orange in colour, with a two sets of fleshy of barbels on the upper jaw.

Carp are the most widely distributed freshwater fish, having invaded all continents apart from Antarctica. They are also the most widely cultured food fish in the world with an annual yield of 200,000 tonnes. They are an extremely fecund species with large females containing hundreds of thousands of eggs per spawning. Koi were introduced to NZ as an ornamental fish, but now breed in freshwater lakes and waterways in Auckland and Waikato, with a small infestation in Nelson. They are classified as a noxious fish under the Freshwater Fisheries (1983) legislation and an unwanted organism under the Biosecurity Act.

Koi carp feed on a range of food including water insects, larvae of insects, worms, molluscs, and zooplankton. Additionally, the carp consumes the stalks, leaves and seeds of aquatic and terrestrial plants, and decayed aquatic plants, etc.

It is the feeding habits of carp that cause the greatest damage. They reduce feed source for other fish, reduce biodiversity, in feeding tend to stir up the bottom causing turbidity, and damage aquatic plant life decreasing bank stability. Koi carp have been estimated at up to 80 per cent of the fish biomass in some Waikato water bodies, with biomass 690–2060kg/ha in the Kimihia outlet and 580–1080 kg/ha in the Waikato river. (http://cber.bio.waikato.ac.nz/images/Pest_fish_presentation.pdf).

Until recently control of koi carp has been very difficult, with success only in small waterbodies. However trialling of a koi carp push trap has proven successful, with 1500kg of carp trapped in Lake Waikare over 2.5 days, with minimal effects on native fish. This success has led to the permanent installation of an automated trapping system on the Waikare outlet. The koi is trapped and automatically run through a digestion process which turns the fish into a fertiliser. This trial is estimated to have cost $500,000 to design and install. There are further trials being explored to place low cost barriers at the entrance to lakes, and netting of small lakes.

Waikato Regional Council estimate that koi carp currently occupy approximately 11,000ha of waterways and lakes, including 3700ha of the lower Waikato, 1300ha of lower Waikato tributaries, 6000ha of lakes in the lower Waikato catchment, and 300ha of the Waipā river catchment.

There is potential for further spread within the Waipā catchment through natural spread, and to other catchments in the region through human mediated spread from deliberate releases. The total area of water bodies in the region is estimated at 160,000ha.

The proposal for koi carp is for site-led control, with objectives of the programme being:

- raise public awareness about the effects of koi
- gather information and contribute to research on ways to control koi
- undertake trials to determine the viability of operating an automated koi trap at Lake Waikare and its impact on restoring the values of the lake.

Analysis

Level of analysis required

National policy direction considerations	Assessment	Comment
Certainty – data available	Low	Poor information on the costs of control with ongoing trap costs commercial viability not well defined. Current location well established.
Certainty – impacts	High	
Significance	Low	
Urgency	Medium	Koi carp well established.
Costs	Medium	Cost of trap significant.

Risks

National policy direction considerations	Assessment	Comment
Objective not being achieved	Medium	Trap has been trialled already.
Management approach inadequately applied	Low	
Adverse impact on implementation	Low	
Unintended adverse effects	Low	
Public and political concerns	Low	

Alternatives assessed

There are two alternate approaches assessed for managing koi carp :

1. Do nothing – where the pest is allowed to continue to be sold and to spread unhindered.
2. Site-led management - use of traps and potentially other control techniques to contain and in some cases locally eradicate koi carp.

Costs and benefits

<u>Costs</u>

- Expenditure on ongoing trials.
- Loss of recreational value from fishing carp.
- Expenditure on other research into management of koi carp.
- Establishment of new traps in other parts of the region ($1 million over five years). However the extent and location of these traps is dependent on the results from trial results from the first trap.

<u>Benefits</u>

- Improved biodiversity and conservation values in the Lake Waikare and immediate environment from a reduction in the pressure placed by koi carp.
- Improved amenity values from reduced turbidity and bank erosion.
- Some improvement in catchment management from reduced bank erosion.

Outcome

The net outcome of the proposed site-led plan is difficult to determine, because the costs have not been finalised and the sites to be managed are not yet known. However if the costs are in the order of $1 million over five years, this would result in an NPV cost of $860,000. Assuming that the total infested area of 11,000ha was improved by the trapping, this would result in an NPV cost of $78/ha for improved biodiversity and amenity values.

Section 71 (d)

Koi carp appears capable of causing damage to conservation and biodiversity values, as well as amenity values with reduction in water clarity. On this basis a strategy to control koi carp meets the requirements of section 71(d).

Section 71(e)

If the council considers that the benefits from expenditure on education and investigations into future management of koi carp exceeds its proposed expenditure, then the requirements of section 71(e) will have been met.

Funding assessment

Assessment of potential funders

Table 24: Assessment of exacerbators and beneficiaries for koi carp proposed strategy

National policy direction considerations		Ability to reduce costs through behaviour change	Determine whether benefits of control outweigh costs	Determine whether control is delivered in most cost effective manner
Beneficiary	Community	No	Yes, through political process	No

Section 71(f)

The benefits of the strategy accrue to the community. Therefore the community should fund the costs of control, less any potential offsets from commercialisation of the koi carp removal. There are no specifically identifiable contributors to the koi carp problem at this stage.

3 Appendix 1: Key model assumptions and results for proposed approach

Pest	Strategy	Area start	Area finish	Years	Proportion of landholders controlling in the absence of a strategy	Cost of control ($/ha /annum)	Gross margin for affected land	Proportion of landholders controlling pest in absence of strategy	RPMP costs	No RPMP production loss	No RPMP total costs (incl production loss)	Net benefit (72a)	Conservation or other values - area protected (ha)	Direct cost to land occupiers (per annum)	Direct cost to land occupiers ($NPV)
Production weeds															
Velvet leaf	Progressive containment	2	56,000	35	80%	$180	$310	80%	$275,000	$5,042,000	$11,709,000	$16,480,000	0	$0	$10,000
Tutsan	Progressive containment	500	320,000	50	10%	$800	$380	10%	$9,090,000	$27,242,000	$25,490,000	$43,640,000	60000	$400,000	$5,200,000
Woolly nightshade	Progressive containment	380,000	620,000	50	10%	$1,000	$380	10%	$685,581,000	$379,359,000	$554,619,000	$248,400,000	20000	$380,000,000	$4,939,910,000
Conservation weeds															
Japanese cherry	Site led	15	290,000	100	5%	$1,000	$0	5%	$753,000	$0	$753,000	$0	220,000 ha	$20,000	$190,000
Chocolate vine	Progressive containment	2	29,500	100	5%	$2,500	$0	5%	$135,000	$0	$227,000	$90,000	22,000 ha	$10,000	$60,000
Chilean rhubarb	Progressive containment	4	55,000	50	5%	$471	$0	5%	$348,000	$0	$823,000	$480,000	26,000 ha	$2,000	$30,000

4 CBA done by Waikato Regional Council staff for 2014 RPMP

4.1 Argentine ant (*Linepithema humile*)

Plan change – advisory animal with discretionary provisions to undertake site-led control if necessary.

Proposed management regime – advisory animal.

Description and biological capability

Form

- A small (2-3mm) honey-brown coloured ant of South American origin.

Habitat

- Wide ranging habitats, from sea level to higher warm areas. Does exhibit some altitudinal intolerance. Will be found on the edges of indigenous forest but doesn't spread beyond the margins. Much of the Waikato region will support infestations of this ant species.

Regional distribution

- Numerous sites in the Waikato including Morrinsville, Whangamata, Thames Coast settlements and Raglan.

Biological success

Dispersal method

- Will spread naturally at an average rate of 150m per year. However, the main dispersal method in the Waikato region is human spread in potplants, trailers etc. In this case human dispersal has been recorded to occur between 10-72km.

Reproductive ability

- Argentine ants are from large related colonies, one colony does not fight its neighboring one. Each colony produces multiple queens. Colonies are high in population and due to their behaviour form related mega-colonies.

Competitive ability

- This species is listed in the ISSG top 100 invasive animals. They have a high level of invasiveness and once present will quickly dominate ecosystems and displace most other insect life, except for aphid and scale insects which they farm for food.

Other considerations

Human health

- Argentine ants will bite, but their worst tendency is to swarm in large numbers.

Management

- This species is difficult to manage due to the large number of colonies that will be present in an infested area. To successfully control Argentine ants all the colonies must be exposed to a poison. This requires placing baits every square metre in a three dimensional matrix i.e. horizontal, and vertical services must be baited in a systematic manner. This also involves cooperation of neighboring landowners.

- Few products are suitable at controlling Argentine ants. The most recognised successful product is Xtinguish using Fipronil as the active ingredient.

ASSUMPTIONS

Initial area infested
Estimated as at least 110 hectares in reported areas within the Waikato region. There are most likely numerous other infestation locations that have not been recorded.

Weighted average gross margin
$3.27/ha.

Argentine ant weighted average gross			
Land use	**Area**	**Gross margin**	
Waikato Regional Council area	2,500,000	$3.27	$8,178,408.42
Weighted average gross margin			**$3**

Proportion of production loss from infested land
Ten per cent, as this species is expected to out compete beneficial species.The projected density is moderate to high at infested sites.

Total area potentially infested (TAPI)
Studies on the potential distribution of Argentine ants indicate they may become widespread in the Waikato region. The estimate is that up to 1186769.2 hectares could be affected. There is currently no method for eradicating this species from mainland sites - at some point all of the potential distribution area shall be infested.

Argentine ants are highly adaptable and have the ability to infest a wide range of habitats. Because they are easily spread through human related movements, new infestations will occur at areas previously free of infestation. The ants will occupy habitats in urban and rural land, pastoral and cropping lands, and a range of forest types. Observations show that Argentine ants tend to only inhabit the margins of indigenous forest, and that to some extent their distribution is moderated by climate and altitude.

Years to infest all TAPI
The timeframe to infest all TAPI is unknown. Natural spread is relatively slow but human movements of ant colonies can offset this. The ants will exploit different habitats at differing rates. For this CBA it has been assumed that it will take at least 200 years for the TAPI to be infested.

Annual cost of control for landholder
Assumed as $3000/year, based on 15 households/ha (660m^2 properties). Per landholder the cost is $200 p.a based on two treatments of Xtinguish baits.

Proportion of land over which pests voluntarily controlled
Two per cent. In the Waikato region few landowners have shown interest in managing Argentine ants.

Proportion of land to which conservation values apply
One per cent. To date, most infestations occur on private and urban land. In addition, the ants appear to only infest the margins of indigenous forests.

Any benefits provided by the ant
N/A.

Biocontrol
N/A.

Year strategy objectives achieved (advisory)
One.

Area infested if objectives (advisory) achieved
Two hundred hectares.. The advisory objective will not halt the spread of the pest, but will enable landowners to mitigate the most serious impacts.

Proportion of production loss from infested land when strategy objectives (containment) achieved
One per cent. The figure is difficult to quantify as it depends on where the ants spread to and how quickly they exploit varying habitats.

Year strategy objectives achieved (eradication)
Assumed as 10 years for the purpose of this analysis.

RESULTS

PEST		Argentine ant	
	No RPMP	**Advisory**	**Site-led**
Cost and losses under option	$312,673	$1,412	$96,008
Section 71(e) NPV		$311,261	$216,665
Section 71(e) regional values cost/ha		$24	$17
Section 71(f) NPV (*NRB*)		$228,436	$204,187
Section 71(f) area of spillover prevented (ha)		1,186,659	1,186,659
Base assumptions			
Discount rate		**8%**	
Initial area infested (IAI)		**110.00ha**	
Weighted average gross margin for infested land (WAGM)		**$3/ha**	
Proportion of production loss from infested land (PPLIL)		**10%**	
Total area potentially infested (TAPI)		**1,186,769ha**	
Years to infest all of TAPI (YI)		**200 years**	
Annual cost of control for landholder (ACCL)		**$3,000/ha affected**	**(**
Proportion of landholders controlling pests (PLCP)		**2.0%**	
Proportion of infested land to which conservation values apply (PILCV)		**1%**	
Any benefits provided by weed (BPBW)		**-**	

Containment assumptions			
Biocontrol		**-**	
Year strategy objectives achieved (YOA)		**1 year**	**(Years)**
Area infested if strategy objectives achieved (AISOA)		**200ha**	
Proportion of production loss from infested land when atrategy objectives chieved (PPLSOA)		**1%**	

Eradication ssumptions			
Year strategy objectives achieved (YOA)		**10 years**	

Regional council costs		
Year	**Advisory**	**Site-led**
1	$100	$1,000
2	$100	$1,000
3	$100	$1,000
4	$100	$1,000
5	$100	$2,000
6	$100	$2,000
7	$100	$2,000
8	$100	$2,000
9	$100	$2,000
Year 10 onward	$100	$2,500
NPV	**$1,300**	**$25,549**

Control costs		
Year	**Advisory**	**Site-led**
1	$0	$3,000
2	$0	$3,000
3	$0	$3,000
4	$0	$3,000
5	$0	$4,000
6	$0	$4,000
7	$0	$4,000
8	$0	$4,000
9	$0	$4,000
Year 10 onward	$0	$7,500
NPV	**$0**	**$70,308**

CONCLUSIONS

The desired outcome of the Regional Pest Management Plan is provide advice to landholders to manage the impacts of Argentine ants.

No RPMP outcome
The outcome in the no RPMP scenario is a loss of $48,570,273 per annum in 75 years as a result of production losses and additional costs of control. This is equivalent to an NPV of approximately $4,338,614. In addition there are 180,666.3 hectares on which damages to regionally significant conservation values will occur.

Advisory outcome
The outcome of the advisory scenario is an NPV of $1300 for administration, inspection, monitoring and enforcement, and an NPV of $0 for costs of control. This is a total cost in present day terms (NPV) of approximately $1411.71 at a discount rate of 0.08 per cent. In addition there will 2.2 hectares of land on which damage to regionally significant conservation values will occur.

The net outcome for the advisory scenario of the net benefits when compared with the no RPMP scenario is an NPV of $311,261.28. For the site-led scenario the net benefits compared with the no RPMP scenario are an NPV of $216,665.35. Both options protect significant regional biodiversity values on 12,791.2 hectares through the prevention of spread.

Advisory is preferred since it produces the highest net benefit and best satisfies the requirements of section 72(a). Advisory also satisfies the requirements of section 72(b) because it helps to prevent damage to regional values on 12,791 hectares.

If the requirements of section 71(e) are deemed by council to have been met, then the costs of the strategy can be charged to the regional community as beneficiaries and the benefits will exceed the costs. Those on whose property the pest currently exists are exacerbators and can reasonably be charged the cost of control, satisfying section 71(f).

SUMMARY

Animal pest	**Proposed programme**	**Section 71(e)** *Do the benefits outweigh the costs?*	**Section 71(f)** *Is there a net regional benefit (prevention of externalities at a reasonable cost)?*	**Section 71** *Who receives the benefit?*	**Estimated council Cost per annum ($NPV)**
Argentine ant	Advisory	Yes., The advisory scenario is preferred as it produces the highest net benefit. The total cost is $1411.71 p.a returning an NPV benefit of $311,265.28.	Yes	Wider regional community	$1,411.71 i

4.2 Bat-wing passion flower (*Passiflora apetala*)

Plan change – New plant to strategy.

Proposed management regime – Exclusion.

Description and biological capability
Form

- A shade tolerant vine. It has leaves with two large lobes (that resemble a bat wing) and some have pale green stripes along the midribs. It has small yellow/green coloured flowers (7-12mm diameter) and produces small black berries about the size of a small grape (7-15mm diameter). The berries are inedible and non-toxic to humans but attractive to birds.

Habitat

- Frost free regenerating native forest and scrub.

Regional distribution

- No known sites in the Waikato.
- Was recorded growing in a butterfly park in Thames in the Waikato.

Biological success
Dispersal method

- Bird spread.

Reproductive ability

- Seed. 2-3 year old plant in excess of 3000 fruit, with 5-25 seed per fruit.

Competitive ability

- Bat-wing passion flower is very invasive, with the ability to smother, shade and strangle the vegetation it grows on. This vine can produce a lot of fruit and many hundreds of seedlings have been found under some plants.

Other considerations
Toxicity

- Non-toxic to humans.

Resistance to control

- Moderate – can be cut and pasted with Vigilant.

Bat-wing passion flower is becoming a serious pest in Northland. It needs warm, frost-free areas to survive and mature, making the Coromandel peninsula vulnerable to establishment.

ASSUMPTIONS

Initial area infested
Zero hectares (model assumes a 0.01ha infestation).

Weighted average gross margin
$136/ha.

Bat-wing passion flower weighted average gross			
Land use	**Area**	**Gross margin**	
Plantation (planted forest) 10m margin	20936.71	$700	14655697
Total	**20936.71**		**14655697**
Weighted average gross margin			**$700**

Proportion of production loss from infested land
Fifteen per cent.

The projected density is moderate to high.

Total area potentially infested (TAPI)
Waikato Regional Council's GIS modelling shows that a potential 220,845ha of terrestrial habitat within the region could be affected if no control work was undertaken and preventive measures are not set up.

The current reality is that this pest plant has not made it to the Waikato yet.

Potential	**ha**
Roads - to towns, 4m x length	4,595ha
Railway - to towns, 4m x length	142ha
Indigenous forest - 10m margin (LCDB2)	19,371ha
Plantation (planted forest) 10m margin	20,937ha
Shrubland/scrub (manuka, kanuka)	175,800ha
Total	**220,845ha**

Years to infest all TAPI
The bat-wing passion flower is a shade tolerant vine with distinctive bat wing shaped leaves that may have a pale green stripe along the midrib. It has small yellow/light green coloured flowers (7-12mm diameter) and produces small black berries the size of a small grape (7-15mm diameter). The berries are inedible and non-toxic to humans but are very attractive to birds.

Bat-wing passion flower is very invasive, with the ability to smother, shade and strangle the vegetation it grows on. This vine can produce a lot of fruit and many hundreds of seedlings have been found under some plants.

Bat-wing passion flower is a serious problem in northern regions, where it is smothering areas of native and exotic forests. The plant has also been found in home gardens and amongst hedges and fence lines.

Bat-wing passion flower is slightly frost tender so it would have a moderately low rate of spread.

Years to infest potential range – 75 years 'high' rate of invasion

Annual cost of control for landholder
Assumed as $2500 ha/year, based on accurate wilding kiwifruit figures from Bay of Plenty Regional Council.

Proportion of land over which pests voluntarily controlled
Five per cent.

Proportion of land to which conservation values apply
Based on GIS analysis, conservation values are assume to be 88 per cent.

Any benefits provided by the weed
N/A.

Biocontrol
N/A.

Year strategy objectives achieved (containment)
N/A.

Area infested if objectives (containment) achieved
N/A.

Proportion of production loss from infested land when strategy objectives (containment) achieved
N/A.

Year strategy objectives achieved (eradication)
Assumed as 10 years for the purpose of this analysis.

RESULTS

PLANT PEST		**Bat-wing passion flower**	
	No RPMP	**Containment**	**Eradication**
Cost and losses under option	**$4,338,614**	**$0**	**$33,734**
Section 71(e) NPV		**$4,338,614**	**$4,304,880**
Section 71(e) regional values cost/ha		**$24**	**$24**
Section 71(f) NPV (*NRB*)		**$4,338,589**	**$4,321,722**
Section 71(f) area of spillover prevented (ha)		**216,108**	**216,108**

Base Assumptions

Discount Rate		**8%**	
Initial Area Infested (ha)	(IAI)	**0.01**	**(ha)**
Weighted Average Gross Margin for Infested Land ($/ha)	(WAGM)	**$700**	**($/ha)**
Proportion of Production Loss from Infested Land (%)	(PPLIL)	**15%**	**(%)**
Total Area Potentially Infested	(TAPI)	**216,108**	**(ha)**
Years to Infest all of TAPI (years)	(YI)	**75**	**(Years)**
Annual Cost of Control for Landholder ($/ha affected)	(ACCL)	**$2,500**	**($/ha)**
Proportion of Landholders Controlling Pests (%)	(PLCP)	**5.0%**	**(%)**
Proportion of Infested Land to which Conservation Values Apply (%)	(PILCV)	**88%**	**(%)**
Any Benefits Provided by Weed (total $ / annum)	(BPBW)	**-**	**($)**

Containment Assumptions			
Biocontrol ($/annum)		**$ -**	**($)**
Year Strategy objectives Achieved	(YOA)	**10**	**(Years)**
Area Infested if Strategy Objectives Achieved (ha)	(AISOA)	**0.01**	**(ha)**
Proportion of Production Loss from Infested Land when Strategy Objectives Achieved(%)	(PPLSOA)	**0%**	**(%)**

Eradication Assumptions			
Year Strategy objectives Achieved	(YOA)	**10**	**(Years)**

Regional Council Costs		
Year	Containment	Eradication
1		$2,500
2		$2,500
3		$2,500
4		$2,500
5		$2,500
6		$2,500
7		$2,500
8		$2,500
9		$2,500
Year 10 onward		$0
NPV	**$0**	**$16,867**

Control Costs		
Year	Containment	Eradication
1		$2,500
2		$2,500
3		$2,500
4		$2,500
5		$2,500
6		$2,500
7		$2,500
8		$2,500
9		$2,500
Year 10 onward		$0
NPV	**$0**	**$16,867**

CONCLUSIONS

The desired outcome of the Regional Pest Management Plan is to prevent this plant from establishing and achieve eradication of this pest plant if an infestation is found.

No RPMP outcome
The outcome in the no RPMP scenario is a loss of $48,570,273 per annum in 75 years as a result of production losses and additional costs of control. This is equivalent to an NPV of approximately $4,338,614. In addition there are 180,666.3ha on which damages to regionally significant conservation values will occur.

Eradication outcome
The outcome of the eradication scenario is an NPV of $16,867 for administration, inspection, monitoring and enforcement, and an NPV of $16,867 for costs of control. This is a total cost in present day terms (NPV) of approximately $33,734 at a discount rate of 0.08 per cent. In addition there will be no damages to regionally significant conservation values from this pest once eradication has been achieved.

The net outcome for eradication net benefits when compared with the no RPMP scenario is $4,304,880 in NPV terms. This option protects significant regional biodiversity values on 180,666.2912ha through the prevention of spread of this organism. Eradication is preferred since it produces the highest net benefit, and best satisfies the requirements of section 71(e).

If the requirements of section 71(e) are deemed by council to have been met, then the costs of the strategy can be charged to the regional community as beneficiaries and the benefits will exceed the costs. Those on whose property the pest currently exists are exacerbators, and can reasonably be charged the cost of control, satisfying section 71(f).

SUMMARY

Potential pest plants	**Proposed programme**	**Section 71(d)** *Is the pest a serious threat to the region?*	**Section 71(e)** *Do the benefits outweigh the costs?*	**Section 71(f)** *Who receives the benefit?*	**Estimated council cost per annum $**
Bat-wing passion flower	Exclusion	Yes, part (ii) and (iv)	Yes, if conservation values protected exceed $0.19/ha or if 5% of area is controlled in the absence of a strategy.	Wider regional community	$2,500

4.3 Broom corn millet (*Panicum miliaceum*)

Plan change – New plant to strategy.

Proposed management regimes – Exclusion.

Description and biological capability
Form

- A grass weed, 2m tall in crops.

Habitat

- Agricultural crops.

Regional distribution

- Not known to be in the Waikato.

Biological success
Dispersal method

- Seeds are spread by water, farm machinery when harvesting grain (e.g. maize), through livestock, and as a contaminant of grain.

Reproductive ability

- Seed.

Competitive ability

- Broom corn millet reduces crop yields via competition and interferes with harvest by clogging machinery. In one study, it was shown to reduce crop yield by 13 – 22 per cent, when present at a density of 10 plants/m^2.
- It competes with maize and sweet corn for water and nutrients early on in its life cycle. Later, when it has become tall enough, it will compete for sunlight as it can reach over 2m high in crops.

Other considerations
Toxicity

- Not known to be toxic.

Resistance to control

- Pre-emergent herbicides were found to be less effective against broom corn millet than other annual grasses (in pot experiments).
- Post-emergent herbicide applications using nicosulfuron were found to be more effective, when applied before or soon after tillering commenced, and while the plants remained small.
- Timing of post-emergent herbicide application is critical as this weed can germinate over a long period of time.
- Often a single application of a post-emergent herbicide is insufficient – a second application may be required if there is further germination.

Control method
Two applications of 3L/ha Roustabout and 3L/ha Gesaprim plus 2 post emergence applications of Nicosulfuron (Latro, 110 g/ha adjuvant) or one of Nicosulfuron and one of Callisto (200mL/ha + adjuvant and maybe some more Gesaprim (1 L/ha))

ASSUMPTIONS

Initial area infested

Broom corn millet is not known to be in the Waikato at present. Our surrounding regions have recorded presence in Auckland, Bay of Plenty, Gisborne and Hawke's Bay. The greatest risk is via machinery or grain coming from Gisborne and Hawke's Bay. It is a potential candidate for a "Pathway Management Plan".

Zero hectares (model assumes a 0.01ha infestation).

Weighted average gross margin

$370/ha.

Broom corn millet weighted average gross margin			
Land	**Area**	**Gross margin**	
Arable	50,000	$370	18500000
Total	50000		18500000
Weighted average gross margin			**$370**

Proportion of production loss from infested land

Impact on pasture / crops
*(*http://www.pestweb.co.nz/view_species.php?sp=Panicum+miliaceum&tab=I)

Broom corn millet reduces crop yields via competition and interferes with harvest by clogging machinery. In one study, it was shown to reduce crop yield by 13 – 22 per cent, when present at a density of 10 plants/m^2.

It competes with maize and sweet corn for water and nutrients early on in its life cycle. Later, when it has become tall enough, it will compete for sunlight as it can reach over 2m high in crops.

Total area potentially infested (TAPI)

Waikato Regional Council GIS modelling shows that a potential 50,000ha of terrestrial habitat within the region could be affected if no control work was undertaken and preventive measures are not set up.

Both staff and contractors have good communication with Foundation for Arable Research (FAR) and AgResearch and undertake regular surveillance for broom corn millet. This pest plant has not made it to the Waikato yet.

Potentially infested	**ha**
Arable	50,000ha
Total	**50,000**

Years to infest all TAPI

Broom corn millet is a serious problem in Gisborne and the Hawke's Bay region. The greatest risk is via machinery or grain coming from Gisborne and Hawke's Bay.

Once broom corn millet was established in the Waikato it would spread relatively quickly by unhygienic machinery practices.

Years to infest potential range – 75 years 'high' rate of invasion.

Annual cost of control for landholder
Control costs are ~$180/ha/annum (based on conversation with FAR).

Arable/cropping land profit per ha – supplied by FAR
Maize silage costs around $3500/ha (includes $1k land lease) to grow. A 20 tonne crop would return $4500 and a 25 tonne crop $5625. Profit is $1000 to $2625, but a 20 to 22 tonne crop is the average.

Maize grain costs $3650/ha (includes drying and $1k land lease) and a 11t/ha crop @$400/t returns $1100/ha profit.

Sweet corn is similar in costs to silage but returns are generally twice as good

Proportion of land over which pests voluntarily controlled
Zero per cent.

Proportion of land to which conservation values apply
None

Any benefits provided by the weed
N/A.

Biocontrol
None

Year strategy objectives achieved (containment)
N/A.

Area infested if objectives (containment) achieved
N/A.

Proportion of production loss from infested land when strategy objectives (containment) achieved
N/A.

Year strategy objectives achieved (eradication)
N/A.

RESULTS

PLANT PEST		Broom corn millet	
	No RPMP	Containment	Eradication
Cost and losses under option	**$8,535,511**	**$468**	**$67,472**
Section 71(e) NPV		**$8,535,043**	**$8,468,039**
Section 71(e) regional values cost/ha		**#DIV/0!**	**#DIV/0!**
Section 71(f) NPV (*NRB*)		**$8,535,499**	**$8,501,766**
Section 71(f) area of spillover prevented (ha)		**637,338**	**637,338**

Base Assumptions

Discount Rate		**8%**	
Initial Area Infested (ha)	(IAI)	**0.01**	**(ha)**
Weighted Average Gross Margin for Infested Land ($/ha)	(WAGM)	**$370**	**($/ha)**
Proportion of Production Loss from Infested Land (%)	(PPLIL)	**15%**	**(%)**
Total Area Potentially Infested	(TAPI)	**637,338**	**(ha)**
Years to Infest all of TAPI (years)	(YI)	**75**	**(Years)**
Annual Cost of Control for Landholder ($/ha affected)	(ACCL)	**$180**	**($/ha)**
Proportion of Landholders Controlling Pests (%)	(PLCP)	**80.0%**	**(%)**
Proportion of Infested Land to which Conservation Values Apply (%)	(PILCV)	**0%**	**(%)**
Any Benefits Provided by Weed (total $ / annum)	(BPBW)	**-**	**($)**

Containment Assumptions			
Biocontrol ($/annum)		**$ -**	**($)**
Year Strategy objectives Achieved	(YOA)	**10**	**(Years)**
Area Infested if Strategy Objectives Achieved (ha)	(AISOA)	**1**	**(ha)**
Proportion of Production Loss from Infested Land when Strategy Objectives Achieved(%)	(PPLSOA)	**15%**	**(%)**

Eradication Assumptions			
Year Strategy objectives Achieved	(YOA)	**100**	**(Years)**

Regional Council Costs		
Year	**Containment**	Eradication
1		$5,000
2		$5,000
3		$5,000
4		$5,000
5		$5,000
6		$5,000
7		$5,000
8		$5,000
9		$5,000
Year 10 onward		$0
NPV	**$0**	**$33,733**

Control Costs		
Year	Containment	Eradication
1		$5,000
2		$5,000
3		$5,000
4		$5,000
5		$5,000
6		$5,000
7		$5,000
8		$5,000
9		$5,000
Year 10 onward		$0
NPV	**$0**	**$33,733**

CONCLUSIONS

The desired outcome of the Regional Pest Management Plan is too exclude and achieve the eradication of this pest plant if an incursion is found.

No RPMP outcome
The outcome in the No RPMP Scenario is a loss of $98,851,124 per annum in 75 years as a result of production losses and additional costs of control. This is equivalent to an NPV of approximately $8535511. In addition there are zero hectares on which damages to regionally significant conservation values will occur.

Eradication outcome
The outcome of the eradication scenario is an NPV of $33,733 for administration, inspection, monitoring and enforcement, and an NPV of $33,733 for costs of control. This is a total cost in present day terms (NPV) of approximately $67,472 at a discount rate of 0.08 per cent. In addition there will be no damages to regionally significant conservation values from this pest once eradication has been achieved.

The net outcome for eradication net benefits when compared with the no RPMP scenario is $8,468,039 in NPV terms. Eradication is preferred since it produces the highest net benefit, and best satisfies the requirements of section 71(e).

If the requirements of section 71(e) are deemed by council to have been met, then the costs of the strategy can be charged to the regional community as beneficiaries and the benefits will exceed the costs. Those on whose property the pest currently exists are exacerbators, and can reasonably be charged the cost of control, satisfying section 71(f).

SUMMARY

Potential pest plants	**Proposed programme**	**Section 71(d)** *Is the pest a serious threat to the region?*	**Section 71(e)** *Do the benefits outweigh the costs?*	**Section 71(f)** *Who receives the benefit?*	**Estimated council cost per annum $**
Broom corn millet	Exclusion	Yes, part (i)	Yes, benefits exceed costs by $637,338 if model assumptions accepted as reasonable.	Agricultural community	$5,000

4.4 Chinese knotweed (*Persicaria chinensis*)

Plan change – New plant to strategy.

Proposed management regimes – Direct control eradication.

Description and biological capability
Form

- Chinese knotweed is a perennial herbaceous vine which quickly spreads and covers any available surfaces. When not climbing over other plants or structures, plants grow from 70cm to 1m tall.
- Stems are pinkish in colour and leaves are generally soft textured, serrated edged and 4-16cm long.
- Chinese knotweed flowers in autumn. Flowers are cream/pink and grow in clusters at the end of leafed stems.
- Plants grow from rhizomes (or tubers) and stem fragments. Rhizomes are irregular in shape and generally 6-15cm long and 4-12cm in diameter. The tubers are reddish brown in colour. Dried rhizomes are used in herbal medicines.

Habitat

- Agricultural lands, disturbed areas, forest, particularly in natural clearings, and in regrowth, abandoned gardens and at roadsides

Regional distribution

- Hamilton (1 site)

Biological success
Dispersal method

- Physical dispersal.

Reproductive ability

- Fragmentation. At present it is not known if the plant can fruit in New Zealand conditions.

Competitive ability

- Grows rapidly and it is thought this plant will be easily spread as plant cuttings or roots. It can be moved with garden rubbish and on contaminated gardening tools, including lawnmowers.
- It can tolerate a wide range of environmental conditions including shade, high temperatures, high salinity and drought.

Toxicity

- Non-toxic.

Resistance to control

- Unknown.

Benefits

- Nil.

ASSUMPTIONS

Initial area infested
Chinese knotweed is present in the Waikato.

Combined known infestation is ~0.1ha.

Weighted average gross margin
N/A.

Proportion of production loss from infested land
N/A.

Total area potentially infested (TAPI)
Chinese knotweed spreads via fragmentation.

Potentially infested Habitat	Area (ha)
Roads - to towns, 4m x length	4,595
Railway - to towns, 4m x length	142
Indigenous forest - 10m margin	19,371
Plantation (Planted forest) 10m margin	20,937
Shrubland/scrub (manuka, kanuka)	175,800
Riparian margins (10m x length)	43,559
Urban	22,400
Total	**286,804**

Years to infest all TAPI
Chinese knotweed spreads via fragmentation and spreads as plant cuttings or roots.

Years to infest potential range – 75 years ‘high’ rate of invasion

Annual cost of control for landholder
Assumed as $1000 ha/year, based on discussion with biosecurity staff.

Proportion of land over which pests voluntarily controlled
Zero per cent.

Proportion of land to which conservation values apply
Based on GIS analysis, conservation values are assumed to be 83 per cent.

Any benefits provided by the weed
Nil.

Biocontrol
Nil.

Year strategy objectives achieved (eradication)
Assumed as 10 years for the purpose of this analysis.

RESULTS

PLANT PEST		Chinese knotweed	
	No RPMP	Containment	Eradication
Cost and losses under option	$0	$0	$134,932
Section 71(e) NPV		$0	-$134,932
Section 71(e) regional values cost/ha		$0	-$1
Section 71(f) NPV (*NRB*)		$0	-$67,466
Section 71(f) area of spillover prevented (ha)		286,804	286,804

Base Assumptions

Discount Rate		**8%**	
Initial Area Infested (ha)	(IAI)	**0.01**	**(ha)**
Weighted Average Gross Margin for Infested Land ($/ha)	(WAGM)	**$1,000**	**($/ha)**
Proportion of Production Loss from Infested Land (%)	(PPLIL)		**(%)**
Total Area Potentially Infested	(TAPI)	**286,804**	**(ha)**
Years to Infest all of TAPI (years)	(YI)	**75**	**(Years)**
Annual Cost of Control for Landholder ($/ha affected)	(ACCL)	**$1,000**	**($/ha)**
Proportion of Landholders Controlling Pests (%)	(PLCP)	**0.0%**	**(%)**
Proportion of Infested Land to which Conservation Values Apply (%)	(PILCV)	**83%**	**(%)**
Any Benefits Provided by Weed (total $ / annum)	(BPBW)	**-**	**($)**

Containment Assumptions			
Biocontrol ($/annum)		**$ -**	**($)**
Year Strategy objectives Achieved	(YOA)	**10**	**(Years)**
Area Infested if Strategy Objectives Achieved (ha)	(AISOA)	**2**	**(ha)**
Proportion of Production Loss from Infested Land when Strategy Objectives Achieved(%)	(PPLSOA)	**0%**	**(%)**

Eradication Assumptions			
Year Strategy objectives Achieved	(YOA)	**10**	**(Years)**

Regional Council Costs		
Year	**Containment**	Eradication
1	$0	$10,000
2	$0	$10,000
3	$0	$10,000
4	$0	$10,000
5	$0	$10,000
6	$0	$10,000
7	$0	$10,000
8	$0	$10,000
9	$0	$10,000
Year 10 onward	$0	$0
NPV	**$0**	**$67,466**

Control Costs		
Year	Containment	Eradication
1	$0	$10,000
2	$0	$10,000
3	$0	$10,000
4	$0	$10,000
5	$0	$10,000
6	$0	$10,000
7	$0	$10,000
8	$0	$10,000
9	$0	$10,000
Year 10 onward	$0	$0
NPV	**$0**	**$67,466**

CONCLUSIONS

The desired outcome of the Regional Pest Management Plan is to prevent this plant from spreading from the existing site and eradicate plants found in the Waikato.

No RPMP outcome
The outcome in the no RPMP Scenario is a loss of $0 per annum in 75 years as a result of production losses and additional costs of control. This is equivalent to an NPV of approximately $0. In addition there are 238,730.4ha on which damages to regionally significant conservation values will occur.

Eradication outcome
The outcome of the eradication scenario is an NPV of $67,466 for administration, inspection, monitoring and enforcement, an NPV of $67,466 for costs of control, and loss of $0 per annum in 10 years as a result of production losses. This is a total cost in present day terms (NPV) of approximately 134,932 at a discount rate of 0.08 per cent. In addition there will be no damages to regionally significant conservation values from this pest once eradication has been achieved.

Section 72(a) conclusion
Eradication produces a net negative outcome in monetary terms from implementation when compared with the no RPMP scenario. This option protects significant values in 238,729ha. If the council considers that the conservation values protected from invasion in 75 years time exceed $0.57c per hectare then the requirements of Section 71(e) have been met.

If the requirements of section 71(e) are deemed by council to have been met, then the costs of the strategy can be charged to the regional community as beneficiaries and the benefits will exceed the costs. Those on whose property the pest currently exists are exacerbators, and can reasonably be charged the cost of control, satisfying section 71(f).

SUMMARY

Potential pest plants	**Proposed programme**	**Section 71(d)** *Is the pest a serious threat to the region?*	**Section 71(e)** *Do the benefits outweigh the costs?*	**Section 71(f)** *Who receives the benefit?*	**Estimated council cost per annum $**
Chinese knotweed	Eradication	Yes, part (i), (ii) and (iv)	Yes, if conservation values protected exceed $0.57 or if 0% of area is controlled in the absence of a strategy.	Wider regional community	$10,000

4.5 Freshwater eel grass (*Vallisneria spiralis* and *Vallisneria gigantea*)

Plan change – carry out direct control if plant is found in the region.

Proposed management regimes – Exclusion.

Description and biological capability
Form

- Attached, submerged, stoloniferous, dioecious perennial up to 5.5m tall with strap-like leaves arising from stout rhizomes. Can colonise lakebed sediments to a depth of 9m.

Habitat

- Lakes, streams and rivers. Colonises sandy to silty sediments and in some situations anchors to bare rock. Maximum growth at 25 degrees Celsius.

Regional distribution

- No known sites in the Waikato region.

Biological success
Dispersal method

- Spread by intentional planting. Fragmentation is not a major method of spread; whole plants are needed for dispersal.

Reproductive ability

- No seeds produced in New Zealand although both sexes do occur here.

Competitive ability

- Can completely dominate stream vegetation, however in some areas is out competed by other more competitive exotic species.

Other considerations
Toxicity

- Nil.

Resistance to control

- Mechanical removal, drying and approved herbicides have been used for control. Chemical and mechanical control are costly.

ASSUMPTIONS

Initial area infested
Freshwater eel grass is not known to be in the Waikato at present.

Freshwater eel grass currently has a relatively restricted distribution largely due to limited spread potential into new water bodies. Spread to new sites is mainly by intentional planting, but once established eel grass spreads by very rapid stolon extension, producing new plants at frequent intervals. Current infestations occur in the Auckland and Wanganui regions.

Zero hectares (model assumes a 0.01ha infestation).

Weighted average gross margin
Nil.

Proportion of production loss from infested land
Nil.

Total area potentially infested (TAPI)
Waikato Regional Council's GIS modelling shows that a potential 83,383ha of aquatic habitat within the region could be affected if no control work was undertaken.

There are only male plants in NZ with no viable seeds. These plants spread locally by rhizomes or intentional planting into new water bodies.

Potential	ha
Lakes (inland water) exclude rivers	74,671ha
Streams/rivers	8,712ha
Total	83,383ha

Years to infest all TAPI
Vallisneria currently has a relatively restricted distribution largely because it does not spread easily into new water bodies. Spread to new sites is mainly by intentional planting, but once established eel grass spreads rapidly by sending out runners, producing new plants at frequent intervals. Current infestations are in the Auckland and Wanganui regions.

Once established in the region, the years to infest potential range – 75 years 'high' rate of invasion.

Annual cost of control for landholder
Assumed as $1000/ha based on conversations with aquatic weed control contractors.

Proportion of land over which pests voluntarily controlled
Assumed for analysis purposes as being zero per cent.

Proportion of land to which conservation values apply (
Based on GIS analysis, conservation values are assumed to be 100 per cent.

Any benefits provided by the weed
Nil.

Biocontrol
Nil.

Year strategy objectives achieved (eradication)
Assumed as 10 years for the purpose of this analysis.

RESULTS

PLANT PEST		Freshwater eel grass	
	No RPMP	Containment	Eradication
Cost and losses under option	**$59,165**	**$0**	**$43,178**
Section 71(e) NPV		**$59,165**	**$15,987**
Section 71(e) regional values cost/ha		**$1**	**$0**
Section 71(f) NPV (*NRB*)		**$59,165**	**$37,576**
Section 71(f) area of spillover prevented (ha)		**83,383**	**83,383**

Base Assumptions

Discount Rate		**8%**	
Initial Area Infested (ha)	(IAI)	**0.01**	**(ha)**
Weighted Average Gross Margin for Infested Land ($/ha)	(WAGM)	**$0**	**($/ha)**
Proportion of Production Loss from Infested Land (%)	(PPLIL)	**15%**	**(%)**
Total Area Potentially Infested	(TAPI)	**83,383**	**(ha)**
Years to Infest all of TAPI (years)	(YI)	**75**	**(Years)**
Annual Cost of Control for Landholder ($/ha affected)	(ACCL)	**$1,600**	**($/ha)**
Proportion of Landholders Controlling Pests (%)	(PLCP)	**0.5%**	**(%)**
Proportion of Infested Land to which Conservation Values Apply (%)	(PILCV)	**100%**	**(%)**
Any Benefits Provided by Weed (total $ / annum)	(BPBW)	**-**	**($)**

Containment Assumptions			
Biocontrol ($/annum)		**$ -**	**($)**
Year Strategy objectives Achieved	(YOA)	**10**	**(Years)**
Area Infested if Strategy Objectives Achieved (ha)	(AISOA)	**0**	**(ha)**
Proportion of Production Loss from Infested Land when Strategy Objectives Achieved(%)	(PPLSOA)	**0.00%**	**(%)**

Eradication Assumptions			
Year Strategy objectives Achieved	(YOA)	**10**	**(Years)**

Regional Council Costs		
Year	**Containment**	Eradication
1		$3,200
2		$3,200
3		$3,200
4		$3,200
5		$3,200
6		$3,200
7		$3,200
8		$3,200
9		$3,200
Year 10 onward		$0
NPV	**$0**	**$21,589**

Control Costs		
Year	Containment	Eradication
1		$3,200
2		$3,200
3		$3,200
4		$3,200
5		$3,200
6		$3,200
7		$3,200
8		$3,200
9		$3,200
Year 10 onward		$0
NPV	**$0**	**$21,589**

CONCLUSIONS

The desired outcome of the Regional Pest Management Plan is to exclude and achieve the eradication of this pest plant if an incursion is found.

No RPMP outcome

The outcome in the no RPMP scenario is a loss of $667,064 per annum in 75 years as a result of production losses and additional costs of control. This is equivalent to an NPV of approximately $59,165. In addition there are 82,966.1ha on which damages to regionally significant conservation values will occur.

Eradication outcome

The outcome of the eradication scenario is an NPV of $21,589 for administration, inspection, monitoring and enforcement, and an NPV of $21589 for costs of control. This is a total cost in present day terms (NPV) of approximately $43,178 at a discount rate of 0.08 per cent. In addition there will be no damages to regionally significant conservation values from this pest once eradication has been achieved.

The net outcome for eradication net benefits when compared with the no RPMP scenario is $15,987 in NPV terms. This option protects significant regional biodiversity values on 82,966.09ha through the prevention of spread of this organism. Eradication is preferred since it produces the highest net benefit, and best satisfies the requirements of section 71(e).

If the requirements of section 71(e) are deemed by council to have been met, then the costs of the strategy can be charged to the regional community as beneficiaries and the benefits will exceed the costs. Those on whose property the pest currently exists are exacerbators, and can reasonably be charged the cost of control, satisfying section 71(f).

SUMMARY

Potential pest plants	**Proposed Programme**	**Section 71(d)** *Is the pest a serious threat to the region?*	**Section 71(e)** *Do the benefits outweigh the costs?*	**Section 71(f)** *Who receives the benefit?*	**Estimated council cost per annum $**
Freshwater eel grass	Exclusion	Yes, part (ii) and (iv)	Yes, if conservation values protected exceed $0.52/ha or if 0.5% of area is controlled in the absence of a strategy.	Wider regional community	$3,200

4.6 Fringed water lily (*Nymphoides peltata*)

Plan change – carry out direct control if plant is found in the region.

Proposed management regimes – Exclusion.

Description and biological capability
Form

- Perennial aquatic herb with floating leaves 5-10cm in diameter.

Habitat

- The only aquatic problem species in New Zealand that occurs in moderately cold temperate areas.

Regional distribution

- Believed to be eradicated from the Waikato, though ongoing surveillance is required to be sure of this.

Biological success
Dispersal method

- Seeds float on water bodies, plants sometimes used as pond plants.

Reproductive ability

- Produces large amounts of viable seeds that remain viable for several years.

Competitive ability

- Very competitive to most native species.

Other considerations
Toxicity

- Unknown.

Resistance to control

- Can be controlled, but long-lived seed bank requires ongoing attention.

ASSUMPTIONS

Initial area infested
Fringed water lily is not known to be in the Waikato at present. Although fringed water lily is of extremely limited distribution in New Zealand, it has the potential to spread and become a very serious problem.

Zero hectares (model assumes a 0.01ha infestation).

Weighted average gross margin
Nil.

Proportion of production loss from infested land
Nil.

Total area potentially infested (TAPI)
Waikato Regional Council's GIS modelling shows that a potential 22,010ha of aquatic habitat within the region could be affected if no control work was undertaken.

Although fringed water lily is of extremely limited distribution in New Zealand, it has the potential to spread and become a very serious problem. It forms dense vegetation blocks in waterways, impeding drainage and disrupting recreational activities. It reduces light penetration, out-competes native species and degrades water quality.

Potential	**ha**
Hydro50 lake	13,298
Streams/rivers	8,712
Total	**22,010**

Years to infest all TAPI
Fringed water lily spreads by seed as well as vegetatively. Localised spread occurs by the running stems which are able to extend up to several metres at a time.

This plant also has the ability to grow roots from detached leaves thus providing an effective mechanism for vegetative dispersal from an established site. The seed hairs help it float and aid attachment to wildlife such as water fowl. Therefore seed is readily dispersed by water currents and birds such as ducks and swans, forming new infestations of the plant which can out-compete other water lilies and native species.

Years to infest potential range – 75 years 'high' rate of invasion.

Annual cost of control for landholder
Assumed as $1000/ha based on conversations with aquatic weed control contractors.

Proportion of land over which pests voluntarily controlled
Assumed for analysis purposes as being zero per cent.

Proportion of land to which conservation values apply
Based on GIS analysis, conservation values assumed to be 100 per cent..
Any benefits provided by the weed
Nil.

Biocontrol
Nil.

Year strategy objectives achieved (eradication)
Assumed as 10 years for the purpose of this analysis.

RESULTS

PLANT PEST		Fringed water lily	
	No RPMP	**Containment**	**Eradication**
Cost and losses under option	**$10,996**	**$0**	**$33,734**
Section 71(e) NPV		**$10,996**	**-$22,738**
Section 71(e) regional values cost/ha		**$1**	**-$1**
Section 71(f) NPV (*NRB*)		**$10,996**	**-$5,871**
Section 71(f) area of spillover prevented (ha)		**22,010**	**22,010**

Base Assumptions

Discount Rate		**8%**	
Initial Area Infested (ha)	(IAI)	**0.01**	**(ha)**
Weighted Average Gross Margin for Infested Land ($/ha)	(WAGM)	**$0**	**($/ha)**
Proportion of Production Loss from Infested Land (%)	(PPLIL)	**35%**	**(%)**
Total Area Potentially Infested	(TAPI)	**22,010**	**(ha)**
Years to Infest all of TAPI (years)	(YI)	**75**	**(Years)**
Annual Cost of Control for Landholder ($/ha affected)	(ACCL)	**$1,000**	**($/ha)**
Proportion of Landholders Controlling Pests (%)	(PLCP)	**0.5%**	**(%)**
Proportion of Infested Land to which Conservation Values Apply (%)	(PILCV)	**100%**	**(%)**
Any Benefits Provided by Weed (total $ / annum)	(BPBW)	**-**	**($)**

Containment Assumptions			
Biocontrol ($/annum)		**$ -**	**($)**
Year Strategy objectives Achieved	(YOA)	**10**	**(Years)**
Area Infested if Strategy Objectives Achieved (ha)	(AISOA)	**0.01**	**(ha)**
Proportion of Production Loss from Infested Land when Strategy Objectives Achieved(%)	(PPLSOA)	**0%**	**(%)**

Eradication Assumptions			
Year Strategy objectives Achieved	(YOA)	**10**	**(Years)**

Regional Council Costs		
Year	**Containment**	Eradication
1		$2,500
2		$2,500
3		$2,500
4		$2,500
5		$2,500
6		$2,500
7		$2,500
8		$2,500
9		$2,500
Year 10 onward		$0
NPV	**$0**	**$16,867**

Control Costs		
Year	Containment	Eradication
1		$2,500
2		$2,500
3		$2,500
4		$2,500
5		$2,500
6		$2,500
7		$2,500
8		$2,500
9		$2,500
Year 10 onward		$0
NPV	**$0**	**$16,867**

CONCLUSIONS

The desired outcome of the Regional Pest Management Plan is to exclude and achieve the eradication of this pest plant if an incursion is found.

No RPMP outcome
The outcome in the no RPMP scenario is a loss of $110,048 per annum in 75 years as a result of production losses and additional costs of control. This is equivalent to an NPV of approximately $10,996. In addition there are 21,899.5ha on which damages to regionally significant conservation values will occur.

Eradication outcome
The outcome of the eradication scenario is an NPV of $16,867 for administration, inspection, monitoring and enforcement, and an NPV of $16,867 for costs of control. This is a total cost in present day terms (NPV) of approximately $33,734 at a discount rate of 0.08 per cent. In addition there will be no damages to regionally significant conservation values from this pest once eradication has been achieved.

The net outcome for eradication net benefits when compared with the no RPMP scenario is $-22,738 in NPV terms. This option protects significant regional biodiversity values on 21,899.49ha through the prevention of spread of this organism. Eradication is preferred since it produces the highest net benefit, and best satisfies the requirements of section 71(e).

If the requirements of section 71(e) are deemed by council to have been met, then the costs of the strategy can be charged to the regional community as beneficiaries and the benefits will exceed the costs. Those on whose property the pest currently exists are exacerbators, and can reasonably be charged the cost of control, satisfying section 71(f).

SUMMARY

Potential pest plants	**Proposed programme**	**Section 71(d)** *Is the pest a serious threat to the region?*	**Section 71(e)** *Do the benefits outweigh the costs?*	**Section 71(f)** *Who receives the benefit?*	**Estimated council cost per annum $**
Fringed water lily	Exclusion	Yes, part (ii) and (iv)	Yes, if conservation values protected exceed $1.54/ha or if 0.5% of area is controlled in the absence of a strategy.	Wider regional community	$2,500

4.7 Japanese walnut (*Juglans ailantifolia*)

New RPMP plant

Proposed management regimes – Direct control – Site-led.

Description and biological capability

Form

- Japanese walnut is a tree that can grow to about 15m in height. It produces fruit (2.5 to 4cm long) that are walnut-like in appearance, with a green husk surrounding the nut. The leaves are large with up to 17 stalkless leaflets. Japanese walnut produces long, hanging male catkins and upright purple-pink female catkins.

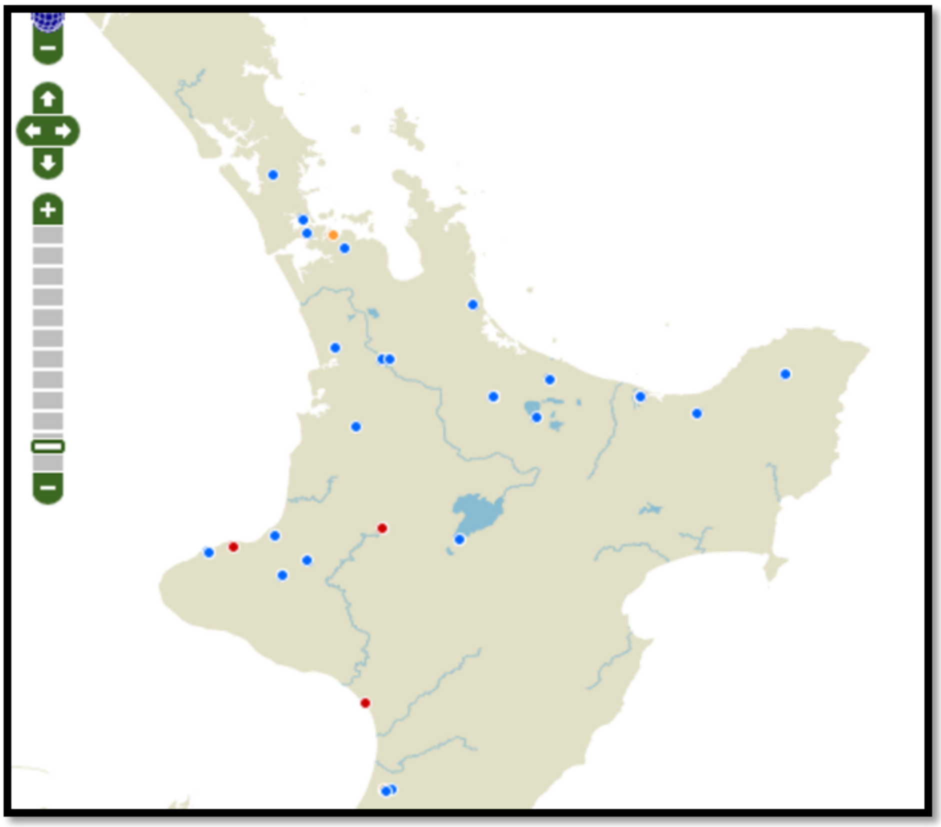
Habitat

- Forest, shrubland, riparian areas.

Regional distribution

- Scattered over the Waikato region.

Map 1. *Juglans ailantifolia* North Island distribution


[32]

Biological success

Dispersal method

- Gravity, flowing water dispersed seeds, possibly pigs and possums.

Reproductive ability

- Produces viable seed

[32] http://www.virtualherbarium.org.nz (12/08/2013)

Competitive ability

- Japanese walnut is a long-lived canopy tree that forms dense stands that prevent recruitment of other plant species. Many seedlings can occur close to the parent tree, out competing other vegetation. Japanese walnut invades disturbed forests, shrubland and edges of water courses.
- Long-lived (50 years +), canopy tree, prevents recruitment. Produces many, long-lived seeds.
- Very tolerant to hot and cold, wet to dry, semi shade conditions.

Toxicity

- Nil.

Resistance to control

- Unknown.

Benefits

- Can have amenity values as an ornamental garden plant.

ASSUMPTIONS

Initial area infested

Japanese walnut is present in the Waikato. It is currently spreading throughout the Waikato region.

Combined known infestation is ~200ha.

Weighted average gross margin

N/A.

Proportion of production loss from infested land

N/A.

Total area potentially infested (TAPI)

Japanese walnut spreads via gravity, water dispersed seeds, possibly pigs and possums.

Potentially infested	**ha**
Roads - to towns, 4m x length	4,595ha
Railway - to towns, 4m x length	142ha
Indigenous forest - 10m margin	19,371ha
Plantation (planted forest) 10m margin	20,937ha
Shrubland/scrub (manuka, kanuka)	175,800ha
Riparian margins (10m x length)	43,559ha
Total	**264,404 ha**

Years to infest all TAPI

Years to infest potential range – 75 years: a reasonably ‘high’ rate of invasion.

Annual cost of control for landholder

Assumed as $1000 ha/year, based on discussion with biosecurity staff.

Proportion of land over which pests voluntarily controlled
One per cent.

Proportion of land to which conservation values apply
Based on GIS analysis, conservation values are estimated to be 90 per cent.

Any benefits provided by the weed
Amenity values

Biocontrol
Nil.

Year strategy objectives achieved (eradication)
Assumed as 10 years for the purpose of this analysis.

RESULTS

PLANT PEST		Japanese walnut	
	No RPMP	Containment	Eradication
Cost and losses under option	$884,098	$129,998	$2,698,656
Section 71(e) NPV		$754,100	-$1,814,558
Section 71(e) regional values cost/ha		$3	-$8
Section 71(f) NPV (NRB)		$794,099	-$490,230
Section 71(f) area of spillover prevented (ha)		264,204	264,204

Base Assumptions			
Discount Rate		8%	
Initial Area Infested (ha)	(IAI)	200	(ha)
Weighted Average Gross Margin for Infested Land ($/ha)	(WAGM)	$0	($/ha)
Proportion of Production Loss from Infested Land (%)	(PPLIL)	0%	(%)
Total Area Potentially Infested	(TAPI)	264,404	(ha)
Years to Infest all of TAPI (years)	(YI)	75	(Years)
Annual Cost of Control for Landholder ($/ha affected)	(ACCL)	$1,000	($/ha)
Proportion of Landholders Controlling Pests (%)	(PLCP)	1.0%	(%)
Proportion of Infested Land to which Conservation Values Apply (%)	(PILCV)	90%	(%)
Any Benefits Provided by Weed (total $ / annum)	(BPBW)	-	($)

Containment Assumptions			
Biocontrol ($/annum)		$ -	($)
Year Strategy objectives Achieved	(YOA)	10	(Years)
Area Infested if Strategy Objectives Achieved (ha)	(AISOA)	100	(ha)
Proportion of Production Loss from Infested Land when Strategy Objectives Achieved(%)	(PPLSOA)	0%	(%)

Eradication Assumptions			
Year Strategy objectives Achieved	(YOA)	10	(Years)

Regional Council Costs		
Year	**Containment**	Eradication
1	$5,000	$200,000
2	$5,000	$200,000
3	$5,000	$200,000
4	$5,000	$200,000
5	$5,000	$200,000
6	$5,000	$200,000
7	$5,000	$200,000
8	$5,000	$200,000
9	$5,000	$200,000
Year 10 onward	$5,000	$0
NPV	**$64,999**	**$1,349,328**

Control Costs		
Year	Containment	Eradication
1	$5,000	$200,000
2	$5,000	$200,000
3	$5,000	$200,000
4	$5,000	$200,000
5	$5,000	$200,000
6	$5,000	$200,000
7	$5,000	$200,000
8	$5,000	$200,000
9	$5,000	$200,000
Year 10 onward	$5,000	$0
NPV	**$64,999**	**$1,349,328**

CONCLUSIONS

The desired outcome of the Regional Pest Management Plan (RPMP) is to prevent this plant from spreading from existing sites and eradicate plants that are in, or close to, significant natural areas.

No RPMP outcome
The outcome in the no RPMP Scenario is a loss of $2,644,039 per annum in 75 years, as a result of production losses and additional costs of control. This is equivalent to a NPV of approximately $884,098. In addition, there is 235,584ha on which damages to regionally significant (conservation/recreation/amenity/Māori/soil and water) values will occur.

Containment outcome
The outcome of the containment scenario is a NPV of $64,999 for administration, inspection, monitoring and enforcement, a NPV of $64,999 for costs of control, and loss of $0 per annum in 10 years as a result of production losses. This is a total cost in present day terms (NPV) of approximately $129,998 at a discount rate of 0.08%. In addition there will be a total of 90ha on which damages to regionally significant values will occur.

Eradication outcome
The outcome of the eradication scenario is a NPV of $1,349,328 for administration, inspection, monitoring and enforcement, a NPV of $1,349,328 for costs of control, and loss of $0 per annum in 10 years as a result of production losses. This is a total cost in present day terms (NPV) of approximately $2,698,656 at a discount rate of 0.08%. In addition there will be no damages to regionally significant values from this pest once eradication has been achieved.

The net outcome for containment when compared with the no RPMP approach produces a net positive benefit of $754,100 in NPV terms because the costs of undertaking the strategy are less than the likely losses in production and control costs if the organisms were allowed to spread. For eradication the net benefits when compared with the no RPMP scenario is $-1,814,558 in NPV terms. Both options protect significant regional biodiversity values on

235,494ha through the prevention of spread of this organism. Containment is preferred since it produces the highest net benefit, and best satisfies the requirements of section 71(e).

If the requirements of section 71(e) are deemed by council to have been met, then the costs of the strategy can be charged to the regional community as beneficiaries and the benefits will exceed the costs. Those on whose property the pest currently exists are exacerbators, and could be charged the cost of control.

Recommendations

The recommendation is that this plant is added to the **site-led programme**. This means the plant is widespread throughout the region and will only be controlled in and around high-value natural areas.

SUMMARY

Potential pest plants	**Proposed programme**	**Section 71(d)** *Is the pest a serious threat to the region?*	**Section 71(e)** *Do the benefits outweigh the costs?*	**Section 71(f)** *Who receives the benefit?*	**Estimated council cost per annum $**
Japanes walnut	Site-led	Yes, part (ii) and (iv)	Yes, if conservation values protected exceed $10.90 or if 1% of area is controlled in the absence of a strategy.	Wider regional community	$5,000

4.8 Lantana (*Lantana camara*)

Plan hange – New plant to strategy.

Proposed management regimes – Landowner responsibility Progressive containment.

Description and biological capability
Form

- Aromatic prickly herbaceous shrub growing to 3m tall.

Habitat

- Coastal scrubland, islands, cliffs, foreshores, consolidated dunes, forest margins, grassland, wasteland, exotic plantations, gardens.

Regional distribution

- Concentrations in urban areas (grown as an ornamental), found naturalised at Waikaretu and Coromandel Peninsula.

Biological success
Dispersal Method

- Spread by birds and vegetative.

Reproductive ability

- Prolific seeder.

Competitive Ability

- Very competitive in disturbed, high light conditions, can tolerate wet and dry. May invade poor pasture

Other considerations
Toxicity

- Thorny, may be poisonous.

Resistance to Control

- Major weed of overseas crops.
- Can be controlled with brush killers, but these would affect surrounding vegetation.
- Biocontrol options have been investigated Two rust fungi *Puccinia lantanae* and *Prospodium tuberculatum*, were approved for *Lantana camara* in April 2012.

ASSUMPTIONS

Initial area infested
There is current very little *Lantana camara* in the region. There are isolated plants in urban areas (grown as an ornamental), found naturalised at Waikaretu and Coromandel Peninsula.

Assumed as 1ha from staff knowledge of regional infestations.

Weighted average gross margin
$325/ha

Lantana weighted average gross margin			
Land use	**Area**	**Gross margin**	
Beef	196757.97	$315	61978761
Deer	19561.12	$340	6650781
Dry	47547.89	$315	14977585
Sheep	25665.44	$315	8084613.6
Mixed sheep and beef	544702.3	$315	171581225
Plantation forestry margin	20936.71	$700	14655697
Total	855171.43		2.78E+08
Weighted average gross margin			**$325**

Proportion of production loss from infested land
Assumed as 35 per cent based on Effect On System (EOS) score.

Total area potentially infested (TAPI)
Waikato Regional Council'ls GIS modelling shows that a potential 1,057,101ha of terrestrial habitat within the region could be affected if no control work was undertaken. Spread by birds and vegetative.

Both staff and contractors undertake regular surveillance. The current reality is that this pest plant is confined to a very small number of known regional historical sites, around Hamilton, Waikaretu and Coromandel Peninsula, and so the area of infestation is unlikely to grow as modelling predicts.

Potential	**ha**
Roads - to towns, 4m x length	4594.8859ha
Railway - to towns, 4m x length	141.91776ha
Indigenous forest - 10m margin (LCDB2)	19371.33ha
Plantation (planted forest) 10m margin	20936.71ha
Shrubland/scrub (manuka, kanuka)	175799.79ha
Coastal dunes	2022ha
Beef	196,758ha
Deer	19,561ha
Dry	47,548ha
Sheep	25,665ha
Mixed sheep and beef	544,702ha
Total	**1,057,101ha**

Years to infest all TAPI
L. camara is a serious problem in northern regions, where it forms dense thickets that invade a wide variety of areas from native and exotic forests to domestic gardens, roadsides, sand dunes, quarries and wasteland. *L. camara* has the potential to do the same in the Waikato and is already formed a self sustaining population on the Coromandel Peninsula.

Typically a low, scrambling shrub with small, colourful flowers, lantana can be poisonous to people and grazing stock. It has strong-smelling leaves, especially if crushed, and also produces fruit that's attractive to birds, which then spread its seeds to uninfected sites.

Years to infest potential range – 75 years 'high' rate of invasion.

Annual cost of control for landholder
Assumed as $1000/ha based on similarities to broom control.Although an Australian report showed it as $78ha, this is too low based on what we know of brush type weed control costs. (http://www.scribd.com/doc/99098961/Lantana-Weed)

Proportion of land over which pests voluntarily controlled
Assumed for analysis purposes as being five per cent.

Proportion of land to which conservation values apply
Based on GIS analysis conservation values are assumed to be 19 per cent.

Any benefits provided by the weed
Nil.

Biocontrol
Nil – a biocontrol agent for lantana has been accepted by EPA although not yet available for release.

Year strategy objectives achieved (eradication)
Assumed as 10 years for the purpose of this analysis.

RESULTS

PLANT PEST		***Lantana camara***	
	No RPMP	**Containment**	**Eradication**
Cost and losses under option	**$103,046,218**	**$0**	**$67,466**
Section 71(e) NPV		**$103,046,218**	**$102,978,752**
Section 71(e) regional values cost/ha		**$2,565**	**$2,564**
Section 71(f) NPV (*NRB*)		**$103,025,656**	**$102,991,923**
Section 71(f) area of spillover prevented (ha)		**1,057,099**	**1,057,099**

Base Assumptions

Discount Rate		**8%**	
Initial Area Infested (ha)	(IAI)	**2**	**(ha)**
Weighted Average Gross Margin for Infested Land ($/ha)	(WAGM)	**$325**	**($/ha)**
Proportion of Production Loss from Infested Land (%)	(PPLIL)	**35%**	**(%)**
Total Area Potentially Infested	(TAPI)	**1,057,101**	**(ha)**
Years to Infest all of TAPI (years)	(YI)	**75**	**(Years)**
Annual Cost of Control for Landholder ($/ha affected)	(ACCL)	**$1,000**	**($/ha)**
Proportion of Landholders Controlling Pests (%)	(PLCP)	**80.0%**	**(%)**
Proportion of Infested Land to which Conservation Values Apply (%)	(PILCV)	**19%**	**(%)**
Any Benefits Provided by Weed (total $ / annum)	(BPBW)	**-**	**($)**

Containment Assumptions			
Biocontrol ($/annum)		**$ -**	**($)**
Year Strategy objectives Achieved	(YOA)	**10**	**(Years)**
Area Infested if Strategy Objectives Achieved (ha)	(AISOA)	**2**	**(ha)**
Proportion of Production Loss from Infested Land when Strategy Objectives Achieved(%)	(PPLSOA)	**0%**	**(%)**

Eradication Assumptions			
Year Strategy objectives Achieved	(YOA)	**10**	**(Years)**

Regional Council Costs		
Year	**Containment**	Eradication
1		$5,000
2		$5,000
3		$5,000
4		$5,000
5		$5,000
6		$5,000
7		$5,000
8		$5,000
9		$5,000
Year 10 onward		$0
NPV	**$0**	**$33,733**

Control Costs		
Year	Containment	Eradication
1		$5,000
2		$5,000
3		$5,000
4		$5,000
5		$5,000
6		$5,000
7		$5,000
8		$5,000
9		$5,000
Year 10 onward		$0
NPV	**$0**	**$33,733**

CONCLUSIONS

The desired outcome of the Regional Pest Management Plan is to achieve eradication of this pest plant.

No RPMP outcome
The outcome in the no RPMP scenario is a loss of $869,729,961 per annum in 75 years as a result of production losses and additional costs of control. This is equivalent to an NPV of approximately $103,046,218. In addition there are 40,169.9ha on which damages to regionally significant conservation values will occur.

Eradication outcome
The outcome of the eradication scenario is an NPV of $33,733 for administration, inspection, monitoring and enforcement, and an NPV of $33,733 for costs of control. This is a total cost in present day terms (NPV) of approximately $67,466 at a discount rate of 0.08 per cent. In addition there will be no damages to regionally significant conservation values from this pest once eradication has been achieved.

The net outcome for eradication net benefits when compared with the no RPMP scenario is $102,978,752 in NPV terms. This option protects significant regional biodiversity values on 40,169.52ha through the prevention of spread of this organism. Eradication is preferred since it produces the highest net benefit, and best satisfies the requirements of section 71(e).

If the requirements of section 71(e) are deemed by council to have been met, then the costs of the strategy can be charged to the regional community as beneficiaries and the benefits will exceed the costs. Those on whose property the pest currently exists are exacerbators, and can reasonably be charged the cost of control, satisfying section 71(f)..

SUMMARY

Potential pest plants	**Proposed programme**	**Section 71(d)** *Is the pest a serious threat to the region?*	**Section 71(e)** *Do the benefits outweigh the costs?*	**Section 71(f)** *Who receives the benefit?*	**Estimated council cost per annum $**
Lantana camara	Eradication	Yes, part (i), (ii) and (iv)	Yes, if conservation values protected exceed $1.70/ha or if 80% of area is controlled in the absence of a strategy.	Wider regional community	$5,000

4.9 Mexican devil (*Ageratina adenophora*)

Plan change – increasing the level of management outside of Coromandel.

Proposed management regimes – Progressive containment programme – direct control.

Description and biological capability

Form

- Herbaceous plant or small shrub growing up to 2m tall.

Habitat

- Lightly shaded frost-free areas: forest edges, shrublands, wetlands, streamsides, open forest, inshore and offshore islands, gumlands, slips, alluvial flats, Coastal dunes and estuaries.

Regional distribution

- Thames-Coromandel district (well established), parts of Hauraki and Waikato district.

Biological success

Dispersal method

- Seeds dispersed by wind, water and roadside mowers.

Reproductive ability

- Seed (100,000 per plant).

Competitive ability

- Forms dense colonies, preventing the seedlings of native species from establishing in a wide range of habitats. Invades strips of land on the margins of waterbodies, replacing vulnerable species, and can impede water flow in swamps, causing flooding.

Other considerations

Toxicity

- Fatally toxic to horses, especially stallions.

Resistance to control

- Dig or pull out small infestations. Herbicide application.

ASSUMPTIONS

Initial area infested

Mexican devil is present in the Waikato at present. Thames-Coromandel district (well established), parts of Hauraki and Waikato district.

This plan only looks at control measures outside of the Coromandel.

Infestation size outside of the Coromandel Peninsula is ~5ha.

Weighted average gross margin

$700/ha.

Mexican Devil Weighted Average Gross			
	Area	**Gross Margin**	
Plantation (planted forest) 10m margin	20936.71	$700	14655697
Total	**20936.71**		**14655697**
Weighted average gross margin			**$700**

Proportion of production loss from infested land
15 per cent.

The projected density is moderate to high.

Total area potentially infested (TAPI)
Waikato Regional Council's GIS modelling shows that a potential 274,602ha of terrestrial habitat within the region could be affected if no control work was undertaken.

Mexican devil has the capacity to infest a large range of plant communities with moderate to high light intensity ranging from dry shrublands to wet stream sides. Open-dense thickets form from spent flowering stems falling flat and overlying one another. It is capable of flattening and pinning down seedlings, and the regeneration of new seedlings is often difficult under such thickets. This plant may impair successional processes of developing forests.

Infestation sites and dispersal routes are often roadsides, track margins, wasteland, grazed or disturbed forest. Seed is spread by wind, water and probably road mowers.

Potential	**ha**
Roads - to towns, 4m x length	4,595ha
Railway - to towns, 4m x length	142ha
Indigenous forest - 10m margin (LCDB2)	19,371ha
Plantation (planted forest) 10m margin	20,937ha
Shrubland/scrub (manuka, kanuka)	175,800ha
Riparian margins (10m x length)	43,559ha
Wetlands (inland wetland, coastal wetlands)	8,176ha
Coastal dunes	2,022ha
Total	**274,602ha**

Years to infest all TAPI
Mexican devil is an erect shrub with reddish stems, triangular leaves with sticky hairs and white flowers. Seeds are wind-dispersed and produced in large numbers (100,000 per plant). It also disperses through root fragments. Mexican devil occurs in a variety of habitats including shrubland, disturbed sites, stream sides and poorly managed pasture.

Mexican devil has the capacity to infest a large range of plant communities, where it forms dense thickets that displace and suppress desirable species. It has a bad reputation in Australia, where in the past it became suddenly invasive on a vast scale during successive drought years, driving farmers off their land. It is also fatally toxic to horses, especially stallions, so its spread to stud stock areas in central Waikato must be prevented.

Mexican devil cannot be contained in the Thames-Coromandel district because it is too widespread. Therefore, it is categorised as a progressive containment pest throughout the region except for the Thames-Coromandel district.

Mexican devil also occurs on coastal dunes, including those in Thames-Coromandel district. In this instance, Mexican devil is categorised and treated as a site-led pest with environmental threats, on coastal dunes anywhere in the region.

Years to infest potential range – 75 years 'high' rate of invasion.

Annual cost of control for landholder
Assumed as $134/ha based figures from 2001 CBA plus inflation.

Proportion of land over which pests voluntarily controlled
Assumed for analysis purposes as being 5 per cent.

Proportion of land to which conservation values apply
Based on GIS analyse assumed conservation values to be 91 per cent.

Any benefits provided by the weed
Nil.

Any benefits provided by the weed
Nil.

Biocontrol
Nil.

Year strategy objectives achieved (eradication)
Assume 10 years for the purposes of this analysis.

RESULTS

PLANT PEST		Mexican Devil	
	No RPMP	Containment	Eradication
Cost and losses under option	$4,109,671	$0	$13,494
Section 71(e) NPV		$4,109,671	$4,096,177
Section 71(e) regional values cost/ha		$17	$17
Section 71(f) NPV (*NRB*)		$4,103,009	$4,096,262
Section 71(f) area of spillover prevented (ha)		274,597	274,597

Base Assumptions

Discount Rate		8%	
Initial Area Infested (ha)	(IAI)	5	(ha)
Weighted Average Gross Margin for Infested Land ($/ha)	(WAGM)	$700	($/ha)
Proportion of Production Loss from Infested Land (%)	(PPLIL)	15%	(%)
Total Area Potentially Infested	(TAPI)	274,602	(ha)
Years to Infest all of TAPI (years)	(YI)	75	(Years)
Annual Cost of Control for Landholder ($/ha affected)	(ACCL)	$134	($/ha)
Proportion of Landholders Controlling Pests (%)	(PLCP)	5.0%	(%)
Proportion of Infested Land to which Conservation Values Apply (%)	(PILCV)	91%	(%)
Any Benefits Provided by Weed (total $ / annum)	(BPBW)	-	($)

Containment Assumptions			
Biocontrol ($/annum)		$ -	($)
Year Strategy objectives Achieved	(YOA)	10	(Years)
Area Infested if Strategy Objectives Achieved (ha)	(AISOA)	5	(ha)
Proportion of Production Loss from Infested Land when Strategy Objectives Achieved(%)	(PPLSOA)	0%	(%)

Eradication Assumptions			
Year Strategy objectives Achieved	(YOA)	10	(Years)

Regional Council Costs		
Year	Containment	Eradication
1		$1,000
2		$1,000
3		$1,000
4		$1,000
5		$1,000
6		$1,000
7		$1,000
8		$1,000
9		$1,000
Year 10 onward		$0
NPV	$0	$6,747

Control Costs		
Year	Containment	Eradication
1		$1,000
2		$1,000
3		$1,000
4		$1,000
5		$1,000
6		$1,000
7		$1,000
8		$1,000
9		$1,000
Year 10 onward		$0
NPV	$0	$6,747

CONCLUSIONS

The desired outcome of the Regional Pest Management Plan is to contain Mexican devil to the Coromandel and achieve eradication for the rest of the region.

No RPMP outcome

The outcome in the no RPMP scenario is a loss of $29,231,383 per annum in 75 years as a result of production losses and additional costs of control. This is equivalent to an NPV of approximately $4,109,671. In addition there are 237,393.4ha on which damages to regionally significant conservation values will occur.

Eradication outcome

The outcome of the eradication scenario is an NPV of $6,747 for administration, inspection, monitoring and enforcement, and an NPV of $6,747 for costs of control. This is a total cost in present day terms (NPV) of approximately $13,494 at a discount rate of 0.08 per cent. In addition there will be no damages to regionally significant conservation values from this pest once eradication has been achieved.

The net outcome for Eradication the net benefits when compared with the no RPMP scenario is $4,096,177 in NPV terms. This option protects significant regional biodiversity values on 237,388.85ha through the prevention of spread of this organism. Eradication is preferred since it produces the highest net benefit, and best satisfies the requirements of section 71(e)..

If the requirements of section 71(e) are deemed by council to have been met, then the costs of the strategy can be charged to the regional community as beneficiaries and the benefits will exceed the costs. Those on whose property the pest currently exists are exacerbators, and can reasonably be charged the cost of control, satisfying section 71(f).

SUMMARY

Potential pest plants	**Proposed programme**	**Section 71(d)** *Is the pest a serious threat to the region?*	**Section 71(e)** *Do the benefits outweigh the costs?*	**Section 71(f)** *Who receives the benefit?*	**Estimated council cost per annum $**
Mexican devil	Eradication (outside TCDC)	Yes, part (ii) and (iv)	Yes, if conservation values protected exceed $0.06/ha or if 5% of area is controlled in the absence of a strategy.	Wider regional community	$1,000

4.10 Mexican water lily (*Nymphaea mexicana*)

Plan change – carry out direct control in the region.

Proposed management regimes – Eradication.

Description and biological capability
Form

- An aquatic perennial herbaceous plant with a stout erect rhizome and floating leaves.
- Leaves are entire or shallowly toothed, hairless, cordate at the base, round, green above but reddish beneath and with brown blotches, and up to 25 cm across.
- Flower is solitary and the numerous petals are up to 6 cm long and yellow.
- Fruit is a spongy berry and the seeds are 2-3 mm long.

Habitat

- Surfaces of lakes

Regional distribution

- One site in the region, Lake Ohakuri.

Biological success
Dispersal method

- Rhizomes, tubers and by seed. Deliberate plantings.

Reproductive ability

- Seed, vegetative/

Competitive ability

- Has the ability to displace native species through restricting light penetration to sub-surface species and by out-competing surface native aquatic species.

Other considerations
Toxicity

- Nil.

Resistance to Control

- Mechanical removal and approved herbicides.

ASSUMPTIONS

Initial area infested
Mexican water lily is present in the Waikato. It currently has a relatively restricted distribution to one known infestation at Lake Ohakuri.

Known infestation is ~15ha.

Weighted average gross margin
Nil.

Proportion of production loss from infested land
Nil.

Total area potentially infested (TAPI)
Waikato Regional Council's GIS modelling shows that a potential 74,671ha of aquatic habitat within the region could be affected if no control work was undertaken.

These plants spread locally by rhizomes and seed or intentional planting into new water bodies.

Potential	**ha**
Lakes (inland water) exclude rivers	74,671ha
Total	**74,671ha**

Years to infest all TAPI
Mexican water lily currently has a relatively restricted distribution to Lake Ohakuri. It is not known why this plant is restricted to Lake Ohakuri as it produces viable seed and can spread via rhizome fragments

Once established in the region, the years to infest potential range – 75 years 'high' rate of invasion.

Annual cost of control for landholder
Assumed as $1000/ha based on conversations with aquatic weed control contractors.

Proportion of land over which pests voluntarily controlled
Assumed for analysis purposes as being 5 per cent. This is by duck hunters around their maimais.

Proportion of land to which conservation values apply
Based on GIS analysis, conservation values are assumed to be 100 per cent.

Any benefits provided by the weed
Nil.

Biocontrol
Nil.

Year strategy objectives achieved (eradication)
Assumed as 10 years for the purpose of this analysis.

RESULTS

PLANT PEST		**Mexican water lily**	
	No RPMP	**Containment**	**Eradication**
Cost and losses under option	**$904,139**	**$0**	**$202,400**
Section 71(e) NPV		**$904,139**	**$701,739**
Section 71(e) regional values cost/ha		**$13**	**$10**
Section 71(f) NPV (*NRB*)		**$894,764**	**$793,564**
Section 71(f) area of spillover prevented (ha)		**74,656**	**74,656**

Base Assumptions

Discount Rate		**8%**	
Initial Area Infested (ha)	(IAI)	**15.00**	**(ha)**
Weighted Average Gross Margin for Infested Land ($/ha)	(WAGM)	**$0**	**($/ha)**
Proportion of Production Loss from Infested Land (%)	(PPLIL)	**35%**	**(%)**
Total Area Potentially Infested	(TAPI)	**74,671**	**(ha)**
Years to Infest all of TAPI (years)	(YI)	**75**	**(Years)**
Annual Cost of Control for Landholder ($/ha affected)	(ACCL)	**$1,000**	**($/ha)**
Proportion of Landholders Controlling Pests (%)	(PLCP)	**5.0%**	**(%)**
Proportion of Infested Land to which Conservation Values Apply (%)	(PILCV)	**100%**	**(%)**
Any Benefits Provided by Weed (total $ / annum)	(BPBW)	**-**	**($)**

Containment Assumptions			
Biocontrol ($/annum)		**$ -**	**($)**
Year Strategy objectives Achieved	(YOA)	**10**	**(Years)**
Area Infested if Strategy Objectives Achieved (ha)	(AISOA)	**15**	**(ha)**
Proportion of Production Loss from Infested Land when Strategy Objectives Achieved(%)	(PPLSOA)	**0%**	**(%)**

Eradication Assumptions			
Year Strategy objectives Achieved	(YOA)	**10**	**(Years)**

Regional Council Costs		
Year	**Containment**	Eradication
1		$15,000
2		$15,000
3		$15,000
4		$15,000
5		$15,000
6		$15,000
7		$15,000
8		$15,000
9		$15,000
Year 10 onward		$0
NPV	**$0**	**$101,200**

Control Costs		
Year	Containment	Eradication
1		$15,000
2		$15,000
3		$15,000
4		$15,000
5		$15,000
6		$15,000
7		$15,000
8		$15,000
9		$15,000
Year 10 onward		$0
NPV	**$0**	**$101,200**

CONCLUSIONS

The desired outcome of the Regional Pest Management Plan is to eradicate this pest plant in the Waikato region.

No RPMP outcome

The outcome in the no RPMP scenario is a loss of $3,733,553 per annum in 75 years as a result of production losses and additional costs of control. This is equivalent to an NPV of approximately $904,139. In addition there are 70,937.5ha on which damages to regionally significant conservation values will occur.

Eradication outcome
The outcome of the eradication scenario is an NPV of $101,200 for administration, inspection, monitoring and enforcement, and an NPV of $101,200 for costs of control. This is a total cost in present day terms (NPV) of approximately $202,400 at a discount rate of 0.08 per cent. In addition there will be no damages to regionally significant conservation values from this pest once eradication has been achieved.

The net outcome for eradication net benefits when compared with the no RPMP scenario is $701,739 in NPV terms. This option protects significant regional biodiversity values on 70,922.5ha through the prevention of spread of this organism. Eradication is preferred since it produces the highest net benefit, and best satisfies the requirements of section 71(e).

If the requirements of section 71(e) are deemed by council to have been met, then the costs of the strategy can be charged to the regional community as beneficiaries and the benefits will exceed the costs. Those on whose property the pest currently exists are exacerbators, and can reasonably be charged the cost of control, satisfying section 71(f).

SUMMARY

Potential pest plants	**Proposed programme**	**Section 71(d)** *Is the pest a serious threat to the region?*	**Section 71(e)** *Do the benefits outweigh the costs?*	**Section 71(f)** *Who receives the benefit?*	**Estimated council cost per annum $**
Mexican water lily	Site-led	Yes, part (ii) and (iv)	Yes, if conservation values protected exceed $2.85/ha or if 5% of area is controlled in the absence of a strategy.	Widerregional community	$15,000

4.11 Mistflower (*Ageratina riparia*)

Plan change – increasing the level of management outside of Coromandel.

Proposed management regimes – Progressive containment programme – direct control.

Description and biological capability
Form
- Erect or sprawling herb to sub-shrub, up to 1m (occasionally 2m) tall.

Habitat
- Forest margins, clearings, waste places, damp banks, wetlands, open damp forests, especially stream sides.

Regional distribution
- Known distribution in the Waikato region centres on the border of Coromandel and Kaimai Ranges, and in north Coromandel.

Biological success
Dispersal method
- Seeds distributed both by wind and by water movement.

Reproductive ability
- 10,000 to 100,000 seeds produced per plant.

Competitive ability
- Completely dominates stream side vegetation.
- Dense stands can impair movement through areas of this plant.

Other considerations
Toxicity
- Potentially a toxic species although no poisonings reported.

Resistance to Control
- Glyphosate and metsulfuron would control, but would damage natural area.
- A fungal biocontrol agent appears to be achieving some success, and a gall fly has also been released.

ASSUMPTIONS

Initial area infested
Mistflower is present in the Waikato at present. The known distribution in the Waikato region centres on the border of Coromandel and Kaimai Ranges and in north Coromandel.

This plan only looks at control measures outside of the Coromandel.

Infestation size outside of the Coromandel Peninsula is ~30ha.

Weighted average gross margin

$700/ha

Mistflower weighted average gross margin			
	Area	**Gross margin**	
Plantation (planted forest) 10m margin	20936.71	$700	14655697
Total	**20936.71**		**14655697**
Weighted average gross Margin			**$700**

Proportion of production loss from infested land
5 per cent.

The projected density is low.

Total area potentially infested (TAPI) (ha)
Waikato Regional Council's GIS modelling shows that a potential 274,602ha of terrestrial habitat within the region could be affected if no control work was undertaken.

Typical dispersal routes are streams and roadsides, as well as forest gap to forest gap. Plant is spread by wind, water and probably road mowing machines. Disturbance caused by flooding of streams opens up habitats and distributes seed.

Potential	Ha
Roads - to towns, 4m x length	4,595ha
Railway - to towns, 4m x length	142ha
Indigenous forest - 10m margin (LCDB2)	19,371ha
Plantation (planted forest) 10m margin	20,937ha
Shrubland/scrub (manuka, kanuka)	175,800ha
Riparian margins (10m x length)	43,559ha
Wetlands (inland wetland, coastal wetlands)	8,176ha
Coastal dunes	2,022ha
Total	**274,602ha**

Years to infest all TAPI
Mistflower is a sprawling perennial herb or small shrub, which grows to approximately to 1m. The oval leaves are about 7cm long and 2cm wide, and are serrated on the upper edges. It has white flowers that grow in small clusters off long stems. Mistflower seeds are dark brown to black with fine white hairs on the tips. Each plant can produce 10,000 to 100,000 seeds that are dispersed by wind or water.

Mistflower is a major environmental weed in the Auckland and Northland regions and in Thames-Coromandel district. It inhabits forest margins, clearings, waste lands, damp banks, wetlands, damp forests and especially stream sides. Small slips on river and stream edges are especially vulnerable.

Mistflower has the ability to invade forest floors forming total ground cover masses, even in unmodified forests. Mistflower prevents seedlings of most other species establishing, especially in riparian areas, where it inhibits forest regeneration. It is shade tolerant but frost sensitive.

Years to infest potential range – 75 years 'high' rate of invasion.

Annual cost of control for landholder
Assumed as $134/ha based figures from 2001 CBA plus inflation.

Proportion of land over which pests voluntarily controlled
Assumed for analysis purposes as being 5 per cent.

Proportion of land to which conservation values apply
Based on GIS analysis, conservation values are assumed to be 91 per cent.

Any benefits provided by the weed
Nil.

Biocontrol
The biological control agent *Entyloma ageratinae* (commonly known as the mist flower smut) is present in the Waikato.

Waikato Regional Council will be carry very minimal to no monitoring of this biocontrol, therefore cost 0$/p.a.

Year strategy objectives achieved (containment)
Ten years.

Area infested if objectives (containment) achieved (ha)
Thirty hectares.

Proportion of production loss from infested land when strategy objectives (containment) achieved
N/A.

Year strategy objectives achieved (eradication)
Ten years

RESULTS

PLANT PEST		**Mistflower**	
	No RPMP	**Containment**	**Eradication**
Cost and losses under option	**$2,384,910**	**$0**	**$108,486**
Section 71(e) NPV		**$2,384,910**	**$2,276,424**
Section 71(e) regional values cost/ha		**$10**	**$10**
Section 71(f) NPV (*NRB*)		**$2,369,923**	**$2,315,680**
Section 71(f) area of spillover prevented (ha)		**274,572**	**274,572**

Base Assumptions

Discount Rate		**8%**	
Initial Area Infested (ha)	(IAI)	**30**	**(ha)**
Weighted Average Gross Margin for Infested Land ($/ha)	(WAGM)	**$700**	**($/ha)**
Proportion of Production Loss from Infested Land (%)	(PPLIL)	**5%**	**(%)**
Total Area Potentially Infested	(TAPI)	**274,602**	**(ha)**
Years to Infest all of TAPI (years)	(YI)	**75**	**(Years)**
Annual Cost of Control for Landholder ($/ha affected)	(ACCL)	**$134**	**($/ha)**
Proportion of Landholders Controlling Pests (%)	(PLCP)	**5.0%**	**(%)**
Proportion of Infested Land to which Conservation Values Apply (%)	(PILCV)	**91%**	**(%)**
Any Benefits Provided by Weed (total $ / annum)	(BPBW)	**-**	**($)**

Containment Assumptions			
Biocontrol ($/annum)		$ -	($)
Year Strategy objectives Achieved	(YOA)	10	(Years)
Area Infested if Strategy Objectives Achieved (ha)	(AISOA)	30	(ha)
Proportion of Production Loss from Infested Land when Strategy Objectives Achieved(%)	(PPLSOA)	0%	(%)

Eradication Assumptions			
Year Strategy objectives Achieved	(YOA)	10	(Years)

Regional Council Costs		
Year	Containment	Eradication
1		$8,040
2		$8,040
3		$8,040
4		$8,040
5		$8,040
6		$8,040
7		$8,040
8		$8,040
9		$8,040
Year 10 onward		$0
NPV	$0	$54,243

Control Costs		
Year	Containment	Eradication
1		$8,040
2		$8,040
3		$8,040
4		$8,040
5		$8,040
6		$8,040
7		$8,040
8		$8,040
9		$8,040
Year 10 onward		$0
NPV	$0	$54,243

CONCLUSIONS

The desired outcome of the Regional Pest Management Plan is to contain mistflower to the Coromandel and achieve eradication for the rest of the region.

No RPMP outcome
The outcome in the no RPMP Scenario is a loss of $10,970,350 per annum in 75 years as a result of production losses and additional costs of control. This is equivalent to an NPV of approximately $2,384,910. In addition there are 237,393.4ha on which damages to regionally significant conservation values will occur.

Eradication outcome
The outcome of the eradication scenario is an NPV of $54,243 for administration, inspection, monitoring and enforcement, and an NPV of $54,243 for costs of control. This is a total cost in present day terms (NPV) of approximately $108,486 at a discount rate of 0.08 per cent. In addition there will be no damages to regionally significant conservation values from this pest once eradication has been achieved.

The net outcome for eradication net benefits when compared with the no RPMP scenario is $2,276,424 in NPV terms. This option protects significant regional biodiversity values on 237,366.1ha through the prevention of spread of this organism. Eradication is preferred since it produces the highest net benefit, and best satisfies the requirements of section 71(e).

If the requirements of section 71(e) are deemed by council to have been met, then the costs of the strategy can be charged to the regional community as beneficiaries and the benefits will exceed the costs. Those on whose property the pest currently exists are exacerbators, and can reasonably be charged the cost of control, satisfying section 71(f).

SUMMARY

Potential pest plants	**Proposed programme**	**Section 71(d)** *Is the pest a serious threat to the region?*	**Section 71(e)** *Do the benefits outweigh the costs?*	**Section 71(f)** *Who receives the benefit?*	**Estimated council cost per annum $**
Mistflower	Eradication (outside TCDC)	Yes, part (ii) and (iv)	Yes, if conservation values protected exceed $0.46/ha or if 5% of area is controlled in the absence of a strategy.	Wider regional community	$8,040

4.12 Purple nutsedge/nutgrass (*Cyperus rotundus*)

Plan change – No change.

Proposed management regimes – Landowner responsibility - Progressive containment programme.

Description and biological capability

Form

- An erect perennial herb usually between 20-50cm high with erect smooth, non-branched triangular stems. Grass-like leaves. A cluster of brownish flattened spikelets forms the inflorescence. It has a deep extensive root system with multiple tubers.

Habitat

- Associated with soils of moderate-high fertility and moderate moisture levels. Found in crops.

Regional distribution

- No sites are known in Taupō and Hauraki areas.
- Several isolated sites are known in other areas.

Biological success

Dispersal method

- Tubers are dragged by cultivation, equipment and other earth moving activities.

Reproductive ability

- Produces little viable seed - grows by tubers.

Competitive ability

- Very invasive and aggressive, produces dense colonies (up to 500 plants per m2) - it smothers all other plants and seriously affects crop yield.

Other considerations

Toxicity

- Nil.

Resistance to control

- Difficult to remove tubers. New herbicide (Sempra™) allows better control than in the past.

ASSUMPTIONS

Initial area infested (ha)

Purple nutsedge is present in the Waikato. It currently has relatively few sites.

Known infestation is ~15ha.

Weighted average gross margin

$1,324

Nutgrass weighted average gross margin			
Land	**Area**	**Gross margin**	
Arable	50,000	$370	18500000
Dairy	627,386	$1,400	878341002
Total	**677386.43**		**896841002**
Weighted average gross margin			**$1,324**

Proportion of production loss from infested land
Twenty per cent. Tthis figure is very conservative.

Purple nutsedge aggressively invades and competes with agricultural crops. More than 500 plants per square metre, and 40 tonnes of rhizomes and tubers per hectare have been recorded in dense colonies. At these densities this pest can smother crops and all other plants, and remove large amounts of moisture and nutrients from the soil. Dispersal occurs when tubers attach to cultivation equipment and are deposited elsewhere.

Total area potentially infested (TAPI)
Purple nutsedge is mainly spread by cultivation equipment and locally from rhizome and tuber (nuts) growth.

Potentially infested	ha
Arable	50,000ha
Dairy	627,386ha
Total	**677,386ha**

Years to infest all TAPI
Years to infest potential range – 75 years 'high' rate of invasion

Annual cost of control for landholder
Control costs are ~$180/ha/annum. (Based on conversation with FAR.)

This cost is based on chemical management not eradication. To manage to eradication the cost could be as high as $6000/ha/annum.

Proportion of land over which pests voluntarily controlled (%)
5%

Proportion of land to which conservation values apply
Nil.

Any benefits provided by the weed
Nil.

Biocontrol
Nil.

Year strategy objectives achieved (containment)
2023.

Area infested if objectives (containment) achieved
4 hectares.

Proportion of production loss from infested land when strategy objectives (containment) achieved
Twenty per cent.

RESULTS

PLANT PEST		**Nutgrass**	
	No RPMP	**Containment**	**Eradication**
Cost and losses under option	**$16,587,949**	**$134,989**	**$8,748**
Section 71(e) NPV		**$16,452,960**	**$16,579,201**
Section 71(e) regional values cost/ha		**#DIV/0!**	**#DIV/0!**
Section 71(f) NPV (*NRB*)		**$16,513,063**	**$16,578,062**
Section 71(f) area of spillover prevented (ha)		**637,334**	**637,334**

Base Assumptions			
Discount Rate		**8%**	
Initial Area Infested (ha)	(IAI)	**4**	**(ha)**
Weighted Average Gross Margin for Infested Land ($/ha)	(WAGM)	**$1,324**	**($/ha)**
Proportion of Production Loss from Infested Land (%)	(PPLIL)	**15%**	**(%)**
Total Area Potentially Infested	(TAPI)	**637,338**	**(ha)**
Years to Infest all of TAPI (years)	(YI)	**75**	**(Years)**
Annual Cost of Control for Landholder ($/ha affected)	(ACCL)	**$180**	**($/ha)**
Proportion of Landholders Controlling Pests (%)	(PLCP)	**5.0%**	**(%)**
Proportion of Infested Land to which Conservation Values Apply (%)	(PILCV)	**0%**	**(%)**
Any Benefits Provided by Weed (total $ / annum)	(BPBW)	**-**	**($)**

Containment Assumptions			
Biocontrol ($/annum)		**$ -**	**($)**
Year Strategy objectives Achieved	(YOA)	**10**	**(Years)**
Area Infested if Strategy Objectives Achieved (ha)	(AISOA)	**1**	**(ha)**
Proportion of Production Loss from Infested Land when Strategy Objectives Achieved(%)	(PPLSOA)	**15%**	**(%)**

Eradication Assumptions			
Year Strategy objectives Achieved	(YOA)	**100**	**(Years)**

Regional Council Costs				Control Costs		
Year	**Containment**	Eradication		**Year**	Containment	Eradication
1	$5,000	$0		1	$5,000	$0
2	$5,000	$0		2	$5,000	$0
3	$5,000	$0		3	$5,000	$0
4	$5,000	$0		4	$5,000	$0
5	$5,000	$0		5	$5,000	$0
6	$5,000	$0		6	$5,000	$0
7	$5,000	$0		7	$5,000	$0
8	$5,000	$0		8	$5,000	$0
9	$5,000	$0		9	$5,000	$0
Year 10 onward	$5,000	$0		Year 10 onward	$5,000	$0
NPV	**$64,999**	**$0**		**NPV**	**$64,999**	**$0**

CONCLUSIONS

The desired outcome of the Regional Pest Management Plan is to prevent this plant from spreading from existing sites.

No RPMP outcome
The outcome in the no RPMP scenario is a loss of $125,980,030 per annum in 75 years as a result of production losses and additional costs of control. This is equivalent to an NPV of approximately $16,587,949.

Containment outcome
The outcome of the containment scenario is an NPV of $64,999 for administration, inspection, monitoring and enforcement, an NPV of $64,999 for costs of control, and loss of $199 per annum in 10 years as a result of production losses. This is a total cost in present day terms (NPV) of approximately $134,989 at a discount rate of 0.08 per cent.

The net outcome for containment when compared with the no RPMP approach produces a net positive benefit of $16,452,960 in NPV terms, because the costs of undertaking the strategy are less than the likely losses in production and control costs if the organisms were allowed to spread. Containment is preferred since it produces the highest net benefit, and best satisfies the requirements of section 71(e).

If the requirements of section 71(e) are deemed by council to have been met, then the costs of the strategy can be charged to the regional community as beneficiaries and the benefits will exceed the costs. Those on whose property the pest currently exists are exacerbators, and can reasonably be charged the cost of control, satisfying section 71(f).

SUMMARY

Potential pest plants	**Proposed programme**	**Section 71(d)** *Is the pest a serious threat to the region?*	**Section 71(e)** *Do the benefits outweigh the costs?*	**Section 71(f)** *Who receives the benefit?*	**Estimated council cost per annum $**
Nutgrass	Containment	Yes, part (i)	Yes, benefits exceed costs by $637,334 if model assumptions accepted as reasonable.	Agricultural community	$5,000

4.13 Red-eared slider turtle *(Trachemys scripta elegans)*

Plan change *– New addition to strategy.*

Proposed management regime *– Site-led.*

Description and biological capability

Form

- A long lived, medium sized freshwater turtle. Red-eared slider turtles are native to southern parts of the United States of America. Red-eared slider turtles can grow up to 350mm long. The shell and skin are olive to brown in colour. There are distinctive patches of colour from yellow to red present on both sides of the head. The turtles can move deceptively quickly.

Habitat

- Aquatic

Regional distribution

- Held in captivity throughout the region and widely available through the pet trade throughout New Zealand.
- In the wild (probably via release of pet turtles) actual distribution is unknown. However, in the Waikato region they have been sighted in parts of the lower Waikato River, Hamilton Lake, Turtle Lake at the Hamilton Gardens, Lake Taupō, the Taupō Prawn Park.

Biological success

Dispersal method

- Human release.

Reproductive ability

- Currently unproven in the wild in New Zealand. However, at some sites like geothermal features or thermal power station outflows, natural conditions may be suitable for breeding. A warming climate through climate change could result in suitable environmental conditions that would allow red-eared slider turtles to breed in many parts of the Waikato region.

Competitive ability

- The Invasive Species Specialist Group rates red-eared slider turtles in the top 100 worldwide invasive species. They are omnivorous and able to tolerate a wide range of environmental conditions. They are able to survive in a wide range of aquatic habitats, both natural and manmade. Their diet consists of aquatic plants and animals and could therefore compete with native fish and eels for food. They may also predate upon fish and eels.

Other considerations

There are large numbers of red-eared slider turtles held in captivity as pets. This potentially creates a large reservoir of red-eared slider turtles that could find their way into the wild in the future through irresponsible ownership. Red-eared slider turtles are typically sold through the pet trade when small, ~50mm. However they can live up to 50 years, and as they increase in size their temperament becomes more aggressive and their care requirements change.

COST BENEFIT ASSUMPTIONS

Initial area infested (ha)
200 hectares (estimated)

Weighted average gross margin ($/ha)
Weighted gross average = $0/ha

The assumption is that red-eared slider turtles have no impacts upon production values.

Proportion of production loss from infested land (%)
As above, therefore the proportion of production loss from infested land = 0%

Total area potentially infested (TAPI) (ha)
Waikato Regional Council GIS modelling shows that a potential 126,406 hectares of aquatic habitat within the region could be affected if red-eared slider turtles are allowed to spread naturally or via human release.

Years to infest all TAPI
Natural spread of red-eared slider turtles will be very slow. However, human spread of the animal will assist, and increase the areas where red-eared slider turtles will be found in the wild. It is assumed however that human assisted spread will correlate to areas of higher population sited close to aquatic habitat, for example, population centres on the banks of the Waikato River or lakes such as Taupō.

Years to infest potential range – 200 years 'slow' rate of invasion. However, changes in breeding success, in the wild, could accelerate the natural rate of spread.

Annual cost of control for landholder ($/ha)
The council isn't proposing any rules requiring landowners to control red-eared slider turtles themselves. However, should they wish to manage red-eared slider turtles on their own properties we have assumed that a cost of at least $1000 ha/year may be required.

Proportion of land over which pests voluntarily controlled (%)
Currently assumed to be 0%

Proportion of land to which conservation values apply (%)
Based on GIS analysis assumed conservation values to be 100%.

Any benefits provided by the pest ($p.a.)
Red-eared slider turtles as pets are assumed to provide some amenity benefits. However quantifiable benefits are zero.

Biocontrol ($p.a.)
N/A

Year strategy objectives achieved (site-led)
10

Area infested if objectives (site-led) achieved (ha)
180 hectares

Proportion of production loss from infested land when strategy objectives (containment) achieved (%)
0%

COST BENEFIT ANALYSIS RESULTS

PEST

	No RPMP	Red-eared slider turtle Site-led	Eradication
Cost and losses under option	**$1,283**	**$142,998**	**$1,312,975**
Section 72(a) NPV		**-$141,715**	**-$1,311,692**
Section 72(a) regional values cost/ha		**-$1**	**-$10**
Section 72(b) NPV (*NRB*)		**-$129,215**	**-$1,299,192**
Section 72(b) area of spillover prevented (ha)		**126,206**	**126,206**

Base Assumptions

Discount Rate		**8%**	
Initial Area Infested (ha)	(IAI)	**200**	**(ha)**
Weighted Average Gross Margin for Infested Land ($/ha)	(WAGM)	**$0**	**($/ha)**
Proportion of Production Loss from Infested Land (%)	(PPLIL)	**0%**	**(%)**
Total Area Potentially Infested	(TAPI)	**126,406**	**(ha)**
Years to Infest all of TAPI (years)	(YI)	**200**	**(Years)**
Annual Cost of Control for Landholder ($/ha affected)	(ACCL)	**$200**	**($/ha)**
Proportion of Landholders Controlling Pests (%)	(PLCP)	**0.1%**	**(%)**
Proportion of Infested Land to which Conservation Values Apply (%)	(PILCV)	**100%**	**(%)**
Any Benefits Provided by Pest (total $ / annum)	(BPBW)	**-**	**($)**

Site-led Assumptions			
Biocontrol ($/annum)		**$ -**	**($)**
Year Strategy objectives Achieved	(YOA)	**10**	**(Years)**
Area Infested if Strategy Objectives Achieved (ha)	(AISOA)	**180**	**(ha)**
Proportion of Production Loss from Infested Land when Strategy Objectives Achieved(%)	(PPLSOA)	**0%**	**(%)**

Regional Council Costs

Year	**Site-led**	Eradication
1	$10,000	$100,000
2	$10,000	$100,000
3	$10,000	$100,000
4	$10,000	$100,000
5	$10,000	$100,000
6	$10,000	$100,000
7	$10,000	$100,000
8	$10,000	$100,000
9	$10,000	$100,000
Year 10 onward	$10,000	$100,000
NPV	**$129,998**	**$1,299,975**

Landowner Control Costs

Year	Site-led	Eradication
1	$1,000	$1,000
2	$1,000	$1,000
3	$1,000	$1,000
4	$1,000	$1,000
5	$1,000	$1,000
6	$1,000	$1,000
7	$1,000	$1,000
8	$1,000	$1,000
9	$1,000	$1,000
Year 10 onward	$1,000	$1,000
NPV	**$13,000**	**$13,000**

CONCLUSIONS

The desired outcome of the Regional Pest Management Plan is to minimise the harm this animal can cause at high value sites.

No RPMP outcome

The outcome in the no RPMP scenario is a loss of $25,281 per annum in 200 years as a result of production losses and additional costs of control. This is equivalent to a NPV of approximately $1283. In addition there is 126279.6ha on which damages to regionally significant (conservation, recreation/ amenity/Māori/ soil and water) values will occur.

Site-led outcome

The outcome of the site-led scenario is a NPV of $129,998 for administration, inspection, monitoring and enforcement, a NPV of $13,000 for costs of control, and loss of $0 per annum in 10 years as a result of production losses. This is a total cost in present day terms (NPV) of approximately $142,998 at a discount rate of 0.08%. In addition there will be a total of 180ha on which damages to regionally significant (conservation, recreation/ amenity/Māori/soil and water) values will occur.

Interpreting the data

The above conclusions are not surprising. The costs of site-led management compared to the no RPMP scenario are greater. However, the analysis is skewed as there is no production impact from the pest and CBA models do a poor job of quantifying the environmental costs/benefits of managing, or not managing, the pest.

Patterson and Cole (1999) determined that the value of aquatic habitat related to rivers is NZ$24,330 per hectare (2013 dollars), and for lakes NZ$28,345 per hectare (2013 dollars). Therefore, a simple analysis may conclude that if the cost of control is no greater than $10,000 per hectare, that a benefit from site-led management of at least $14,330 per hectare for rivers and $18,345 per hectare for lake habitats could be expected. That is certainly the case here. Patterson and Cole (1999)[33] used global data from other researchers in their study. In their opinion the *"global data used in the study was incomplete, and probably means a 'significant underestimate' for the Waikato regional values".* Therefore the benefit values from management could be higher than stated.

[33] Patterson, M and Cole, A. (1999) Estimation of the value of ecosystem services in the Waikato region. Environment Waikato Internal Series report 1999/02.

4.14 Royal fern *(Osmunda regalis)*

Plan change – New plant to strategy.

Proposed management regimes – Direct control - Site-led.

Description and biological capability

Form

- Terrestrial, deciduous fern with short, woody trunk (<1.5m tall, can grow <1+m diameter). Covered in persistent stalk bases.
- Yellow-brown leaf stalks have ear-like lobes at base and large, tough, leathery, yellow-green fronds (30-300 x 20-75cm) divided twice with primary leaflets (pinnae) (up to 30cm long) and secondary leaflets (20-70 x 8-18mm), in up to 15 pairs.
- Inner fronds often have fertile secondary pinnae at their ends (each 30 x 4mm), densely covered with clusters of light brown spore bodies.

Habitat

- Wetlands, swamps, streamsides, and damp bare (especially acidic) land.

Regional distribution

- North Waikato/Hauraki Plains area, small areas scattered south of Hamilton.

Biological success

Dispersal method

- Wind.

Reproductive ability

- Spores.

Competitive ability

- Grows rapidly, matures quickly, and can produce a large number of spores that are widely dispersed by the wind.
- One of the very few weeds of bogs, royal fern competes with native species for space in specialised niches.

Toxicity

- Nil.

Resistance to control

- Unknown.

Benefits

- Nil.

ASSUMPTIONS

Initial area infested

Royal fern is widely present in the north Waikato.

Combined known infestation is ~8000ha.

Weighted average gross margin

N/A.

Proportion of production loss from infested land

N/A.

Total area potentially infested (TAPI)
Royal fern spreads via wind.

Potentially infested	ha
Riparian margins (10m x length)	43,559ha
Wetlands (inland wetland, coastal wetlands)	8,176ha
Total	**51,735ha**

Years to infest all TAPI
Royal fern is spread by the wind.

Years to infest potential range – 75 years 'high' rate of invasion.

Annual cost of control for landholder
Assumed as $1000 ha/year, based on discussion with biosecurity staff.

Proportion of land over which pests voluntarily controlled
Ten per cent.

Proportion of land to which conservation values apply
Based on GIS analysis, conservation values are assumed to be 100 per cent.

Any benefits provided by the weed
Nil.

Biocontrol
Nil.

Year strategy objectives achieved (eradication)
Assumed as 10 years for the purpose of this analysis.

RESULTS

PLANT PEST		Royal fern	
	No RPMP	**Containment**	**Eradication**
Cost and losses under option	**$18,854,771**	**$259,996**	**$0**
Section 71(e) NPV		**$18,594,775**	**$18,854,771**
Section 71(e) regional values cost/ha		**$399**	**$405**
Section 71(f) NPV (*NRB*)		**$8,724,773**	**$8,854,771**
Section 71(f) area of spillover prevented (ha)		**43,735**	**43,735**

Base Assumptions			
Discount Rate		**8%**	
Initial Area Infested (ha)	(IAI)	**8,000**	**(ha)**
Weighted Average Gross Margin for Infested Land ($/ha)	(WAGM)	$0	**($/ha)**
Proportion of Production Loss from Infested Land (%)	(PPLIL)	**0%**	**(%)**
Total Area Potentially Infested	(TAPI)	**51,735**	**(ha)**
Years to Infest all of TAPI (years)	(YI)	**75**	**(Years)**
Annual Cost of Control for Landholder ($/ha affected)	(ACCL)	**$1,000**	**($/ha)**
Proportion of Landholders Controlling Pests (%)	(PLCP)	**10.0%**	**(%)**
Proportion of Infested Land to which Conservation Values Apply (%)	(PILCV)	**100%**	**(%)**
Any Benefits Provided by Weed (total $ / annum)	(BPBW)	**-**	**($)**

Containment Assumptions			
Biocontrol ($/annum)		**$ -**	**($)**
Year Strategy objectives Achieved	(YOA)	**10**	**(Years)**
Area Infested if Strategy Objectives Achieved (ha)	(AISOA)	**2**	**(ha)**
Proportion of Production Loss from Infested Land when Strategy Objectives Achieved(%)	(PPLSOA)	**0%**	**(%)**

Eradication Assumptions			
Year Strategy objectives Achieved	(YOA)	**10**	**(Years)**

Regional Council Costs		
Year	**Containment**	Eradication
1	$10,000	$0
2	$10,000	$0
3	$10,000	$0
4	$10,000	$0
5	$10,000	$0
6	$10,000	$0
7	$10,000	$0
8	$10,000	$0
9	$10,000	$0
Year 10 onward	$10,000	$0
NPV	**$129,998**	**$0**

Control Costs		
Year	Containment	Eradication
1	$10,000	$0
2	$10,000	$0
3	$10,000	$0
4	$10,000	$0
5	$10,000	$0
6	$10,000	$0
7	$10,000	$0
8	$10,000	$0
9	$10,000	$0
Year 10 onward	$10,000	$0
NPV	**$129,998**	**$0**

CONCLUSIONS

The desired outcome of the Regional Pest Management Plan is to prevent this plant from spreading from existing sites and eradicate plants that are in or close to significant natural areas.

No RPMP outcome
The outcome in the no RPMP scenario is a loss of $5,173,511 per annum in 75 years as a result of production losses and additional costs of control. This is equivalent to an NPV of approximately $18,854,771. In addition there are 46,561.6ha on which damages to regionally significant conservation values will occur.

Containment outcome
The outcome of the containment scenario is an NPV of $129,998 for administration, inspection, monitoring and enforcement, an NPV of $129,998 for costs of control, and loss of $0 per annum in 10 years as a result of production losses. This is a total cost in present day terms (NPV) of approximately $259,996 at a discount rate of 0.08 per cent. In addition there will be a total of 2ha on which damages to regionally significant values will occur.

The net outcome for containment when compared with the no RPMP approach produces a net positive benefit of $18,594,775 in NPV terms, because the costs of undertaking the strategy are less than the likely losses in production and control costs if the organisms were allowed to spread. This option protects significant regional biodiversity values on 46,559.6ha through the prevention of spread of this organism. Containment is preferred since it produces the highest net benefit, and best satisfies the requirements of section 71(e).

If the requirements of section 71(e) are deemed by council to have been met, then the costs of the strategy can be charged to the regional community as beneficiaries and the benefits will exceed the costs. Those on whose property the pest currently exists are exacerbators, and can reasonably be charged the cost of control, satisfying section 71(f)..

Potential pest plants	**Proposed programme**	**Section 71(d)** *Is the pest a serious threat to the region?*	**Section 71(e)** *Do the benefits outweigh the costs?*	**Section 71(f)** *Who receives the benefit?*	**Estimated council cost per annum $**
Royal fern	Site-led	Yes, part (ii) and (iv)	Yes, if conservation values protected exceed $5.57 or if 10% of area is controlled in the absence of a strategy.	Wider regional community	$10,000

4.15 Sea spurge (*Euphorbia paralias*)

Plan change – New plant to strategy.

Proposed management regimes – Direct control - Eradication.

Description and biological capability
Form

- Long-lived herbaceous plant with several upright or semi-upright stems (usually 20-70 cm tall) growing from a woody base.
- Its stems are somewhat fleshy, contain a milky sap, and usually divide into branches near their tips.
- Its stalkless leaves (5-30 mm long and 2-15 mm wide) are crowded along the stems.
- Its tiny cup-like, yellowish-green, 'flowers' are borne near the tips of the stems and have a large stalked ovary.
- Its fruiting capsules (3-5 mm long and 4.5-6 mm wide) each containing three seeds.

Habitat

- Dunes from the high tide point.

Regional distribution

- Aotea beach, Waikato (one site).

Biological success
Dispersal Method

- Wind (via rolling along the beach), water.

Reproductive ability

- Seed.

Competitive ability

- Grows rapidly, matures quickly, and can produce a large number of seed that are widely dispersed by the water currents.
- One of the very few weeds that can grow in the frontal dune.

Toxicity

- Yes, sap can cause skin problems.

Resistance to control

- Unknown.

Benefits

- Nil.

ASSUMPTIONS

Initial area infested
Sea spurge is present in the Waikato.

Combined known infestation is ~0.2ha.

Weighted average gross margin
N/A.

Proportion of production loss from infested land
N/A.

Total area potentially infested (TAPI)
Sea spurge spreads via water currents and wind.

Potentially infested	ha
Coastal dunes	2,022
Total	**2,022**

Years to infest all TAPI
Sea spurge spreads via water currents and wind.

Years to infest potential range – 75 years 'high' rate of invasion.

Annual cost of control for landholder
Assumed as $1000 ha/year, based on discussion with biosecurity staff.

Proportion of land over which pests voluntarily controlled
Zero per cent.

Proportion of land to which conservation values apply
Based on GIS analysis, conservation values are assumed to be 100 per cent.

Any benefits provided by the weed
Nil.

Biocontrol
Nil.

Year strategy objectives achieved (eradication)
Assumed as 10 years for the purpose of this analysis.

RESULTS

PLANT PEST		Sea spurge	
	No RPMP	**Containment**	**Eradication**
Cost and losses under option	**$0**	**$0**	**$134,932**
Section 71(e) NPV		**$0**	**-$134,932**
Section 71(e) regional values cost/ha		**$0**	**-$67**
Section 71(f) NPV (*NRB*)		**$0**	**-$67,466**
Section 71(f) area of spillover prevented (ha)		**2,022**	**2,022**

Base Assumptions

Discount Rate		**8%**	
Initial Area Infested (ha)	(IAI)	**0.20**	**(ha)**
Weighted Average Gross Margin for Infested Land ($/ha)	(WAGM)	$0	**($/ha)**
Proportion of Production Loss from Infested Land (%)	(PPLIL)	**35%**	**(%)**
Total Area Potentially Infested	(TAPI)	**2,022**	**(ha)**
Years to Infest all of TAPI (years)	(YI)	**75**	**(Years)**
Annual Cost of Control for Landholder ($/ha affected)	(ACCL)	**$1,000**	**($/ha)**
Proportion of Landholders Controlling Pests (%)	(PLCP)	**0.0%**	**(%)**
Proportion of Infested Land to which Conservation Values Apply (%)	(PILCV)	**100%**	**(%)**
Any Benefits Provided by Weed (total $ / annum)	(BPBW)	**-**	**($)**

Containment Assumptions			
Biocontrol ($/annum)		**$ -**	**($)**
Year Strategy objectives Achieved	(YOA)	**10**	**(Years)**
Area Infested if Strategy Objectives Achieved (ha)	(AISOA)	**2**	**(ha)**
Proportion of Production Loss from Infested Land when Strategy Objectives Achieved(%)	(PPLSOA)	**0%**	**(%)**

Eradication Assumptions			
Year Strategy objectives Achieved	(YOA)	**10**	**(Years)**

Regional Council Costs		
Year	**Containment**	Eradication
1	$0	$10,000
2	$0	$10,000
3	$0	$10,000
4	$0	$10,000
5	$0	$10,000
6	$0	$10,000
7	$0	$10,000
8	$0	$10,000
9	$0	$10,000
Year 10 onward	$0	$0
NPV	**$0**	**$67,466**

Control Costs		
Year	Containment	Eradication
1	$0	$10,000
2	$0	$10,000
3	$0	$10,000
4	$0	$10,000
5	$0	$10,000
6	$0	$10,000
7	$0	$10,000
8	$0	$10,000
9	$0	$10,000
Year 10 onward	$0	$0
NPV	**$0**	**$67,466**

CONCLUSIONS

The desired outcome of the Regional Pest Management Plan is to prevent this plant from spreading from the existing site and eradicate plants found in the Waikato.

No RPMP outcome
The outcome in the no RPMP scenario is a loss of $0 per annum in 75 years as a result of production losses and additional costs of control. This is equivalent to an NPV of approximately $0. In addition there are 2022ha on which damages to regionally significant conservation values will occur.

Eradication outcome
The outcome of the eradication scenario is an NPV of $67,466 for administration, inspection, monitoring and enforcement, an NPV of $67,466 for costs of control, and loss of $0 per annum in 10 years as a result of production losses. This is a total cost in present day terms (NPV) of approximately $134,932 at a discount rate of 0.08 per cent. In addition there will be no damages to regionally significant values from this pest once eradication has been achieved.

Eradication produces a net negative outcome in monetary terms from their implementation when compared with the no RPMP scenario. This option protects significant regional biodiversity values on 2020ha. If the council considers that the conservation values protected from invasion in 75 years time exceed $66.73 per hectare then the requirements of section 71(e) have been met.

If the requirements of section 71(e) are deemed by council to have been met, then the costs of the strategy can be charged to the regional community as beneficiaries and the benefits will exceed the costs. Those on whose property the pest currently exists are exacerbators, and can reasonably be charged the cost of control, satisfying section 71(f) .

SUMMARY

Potential pest plants	**Proposed programme**	**Section 71(d)** *Is the pest a serious threat to the region?*	**Section 71(e)** *Do the benefits outweigh the costs?*	**Section 71(f)** *Who receives the benefit?*	**Estimated council cost per annum $**
Sea spurge	Site-led	Yes, part (ii) and (iv)	Yes, if conservation values protected exceed $66.73 or if 0% of area is controlled in the absence of a strategy.	Wider regional community	$10,000

4.16 Strawberry dogwood (*Cornus capitata*)

Plan change – New plant to strategy.

Proposed management regimes – Direct control - Site-led.

Description and biological capability
Form

- Bushy evergreen tree to 6m tall with oval grey-green leaves tapering to a long point, paler underneath, and densely covered in fine hairs. Pale yellow flowers, red strawberry-like bird-dispersed fruit.

Habitat

- Disturbed forest, shrubland, grassland.

Regional distribution

- Northern parts of Waitomo district.
- Southern parts Ōtorohanga district.
- In plantation forestry in South Waikato district (visible from SH1).
- Kawhia (road side).

Biological success
Dispersal method

- Seed dispersed by birds and animals.

Reproductive ability

- Produces viable seed, suckering.

Competitive ability

- Grows rapidly, matures quickly, and can produce a large number of seeds that are widely dispersed by birds. Tolerates harsh conditions such as drought and shade ,and creates dense thickets by growth (suckering) from a system of underground stems.

Toxicity

- Nil.

Resistance to control

- Unknown.

Benefits

- Fruits are edible and used as a food source by native birds, e.g. tui.

ASSUMPTIONS

Initial area infested
Strawberry dogwood is present in the Waikato. It is currently spreading through the southern parts of the Waikato.

Combined known infestation is ~200ha.

Weighted average gross margin
N/A.

Proportion of production loss from infested land
N/A.

Total area potentially infested (TAPI)
Strawberry dogwood spreads via animals (birds, pigs, deer and possums).

Potentially infested	ha
Roads - to towns, 4m x length	4,595ha
Railway - to towns, 4m x length	142ha
Indigenous forest - 10m margin	19,371ha
Plantation (planted forest) 10m margin	20,937ha
Shrubland/scrub (manuka, kanuka)	175,800ha
Riparian margins (10m x length)	43559ha
Total	**264404.00ha**

Years to infest all TAPI
Strawberry dogwood is predominantly spread by birds and possums.

In the USA, dogwoods grow into dense thickets in grasslands which crowd out desired grasses, sedges and herbs, and alter wildlife habitat. In Australia, it shades and crowds out understorey species in tall open forest.

Years to infest potential range – 75 years 'high' rate of invasion.

Annual cost of control for landholder
Assumed as $1000 ha/year, based on discussion with biosecurity staff.

Proportion of land over which pests voluntarily controlled
One per cent.

Proportion of land to which conservation values apply
Based on GIS analysis, conservation values are assumed to be 90 per cent.

Any benefits provided by the weed
Possible food source for birds

Biocontrol
Nil.

Year strategy objectives achieved (eradication)
Assumed as 10 years for the purpose of this analysis.

RESULTS

PLANT PEST		Strawberry dogwood	
	No RPMP	**Containment**	**Eradication**
Cost and losses under option	**$884,098**	**$129,998**	**$0**
Section 71(e) NPV		**$754,100**	**$884,098**
Section 71(e) regional values cost/ha		**$3**	**$4**
Section 71(f) NPV (*NRB*)		**$794,099**	**$859,098**
Section 71(f) area of spillover prevented (ha)		**264,204**	**264,204**

Base Assumptions

Discount Rate		**8%**	
Initial Area Infested (ha)	(IAI)	**200**	**(ha)**
Weighted Average Gross Margin for Infested Land ($/ha)	(WAGM)	**$0**	**($/ha)**
Proportion of Production Loss from Infested Land (%)	(PPLIL)	**0%**	**(%)**
Total Area Potentially Infested	(TAPI)	**264,404**	**(ha)**
Years to Infest all of TAPI (years)	(YI)	**75**	**(Years)**
Annual Cost of Control for Landholder ($/ha affected)	(ACCL)	**$1,000**	**($/ha)**
Proportion of Landholders Controlling Pests (%)	(PLCP)	**1.0%**	**(%)**
Proportion of Infested Land to which Conservation Values Apply (%)	(PILCV)	**90%**	**(%)**
Any Benefits Provided by Weed (total $ / annum)	(BPBW)	**-**	**($)**

Containment Assumptions			
Biocontrol ($/annum)		**$ -**	**($)**
Year Strategy objectives Achieved	(YOA)	**10**	**(Years)**
Area Infested if Strategy Objectives Achieved (ha)	(AISOA)	**100**	**(ha)**
Proportion of Production Loss from Infested Land when Strategy Objectives Achieved(%)	(PPLSOA)	**0%**	**(%)**

Eradication Assumptions			
Year Strategy objectives Achieved	(YOA)	**10**	**(Years)**

Regional Council Costs

Year	**Containment**	Eradication
1	$5,000	$0
2	$5,000	$0
3	$5,000	$0
4	$5,000	$0
5	$5,000	$0
6	$5,000	$0
7	$5,000	$0
8	$5,000	$0
9	$5,000	$0
Year onward 10	$5,000	$0
NPV	**$64,999**	**$0**

Control Costs

Year	Containment	Eradication
1	$5,000	$0
2	$5,000	$0
3	$5,000	$0
4	$5,000	$0
5	$5,000	$0
6	$5,000	$0
7	$5,000	$0
8	$5,000	$0
9	$5,000	$0
Year onward 10	$5,000	$0
NPV	**$64,999**	**$0**

CONCLUSIONS

The desired outcome of the Regional Pest Management Plan is to prevent this plant from spreading from existing sites and eradicate plants that are in or close to significant natural areas.

No RPMP outcome
The outcome in the no RPMP Scenario is a loss of $2,644,039 per annum in 75 years as a result of production losses and additional costs of control. This is equivalent to an NPV of approximately $884,098. In addition there are 235,583.9ha on which damages to regionally significant values will occur.

Containment outcome
The outcome of the containment scenario is an NPV of $64,999 for administration, inspection, monitoring and enforcement, an NPV of $64,999 for costs of control, and loss of $0 per annum in 10 years as a result of production losses. This is a total cost in present day terms (NPV) of approximately $129,998 at a discount rate of 0.08 per cent. In addition there will be a total of 90ha on which damages to regionally significant conservation values will occur.

The net outcome for containment when compared with the no RPMP approach produces a net positive benefit of $754,100 in NPV terms. This option protects significant regional biodiversity values on 235,493.9ha through the prevention of spread of this organism. Containment is preferred since it produces the highest net benefit, and best satisfies the requirements of section 71(e).

If the requirements of section 71(e) are deemed by council to have been met, then the costs of the strategy can be charged to the regional community as beneficiaries and the benefits will exceed the costs. Those on whose property the pest currently exists are exacerbators, and can reasonably be charged the cost of control, satisfying section 71(f).

SUMMARY

Potential pest plants	**Proposed programme**	**Section 71(d)** *Is the pest a serious threat to the region?*	**Section 71(e)** *Do the benefits outweigh the costs?*	**Section 71(f)** *Who receives the benefit?*	**Estimated council cost per annum $**
Strawberry dogwood	Site-led	Yes, part (ii) and (iv)	Yes, if conservation values protected exceed $0.55 or if 1% of area is controlled in the absence of a strategy.	Wider regional community	$5,000

4.17 Wilding kiwifruit (*Actinidia spp.)*

Description and biological capability
Form

- Vigorous perennial vine up to 15m. Climbing or straggling.

Habitat

- Exotic and native forest, particularly on the margins and in light gaps, regenerating forest, riparian margins, and scrub. Usually close to kiwifruit orchards or where excess fruit has been dumped or fed to stock.

Regional distribution

- Scattered throughout region.

Biological success
Dispersal methods

- Birds and stock can spread seed. Fruit also distributed by dumping or used as stock food for cattle and deer.

Reproductive ability

- Each fruit contains numerous small seeds.

Competitive ability

- Can smother or strangle host plants. Very vigorous grower.

Other considerations
Toxicity

- Nil.

Resistance to control

- Can be cut and treated with herbicide or sprayed during spring and summer.

Benefits

- Edible fruit. Reject export fruit used as livestock feed.

Wilding kiwifruit will be new to the RPMP. Wilding kiwifruit is a serious pest in the Bay of Plenty due to large scale commercial production, the dumping of reject fruit and reject fruit used as stock feed. The Department of Conservation and MPI have assessed this plant as the highest weed risk (equal to woolly nightshade).

Small infestations of wilding kiwifruit have been found across the region but the true extent of wilding kiwifruit is unknown. Due to the PSA incursion the Kiwifruit Vine Health (KVH) are working through the process of forming a National Pest Management Strategy (NPMS).

Change – New plant to strategy.

Proposed rule – Site-led, where council may undertake direct control if appropriate.

Waikato distribution – scattered across the region

Potential distribution – 400000ha (same as old man's beard).

Waikato infestation size – 2ha (each site is ~4m^2).

Cost of control – $2500/ha.

ASSUMPTIONS

Initial area infested

Wilding kiwifruit is present in the Waikato. It currently has relatively few sites.

Known infestation is ~2ha

Weighted average gross margin

$700/ha

Wilding kiwifruit weighted average gross margin			
Land use	Area	Gross margin	
Plantation (planted forest) 10m margin	20936.71	$700	14655697
Total	**20936.71**		**14655697**
Weighted average gross margin			**$700**

Proportion of production loss from infested land

Assumed as 35 per cent, based on effect on system (EOS) score.

Wilding kiwifruit can invade the edge of plantation forestry. Once the plantation is felled the seed from bird spread kiwifruit will germinate and dominate the disturbed site.

Total area potentially infested (TAPI)

Wilding kiwifruit spreads via animal (birds, pigs, deer).

Potentially infested	ha
Roads - to towns, 4m x length	4,595ha
Railway - to towns, 4m x length	142ha
Indigenous forest - 10m margin	19,371ha
Plantation (planted forest) 10m margin	20,937ha
Shrubland/scrub (manuka, kanuka)	175,800ha
Total	**220,845ha**

Years to infest all TAPI

Kiwifruit is an easily accessible food source for birds, rats and possums, as reject kiwifruit are used by farmers to feed stock.

Each kiwifruit has about 1100 seeds. This means a large number of seeds can be spread from bird droppings, allowing for growth of wilding kiwifruit wherever the birds fly. Wilding kiwifruit can form a mound of tangled stems up to three metres high, or grow up and over native and exotic trees. If left uncontrolled, wild kiwifruit can strangle trees causing them to die or fall. Without active control of wilding kiwifruit, areas of forests and native bush might soon disappear in parts of our region.

Years to infest potential range – 75 years 'high' rate of invasion .

Annual cost of control for landholder
Assumed as $2500 ha/year, based on discussion with Bay of Plenty biosecurity staff.

Proportion of land over which pests voluntarily controlled
Two per cent.

Proportion of land to which conservation values apply
Based on GIS analysis, conservation values are assumed to be 90 per cent.

Any benefits provided by the weed
Nil.

Biocontrol
Nil.

Year strategy objectives achieved (containment)
2023.

Area infested if objectives (containment) achieved
Two hectares.

Proportion of production loss from infested land when strategy objectives (containment) achieved
N/A.

Year strategy objectives achieved (eradication)
Assumed as 10 years for the purpose of this analysis.

RESULTS

PLANT PEST		**Wilding kiwifruit**	
	No RPMP	**Containment**	**Eradication**
Cost and losses under option	**$10,889,913**	**$0**	**$519,990**
Section 71(e) NPV		**$10,889,913**	**$10,369,923**
Section 71(e) regional values cost/ha		**$47**	**$44**
Section 71(f) NPV (*NRB*)		**$10,882,663**	**$10,622,668**
Section 71(f) area of spillover prevented (ha)		**264,402**	**264,402**

Base Assumptions

Discount Rate		**8%**	
Initial Area Infested (ha)	(IAI)	**2**	**(ha)**
Weighted Average Gross Margin for Infested Land ($/ha)	(WAGM)	**$700**	**($/ha)**
Proportion of Production Loss from Infested Land (%)	(PPLIL)	**35%**	**(%)**
Total Area Potentially Infested	(TAPI)	**264,404**	**(ha)**
Years to Infest all of TAPI (years)	(YI)	**75**	**(Years)**
Annual Cost of Control for Landholder ($/ha affected)	(ACCL)	**$2,500**	**($/ha)**
Proportion of Landholders Controlling Pests (%)	(PLCP)	**2.0%**	**(%)**
Proportion of Infested Land to which Conservation Values Apply (%)	(PILCV)	**90%**	**(%)**
Any Benefits Provided by Weed (total $ / annum)	(BPBW)	**-**	**($)**

Containment Assumptions			
Biocontrol ($/annum)		$ -	($)
Year Strategy objectives Achieved	(YOA)	10	(Years)
Area Infested if Strategy Objectives Achieved (ha)	(AISOA)	2	(ha)
Proportion of Production Loss from Infested Land when Strategy Objectives Achieved(%)	(PPLSOA)	0%	(%)

Eradication Assumptions			
Year Strategy objectives Achieved	(YOA)	10	(Years)

Regional Council Costs		
Year	Containment	Eradication
1		$20,000
2		$20,000
3		$20,000
4		$20,000
5		$20,000
6		$20,000
7		$20,000
8		$20,000
9		$20,000
Year 10 onward		$20,000
NPV	$0	$259,995

Control Costs		
Year	Containment	Eradication
1		$20,000
2		$20,000
3		$20,000
4		$20,000
5		$20,000
6		$20,000
7		$20,000
8		$20,000
9		$20,000
Year 10 onward		$20,000
NPV	$0	$259,995

CONCLUSIONS

The desired outcome of the Regional Pest Management Plan is to prevent this plant from spreading from existing sites and eradicate plants that are in or close to significant natural areas.

No RPMP outcome
The outcome in the no RPMP scenario is a loss of $76,703,600 per annum in 75 years as a result of production losses and additional costs of control. This is equivalent to an NPV of approximately $10,889,913. In addition there are 233,204.3ha on which damages to regionally significant conservation values will occur.

Eradication outcome
The outcome of the eradication scenario is an NPV of $259,995 for administration, inspection, monitoring and enforcement, and an NPV of $259,995 for costs of control. This is a total cost in present day terms (NPV) of approximately $519,990 at a discount rate of 0.08 per cent. In addition there will be no damages to regionally significant conservation values from this pest once eradication has been achieved.

The net outcome for eradication net benefits when compared with the no RPMP scenario is $10,369,923 in NPV terms. This option protects significant regional biodiversity values on 233,202.5ha through the prevention of spread of this organism. Eradication is preferred since it produces the highest net benefit, and best satisfies the requirements of section 71(e).

If the requirements of section 71(e) are deemed by council to have been met, then the costs of the strategy can be charged to the regional community as beneficiaries and the benefits will exceed the costs. Those on whose property the pest currently exists are exacerbators, and can reasonably be charged the cost of control, satisfying section 71(f).

SUMMARY

Potential pest plants	**Proposed**	**Section 71(d)** *Is the pest a serious threat to the region?*	**Section 71(e)** *Do the benefits outweigh the costs?*	**Section 71(f)** *Who receives the benefit?*	**Estimated council cost per annum $**
Wilding kiwifruit	Site-led	Yes, part (i), (ii) and (iv)	Yes, if conservation values protected exceed $2.23 or if 2% of area is controlled in the absence of a strategy.	Wider regional community	$20,000

5 CBA prepared for previous pest management plans

5.1 African feather grass (*Pennisetum macrourum*) (2002)

Description and biological capability	
Form	• An erect perennial grass, commonly 1-1.8m high. Leaves are light green and purplish along the edges and tips. Florets are numerous, 5-7mm long surrounded by feather-like serrated bristles to 1cm long. Very similar to pampas grass.
Habitat	• Prefers damp situations in swamps and along streams. • Prefers temperate regions, sandy soil and annual rainfall above 600mm.
Regional distribution	• There are very few known sites in the region (Te Kauwhata/ Taupō). Only one site appears to be increasing in size.
Biological success	
Dispersal method	• Most reproduction is by rhizomes, which grow rapidly in spring and summer, depending largely on available moisture. Seeds can travel by water, gravel and animals.
Reproductive ability	• Seeds are capable of germination (99,000 seeds per m^2) but seedling establishment is poor. Has extensive fibrous roots to a depth of 1m and stout rhizomes which can reproduce from small pieces.
Competitive ability	• Can displace competing species due to spread of rhizomes. Forms dense clumps that exclude desirable vegetation.
Other considerations	
Toxicity	• Nil.
Resistance to control	• Not readily controlled by herbicides. Cultivation can exacerbate problem. Re-establishment from seed causes problems also. • Regenerates easily from small fragments. Extremely drought resistant. Recovers from burning.

Impact evaluation				
	Current impact (Y\N)	**Current level of impact (Nil, L, M, H)**	**Potential impact (Y\N)**	**Potential level of impact (Nil, L, M, H)**
Endangered Species	Y	L	Y	M
Species Diversity	Y	L	Y	M
Soil resources	N	-	N	-
Water Quality	N	-	N	-
Human Health	N	-	N	-
Māori Culture	Y	L	Y	M
Production	Y	L	Y	H
Recreation	Y	-	N	-
International trade	N	-	N	-

Assessment of effects status: Major

Scenario: No RPMS

Assumptions		
Initial area infested (ha)	(IAI)	3
Total area potentially infested	(TAPI)	3,000
Years to infest all of TAPI (years)	(YI)	20
Weighted average gross margin for infested land ($/ha)	(WAGM)	100
Annual cost of control for land occupier ($/ha affected)	(ACCL)	250
Proportion of land occupiers controlling pests (%)	(PLCP)	10
Proportion of production loss from infested land (%)	(PPLIL)	5
Proportion of infested land to which conservation values apply (%)	(PILCV)	100
Any benefits provided by the weed	(BPBW)	0
Discount Rate	(DRATE)	8
Calculations		
Multiplier: work out using "RPMS guidelines - Do Nothing.xls" (IAI. TAPI, YI, DRATE)	(MDN)	3.919
Loss of production from initial area infested = IAI X WAGM X (1 - (PLCP/100)) X PPLIL	(LOPIAI)	14
Loss of production in year Y1 =WAGM X TAPI X (1 - (PLCP/100)) X PPLIL	(LOP)	13,500
Costs of control in initial area = IAI x ACCL x (PLCP/100)	(COCIAI)	75
Costs of control in year Y1 = TAPI X ACCL X (PLCP/100)	(COC)	75,000
Total damage in No RPMS Scenario ($/annum) = (LOP + COC - BPBW)	(TDDNS)	88,500
Net present value No RPMS = TDDNS X MDN	(NPVDN)	346,832
Area of conservation and other regional damages = PILCV/100 X (1 - (PLCP/100)) X TAPI (ha)	(ACORD)	2,700

Scenario: Eradication

1. Annual regional costs (inspection, monitoring, enforcement, administration etc) converted to present day terms

Year	Regional cost (A)	8% discount rate multiplier (B)	NPV (A x B)	
1	19,457	1.000	19457.000	
2	19,457	0.926	18017.182	
3	19,457	0.857	16674.649	
4	19,457	0.794	15448.858	
5	19,457	0.735	14300.895	
6	19,457	0.681	13250.217	
7	19,457	0.630	12257.910	
8	19,457	0.583	11343.431	
9	19,457	0.540	10506.780	
Year 10 onward	19,457	6.253	121664.621	
	Total Sum NPV Column		**$252,922**	**(TRC)**

2. Annual cost of control for pest weed converted to present day terms

Year	Control cost (A)	8% discount rate multiplier (B)	NPV (A x B)	
1	750	1.000	750	
2	675	0.926	625	
3	608	0.857	521	
4	547	0.794	434	
5	492	0.735	362	
6	443	0.681	302	
7	399	0.630	251	
8	359	0.583	209	
9	323	0.540	174	
Year 10 onward	291	6.253	1817	
	Total Sum NPV Column		**$5,445**	**(TCC)**

Assumptions		
Current area infested (ha)	(CAI)	3
Current density (area displaced ha/ha) %	(DCY)	2
Year strategy objectives achieved	(YOA)	5
Area infested if strategy objectives achieved (ha)	(AISOA)	-
Average density if strategy objectives achieved (area displaced ha/ha) %	(DSOA)	-
Any benefits provided by weed (total $ / annum)	(BPBW)	-
Calculations		
Multiplier: "RPMS Guideline - Scenarios.xls"	(MRPMS)	2.592
Loss of production in current year = WAGM x CAI x DCY	(LOPC)	7
Loss of production in YOA = WAGM x AISOA x DSOA	(LOPYOA)	0
Total damage in RPMS Scenario ($/annum) = LOPC x MRPMS	(TDRPMS)	19
Area of conservation and other regional damages = PILCV/100 x AISOA	(ACORDRRPMS)	0
Total cost RPMS Scenario = TDRPMS + TCC + TRC	(NPVRPMS)	258,385
CALCULATIONS: SECTION 72(A)		
Net benefit of RPMS Scenario = NPVDN - NPVRPMS ($)	(NBRPMS)	88,447
Prevented damage to regional values ACORD - ACORDRPMS (ha)	(APDCV)	2,700
Cost/ha of preventing damage to regional values = NBRPMS / APDCV	(CVHA)	33

CALCULATIONS: SECTION 72(B)		
Damage on initially infested area = (LOPIAI + COCIAI) / Multiplier ($)	(DOIAI)	1,106
Costs of spill over = NPVDN - DOIAI	(COS)	345,725
Net regional benefit = COS - TRC	(NRB)	92,804
Area spill over prevented = TAPI - IAI	(ASP)	2,997

Cost benefit analysis summary

Two scenarios for control of African feather grass have been considered:

1. do nothing
2. eradication.

The "do nothing" scenario results in total regional damage of $88,500 NPV.

The "eradication" scenario has costs of $20,207 per annum. The cost to the region is $258,385 NPV. This results in a positive benefit of $88,447 NPV and therefore it meets the requirements of section 72 (1)(a) of the Act.

Eradication is the preferred option as it produces a positive net benefit. The regional net benefit is $92,804, therefore the requirements of section 72(1)(b) of the Act are met.

5.2 Alligator weed (*Alternanthera philoxeroides*) (2007)

ASSUMPTIONS (For terrestrial infestations)

Initial area infested (ha)
Known terrestrial urban and industrial sites in and around Hamilton cover some 249 ha with a further 100ha infested at four different rural sites across the region. First noted in the region at a rural site in the mid 1990s. Believed to have been brought into Hamilton with contaminated soil.

Weighted average gross margin ($/ha)
Assume an average $3641.00 per hectare calculated from the MAF farm monitoring website and other relevant information.

Proportion of production loss from infested land (%)
15%, based on the fact that while palatable to stock, alligator weed is actually toxic and can cause blindness (and possibly other ill effects) to animals that eat the plant. Given that the majority of known sites are urban a conservative percentage is assumed for this analysis.

Total area potentially infested (TAPI) (ha)
Assuming eradication is not achieved within the 20 years predicted; infestation of up to 10,000 ha could reasonably be expected at that time. Potentially up to 1,607,322ha within the region has been identified from GIS mapping as being capable of supporting this weed in terrestrial sites.

Years to infest all TAPI
Alligator weed (*Alternanthera philoxeroides*) is a native of South America and was accidentally introduced to New Zealand in the 1880s in ballast water discarded from ships. Since then, it has spread through the northern part of the North Island and is found in the lower Waikato River, on several farms, in market gardens and urban properties in the Waikato Region.

Alligator weed is not just a serious threat to wetlands, lakes, rivers, dams, drains and waterways. It is also a major threat to farming and market gardens and urban properties because it grows quickly on dry land and is hard to eradicate. It can affect urban amenities and rural or horticultural production, reducing the value of property and business viability.

Alligator weed does not set seed in New Zealand but spreads aggressively from even the smallest of fragmented stems. It can double in area in less than two months. Alligator weed is a perennial prostrate herb. Leaves are generally arranged in pairs or whorls at intervals along hollow horizontal stems. Stem and leaf size vary greatly. They can be very compact in lawns or grazed pasture, or much larger when growing in water. The flowers are white, papery and clover-like, held erect on stalks. They appear between December and March. Alligator weed floats on water and thrives in shallow drainage ditches, canals, rivers, lakes, reservoirs, swamps and wet pastures. It can also grow easily on dry land.

Taking into account all the available information regarding this pest plant an assumption has been made that without any control there is the potential to infest the entire available habitat within 100 years. Alligator weed is banned from sale, propagation and distribution under the National Plant Pest Accord.

Annual cost of control for landholder ($/ha)
$220.00 per hectare has been assumed to be the cost of landowner control for this pest accounting for both urban and rural sites.

Proportion of land over which pests voluntarily controlled (%)
An assumption has been made that up to 10% of urban property owners will attempt voluntary control in lawns and gardens.

Proportion of land to which conservation values apply (%)
It is assumed that up to 10% of land will have conservation values in a terrestrial situation.

Any benefits provided by the weed ($p.a.)
Nil.

Biocontrol ($p.a.)
Nil.

Year strategy objectives achieved (eradication)
Assume 20 years for the purposes of this analysis.

RESULTS

PLANT PEST		Alligator weed-terrestrial	
	No RPMS	Containment	Eradication
Cost and losses under option	$27,414,984	$0	$1,299,976
Section 72(a) NPV		$0	$26,115,008
Section 72(a) regional values cost/ha		$0	$29,017
Section 72(b) NPV (*NRB*)		$0	$24,784,691
Section 72(b) area of spillover prevented (ha)		0	9,651

Base Assumptions

Discount Rate		8%	
Initial Area Infested (ha)	(IAI)	349	(ha)
Weighted Average Gross Margin for Infested Land ($/ha)	(WAGM)	$3,641	($/ha)
Proportion of Production Loss from Infested Land (%)	(PPLIL)	15%	(%)
Total Area Potentially Infested	(TAPI)	10,000	(ha)
Years to Infest all of TAPI (years)	(YI)	20	(Years)
Annual Cost of Control for Landholder ($/ha affected)	(ACCL)	$220	($/ha)
Proportion of Landholders Controlling Pests (%)	(PLCP)	10.0%	(%)
Proportion of Infested Land to which Conservation Values Apply (%)	(PILCV)	10%	(%)
Any Benefits Provided by Weed (total $ / annum)	(BPBW)		($)

Containment Assumptions			
Biocontrol ($/annum)			($)
Year Strategy objectives Achieved	(YOA)		(Years)
Area Infested if Strategy Objectives Achieved (ha)	(AISOA)		(ha)
Proportion of Production Loss from Infested Land when Strategy Objectives Achieved(%)	(PPLSOA)	0%	(%)

Eradication Assumptions			
Year Strategy objectives Achieved	(YOA)	20	(Years)

Regional Council Costs		
Year	**Containment**	Eradication
1		$30,000
2		$30,000
3		$30,000
4		$30,000
5		$30,000
6		$30,000
7		$30,000
8		$30,000
9		$30,000
Year 10 onward		$30,000
NPV	**$0**	**$389,993**

Control Costs		
Year	Containment	Eradication
1		$70,000
2		$70,000
3		$70,000
4		$70,000
5		$70,000
6		$70,000
7		$70,000
8		$70,000
9		$70,000
Year 10 onward		$70,000
NPV	**$0**	**$909,983**

CONCLUSIONS

This analysis considers only two options, no control and eradication because the aim of the Regional Pest Management Strategy is to eradicate this pest plant.

The outcome in the no RPMS scenario is a loss of $5,135,350 per annum in 20 years as a result of production losses and additional costs of control. This is equivalent to a NPV of approximately $27,414,984. In addition there is 900ha on which damages to regionally significant conservation, recreation, amenity, Māori or soil and water values will occur.

The outcome of the eradication scenario is a NPV of $389,993 for administration, inspection, monitoring and enforcement, a NPV of $909,983 for costs of control, and loss of $0 per annum in 20 years as a result of production losses. This is a total cost in present day terms (NPV) of approximately $1,299,976 at a discount rate of 0.08%. In addition there will be no damages to regionally significant conservation, recreation, amenity, Māori or soil and water values from this pest once eradication has been achieved.

The net outcome for eradication when compared with the no RPMS scenario is $26,115,008 in NPV terms. This option protects significant regional biodiversity values on 900ha through the prevention of spread of this organism. Eradication is preferred since it produces the highest net benefit, and best satisfies the requirements of section 72(a) of the BSA 1993.

The net regional benefits exceed the individual benefits by $24,784,691 because the strategy prevents the spread of the pest onto 900ha. The strategy also prevents damage to regional values on 900 ha, and eradication therefore satisfies the requirements of section 72(b).

If the requirements of section 72(a) and (b) are deemed by council to have been met, then the costs of the strategy can be charged to the regional community as beneficiaries and the benefits received will exceed the costs. Those on whose property the pest currently exists are exacerbators, and can reasonably be charged the cost of control, satisfying section 72(ba) of the Biosecurity Act 1993.

5.3 Australian sedge (*Carex longebranchiata*) (2002)

Description and biological capability	
Form	• Perennial tussock 30-60cm high. It has harsh cutting leaves with definite Y-shaped groove and is bluish-green.
Habitat	• Grows on poor land with low fertility and exposed conditions. • Persists in pastures, grassy places.
Regional distribution	• Limited distribution, but sites known in Hauraki, Coromandel, Waitomo and North Waikato.
Biological success	
Dispersal method	• Mostly by livestock transporting the heavy seed.
Reproductive ability	• It is a prolific seeder (around 800 seeds produced per plant). • New plants are produced at the base. • Seeds viable for up to three years.
Competitive ability	• Displaces native species in wetland areas. Forms dense patches excluding pasture species when established.
Other considerations	
Toxicity	• Seeds can damage pelts.
Resistance to control	• When established it is difficult and costly to eradicate especially on hill country.

Impact evaluation				
	Current impact (Y\N)	**Current level of impact (Nil, L, M, H)**	**Potential impact (Y\N)**	**Potential level of impact (Nil, L, M, H)**
Endangered Species	N	-	N	-
Species Diversity	Y	L	Y	L-M
Soil resources	N	-	N	-
Water Quality	N	-	N	-
Human Health	N	-	N	-
Māori Culture	Y	L	Y	L-M
Production	Y	L	Y	L-M
Recreation	N	-	N	-
International trade	N	-	N	-

Assessment of effects status: Moderate

Scenario: No RPMS

Assumptions		
Initial area infested (ha)	(IAI)	1,080
Total area potentially infested	(TAPI)	2,000
Years to infest all of TAPI (years)	(YI)	50
Weighted average gross margin for infested land ($/ha)	(WAGM)	$402
Annual cost of control for land occupier ($/ha affected)	(ACCL)	$351
Proportion of land occupiers controlling pests (%)	(PLCP)	10
Proportion of production loss from infested land (%)	(PPLIL)	20
Proportion of infested land to which conservation values apply (%)	(PILCV)	5
Any benefits provided by the weed	(BPBW)	0
Discount rate	(DRATE)	8
Calculations		
Multiplier: work out using "RPMS guidelines - Do Nothing.xls" (IAI. TAPI, YI, DRATE)	(MDN)	8.424
Loss of production from initial area infested = IAI X WAGM X (1 - (PLCP/100)) X PPLIL	(LOPIAI)	78,149
Loss of production in year Y1 =WAGM X TAPI X (1 - (PLCP/100)) X PPLIL	(LOP)	144,720
Costs of control in initial area = IAI x ACCL x (PLCP/100)	(COCIAI)	37,908
Costs of control in Year Y1 = TAPI X ACCL X (PLCP/100)	(COC)	70,200
Total damage in No RPMS Scenario ($/annum) = (LOP + COC - BPBW)	(TDDNS)	214,920
Net present value No RPMS = TDDNS X MDN	(NPVDN)	1,810,486
Area of conservation and other regional damages = PILCV/100 X (1 - (PLCP/100)) X TAPI (ha)	(ACORD)	90

Scenario: Containment Control

1. Annual regional costs (inspection, monitoring, enforcement, administration etc) converted to present day terms

Year	Regional Cost (A)	8% Discount Rate Multiplier (B)	NPV (A x B)	
1	14,500	1.000	14500	
2	14,500	0.926	13427	
3	14,500	0.857	12427	
4	14,500	0.794	11513	
5	14,500	0.735	10658	
6	14,500	0.681	9875	
7	14,500	0.630	9135	
8	14,500	0.583	8454	
9	14,500	0.540	7830	
Year 10 onward	14,500	6.253	90669	
	Total Sum NPV Column		**$ 188,486**	**(TRC)**

2. Annual cost of control for pest weed converted to present day terms

Year	Control cost (A)	8% discount rate multiplier (B)	NPV (A x B)	
1	30,326	1.000	30326	
2	30,326	0.926	28082	
3	30,326	0.857	25990	
4	30,326	0.794	24079	
5	30,326	0.735	22290	
6	30,326	0.681	20652	
7	30,326	0.630	19106	
8	30,326	0.583	17680	
9	30,326	0.540	16376	
Year 10 onward	30,326	6.253	189631	
	Total Sum NPV Column		**$394,213**	**(TCC)**

Assumptions		
Current area infested (ha)	(CAI)	1,080
Current density (area displaced ha/ha) %	(DCY)	80
Year strategy objectives achieved	(YOA)	10
Area infested if strategy objectives achieved (ha)	(AISOA)	860
Average density if strategy objectives achieved (area displaced ha/ha) %	(DSOA)	25
Any benefits provided by weed (total $ / annum)	(BPBW)	-
Calculations		
Multiplier: "RPMS Guideline - Scenarios.xls"	(MRPMS)	10.897
Loss of production in current year = WAGM x CAI x DCY	(LOPC)	347,328
Loss of production in YOA = WAGM x AISOA x DSOA	(LOPYOA)	86,430
Total damage in RPMS scenario ($/annum) = LOPC x MRPMS	(TDRPMS)	3,784,833
Area of conservation and other regional damages = PILCV/100 x AISOA	(ACORDRRPMS)	43
Total cost RPMS Scenario = TDRPMS + TCC + TRC	(NPVRPMS)	4,367,532
CALCULATIONS: SECTION 72(A)		
Net benefit of RPMS Scenario = NPVDN - NPVRPMS ($)	(NBRPMS)	(2,557,046)
Prevented damage to regional values ACORD - ACORDRPMS (ha)	(APDCV)	47
Cost/ha of preventing damage to regional values = NBRPMS / APDCV	(CVHA)	(54,405)

CALCULATIONS: SECTION 72(B)		
Damage on initially infested area = (LOPIAI + COCIAI) / Multiplier ($)	(DOIAI)	1,450,710
Costs of spill over = NPVDN - DOIAI	(COS)	359,776
Net regional benefit = COS - TRC	(NRB)	171,291
Area spill over prevented = TAPI - IAI	(ASP)	920

Scenario: Eradication

1. Annual regional costs (inspection, monitoring, enforcement, administration etc) converted to present day terms

Year	Regional cost (A)	8% discount rate multiplier (B)	NPV (A x B)	
1	14,500	1.000	14500.000	
2	14,500	0.926	13427.000	
3	14,500	0.857	12426.500	
4	14,500	0.794	11513.000	
5	14,500	0.735	10657.500	
6	14,500	0.681	9874.500	
7	14,500	0.630	9135.000	
8	14,500	0.583	8453.500	
9	14,500	0.540	7830.000	
Year 10 onward	14,500	6.253	90668.500	
	Total Sum NPV Column		**$188,486**	**(TRC)**

2. Annual cost of control for pest weed converted to present day terms

Year	Control cost (A)	8% discount rate multiplier (B)	NPV (A x B)	
1	379,080	1.000	379080	
2	341,172	0.926	315925	
3	307,055	0.857	263146	
4	276,349	0.794	219421	
5	248,714	0.735	182805	
6	223,843	0.681	152437	
7	201,459	0.630	126919	
8	181,313	0.583	105705	
9	163,182	0.540	88118	
Year 10 onward	146,863	6.253	918337	
	Total Sum NPV Column		**$2,751,894**	**(TCC)**

Assumptions		
Current area infested (ha)	(CAI)	1,080
Current density (area displaced ha/ha) %	(DCY)	80
Year strategy objectives achieved	(YOA)	10
Area infested if strategy objectives achieved (ha)	(AISOA)	607
Average density if strategy objectives achieved (area displaced ha/ha) %	(DSOA)	10
Any benefits provided by weed (total $ / annum)	(BPBW)	-
Calculations		
Multiplier: "RPMS Guideline - Scenarios.xls"	(MRPMS)	4.186
Loss of production in current year = WAGM x CAI x DCY	(LOPC)	347,328
Loss of production in YOA = WAGM x AISOA x DSOA	(LOPYOA)	24,401
Total damage in RPMS Scenario ($/annum) = LOPC x MRPMS	(TDRPMS)	1,453,915
Area of conservation and other regional damages = PILCV/100 x AISOA	(ACORDRRPMS)	30
Total cost RPMS Scenario = TDRPMS + TCC + TRC	(NPVRPMS)	4,394,294
CALCULATIONS: SECTION 72(A)		
Net benefit of RPMS Scenario = NPVDN - NPVRPMS ($)	(NBRPMS)	(2,583,808)
Prevented damage to regional values ACORD - ACORDRPMS (ha)	(APDCV)	60
Cost/ha of preventing damage to regional values = NBRPMS / APDCV	(CVHA)	(43,316)

CALCULATIONS: SECTION 72(B)		
Damage on initially infested area = (LOPIAI + COCIAI) / Multiplier ($)	(DOIAI)	1,450,710
Costs of spill over = NPVDN - DOIAI	(COS)	359,776
Net regional benefit = COS - TRC	(NRB)	171,291
Area spill over prevented = TAPI - IAI	(ASP)	920

Cost benefit analysis summary

Three scenarios for control of Australian sedge have been considered:

1. do nothing
2. eradication
3. containment control.

The "do nothing" scenario results in total regional damage of $214,920 NPV.

The "eradication" scenario has costs of $393,580 per annum. The cost to the region is $4,394,294 NPV. This results in a negative benefit of $2,583,808 NPV and therefore it does not meet the requirements of section 72 (1)(a) of the Act.

The "containment control" scenario has costs of $44,826 per annum. The cost to the region is $4,367,532 NPV. The result of this scenario is a negative benefit of $2,557,046 NPV and therefore it does not meet the requirements of section 72 (1)(a) of the Act.

Containment control, through a boundary control standard, is the preferred option as it has a lower cost. The regional net benefit is positive $171,291 therefore the requirements of section 72(1)(b) of the Act are met. Council has exercised its discretion and concluded that while mandatory boundary control of Australian sedge is not cost effective, a fall-back position should be adopted to allow for enforcement on a complaints only basis.

5.4 Banana passionfruit (*Passiflora mixta* and *P. mollissima*) (2002)

Description and biological capability	
Form	• Vigorous high climbing vine. • Three-lobed leaves large hanging pink star-shaped flowers which become a yellow oval fruit.
Habitat	• Margins of disturbed forest, wind breaks, plantations, usually close to habitation. Also on roadsides and wasteland. • Open coastal forest, invades weeded forest areas.
Regional distribution	• Known sites Raglan, Coromandel, possible other coastal areas and temperate climates. Extent of distribution unknown.
Biological success	
Dispersal method	• Dispersed by possums and birds that peck at fallen fruit. Overseas evidence shows mainly dispersed by pigs, cattle and pheasants. Also spread by humans who discard partly eaten fruit or who grow it for its fruit.
Reproductive ability	• Low percentage of seeds develop to maturity, but if a pollinator were introduced this rate would increase dramatically.
Competitive ability	• Plants are shade intolerant but tolerant of physical damage and grazing. In wet areas the damping of fungus, *Pythiums* and slugs may decrease establishment success. • Very rapid growth rate. Seeds require high light for germination.
Other considerations	
Toxicity	• Fruits are edible- this has led to the human-caused spread of the plant
Resistance to control	• Plants can be hand pulled when young, but regrowth needs to be sprayed with 2% glyphosphate. Biocontrol possibilities being investigated in Hawaii.

Impact evaluation				
	Current impact (Y\N)	**Current level of impact (Nil, L, M, H)**	**Potential impact (Y\N)**	**Potential level of impact (Nil, L, M, H)**
Endangered Species	Y	L	Y	M
Species Diversity	Y	L	Y	H
Soil resources	N	-	N	-
Water Quality	N	-	N	-
Human Health	N	-	N	-
Māori Culture	Y	L	Y	M
Production	N	-	N	-
Recreation	N	-	N	-
International trade	N	-	N	-

Assessment of effects status: Moderate

5.5 Boneseed (*Chrysanthemoides monilifera*) (2002)

Description and biological capability	
Form	• Bushy, much branched shrub growing to 3m tall.
Habitat	• Coastal cliffs, waste places, consolidated dunes and scrubland.
Regional distribution	• East coast and west coast Waikato Region.
Biological success	
Dispersal method	• Birds disperse seeds.
Reproductive ability	• 50,000 seeds produced per plant, viable for up to 10 years.
Competitive ability	• Plants are tolerant of low fertility and drought, but intolerant of shade and wet. Plant is fire adapted with seed germination stimulated by fire events. • Fast shoot growth. • Can spread by layering, forming pure stands
Other considerations	
Toxicity	• Unknown.
Resistance to control	• Plants tolerant of some physical damage. Can be controlled with brush weed killers but leaves a large seed bank. This plant is the highest priority for biological control in Australia.

Impact evaluation				
	Current impact (Y\N)	**Current level of impact (Nil, L, M, H)**	**Potential impact (Y\N)**	**Potential level of impact (Nil, L, M, H)**
Endangered Species	Y	L	Y	H
Species Diversity	Y	M	Y	H
Soil resources	N	-	N	-
Water Quality	N	-	N	-
Human Health	N	-	N	-
Māori Culture	Y	L	Y	M
Production	Y	L	Y	L
Recreation	Y	L	Y	L
International trade	N	-	N	-

Assessment of effects status: Major

Scenario: No RPMS

Assumptions		
Initial area infested (ha)	(IAI)	22
Total area potentially infested	(TAPI)	11,000
Years to infest all of TAPI (years)	(YI)	20
Weighted average gross margin for infested land ($/ha)	(WAGM)	-
Annual cost of control for land occupier ($/ha affected)	(ACCL)	341
Proportion of land occupiers controlling pests (%)	(PLCP)	5
Proportion of production loss from infested land (%)	(PPLIL)	-
Proportion of infested land to which conservation values apply (%)	(PILCV)	90
Any benefits provided by the weed	(BPBW)	0
Discount rate	(DRATE)	8

Calculations		
Multiplier: work out using "RPMS guidelines - Do Nothing.xls" (IAI. TAPI, YI, DRATE)	(MDN)	4.076
Loss of production from initial area infested = IAI X WAGM X (1 - (PLCP/100)) X PPLIL	(LOPIAI)	0
Loss of production in year Y1 =WAGM X TAPI X (1 - (PLCP/100)) X PPLIL	(LOP)	0
Costs of control in initial area = IAI x ACCL x (PLCP/100)	(COCIAI)	375
Costs of control in Year Y1 = TAPI X ACCL X (PLCP/100)	(COC)	187,550
Total damage in No RPMS Scenario ($/annum) = (LOP + COC - BPBW)	(TDDNS)	187,550
Net present value No RPMS = TDDNS X MDN	(NPVDN)	764,454
Area of conservation and other regional damages = PILCV/100 X (1 - (PLCP/100)) X TAPI (ha)	(ACORD)	9,405

Scenario: Containment Control

1. Annual regional costs (inspection, monitoring, enforcement, administration etc) converted to present day terms

Year	Regional cost (A)	8% discount rate multiplier (B)	NPV (A x B)	
1	19,979	1.000	19979	
2	19,979	0.926	18501	
3	19,979	0.857	17122	
4	19,979	0.794	15863	
5	19,979	0.735	14685	
6	19,979	0.681	13606	
7	19,979	0.630	12587	
8	19,979	0.583	11648	
9	19,979	0.540	10789	
Year 10 onward	19,979	6.253	124929	
	Total Sum NPV Column		**$259,707**	**(TRC)**

2. Annual cost of control for pest weed converted to present day terms

Year	Control cost (A)	8% discount rate multiplier (B)	NPV (A x B)	
1	600	1.000	600	
2	600	0.926	556	
3	600	0.857	514	
4	600	0.794	477	
5	600	0.735	441	
6	600	0.681	409	
7	600	0.630	378	
8	600	0.583	350	
9	600	0.540	324	
Year 10 onward	600	6.253	3753	
	Total Sum NPV Column		**$7,801**	**(TCC)**

Assumptions		
Current area infested (ha)	(CAI)	22
Current density (area displaced ha/ha) %	(DCY)	80
Year strategy objectives achieved	(YOA)	5
Area infested if strategy objectives achieved (ha)	(AISOA)	17
Average density if strategy objectives achieved (area displaced ha/ha) %	(DSOA)	80
Any benefits provided by weed (total $ / annum)	(BPBW)	-
Calculations		
Multiplier: "RPMS Guideline - Scenarios.xls"	(MRPMS)	10.305
Loss of production in current year = WAGM x CAI x DCY	(LOPC)	0
Loss of production in YOA = WAGM x AISOA x DSOA	(LOPYOA)	0
Total damage in RPMS Scenario ($/annum) = LOPC x MRPMS	(TDRPMS)	0
Area of conservation and other regional damages = PILCV/100 x AISOA	(ACORDRR PMS)	15
Total cost RPMS Scenario = TDRPMS + TCC + TRC	(NPVRPMS)	267,509
CALCULATIONS: SECTION 72(A)		
Net benefit of RPMS Scenario = NPVDN - NPVRPMS ($)	(NBRPMS)	496,945
Prevented damage to regional values ACORD - ACORDRPMS (ha)	(APDCV)	9,390
Cost/ha of preventing damage to regional values = NBRPMS / APDCV	(CVHA)	53

CALCULATIONS: SECTION 72(B)		
Damage on initially infested area = (LOPIAI + COCIAI) / Multiplier ($)	(DOIAI)	4,689
Costs of spill over = NPVDN - DOIAI	(COS)	759,765
Net regional benefit = COS - TRC	(NRB)	500,058
Area spill over prevented = TAPI - IAI	(ASP)	10,978

Scenario: Eradication

1. Annual regional costs (inspection, monitoring, enforcement, administration etc) converted to present day terms

Year	Regional cost (A)	8% discount rate multiplier (B)	NPV (A x B)	
1	19,979	1.000	19979.000	
2	19,979	0.926	18500.554	
3	19,979	0.857	17122.003	
4	19,979	0.794	15863.326	
5	19,979	0.735	14684.565	
6	19,979	0.681	13605.699	
7	19,979	0.630	12586.770	
8	19,979	0.583	11647.757	
9	19,979	0.540	10788.660	
Year 10 onward	19,979	6.253	124928.687	
	Total Sum NPV Column		**$259,707**	**(TRC)**

2. Annual cost of control for pest weed converted to present day terms

Year	Control cost (A)	8% discount rate multiplier (B)	NPV (A x B)	
1	7,502	1.000	7502	
2	6,752	0.926	6252	
3	6,077	0.857	5208	
4	5,469	0.794	4342	
5	4,922	0.735	3618	
6	4,430	0.681	3017	
7	3,987	0.630	2512	
8	3,588	0.583	2092	
9	3,229	0.540	1744	
Year 10 onward	2,906	6.253	18174	
	Total Sum NPV Column		**$54,460**	**(TCC)**

Assumptions		
Current area infested (ha)	(CAI)	22
Current density (area displaced ha/ha) %	(DCY)	80
Year strategy objectives achieved	(YOA)	5
Area infested if strategy objectives achieved (ha)	(AISOA)	-
Average density if strategy objectives achieved (area displaced ha/ha) %	(DSOA)	-
Any benefits provided by weed (total $ / annum)	(BPBW)	-
Calculations		
Multiplier: "RPMS Guideline - Scenarios.xls"	(MRPMS)	2.592
Loss of production in current year = WAGM x CAI x DCY	(LOPC)	0
Loss of production in YOA = WAGM x AISOA x DSOA	(LOPYOA)	0
Total damage in RPMS Scenario ($/annum) = LOPC x MRPMS	(TDRPMS)	0
Area of conservation and other regional damages = PILCV/100 x AISOA	(ACORDRR PMS)	0
Total cost RPMS Scenario = TDRPMS + TCC + TRC	(NPVRPMS)	314,167
CALCULATIONS: SECTION 72(A)		
Net benefit of RPMS Scenario = NPVDN - NPVRPMS ($)	(NBRPMS)	450,287
Prevented damage to regional values ACORD - ACORDRPMS (ha)	(APDCV)	9,405
Cost/ha of preventing damage to regional values = NBRPMS / APDCV	(CVHA)	48

CALCULATIONS: SECTION 72(B)		
Damage on initially infested area = (LOPIAI + COCIAI) / Multiplier ($)	(DOIAI)	4,689
Costs of spill over = NPVDN - DOIAI	(COS)	759,765
Net regional benefit = COS - TRC	(NRB)	500,058
Area spill over prevented = TAPI - IAI	(ASP)	10,978

Cost benefit analysis summary

Three scenarios for control of boneseed have been considered:

1. do nothing
2. eradication
3. containment control.

The "do nothing" scenario results in total regional damage of $187,550 NPV.

The "eradication" scenario has costs of $27,481 per annum. The cost to the region is $314,167 NPV. This results in a positive benefit of $450,287 NPV and therefore it does meet the requirements of section 72 (1)(a) of the Act.

The "containment control" scenario has costs of $20,579 per annum. The cost to the region is $267,509 NPV. The result of this scenario is a positive benefit of $496,945 NPV and therefore it meets the requirements of section 72 (1)(a) of the Act.

Containment control is the preferred option as it produces a positive net benefit at a lower cost. The regional net benefit is $500,058, therefore the requirements of section 72(1)(b) of the Act are met. Council considers that the value of land protected is greater than $30 per hectare.

5.6 Broom (*Cytisus scoparius*) (2002)

Description and biological capability	
Form	• Broom is a deciduous shrub with many hairless green twigs generally branching at 45^{o} to the stalk. Leaves are small and in groups of up to three. Flowers are usually single and bright yellow.
Habitat	• Wasteland, scrub, riverbeds, coastal areas, native grassland and previously forested hill country.
Regional distribution	• Widely distributed across region and abundant especially South Waikato and Taupō areas.
Biological success	
Dispersal method	• The seeds are explosively released from the pod in hot dry weather and can be transported by water and on contaminated machinery.
Reproductive ability	• Produces around 18,000 seeds per bush with two flowering periods per year. • Large seedbank remains in soil, still viable after 15 years.
Competitive ability	• Once established in large stands broom shades out most species.
Other considerations	
Toxicity	• Seeds thought to be poisonous if large quantities ingested. Foliage causes digestive disorders in horses.
Resistance to control	• Seeds remain viable in the soil for many years.

Impact evaluation				
	Current impact (Y\N)	**Current level of impact (Nil, L, M, H)**	**Potential impact (Y\N)**	**Potential level of impact (Nil, L, M, H)**
Endangered Species	N	-	N	-
Species Diversity	N	L	N	M
Soil resources	N	-	N	-
Water Quality	N	-	N	-
Human Health	N	-	N	-
Māori Culture	N	L	N	M
Production	Y	L	Y	L-M
Recreation	N	L	N	L
International trade	N	-	N	-

Assessment of effects status: Moderate

5.7 Bushy asparagus (*Asparagus aethiopicus*) (2007)

ASSUMPTIONS

Initial area infested (ha)
Assume 3 ha based on staff knowledge of known sites within the region.

Weighted average gross margin ($/ha)
N/A

Proportion of production loss from infested land (%)
Assumed to be 5% based on staff knowledge of infestation locations.

Total area potentially infested (TAPI) (ha)
GIS modelling shows a potential 5,350 ha as being capable of infestation if no control is undertaken.

Years to infest all TAPI
Bushy asparagus, also known as asparagus fern and ferny asparagus, is a much-branched perennial herb (i.e. not a woody plant). It develops quickly into a thick smothering blanket, killing seedlings or preventing their growth. In well-established colonies, it can completely suppress the growth of native plants, preventing regeneration. Its spiny nature can also seriously restrict access through coastal or recreational areas. Bushy asparagus is spread mainly by plant fragments or seed. Its rhizomes (underground shoots) can spread outwards from the parent plant, or new plants can form from tubers or fragments of rhizomes dumped by home gardeners on roadsides, forest margins, or on waste ground. Alternatively, it is spread when birds eat the fruit, and distribute the seeds in their droppings. Bushy asparagus is a shade loving species, and grows best under a partial or closed canopy of trees. It prefers sandy or poorly structured low fertility soils, on forest floors, in scrublands, along coastal margins, and on sand dunes. Well established Bushy asparagus infestations can have a mass of aerial stems, foliage and underground tubers. They can completely out compete and suppress other desirable species. This analysis assumes that all areas of suitable habitat would be infested within 50 years if no control was undertaken.

Annual cost of control for landholder ($/ha)
$300.00 per ha based on staff experience.

Proportion of land over which pests voluntarily controlled (%)
Assumed to be 30% based on staff knowledge

Proportion of land to which conservation values apply (%)
Assumed to be 50% based on staff knowledge of the infestation locations.

Any benefits provided by the weed ($p.a.)
Nil

Biocontrol ($p.a.)
None available

Year strategy objectives achieved (eradication)
Assumed as twenty years for the purpose of this analysis.

RESULTS

PLANT PEST		Bushy asparagus	
	No RPMS	**Containment**	**Eradication**
Cost and losses under option	**$171,036**	**$0**	**$142,998**
Section 72(a) NPV		**$0**	**$28,038**
Section 72(a) regional values cost/ha		**$0**	**$42**
Section 72(b) NPV (*NRB*)		**$0**	**$102,662**
Section 72(b) area of spillover prevented (ha)		**$0**	**1,897**

Base Assumptions

Discount Rate		**8%**	
Initial Area Infested (ha)	(IAI)	**3**	**(ha)**
Weighted Average Gross Margin for Infested Land ($/ha)	(WAGM)	$0	**($/ha)**
Proportion of Production Loss from Infested Land (%)	(PPLIL)	**5%**	**(%)**
Total Area Potentially Infested	(TAPI)	**1,900**	**(ha)**
Years to Infest all of TAPI (years)	(YI)	**50**	**(Years)**
Annual Cost of Control for Landholder ($/ha affected)	(ACCL)	**$300**	**($/ha)**
Proportion of Landholders Controlling Pests (%)	(PLCP)	**30.0%**	**(%)**
Proportion of Infested Land to which Conservation Values Apply (%)	(PILCV)	**50%**	**(%)**
Any Benefits Provided by Weed (total $ / annum)	(BPBW)		**($)**

Containment Assumptions			
Biocontrol ($/annum)			**($)**
Year Strategy objectives Achieved	(YOA)		**(Years)**
Area Infested if Strategy Objectives Achieved (ha)	(AISOA)		**(ha)**
Proportion of Production Loss from Infested Land when Strategy Objectives Achieved (%)	(PPLSOA)		**(%)**

Eradication Assumptions			
Year Strategy objectives Achieved	(YOA)	**20**	**(Years)**

Regional Council Costs		
Year	**Containment**	Eradication
1		$5,000
2		$5,000
3		$5,000
4		$5,000
5		$5,000
6		$5,000
7		$5,000
8		$5,000
9		$5,000
Year 10 onward		$5,000
NPV	**$0**	**$64,999**

Control Costs		
Year	Containment	Eradication
1		$6,000
2		$6,000
3		$6,000
4		$6,000
5		$6,000
6		$6,000
7		$6,000
8		$6,000
9		$6,000
Year 10 onward		$6,000
NPV	**$0**	**$77,999**

CONCLUSIONS

The desired outcome of the Regional Pest Management Strategy is to achieve eradication of this pest plant.

The outcome in the no RPMS Scenario is a loss of $171,000 per annum in 50 years as a result of production losses and additional costs of control. This is equivalent to a NPV of approximately $171,036. In addition there is 665ha on which damages to regionally significant conservation, recreation or amenity values will occur.

The outcome of the eradication scenario is a NPV of $64,999 for administration, inspection, monitoring and enforcement, a NPV of $77,999 for costs of control, and loss of $0 per annum in 20 years as a result of production losses. This is a total cost in present day terms (NPV) of approximately $142,998 at a discount rate of 8%. In addition there will be no damages to regionally significant conservation, recreation or amenity values from this pest once eradication has been achieved.

The net outcome for eradication when compared with the no RPMS scenario is $28,038 in NPV terms. This option protects significant regional biodiversity values on 665ha through the prevention of spread of this organism. This option is preferred since it produces the highest net benefit, and best satisfies the requirements of section 72(a) of the Biosecurity Act 1993.

The net regional benefits exceed the individual benefits by $167,661 because the strategy prevents the spread of the pest onto 1,897 ha. The strategy also prevents damage to regional values on 665 ha, and eradication therefore satisfies the requirements of section 72(b).

If the requirements of section 72(a) and (b) are deemed by council to have been met, then the costs of the strategy can be charged to the regional community as beneficiaries and the benefits received will exceed the costs. Those on whose property the pest currently exists are exacerbators, and can reasonably be charged the cost of control, satisfying section 72(ba) of the Biosecurity Act 1993.

5.8 California bulrush (*Schoenoplectus californicus*) (2007)

ASSUMPTIONS

Initial area infested (ha)
14ha based on staff knowledge of regional infestations.

Weighted average gross margin ($/ha)
N/A

Proportion of production loss from infested land (%)
Nil

Total area potentially infested (TAPI) (ha)
GIS modelling shows that potentially 3,432 ha within the region could be infested if no controls were initiated. However, given the limited spread of this pest plant it is unlikely that spread will be more than incremental at existing sites.

Years to infest all TAPI
In New Zealand, Californian bulrush appears to be confined to the west coast of the northern North Island, where it is found on the Wairoa River (from Ruawai to near Dargaville), and on the Waikato River (Port Waikato to Tuakau). It grows on the muddy river banks and delta islands within the tidal portion of these rivers. Californian bulrush may well have arrived in ship ballast dumped on the banks of the Wairoa River during kauri-milling days, in the same way that Manchurian wild rice and alligator weed seem to have been introduced. Spread to the Waikato may have been by a separate introduction, or the result of subsequent movement of shipping from the Dargaville area.

In addition to its two wild occurrences, Californian bulrush now also occurs at a number of artificial wetlands in the North Island where it was planted in sites at Maraetai, Parata, Drury, Tuakau , Ohinewai, Hautapu, Te Pahu, Waikeria, and Taumarunui.

In estuarine situations, Californian bulrush tends to be the dominant species of the deepest-water vegetation type. This habitat preference is reflected in its New Zealand sites. In the Waikato River it is more or less restricted to the lowest 2 km of the river where it commonly forms pure deep-water stands within the lower delta of the river. Along the shore, at Maioro Bay, it forms a deep - water band outside other reed species. Further up stream it is less common.

In the Wairoa River, Californian bulrush appears to grow, flower, and fruit throughout the year. At Port Waikato, in contrast, it usually dies back partially during April and May, to recommence growth in September. Flowering and fruiting at this location occurs from late September to April. Only spread by deliberate human planting as a wetland treatment species and subsequent movement by water. This pest plant is now on the National Plant Pest Accord “banned from sale or propagation” list. It has been assumed that available habitat will be infested within 30 years if no control is undertaken.

Annual cost of control for landholder ($/ha)
Assumed to be $100.00 per hectare from staff inputs.

Proportion of land over which pests voluntarily controlled (%)
Assumed to be 10% for the purposes of this analysis.

Proportion of land to which conservation values apply (%)
Assumed to be 80% given the estuarine environment.

Any benefits provided by the weed ($p.a.)
Nil

Biocontrol ($p.a.)
Not available.

Year strategy objectives achieved (eradication)
Assumed as 20 years for the purposes of this analysis.

RESULTS

PLANT PEST		California bulrush	
	No RPMS	Containment	Eradication
Cost and losses under option	$91,147	$0	$84,499
Section 72(a) NPV		$0	$6,648
Section 72(a) regional values cost/ha		$0	$3
Section 72(b) NPV (*NRB*)		$0	$69,897
Section 72(b) area of spillover prevented (ha)		3,418	3,418

Base Assumptions

Discount Rate		8%	
Initial Area Infested (ha)	(IAI)	14	(ha)
Weighted Average Gross Margin for Infested Land ($/ha)	(WAGM)	$0	($/ha)
Proportion of Production Loss from Infested Land (%)	(PPLIL)	0%	(%)
Total Area Potentially Infested	(TAPI)	3,432	(ha)
Years to Infest all of TAPI (years)	(YI)	30	(Years)
Annual Cost of Control for Landholder ($/ha affected)	(ACCL)	$100	($/ha)
Proportion of Landholders Controlling Pests (%)	(PLCP)	10.0%	(%)
Proportion of Infested Land to which Conservation Values Apply (%)	(PILCV)	80%	(%)
Any Benefits Provided by Weed (total $ / annum)	(BPBW)		($)

Containment Assumptions			
Biocontrol ($/annum)			($)
Year Strategy objectives Achieved	(YOA)		(Years)
Area Infested if Strategy Objectives Achieved (ha)	(AISOA)		(ha)
Proportion of Production Loss from Infested Land when Strategy Objectives Achieved(%)	(PPLSOA)		(%)

Eradication Assumptions			
Year Strategy objectives Achieved	(YOA)	20	(Years)

Regional Council Costs		
Year	**Containment**	Eradication
1		$1,500
2		$1,500
3		$1,500
4		$1,500
5		$1,500
6		$1,500
7		$1,500
8		$1,500
9		$1,500
Year 10 onward		$1,500
NPV	**$0**	**$19,500**

Control Costs		
Year	Containment	Eradication
1		$5,000
2		$5,000
3		$5,000
4		$5,000
5		$5,000
6		$5,000
7		$5,000
8		$5,000
9		$5,000
Year 10 onward		$5,000
NPV	**$0**	**$64,999**

CONCLUSIONS

The objective of the Regional Plant Pest Strategy is to achieve eradication of this pest plant.

The outcome in the no RPMS Scenario is a loss of $34,320 per annum in 30 years as a result of production losses and additional costs of control. This is equivalent to a NPV of approximately $91,147. In addition there is 2,471ha on which damages to regionally significant conservation, recreation, Māori or soil and water values will occur.

The outcome of the eradication scenario is a NPV of $19 500 for administration, inspection, monitoring and enforcement, a NPV of $64 999 for costs of control, and loss of $0 per annum in 20 years as a result of production losses. This is a total cost in present day terms (NPV) of approximately $84,499 at a discount rate of 8%. In addition there will be no damages to regionally significant conservation, recreation, Māori or soil and water values from this pest once eradication has been achieved.

The net outcome for eradication when compared with the no RPMS scenario is $6,648 in NPV terms. This option protects significant regional biodiversity values on 2,471ha through the prevention of spread of this organism. Eradication is preferred since it produces the highest net benefit, and best satisfies the requirements of section 72(a) of the Biosecurity Act 1993.

The net regional benefits exceed the individual benefits by $89,397 because the strategy prevents the spread of the pest onto 3,418 ha. The strategy also prevents damage to regional values on 2,471 ha, and eradication therefore satisfies the requirements of section 72(b).

If the requirements of section 72(a) and (b) are deemed by council to have been met, then the costs of the strategy can be charged to the regional community as beneficiaries and the benefits received will exceed the costs. Those on whose property the pest currently exists are exacerbators, and can reasonably be charged the cost of control, satisfying section 72(ba) of the Biosecurity Act 1993.

5.9 Cathedral bells (*Cobea scandens*) (2007)

ASSUMPTIONS

Initial area infested (ha)
Assume 1ha based on staff experience and contractor reports. Currently only known to be present on the middle reaches of the Waikato River.

Weighted average gross margin ($/ha)
N/A

Proportion of production loss from infested land (%)
100% in conservation areas, because is a vine and covers everything.
0% in grazed areas (NB: grazed areas are therefore excluded from the estimated area of total infestation).

Total area potentially infested (TAPI) (ha)
Main method of natural, long-distance dispersal is by water. Waikato River is 425km. If the plant spreads downstream from the current known site and infests river side land 5m each side of lower 212km, the total infestation would be 212ha in 50 years. This assumes it does not spread by wind or contaminated materials into other water courses.

Years to infest all TAPI
A fast growing, evergreen dense vine that scrambles over most other species to form long-lived masses. Fairly tolerant of shade, drought and damp, wind, salt and most soil types. Produces many long-lived well-dispersed seeds. Climbing to 6 m, growing from shallow roots. Stems are angled with hook-like branch tips. Alternate leaves are usually in three pairs of oval leaflets, which are dark green above and whitish below, with branched purplish twining tendrils. Bell-shaped flowers are long green and smelly when young turning to deep purple lanterns, Dec.-May. Produce large purple seed pods in summer that release winged seeds.

The plant is spread down waterways and locally by wind. Its most important method of long-distance spread is human assisted. This is currently controlled as the sale and distribution of Cathedral Bells is banned nationally under the National Pest Plant Accord.

The ‘sleeper’ habit of plant species is well documented worldwide. In New Zealand, Sullivan *et al* (2004) suggests that it *“…takes most plant species more than 50 years to become abundant…”* and *“…more than a century after naturalisation to appear in all ecologically suitable region-scales areas of NZ.”* This work is in line with work on agricultural weeds by Dr Tereso Morfe from the Department of Primary Industry in Victoria; who classified weeds with a ‘very high’ rate of spread as having a 50 years invasion period, weeds with a ‘high’ rate of spread as having a 75 year invasion period, weeds with a ‘moderately high’ rate of spread as having a 100 years invasion period, weeds with a ‘moderately low’ rate of spread as having a 125 year invasion period and weeds with a ‘low’ rate of spread as having a 200 year invasion period.

Because human assisted spread is already controlled under the National Pest Plant Accord, and natural spread is relatively slow over longer distances, it is assumed that Cathedral Bells have a moderately slow rate of spread, and it will therefore take around 125 years for this plant to reach all ecologically suitable areas within the Waikato Region.

Annual cost of control for landholder ($/ha)
Assume as being $100ha for the purpose of this analysis.

Proportion of land over which pests voluntarily controlled (%)
10%, based on staff experience and limited knowledge of weed in the region.

Proportion of land to which conservation values apply (%)
Cathedral bells are currently located in riparian areas, and likely to spread further within riparian areas because of its natural dispersal mechanisms. Riparian habitats are ecologically important, with relatively unmodified riparian habitats becoming increasingly rare in most urban and production landscapes. For this reason, 50% of riparian habitats are ascribed a conservation value.

Any benefits provided by the weed ($p.a.)
$0 –not legal to sell as an ornamental.

Biocontrol ($p.a.)
None available, no research on this species currently planned.

Year strategy objectives achieved (eradication)
Twenty years, based on size of initial infestation as well as rate and predictability of natural spread.

RESULTS

PLANT PEST		Cathedral bells	
	No RPMS	**Containment**	**Eradication**
Cost and losses under option	**$225,676**	**$0**	**$45,500**
Section 72(a) NPV		**$0**	**$180,176**
Section 72(a) regional values cost/ha		**$0**	**$11**
Section 72(b) NPV (*NRB*)		**$0**	**$199,551**
Section 72(b) area of spillover prevented (ha)		**36,791**	**36,791**

Base Assumptions			
Discount Rate		**8%**	
Initial Area Infested (ha)	(IAI)	**1**	**(ha)**
Weighted Average Gross Margin for Infested Land ($/ha)	(WAGM)	**$0**	**($/ha)**
Proportion of Production Loss from Infested Land (%)	(PPLIL)	**0%**	**(%)**
Total Area Potentially Infested	(TAPI)	**36,792**	**(ha)**
Years to Infest all of TAPI (years)	(YI)	**50**	**(Years)**
Annual Cost of Control for Landholder ($/ha affected)	(ACCL)	**$100**	**($/ha)**
Proportion of Landholders Controlling Pests (%)	(PLCP)	**10.0%**	**(%)**
Proportion of Infested Land to which Conservation Values Apply (%)	(PILCV)	**50%**	**(%)**
Any Benefits Provided by Weed (total $ / annum)	(BPBW)		**($)**

Containment Assumptions			
Biocontrol ($/annum)			**($)**
Year Strategy objectives Achieved	(YOA)		**(Years)**
Area Infested if Strategy Objectives Achieved (ha)	(AISOA)		**(ha)**
Proportion of Production Loss from Infested Land when Strategy Objectives Achieved(%)	(PPLSOA)		**(%)**

Eradication Assumptions			
Year Strategy objectives Achieved	(YOA)	**20**	**(Years)**

Regional Council Costs		
Year	**Containment**	Eradication
1		$2,000
2		$2,000
3		$2,000
4		$2,000
5		$2,000
6		$2,000
7		$2,000
8		$2,000
9		$2,000
Year 10 onward		$2,000
NPV	**$0**	**$26,000**

Control Costs		
Year	Containment	Eradication
1		$1,500
2		$1,500
3		$1,500
4		$1,500
5		$1,500
6		$1,500
7		$1,500
8		$1,500
9		$1,500
Year 10 onward		$1,500
NPV	**$0**	**$19,500**

CONCLUSIONS

The desired outcome of the Regional Pest Management Strategy is eradication of this pest plant.

The outcome in the no RPMS Scenario is a loss of $367,920 per annum in 50 years as a result of production losses and additional costs of control. This is equivalent to a NPV of approximately $225,676. In addition there is 16,556ha on which damages to regionally significant conservation, recreation, amenity, Māori or soil and water values will occur.

The outcome of the eradication scenario is a NPV of $26,000 for administration, inspection, monitoring and enforcement, a NPV of $19,500 for costs of control, and loss of $0 per annum in 20 years as a result of production losses. This is a total cost in present day terms (NPV) of approximately $45,500 at a discount rate of 8%. In addition there will be no damages to regionally significant conservation, recreation, amenity, Māori or soil and water values from this pest once eradication has been achieved.

The net outcome for eradication when compared with the no RPMS scenario is $180,176 in NPV terms. This option protects significant regional biodiversity values on 1,654 ha through the prevention of spread of this organism. Eradication is preferred since it produces the highest net benefit, and best satisfies the requirements of section 72(a) of the Biosecurity Act 1993.

The net regional benefits exceed the individual benefits by $225,551 because the strategy prevents the spread of the pest onto 36,791ha. The strategy also prevents damage to regional values on 16,556 ha, and eradication therefore satisfies the requirements of section 72(b).

If the requirements of section 72(a) and (b) are deemed by council to have been met, then the costs of the strategy can be charged to the regional community as beneficiaries and the benefits received will exceed the costs. Those on whose property the pest currently exists are exacerbators, and can reasonably be charged the cost of control, satisfying section 72(ba) of the Biosecurity Act 1993.

5.10 Chilean flame creeper (*Tropaeolum speciosum*) (2002)

Description and biological capability	
Form	• A climber with five-fingered leaves and scarlet flowers.
Habitat	• Scrub and forest remnants
Regional distribution	• Limited in distribution.
Biological success	
Dispersal method	• Seed is spread by birds, but also has the ability to clone through its tuberous root system.
Reproductive ability	• Produces viable seed.
Competitive ability	• Can probably out-compete many native species.
Other considerations	
Toxicity	• Unlikely to be toxic.
Resistance to control	• Cloning ability makes it difficult to control.

Impact evaluation				
	Current impact (Y\N)	**Current level of impact (Nil, L, M, H)**	**Potential impact (Y\N)**	**Potential level of impact (Nil, L, M, H)**
Endangered Species	N	-	Y	M
Species Diversity	Y	L	Y	H
Soil resources	N	-	-	-
Water Quality	N	-	-	-
Human Health	N	-	-	-
Māori Culture	N	-	Y	M
Production	Y	L	Y	M
Recreation	Y	L	Y	L
International trade	N	-	-	-

Assessment of effects status: Moderate/Major

Scenario: No RPMS

Assumptions		
Initial area infested (ha)	(IAI)	5
Total area potentially infested	(TAPI)	11,700
Years to infest all of TAPI (years)	(YI)	50
Weighted average gross margin for infested land ($/ha)	(WAGM)	-
Annual cost of control for land occupier ($/ha affected)	(ACCL)	873
Proportion of land occupiers controlling pests (%)	(PLCP)	10
Proportion of production loss from infested land (%)	(PPLIL)	5
Proportion of infested land to which conservation values apply (%)	(PILCV)	50
Any benefits provided by the weed	(BPBW)	0
Discount rate	(DRATE)	8

Calculations		
Multiplier: Work out using "RPMS guidelines - Do Nothing.xls" (IAI. TAPI, YI, DRATE)	(MDN)	0.803
Loss of production from initial area infested = IAI X WAGM X (1 - (PLCP/100)) X PPLIL	(LOPIAI)	0
Loss of production in year Y1 =WAGM X TAPI X (1 - (PLCP/100)) X PPLIL	(LOP)	0
Costs of control in initial area = IAI x ACCL x (PLCP/100)	(COCIAI)	437
Costs of control in Year Y1 = TAPI X ACCL X (PLCP/100)	(COC)	1,021,410
Total damage in No RPMS Scenario ($/annum) = (LOP + COC - BPBW)	(TDDNS)	1,021,410
Net present value No RPMS = TDDNS X MDN	(NPVDN)	820,192
Area of conservation and other regional damages = PILCV/100 X (1 - (PLCP/100)) X TAPI (ha)	(ACORD)	5,265

Scenario: Eradication

1. Annual regional costs (inspection, monitoring, enforcement, administration etc) converted to present day terms

Year	Regional cost (A)	8% discount rate multiplier (B)	NPV (A x B)	
1	12,885	1.000	12885.000	
2	12,885	0.926	11931.510	
3	12,885	0.857	11042.445	
4	12,885	0.794	10230.690	
5	12,885	0.735	9470.475	
6	12,885	0.681	8774.685	
7	12,885	0.630	8117.550	
8	12,885	0.583	7511.955	
9	12,885	0.540	6957.900	
Year 10 onward	12,885	6.253	80569.905	
	Total Sum NPV Column		**$167,492**	**(TRC)**

2. Annual cost of control for pest weed converted to present day terms

Year	Control cost (A)	8% discount rate multiplier (B)	NPV (A x B)	
1	4,365	1.000	4365	
2	3,929	0.926	3638	
3	3,536	0.857	3030	
4	3,182	0.794	2527	
5	2,864	0.735	2105	
6	2,577	0.681	1755	
7	2,320	0.630	1461	
8	2,088	0.583	1217	
9	1,879	0.540	1015	
Year 10 onward	1,691	6.253	10574	
	Total Sum NPV Column		**$31,687**	**(TCC)**

Assumptions		
Current area infested (ha)	(CAI)	5
Current density (area displaced ha/ha) %	(DCY)	4
Year strategy objectives achieved	(YOA)	10
Area infested if strategy objectives achieved (ha)	(AISOA)	-
Average density if strategy objectives achieved (area displaced ha/ha) %	(DSOA)	2
Any benefits provided by weed (total $ / annum)	(BPBW)	-
Calculations		
Multiplier: "RPMS Guideline - Scenarios.xls"	(MRPMS)	4.186
Loss of production in current year = WAGM x CAI x DCY	(LOPC)	0
Loss of production in YOA = WAGM x AISOA x DSOA	(LOPYOA)	0
Total damage in RPMS scenario ($/annum) = LOPC x MRPMS	(TDRPMS)	0
Area of conservation and other regional damages = PILCV/100 x AISOA	(ACORDRRPMS)	0
Total cost RPMS Scenario = TDRPMS + TCC + TRC	(NPVRPMS)	199,179
CALCULATIONS: SECTION 72(A)		
Net benefit of RPMS Scenario = NPVDN - NPVRPMS ($)	(NBRPMS)	621,013
Prevented damage to regional values ACORD - ACORDRPMS (ha)	(APDCV)	5,265
Cost/ha of preventing damage to regional values = NBRPMS / APDCV	(CVHA)	118

CALCULATIONS: SECTION 72(B)		
Damage on initially infested area = (LOPIAI + COCIAI) / Multiplier ($)	(DOIAI)	5,456
Costs of spill over = NPVDN - DOIAI	(COS)	814,736
Net regional benefit = COS - TRC	(NRB)	647,244
Area spill over prevented = TAPI - IAI	(ASP)	11,695

Cost benefit analysis summary

Two scenarios for control of Chilean flame creeper have been considered:

1. do nothing
2. eradication.

The "do nothing" scenario results in total regional damage of $1,021,410 NPV.

The "eradication" scenario has costs of $17,250 per annum. The cost to the region is $199,179 NPV. This results in a positive benefit of $621,013 NPV and therefore it does meet the requirements of section 72 (1)(a) of the Act. Council considers that the value of land protected is greater than $40 per hectare.

Eradication is the preferred option as it produces a positive net benefit. The regional net benefit is $647,244, therefore the requirements of section 72(1)(b) of the Act are met.

5.11 Climbing asparagus (*Asparagus scandens*) (2002)

Description and biological capability	
Form	• A slender vine, climbing to about 6m. Feathery leaves, produces small orange/red fruit. Forms mats of tubers.
Habitat	• Bush margins, tree-fall gaps, hedgerows, wastelands etc.
Regional distribution	• Scattered distribution, generally in low numbers.
Biological success	
Dispersal method	• Seed dispersed by birds, while tubers are sometimes moved in contaminated soil.
Reproductive ability	• Can form large numbers of viable seed
Competitive ability	• Grows very strongly, smothering seedlings and saplings, and shading out larger trees. • Can ring bark trees
Other considerations	
Toxicity	• Nil
Resistance to control	• Tubers are hard to kill, so repeat spraying is required. Climbing habit means host plants also likely to be killed by spraying.

Impact evaluation				
	Current impact (Y\N)	**Current level of impact (Nil, L, M, H)**	**Potential impact (Y\N)**	**Potential level of impact (Nil, L, M, H)**
Endangered Species	Y	L	Y	H
Species Diversity	Y	L	Y	H
Soil resources	N	-	N	-
Water Quality	N	-	N	-
Human Health	N	-	N	-
Māori Culture	Y	L	Y	M
Production	N	-	N	-
Recreation	Y	-	N	-
International trade	N	-	N	-

Assessment of effects status: Major

Scenario: No RPMS

Assumptions		
Initial area infested (ha)	(IAI)	61
Total area potentially infested	(TAPI)	2,000
Years to infest all of TAPI (years)	(YI)	20
Weighted average gross margin for infested land ($/ha)	(WAGM)	-
Annual cost of control for land occupier ($/ha affected)	(ACCL)	873
Proportion of land occupiers controlling pests (%)	(PLCP)	10
Proportion of production loss from infested land (%)	(PPLIL)	-
Proportion of infested land to which conservation values apply (%)	(PILCV)	60
Any benefits provided by the weed	(BPBW)	0
Discount rate	(DRATE)	8
Calculations		
Multiplier: work out using "RPMS guidelines - Do Nothing.xls" (IAI. TAPI, YI, DRATE)	(MDN)	5.259
Loss of production from initial area infested = IAI X WAGM X (1 - (PLCP/100)) X PPLIL	(LOPIAI)	0
Loss of production in year Y1 =WAGM X TAPI X (1 - (PLCP/100)) X PPLIL	(LOP)	0
Costs of control in initial area = IAI x ACCL x (PLCP/100)	(COCIAI)	5,325
Costs of control in Year Y1 = TAPI X ACCL X (PLCP/100)	(COC)	174,600
Total damage in No RPMS Scenario ($/annum) = (LOP + COC - BPBW)	(TDDNS)	174,600
Net present value No RPMS = TDDNS X MDN	(NPVDN)	918,221
Area of conservation and other regional damages = PILCV/100 X (1 - (PLCP/100)) X TAPI (ha)	(ACORD)	1,080

Scenario: Containment Control

1. Annual regional costs (inspection, monitoring, enforcement, administration etc) converted to present day terms

Year	Regional cost (A)	8% discount rate multiplier (B)	NPV (A x B)	
1	15,050	1.000	15050	
2	15,050	0.926	13936	
3	15,050	0.857	12898	
4	15,050	0.794	11950	
5	15,050	0.735	11062	
6	15,050	0.681	10249	
7	15,050	0.630	9482	
8	15,050	0.583	8774	
9	15,050	0.540	8127	
Year 10 onward	15,050	6.253	94108	
	Total Sum NPV Column		**$195,635**	**(TRC)**

2. Annual cost of control for pest weed converted to present day terms

Year	Control cost (A)	8% discount rate multiplier (B)	NPV (A x B)	
1	4,260	1.000	4260	
2	4,260	0.926	3945	
3	4,260	0.857	3651	
4	4,260	0.794	3383	
5	4,260	0.735	3131	
6	4,260	0.681	2901	
7	4,260	0.630	2684	
8	4,260	0.583	2484	
9	4,260	0.540	2301	
Year 10 onward	4,260	6.253	26639	
	Total Sum NPV Column		**$55,379**	**(TCC)**

Assumptions		
Current area infested (ha)	(CAI)	61
Current density (area displaced ha/ha) %	(DCY)	60
Year strategy objectives achieved	(YOA)	5
Area infested if strategy objectives achieved (ha)	(AISOA)	50
Average density if strategy objectives achieved (area displaced ha/ha) %	(DSOA)	60
Any benefits provided by weed (total $ / annum)	(BPBW)	-
Calculations		
Multiplier: "RPMS Guideline - Scenarios.xls"	(MRPMS)	10.774
Loss of production in current year = WAGM x CAI x DCY	(LOPC)	0
Loss of production in YOA = WAGM x AISOA x DSOA	(LOPYOA)	0
Total damage in RPMS Scenario ($/annum) = LOPC x MRPMS	(TDRPMS)	0
Area of conservation and other regional damages = PILCV/100 x AISOA	(ACORDRR PMS)	30
Total cost RPMS Scenario = TDRPMS + TCC + TRC	(NPVRPMS)	251,014
CALCULATIONS: SECTION 72(A)		
Net benefit of RPMS Scenario = NPVDN - NPVRPMS ($)	(NBRPMS)	667,208
Prevented damage to regional values ACORD - ACORDRPMS (ha)	(APDCV)	1,050
Cost/ha of preventing damage to regional values = NBRPMS / APDCV	(CVHA)	635

CALCULATIONS: SECTION 72(B)		
Damage on initially infested area = (LOPIAI + COCIAI) / Multiplier ($)	(DOIAI)	66,566
Costs of spill over = NPVDN - DOIAI	(COS)	851,655
Net regional benefit = COS - TRC	(NRB)	656,020
Area spill over prevented = TAPI - IAI	(ASP)	1,939

Scenario: Eradication

1. Annual regional costs (inspection, monitoring, enforcement, administration etc) converted to present day terms

Year	Regional cost (A)	8% discount rate multiplier (B)	NPV (A x B)	
1	15,050	1.000	15050.000	
2	15,050	0.926	13936.300	
3	15,050	0.857	12897.850	
4	15,050	0.794	11949.700	
5	15,050	0.735	11061.750	
6	15,050	0.681	10249.050	
7	15,050	0.630	9481.500	
8	15,050	0.583	8774.150	
9	15,050	0.540	8127.000	
Year 10 onward	15,050	6.253	94107.650	
	Total Sum NPV Column		**$195,635**	**(TRC)**

2. Annual cost of control for pest weed converted to present day terms

Year	Control cost (A)	8% discount rate multiplier (B)	NPV (A x B)	
1	53,253	1.000	53253	
2	47,928	0.926	44381	
3	43,135	0.857	36967	
4	38,821	0.794	30824	
5	34,939	0.735	25680	
6	31,445	0.681	21414	
7	28,301	0.630	17830	
8	25,471	0.583	14849	
9	22,924	0.540	12379	
Year 10 onward	20,631	6.253	129008	
	Total Sum NPV Column		**$386,585**	**(TCC)**

Assumptions		
Current area infested (ha)	(CAI)	61
Current density (area displaced ha/ha) %	(DCY)	60
Year strategy objectives achieved	(YOA)	5
Area infested if strategy objectives achieved (ha)	(AISOA)	-
Average density if strategy objectives achieved (area displaced ha/ha) %	(DSOA)	
Any benefits provided by weed (total $ / annum)	(BPBW)	-
Calculations		
Multiplier: "RPMS Guideline - Scenarios.xls"	(MRPMS)	2.592
Loss of production in current year = WAGM x CAI x DCY	(LOPC)	0
Loss of production in YOA = WAGM x AISOA x DSOA	(LOPYOA)	0
Total damage in RPMS Scenario ($/annum) = LOPC x MRPMS	(TDRPMS)	0
Area of conservation and other regional damages = PILCV/100 x AISOA	(ACORDRRPMS)	0
Total cost RPMS Scenario = TDRPMS + TCC + TRC	(NPVRPMS)	582,220
CALCULATIONS: SECTION 72(A)		
Net benefit of RPMS Scenario = NPVDN - NPVRPMS ($)	(NBRPMS)	336,002
Prevented damage to regional values ACORD - ACORDRPMS (ha)	(APDCV)	1,080
Cost/ha of preventing damage to regional values = NBRPMS / APDCV	(CVHA)	311

CALCULATIONS: SECTION 72(B)		
Damage on initially infested area = (LOPIAI + COCIAI) / Multiplier ($)	(DOIAI)	66,566
Costs of spill over = NPVDN - DOIAI	(COS)	851,655
Net regional benefit = COS - TRC	(NRB)	656,020
Area apill over prevented = TAPI - IAI	(ASP)	1,939

Cost benefit analysis summary

Three scenarios for control of climbing asparagus have been considered:

1. do nothing
2. eradication
3. containment control.

The "do nothing" scenario results in total regional damage of $174,600 NPV.

The "eradication" scenario has costs of $68,303 per annum. The cost to the region is $582,220 NPV. This results in a positive benefit of $336,002 NPV and therefore it does meet the requirements of section 72 (1)(a) of the Act.

The "containment control" scenario has costs of $19,310 per annum. The cost to the region is $251,014 NPV. The result of this scenario is a positive benefit of $667,208 NPV and therefore it meets the requirements of section 72 (1)(a) of the Act. Council considers that the value of land protected is greater than $251 per hectare.

Containment control is the preferred option as it produces a positive net benefit at a lower cost. The regional net benefit is $656,020 therefore the requirements of section 72(1)(b) of the Act are met.

5.12 Climbing spindleberry (*Celastrus orbiculatus*) (2002)

Description and biological capability	
Form	• A deciduous climber that can grow to 12m high. Produces yellow fruit which then open to expose a scarlet centre.
Habitat	• Forest margins, scrub and gardens.
Regional distribution	• Populations concentrated in the southern districts of the region.
Biological success	
Dispersal method	• Has been planted widely as an ornamental, its seeds are also dispersed by birds
Reproductive ability	• Produces viable seeds
Competitive ability	• Can smother and out-compete native species.
Other considerations	
Toxicity	• Not known to be toxic.
Resistance to control	• Can be controlled using application of picloram and triclopyr or glyphosphate, and also by stump application of the same herbicides.

Impact evaluation				
	Current impact (Y\N)	**Current level of impact (Nil, L, M, H)**	**Potential impact (Y\N)**	**Potential level of impact (Nil, L, M, H)**
Endangered Species	N	-	Y	H
Species Diversity	Y	L	Y	M
Soil resources	N	-	N	-
Water Quality	N	-	N	-
Human Health	N	-	N	-
Māori Culture	Y	L	Y	H
Production	N	-	N	-
Recreation	N	-	N	-
International trade	N	-	N	-

Assessment of effects status: Major

Scenario: No RPMS

Assumptions		
Initial area infested (ha)	(IAI)	62
Total area potentially infested	(TAPI)	10,000
Years to infest all of TAPI (years)	(YI)	60
Weighted average gross margin for infested land ($/ha)	(WAGM)	-
Annual cost of control for land occupier ($/ha affected)	(ACCL)	873
Proportion of land occupiers controlling pests (%)	(PLCP)	60
Proportion of production loss from infested land (%)	(PPLIL)	-
Proportion of infested land to which conservation values apply (%)	(PILCV)	50
Any benefits provided by the weed	(BPBW)	0
Discount rate	(DRATE)	8
Calculations		
Multiplier: work out using "RPMS guidelines - Do Nothing.xls" (IAI. TAPI, YI, DRATE)	(MDN)	0.958
Loss of production from initial area infested = IAI X WAGM X (1 - (PLCP/100)) X PPLIL	(LOPIAI)	0
Loss of production in year Y1 =WAGM X TAPI X (1 - (PLCP/100)) X PPLIL	(LOP)	0
Costs of control in initial area = IAI x ACCL x (PLCP/100)	(COCIAI)	32,476
Costs of control in Year Y1 = TAPI X ACCL X (PLCP/100)	(COC)	5,238,000
Total damage in No RPMS Scenario ($/annum) = (LOP + COC - BPBW)	(TDDNS)	5,238,000
Net present value No RPMS = TDDNS X MDN	(NPVDN)	5,018,004
Area of conservation and other regional damages = PILCV/100 X (1 - (PLCP/100)) X TAPI (ha)	(ACORD)	2,000

Scenario: Eradication

1. Annual regional costs (inspection, monitoring, enforcement, administration etc) converted to present day terms

Year	Regional cost (A)	8% discount rate multiplier (B)	NPV (A x B)	
1	28,699	1.000	28699.000	
2	28,699	0.926	26575.274	
3	28,699	0.857	24595.043	
4	28,699	0.794	22787.006	
5	28,699	0.735	21093.765	
6	28,699	0.681	19544.019	
7	28,699	0.630	18080.370	
8	28,699	0.583	16731.517	
9	28,699	0.540	15497.460	
Year 10 onward	28,699	6.253	179454.847	
	Total Sum NPV Column		**$373,058**	**(TRC)**

2. Annual cost of control for pest weed converted to present day terms

Year	Control cost (A)	8% discount rate multiplier (B)	NPV (A x B)	
1	54,126	1.000	54126	
2	48,713	0.926	45109	
3	43,842	0.857	37573	
4	39,458	0.794	31330	
5	35,512	0.735	26101	
6	31,961	0.681	21765	
7	28,765	0.630	18122	
8	25,888	0.583	15093	
9	23,299	0.540	12582	
Year 10 onward	20,970	6.253	131122	
	Total Sum NPV Column		**$392,922**	**(TCC)**

Assumptions		
Current area infested (ha)	(CAI)	62
Current density (area displaced ha/ha) %	(DCY)	50
Year strategy objectives achieved	(YOA)	10
Area infested if strategy objectives achieved (ha)	(AISOA)	-
Average density if strategy objectives achieved (area displaced ha/ha) %	(DSOA)	2
Any benefits provided by weed (total $ / annum)	(BPBW)	-
Calculations		
Multiplier: "RPMS Guideline - Scenarios.xls"	(MRPMS)	4.186
Loss of production in current year = WAGM x CAI x DCY	(LOPC)	0
Loss of production in YOA = WAGM x AISOA x DSOA	(LOPYOA)	0
Total damage in RPMS Scenario ($/annum) = LOPC x MRPMS	(TDRPMS)	0
Area of conservation and other regional damages = PILCV/100 x AISOA	(ACORDRRPMS)	0
Total cost RPMS Scenario = TDRPMS + TCC + TRC	(NPVRPMS)	765,981
CALCULATIONS: SECTION 72(A)		
Net benefit of RPMS Scenario = NPVDN - NPVRPMS ($)	(NBRPMS)	4,252,023
Prevented damage to regional values ACORD - ACORDRPMS (ha)	(APDCV)	2,000
Cost/ha of preventing damage to regional values = NBRPMS / APDCV	(CVHA)	2,126

CALCULATIONS: SECTION 72(B)		
Damage on initially infested area = (LOPIAI + COCIAI) / Multiplier ($)	(DOIAI)	405,945
Costs of spill over = NPVDN - DOIAI	(COS)	4,612,059
Net regional benefit = COS - TRC	(NRB)	4,239,001
Area spill over prevented = TAPI - IAI	(ASP)	9,938

Cost benefit analysis summary

Two scenarios for control of climbing spindleberry have been considered:

1. do nothing
2. eradication.

The "do nothing" scenario results in total regional damage of $5,238,000 NPV.

The "eradication" scenario has costs of $82,825 per annum. The cost to the region is $765,981 NPV. This results in a positive benefit of $4,252,023 NPV and therefore it does meet the requirements of section 72 (1)(a) of the Act. Council considers that the value of land protected is greater than $383 per hectare.

Eradication is the preferred option as it produces a positive net benefit. The regional net benefit is $4,239,001, therefore the requirements of section 72(1)(b) of the Act are met.

5.13 Coastal paspalum (*Paspalum vaginatum*) (2007)

ASSUMPTIONS

Initial area infested (ha)
Assumed as 2 ha from staff knowledge of known pest infestations.

Weighted average gross margin ($/ha)
N/A

Proportion of production loss from infested land (%)
Nil

Total area potentially infested (TAPI) (ha)
Assumed to be a potential 663 ha from staff knowledge and habitat information available.

Years to infest all TAPI
Saltwater paspalum is classified as *Paspalum vaginatum*. It is superficially similar in appearance to Mercer grass (*Paspalum distichum*), which is, however, distinguished by its soft leaf blade, and its intolerance of saline soil conditions. In New Zealand estuaries: saltwater paspalum changes the composition and structure of indigenous vegetation, excludes burrowing fauna, reduces access to feeding and roosting sites of shore birds, alters fish spawning and feeding grounds, and changes estuarine hydrology by accumulating sediment.

The New Zealand distribution of saltwater paspalum is recorded as being in coastal, often brackish, environments of North and South Auckland and Gisborne. There are also records from the Coromandel Peninsula, northern Waikato, and outlying islands, but it is confirmed as mostly confined to subtropical latitudes. It is also known from the Kawhia Harbour

Saltwater paspalum is a stoloniferous grass native to tropical and subtropical North and South America, and possibly Europe. It has been introduced to South Africa, Australia, Hawaii and several other Pacific islands, and New Zealand, primarily as a turf grass for coastal golf courses. In New Zealand, it forms swards near the edge of mud flats or on sandy and shingly shores, occasionally spreading into nearby pasture. Observers note that it is semi-aquatic, growing as dense swards on open mudflats and along creek banks above the mid-tide level, and as a spreading mat over mud, shingle, and sand, or amongst boulders, in the salt spray zone near the high tide mark. It is able to establish in coastal vegetation including mangroves, shrubland, and salt marsh, and on dunes with spinifex and pingao. However, it is unlikely to survive competition from other plant species out of a saline environment. It has been assumed infestation will take 50 years if no control undertaken.

Annual cost of control for landholder ($/ha)
Assumption is a cost of $100 per hectare from staff estimates.

Proportion of land over which pests voluntarily controlled (%)
As most of area affected crown land assume 90%.

Proportion of land to which conservation values apply (%)
As infestations occur in riparian margins assume 100%.

Any benefits provided by the weed ($p.a.)
Nil although has limited value if accessible to grazing animals.

Biocontrol ($p.a.)
Not available for this pest plant.

Year strategy objectives achieved (eradication)
Assume 20 years for the purposes of this analysis.

RESULTS

PLANT PEST		Coastal paspalum	
	No RPMS	**Containment**	**Eradication**
Cost and losses under option	**$62,920**	**$0**	**$58,499**
Section 72(a) NPV		**$0**	**$4,421**
Section 72(a) regional values cost/ha		**$0**	**$67**
Section 72(b) NPV (*NRB*)		**$0**	**$28734**
Section 72(b) area of spillover prevented (ha)		**662**	**662**

Base Assumptions			
Discount Rate		**8%**	
Initial Area Infested (ha)	(IAI)	**2**	**(ha)**
Weighted Average Gross Margin for Infested Land ($/ha)	(WAGM)	**$0**	**($/ha)**
Proportion of Production Loss from Infested Land (%)	(PPLIL)	**0%**	**(%)**
Total Area Potentially Infested	(TAPI)	**663**	**(ha)**
Years to Infest all of TAPI (years)	(YI)	**50**	**(Years)**
Annual Cost of Control for Landholder ($/ha affected)	(ACCL)	**$100**	**($/ha)**
Proportion of Landholders Controlling Pests (%)	(PLCP)	**90.0%**	**(%)**
Proportion of Infested Land to which Conservation Values Apply (%)	(PILCV)	**100%**	**(%)**
Any Benefits Provided by Weed (total $ / annum)	(BPBW)		**($)**

Containment Assumptions			
Biocontrol ($/annum)			**($)**
Year Strategy objectives Achieved	(YOA)		**(Years)**
Area Infested if Strategy Objectives Achieved (ha)	(AISOA)		**(ha)**
Proportion of Production Loss from Infested Land when Strategy Objectives Achieved (%)	(PPLSOA)		**(%)**

Eradication Assumptions			
Year Strategy objectives Achieved	(YOA)	**20**	**(Years)**

Regional Council Costs		
Year	**Containment**	Eradication
1		$2,500
2		$2,500
3		$2,500
4		$2,500
5		$2,500
6		$2,500
7		$2,500
8		$2,500
9		$2,500
Year 10 onward		$2,500
NPV	**$0**	**$32,499**

Control Costs		
Year	Containment	Eradication
1		$2,000
2		$2,000
3		$2,000
4		$2,000
5		$2,000
6		$2,000
7		$2,000
8		$2,000
9		$2,000
Year 10 onward		$2,000
NPV	**$0**	**$26,000**

CONCLUSIONS

The desired Regional Pest Management Strategy outcome for this pest plant is eradication.

The outcome in the no RPMS scenario is a loss of $59,670 per annum in 50 years as a result of production losses and additional costs of control. This is equivalent to a NPV of approximately $62,920. In addition there is 66.3ha on which damages to regionally significant conservation, Māori or soil and water values will occur.

The outcome of the eradication scenario is a NPV of $32,499 for administration, inspection, monitoring and enforcement, a NPV of $26,000 for costs of control, and loss of $0 per annum in 20 years as a result of production losses. This is a total cost in present day terms (NPV) of approximately 58,499 at a discount rate of 8%. In addition there will be no damages to regionally significant conservation, Māori or soil and water values from this pest once eradication has been achieved.

The net outcome for eradication when compared with the no RPMS scenario is $4,421 in NPV terms. This option protects significant regional biodiversity values on 66 ha through the prevention of spread of this organism. Eradication is preferred since it produces the highest net benefit, and best satisfies the requirements of section 72(a) of the Biosecurity Act 1993.

The net regional benefits exceed the individual benefits by $61,233 because the strategy prevents the spread of the pest onto 661.5ha. The strategy also prevents damage to regional values on 66.3ha, and eradication therefore satisfies the requirements of section 72(b).

If the requirements of section 72(a) and (b) are deemed by council to have been met, then the costs of the strategy can be charged to the regional community as beneficiaries and the benefits received will exceed the costs. Those on whose property the pest currently exists are exacerbators, and can reasonably be charged the cost of control, satisfying section 72(ba) of the Biosecurity Act 1993.

5.14 Darwin's barberry (*Berberis darwinii*) (2007)

ASSUMPTIONS

Initial area infested (ha)
Assumed as 400 ha from staff knowledge of regional infestations.

Weighted average gross margin ($/ha)
N/A

Proportion of production loss from infested land (%)
Assumed as being 50% gained from staff knowledge.

Total area potentially infested (TAPI) (ha)
GIS modelling shows a potential 241,538 ha of suitable habitat within the region capable of infestation if no control undertaken.

Years to infest all TAPI
Dawin's barberry is an evergreen, spiny shrub to 4+ m tall. The stems are tough and yellow-wooded, densely hairy with tough needle-sharp 5-pronged spines. The leaves are prickly, hairless and glossy, dark green. The flowers are deep yellow-orange, blooming from July/Feb producing purple-black berries with bluish bloom. This plant is often confused with the European barberry, *B.vulgaris*, which is deciduous and has red berries. Seeds are well dispersed. The plant tolerates a range of cold, damp and dry conditions, wind, salt, shade, damage, many soils and grazing, and it is long lived. Methods of dispersal include birds and possibly possums, occasionally soil and water movement. This plant has the capacity to replace shrubland and regenerating forest and is occasionally found in open habitats. Typical habitats include roadsides, farm hedges, disturbed forest and shrubland, tussock land, meadows and bare land. This plant is on the national "banned from sale or distribution" list. Taking available information into account it is assumed that this plant is capable of infesting all available habitats within 50 years if no control was undertaken.

Annual cost of control for landholder ($/ha)
Assumed as being $50 ha.

Proportion of land over which pests voluntarily controlled (%)
Given the suitable habitats 10% has been assumed for this analysis.

Proportion of land to which conservation values apply (%)
Assumed as being 10%.

Any benefits provided by the weed ($p.a.)
Nil

Biocontrol ($p.a.)
Not available

Year strategy objectives achieved (containment)
Assumed as being 20 years.

Area infested if objectives (containment) achieved (ha)
Assumed as being 300 ha.

Proportion of production loss from infested land when strategy objectives (containment) achieved (%)
Assumed as 25%.

Year strategy objectives achieved (eradication)
20 years.

RESULTS

PLANT PEST		Darwin's barberry	
	No RPMS	Containment	Eradication
Cost and losses under option	**$1,233,124**	**$285,995**	**$0**
Section 72(a) NPV		**$947,129**	**0**
Section 72(a) regional values cost/ha		**$44**	**0**
Section 72(b) NPV (*NRB*)		**$1,182,124**	**0**
Section 72(b) area of spillover prevented (ha)		**241,138**	**0**

Base Assumptions			
Discount Rate		**8%**	
Initial Area Infested (ha)	(IAI)	**400**	**(ha)**
Weighted Average Gross Margin for Infested Land ($/ha)	(WAGM)	**$0**	**($/ha)**
Proportion of Production Loss from Infested Land (%)	(PPLIL)	**50%**	**(%)**
Total Area Potentially Infested	(TAPI)	**241,538**	**(ha)**
Years to Infest all of TAPI (years)	(YI)	**50**	**(Years)**
Annual Cost of Control for Landholder ($/ha affected)	(ACCL)	**$50**	**($/ha)**
Proportion of Landholders Controlling Pests (%)	(PLCP)	**10.0%**	**(%)**
Proportion of Infested Land to which Conservation Values Apply (%)	(PILCV)	**10%**	**(%)**
Any Benefits Provided by Weed (total $ / annum)	(BPBW)		**($)**

Containment Assumptions			
Biocontrol ($/annum)			**($)**
Year Strategy objectives Achieved	(YOA)	**20**	**(Years)**
Area Infested if Strategy Objectives Achieved (ha)	(AISOA)	**300**	**(ha)**
Proportion of Production Loss from Infested Land when Strategy Objectives Achieved (%)	(PPLSOA)	**25%**	**(%)**

Eradication Assumptions			
Year Strategy objectives Achieved	(YOA)	**20**	**(Years)**

Regional Council Costs		
Year	**Containment**	Eradication
1	$2,000	
2	$2,000	
3	$2,000	
4	$2,000	
5	$2,000	
6	$2,000	
7	$2,000	
8	$2,000	
9	$2,000	
Year 10 onward	$2,000	
NPV	**$26,000**	**$0**

Control Costs		
Year	Containment	Eradication
1	$20,000	
2	$20,000	
3	$20,000	
4	$20,000	
5	$20,000	
6	$20,000	
7	$20,000	
8	$20,000	
9	$20,000	
Year 10 onward	$20,000	
NPV	**$259,995**	**$0**

CONCLUSIONS

Containment with an option for direct control at selected sites is the desired Regional Pest Management Strategy outcome for this pest plant.

The outcome in the no RPMS Scenario is a loss of $1,207,690 per annum in 50 years as a result of production losses and additional costs of control. This is equivalent to a NPV of approximately $1,233,124. In addition there are 21,738 ha on which damages to regionally significant conservation, amenity, Māori or soil and water values will occur.

The outcome of the containment scenario is a NPV of $26,000 for administration, inspection, monitoring and enforcement, a NPV of $259,995 for costs of control, and loss of $0 per annum in 20 years as a result of production losses. This is a total cost in present day terms (NPV) of approximately $285,995 at a discount rate of 8%. In addition there will be a total of 30ha on which damages to regionally significant conservation, amenity, Māori or soil and water values will occur.

The net outcome for containment when compared with the no RPMS approach produces a net positive benefit of $947,129 in NPV terms because the costs of undertaking the strategy are less than the likely losses in production and control costs if the organisms were allowed to spread. This option protects significant regional biodiversity values on 21,708ha through the prevention of spread of this organism. Containment is preferred since it best satisfies the requirements of section 72(a) of the Biosecurity Act 1993.

The net regional benefits exceed the individual benefits by $1,208,124 because the strategy prevents the spread of the pest onto 241,138ha. The strategy also prevents damage to regional values on 21,708ha, and containment therefore satisfies the requirements of section 72(b).

If the requirements of section 72(a) and (b) are deemed by council to have been met, then the costs of the strategy can be charged to the regional community as beneficiaries and the benefits received will exceed the costs. Those on whose property the pest currently exists are exacerbators, and can reasonably be charged the cost of control, satisfying section 72(ba) of the Biosecurity Act 1993.

5.15 Evergreen buckthorn (*Rhamnus alaternus*) (2002)

Description and biological capability	
Form	• Evergreen shrub growing up to 12m tall.
Habitat	• Coastal areas and bare rock • Also grows on margins of streams, forests and disturbed forest and undisturbed alluvial forests.
Regional Distribution	• Sites known in Hamilton city but not documented outside the city.
Biological success	
Dispersal method	• Birds, such as wax eyes, readily disperse the small fruit. Seeds have 80% viability.
Reproductive ability	• 90,000 to 180,000 seeds produced per individual. Separate male and female plants, which may account for its slow spread to date.
Competitive ability	• Plants grow equally well in shade or in the open, completely dominating many vegetation types. Plants will fruit under a closed canopy.
Other considerations	
Toxicity	• Unknown.
Resistance to control	• Control using herbicides e.g. metsulfuron, however this would damage the natural areas as well.

Impact evaluation				
	Current impact (Y\N)	**Current level of impact (Nil, L, M, H)**	**Potential impact (Y\N)**	**Potential level of impact (Nil, L, M, H)**
Endangered Species	Y	L	Y	H
Species Diversity	Y	M	Y	H
Soil resources	N	-	N	-
Water Quality	N	-	N	-
Human Health	N	-	N	-
Māori Culture	Y	L	Y	H
Production	N	-	N	-
Recreation	N	-	N	-
International trade	N	-	N	-

Assessment of effects status: Major

Scenario: No RPMS

Assumptions		
Initial area infested (ha)	(IAI)	1
Total area potentially infested	(TAPI)	22,000
Years to infest all of TAPI (years)	(YI)	60
Weighted average gross margin for infested land ($/ha)	(WAGM)	
Annual cost of control for land occupier ($/ha affected)	(ACCL)	400
Proportion of land occupiers controlling pests (%)	(PLCP)	5
Proportion of production loss from infested land (%)	(PPLIL)	
Proportion of infested land to which conservation values apply (%)	(PILCV)	15
Any benefits provided by the weed	(BPBW)	0
Discount rate	(DRATE)	8
Calculations		
Multiplier: work out using "RPMS guidelines - Do Nothing.xls" (IAI. TAPI, YI, DRATE)	(MDN)	0.386
Loss of production from initial area infested = IAI X WAGM X (1 - (PLCP/100)) X PPLIL	(LOPIAI)	0
Loss of production in year Y1 =WAGM X TAPI X (1 - (PLCP/100)) X PPLIL	(LOP)	0
Costs of control in initial area = IAI x ACCL x (PLCP/100)	(COCIAI)	20
Costs of control in Year Y1 = TAPI X ACCL X (PLCP/100)	(COC)	440,000
Total damage in No RPMS Scenario ($/annum) = (LOP + COC - BPBW)	(TDDNS)	440,000
Net present value No RPMS = TDDNS X MDN	(NPVDN)	169,840
Area of conservation and other regional damages = PILCV/100 X (1 - (PLCP/100)) X TAPI (ha)	(ACORD)	3,135

Scenario: Eradication

1. Annual regional costs (inspection, monitoring, enforcement, administration etc) converted to present day terms

Year	Regional cost (A)	8% discount rate multiplier (B)	NPV (A x B)	
1	10,694	1.000	10694.000	
2	10,694	0.926	9902.644	
3	10,694	0.857	9164.758	
4	10,694	0.794	8491.036	
5	10,694	0.735	7860.090	
6	10,694	0.681	7282.614	
7	10,694	0.630	6737.220	
8	10,694	0.583	6234.602	
9	10,694	0.540	5774.760	
Year 10 onward	10,694	6.253	66869.582	
	Total Sum NPV Column			**(TRC)**

2. Annual cost of control for pest weed converted to present day terms

Year	Control cost (A)	8% discount rate multiplier (B)	NPV (A x B)	
1	400	1.000	400	
2	360	0.926	333	
3	324	0.857	278	
4	292	0.794	232	
5	262	0.735	193	
6	236	0.681	161	
7	213	0.630	134	
8	191	0.583	112	
9	172	0.540	93	
Year 10 onward	155	6.253	969	
	Total Sum NPV Column		**$2,904**	**(TCC)**

Assumptions		
Current area infested (ha)	(CAI)	1
Current density (area displaced ha/ha) %	(DCY)	2
Year strategy objectives achieved	(YOA)	5
Area infested if strategy objectives achieved (ha)	(AISOA)	-
Average density if strategy objectives achieved (area displaced ha/ha) %	(DSOA)	2
Any benefits provided by weed (total $ / annum)	(BPBW)	-
Calculations		
Multiplier: "RPMS Guideline - Scenarios.xls"	(MRPMS)	2.592
Loss of production in current year = WAGM x CAI x DCY	(LOPC)	0
Loss of production in YOA = WAGM x AISOA x DSOA	(LOPYOA)	0
Total damage in RPMS Scenario ($/annum) = LOPC x MRPMS	(TDRPMS)	0
Area of conservation and other regional damages = PILCV/100 x AISOA	(ACORDRRPMS)	0
Total cost RPMS Scenario = TDRPMS + TCC + TRC	(NPVRPMS)	141,915
CALCULATIONS: SECTION 72(A)		
Net benefit of RPMS Scenario = NPVDN - NPVRPMS ($)	(NBRPMS)	27,925
Prevented damage to regional values ACORD - ACORDRPMS (ha)	(APDCV)	3,135
Cost/ha of preventing damage to regional values = NBRPMS / APDCV	(CVHA)	9

CALCULATIONS: SECTION 72(B)		
Damage on initially infested area = (LOPIAI + COCIAI) / Multiplier ($)	(DOIAI)	250
Costs of spill over = NPVDN - DOIAI	(COS)	169,590
Net regional benefit = COS - TRC	(NRB)	30,579
Area spill over prevented = TAPI - IAI	(ASP)	21,999

Cost benefit analysis summary

Two scenarios for control of evergreen buckthorn have been considered:

1. do nothing
2. eradication.

The "do nothing" scenario results in total regional damage of $440,000 NPV.

The "eradication" scenario has costs of $11,094 per annum. The cost to the region is $141,915 NPV. This results in a positive benefit of $27,925 NPV and therefore it does meet the requirements of section 72 (1)(a) of the Act. Council considers that the value of land protected is greater than $47 per hectare.

Eradication is the preferred option as it produces a positive net benefit. The regional net benefit is $30,579, therefore the requirements of section 72(1)(b) of the Act are met.

5.16 Gorse (*Ulex europaeus*) (2002)

Description and biological capability	
Form	• Sharply spiny perennial shrub up to 4m tall, leaves reduced to a spine-like tip with a very deep tap root and extensive lateral roots.
Habitat	• Grasslands, scrubland, forest margins, hill country, coastal habitats, wasteland, optimum growth on low fertility soils.
Regional distribution	• Widespread throughout region.
Biological success	
Dispersal method	• Most seeds fall close to parent plant but may be ejected up to 6m. • Also spread by water, birds, roadmaking gravel, and machinery.
Reproductive ability	• Seeds have hard coat, can be dormant for up to 30 years. Huge seed bank in soil (estimated 20,000 seeds/m^2).
Competitive ability	• Fast growth and being a nitrogen fixer means it can compete effectively with tree seedlings.
Other considerations	
Toxicity	• Spines pull fleece and lower value of wool. • Serious fire hazard.
Resistance to control	• Difficult to control on infertile and steep land, best controlled by combination of methods.

Impact evaluation				
	Current impact (Y\N)	**Current level of impact (Nil, L, M, H)**	**Potential impact (Y\N)**	**Potential level of impact (Nil, L, M, H)**
Endangered Species	N	-	N	-
Species Diversity	Y	L	Y	M
Soil resources	N	-	N	-
Water Quality	N	-	N	-
Human Health	N	-	N	-
Māori Culture	N	-	N	-
Production	Y	L-H	Y	L-H
Recreation	Y	L-M	Y	L-M
International trade	N	-	N	-

Notes: Recognised as a good ‘nursery’ crop for native species to grow through in some situations.

Assessment of effects status: Moderate

Proposal

Environment Waikato is proposing that control of gorse be undertaken over an entire property on complaint from a neighbour with a common boundary. Control is also to be required in all quarries and transport corridors, and Environment Waikato will support biocontrol using gorse thrips and gorse pod moth.

Analysis – No RPMS
As gorse is present in most parts of the region, and the major effect of the strategy is to allow spread between neighbouring properties. The costs of this scenario arise from lost production on land where gorse displaces pasture, and control costs to the neighbour from gorse seed crossing a boundary. The Environment Waikato database indicates approximately 14 complaints per annum are received, and these would go unresponded.

The biocontrol agents for gorse may become established in the region, although this is likely to take longer and be less effective than under the RPMS.

Analysis – RPMS
In this scenario Environment Waikato receives complaints and undertakes control. This results in costs of control to the occupier throughout their property where gorse is present[34], and costs for inspection, monitoring and management of $11,000 per annum, and a further $13,000 for biocontrol. This approach is expected to result in no unresolved boundary disputes between neighbours, and the faster and more comprehensive spread of the biocontrol agents.

Section 72(a)
Modelling of neighbouring situations where gorse may cause cross boundary problems indicates that the strategy is only likely to produce a net benefit in situations where the infested property is a hill country sheep and beef property where the gorse is occupying pasture, and where more than 700 – 2000m of boundary are involved. In other situations the costs of inspection and management will mean that there is no net benefit to the regional intervention. A universal boundary control strategy is therefore unlikely to satisfy section 72(a) of the BSA, although a targeted boundary control strategy might.

If the council believes that the benefits of faster and more effective spread of the gorse biocontrol agents exceed $13,000 per annum or a NPV of $52,000 over the next five years, then the requirements of section 72(a) in respect of the biocontrol expenditure will have been satisfied.

Section 72(b)
In order for section 72(b) to be worthwhile at each time intervention occurred the strategy would need to prevent spread onto the clear property of between 6 and 30 km depending on the property and infestation type. This is because the regional costs of intervention are high per complaint ($1700 per complaint) and gorse does not spread far in that most of its seed land within 5m of the parent. In order to meet the requirements of section 72(b) the council would need to consider that there were other regional benefits to requiring control in a complaint situation.

Section 72(ba)
As the benefits of the strategy are primarily to rural property owners through prevention of spread of gorse onto their property and from more effective spread of the biocontrol agents, a charge for the costs of inspection, monitoring and enforcement against complainants directly and/or as a rate over rural land types will satisfy the requirements of section 72(ba).

As those harbouring the pest can be considered to be contributing to the problem, a charge for control costs against responsible land occupiers where these can be identified will also satisfy the requirements of section 72(ba).

[34] It has been assumed for the purposes of modelling that gorse covers 200m back from the boundary where the dispute is occurring.

Cost benefit analysis summary

Three scenarios for control of gorse have been considered:

1. do nothing
2. eradication
3. containment control.

The "do nothing" scenario results in identifiable regional damage.

Section 72(1)(a) tests would only be met in targeted situations where sheep and beef farmers are heavily infested with gorse where more than 700-2,000 m of boundary are involved.

Under the "containment control" scenario, the council believes that effective spread of gorse biocontrol agents exceeds $13,000 per annum or a NPV of $52,000 over the next five years.

Containment control is the preferred option as it produces some benefit at a lower cost. Costs of regional intervention are high ($1,700 per complaint) relative to regional costs of spillover. Council has exercised its discretion and concluded that while mandatory boundary control of gorse is not cost effective, a fall-back position should be adopted to allow for enforcement on a complaints only basis.

5.17 Hydrilla (*Hydrilla verticillata*) (2007)

Description and background

Hydrilla verticillata (hydrilla) is an invasive submerged macrophyte that has been in New Zealand since the 1960s. It is established in four lakes (Tutira, Waikapiro, Opouahi and Eland) in the Hawke's Bay Region (NIWA 2006). It is not thought to be present in the Waikato region. Hydrilla is listed on the National Plant Pest Accord (NPPA), which is a cooperative agreement between regional councils and government departments with biosecurity responsibilities. Under this accord, regional councils will undertake surveillance to prevent the commercial sale and/or distribution of named pest plants.[35]

The invasive nature of aquatic water weeds is evidenced in the New Zealand context with the colonisation of the hydro-electric lakes of the Waikato River by *Egeria densa*, *Lagarosiphon major* and other introduced aquatic weed species. Introduced aquatic weeds are ubiquitous in these lakes. Whilst currently thought to be restricted to four lakes in the Hawke's Bay region the invasive potential of hydrilla is well recognised nationally and internationally.

Hydrilla was discovered in the United States in 1960 at two Florida locations, a canal near Miami and in Crystal River. By the early 1970s it was established in major water bodies of all drainage basins in the state. In 1988, the Florida Department of Natural Resources estimated over 20,000 ha of water in Florida contained hydrilla and by 1995 it was estimated to cover 40,000 ha of water in 43% of public lakes. Hydrilla is now found in all Gulf Coast states, Atlantic Coast states as far north as Maryland and Delaware, and in the western states, California, Washington, and Arizona (Langeland 1996). During the period from 1980-1993, hydrilla management in public lakes and rivers in Florida cost USD38.5 million (Westbrooks 1998). Westbrooks cites Schmitz and Brown's (1994) estimate indicating that USD10 million/annum is actually needed for adequate annual control of hydrilla on a state-wide basis.

In several areas of the United States, hydrilla has become a severe problem. Hydrilla clogs drainage and irrigation canals, prevents boating access for fishing and other water recreation, impedes commercial navigation, shades out beneficial native plants, degrades water quality, restricts water movement, and interferes with hydroelectric plants and urban water supplies (Westbrooks 1998).

Whilst much of the potential range of hydrilla in the Waikato region is occupied by *Egeria densa*, *Lagarosiphon major* and other introduced aquatic weed species, hydrilla is considered to have the potential to displace these species (NIWA 2006) possibly causing further loss of biodiversity, recreational and production values. Hydrilla has the ability to grow at lower light levels than other weed species. It often forms mono-specific communities that can grow from the water's margins to depths of about 7m and reach the waters surface from depths of 4m forming dense canopies (Ibid). Unlike other problem aquatic plants that reproduce only by fragmentation, hydrilla spreads by seed[36], tubers, plant fragments, and turions (over-wintering buds).

The National Institute of Water and Atmospheric Research (NIWA) have investigated several strategies (including containment measures and control/eradication trials) on the lakes of Hawke's Bay. Containment measures have included:

- the use of signage beside lakes with hydrilla to ensure public awareness of the plant
- weed mat has been used in selected areas of public use to minimise the risk of spread to other water bodies; and

[35] http://www.biosecurity.govt.nz/pests-diseases/plants/accord/nppa-2001.htm
[36] Hydrilla is dioecious and with only male plants present in New Zealand it does not reproduce sexually.

- a prohibition of motorised boats on Lakes Tutira and Waikapiro, the most publicly accessible of the hydrilla-infested lakes (NIWA 2006).

NIWA (2006) initiated grass carp trials in Lake Eland in 1988 in an effort to understand their efficacy in containing/eradicating hydrilla. Two and a half years after the original release of the grass carp there was no trace of hydrilla weed beds in the lake. However, in November of the same year, there was occasional spring growth from turions, tubers and stem fragments. In April 1996 newly formed tubers were discovered on a small plant in Lake Eland, and in subsequent years (1997–2002) remnant hydrilla plants have been located and viable tubers are sometimes found during annual lake surveys. Carp are not, however, selective and are capable of eliminating “virtually all aquatic plants in discrete water bodies and streams” (Ibid).

Part of the concern regarding hydrilla’s potential invasiveness in New Zealand has stemmed from the fact that diquat, which was until recently the only herbicide registered for submerged aquatic use in New Zealand, is ineffective in the control of hydrilla. NIWA has evaluated the potential of herbicides in the control hydrilla. The best results were obtained with endothall (dipotassium), a selective contact herbicide that has a long history of use in the USA. Field trials undertaken at Lake Waikapiro resulted in a significant reduction in hydrilla biomass and height, while native charophytes and shallow-water plant species were maintained (NIWA 2006).

Registration to import endothall, under the names ‘Aquathol K’ (liquid form) and ‘Aquathol Super K’ (granular form), was granted by ERMA in November 2004[37]. The Greater Wellington Regional Council has recently given consent for the use of endothall in the control of aquatic water weeds in the Wellington region.[38]

The eradication of aquatic water weeds is often problematic and containment and control the more likely outcome (MfE 2002). Methods for eradication include but are not limited to:

- physical removal – estimated cost $10,000 to $15,000/ha in 1996 (MfE, 2002)
- habitat manipulation such as the lowering of lake levels or light exclusion (shading with polythene) if scale allows
- chemical control
- biological control, such as grass carp.

Containment and control methods include but are not limited to:

- physical control such as weed harvesting ($1,000 to $3,000/ha [MfE 2002]), canal dredging using diggers ($1,000/km [NIWA, 2002]) or weed cutting ($130/km [Ibid])
- habitat manipulation
- chemical control ($1,000 to $1,200/ha [MfE 2002])
- biological control
- education and signage.

It is unlikely that a single type of weed control will remedy an aquatic weed problem (NIWA 2002) generally a combination of methods is required.

Pest management strategy

The analysis undertaken employs a matrix type model that spreads the pest into new cells at a specified age and then grows the infestation within each cell. The details of this model are provided in Annex I. The assumptions used are detailed in Annex II.

[37] ERMA approval codes HSR000946 and HSR000947

[38] Decision on the consent application by Greater Wellington’s Biosecurity Department to discharge the herbicide ‘endothall’ to water. 29 May 2006. File: WGN060079 [24807]

No RPMS
Whilst not currently present in the region, Environment Waikato has identified 12,000ha that could potentially be infested by hydrilla. Analysis of the 'no RPMS' assumes that:

- Hydrilla finds its way to the region and infests 1ha. Its subsequent spread infests the area identified by Enviroment Waikato as possessing the potential to be infested to a maximum density of 50%.
- 90% of maximum density is reached within five to twenty years.
- The rate of vegetative spread is between 20 and 100m/annum.
- Control is implemented voluntarily in 5% of the area infested at a cost of $3,000/ha/annum.

The outcome of the no RPMS scenario has a $NPV_{8\%}$ in the range of –$0.4 to –$4.2 million as a result of ongoing control costs associated with 5% of the infested area. The range is dependent on assumptions made with regard to the rate of spread by vegetative growth of the organism and the time taken to reach 90% of maximum density. The assumptions employed are respectively:

- rate of spread through vegetative growth – 20 metres/annum, years to 90% of maximum density – 20 years; and
- rate of spread through vegetative growth – 100 metres/annum, years to 90% of maximum density – 5 years.

With RPMS – Potential Pest
The strategy's objective is to prevent the distribution and propagation of the organism and to facilitate early intervention in order to secure eradication if it becomes established in the region. Under this scenario the regional council expends $20,000/annum in education, inspection, enforcement and monitoring. The strategy is assumed to be successful in maintaining a pest free status with respect to hydrilla. The net present value of the costs of the strategy are estimated as $300 000.

Section 72(a) conclusion
The successful exclusion of hydrilla from the region delivers a net benefit in $NPV_{8\%}$ terms when compared with the no RPMS scenario in the range of $0.3 million to $4.1 million through avoiding the costs of control associated with its presence in the region. The benefit range illustrated is dependent on assumptions with regard to the rate of spread of the organism and the time taken to reach 90% of maximum density (see above).

Assuming it is technically feasible, maintenance of the pest free status of hydrilla in the region or early intervention and eradication of the organism provides a higher net present value of benefits than the no RPMS scenario's reliance on voluntary control[39] and thus satisfies the requirements of section 72(a).

Section 72(b) conclusion
The American experience suggests that the values potentially compromised by the infestation of hydrilla in the region include but are not limited to:

- biodiversity and conservation – loss of indigenous species and habitat
- recreational – fishing, swimming, boating, etc
- flood protection – siltation and clogging of ditches/waterways; and
- commercial – property values, tourism, navigation and possibly additional costs to hydro-electric generation facilities.

[39] The 'No RPMS' scenario assumes that some control will be required when the organism arrives in the region and that control costs will be incurred.

The values protected by the proposed strategy are regional values. If the council considers that the assumptions employed in this analysis are robust the strategy will satisfy section 72(b). Essentially the alternative option of no RPMS will result in significant additional costs to the community with respect to lost natural values and the cost of control.

Section 72(c)
Hydrilla is capable of having a significant impact on Māori cultural values, biodiversity, conservation, recreation and amenity values. A RPMS in respect of this pest will therefore satisfy section 72(c) parts (ii), (iv) and (v).

Section 72(ba)
The beneficiaries of the proposed strategy are the wider community. If the council considers that section 72(a) and 72(b) have been satisfied and that exclusion/eradication can be achieved, then the strategy can be funded through a charge on the regional community. The requirements of section 72(ba) will then have been met.

5.18 Horsetail (*Equisetum spp.*) (2007)

Description and background

Horsetail is native to most temperate regions of the Northern Hemisphere, including Europe, North America and Asia. Horsetail is a weed of many crops, pastures and fruit growing areas in the United States, Canada, Europe and Japan. It can reduce yield drastically if present in sufficient numbers, whilst in pastures it not only reduces yield but is toxic to horses, sheep and cattle (Parsons and Cuthberston 1992). In dairy pastures it can taint the milk (Copper 1988; cited in Bell and Popay 1988). Horsetails have spread to Australia, New Zealand, Madagascar and parts of South America.

Horsetails generally require moist conditions to establish but can then persist in a wide range of climates due to a number of adaptations which help to increase water use efficiency. Preferring disturbed sites, habitat includes swampy areas such as the edges of lakes, rivers and creeks. They grow on many types of soil and can tolerate low nutrient levels. Common horsetail (*E. arvense*) usually grows in damp, open woodlands, pastures, arable lands, roadsides, stream banks and embankments. (CRC Weed Management 2003a). Invasive where the water table is high, species in this genus are extremely hard to control once established (Biosecurity New Zealand 2006), due in part to the extensive rhizome system and deeply buried tubers.

The results of Bell and Popay's (1998) study suggest that dichlobenil (trade name Prefix D) is likely to give the best herbicide control of Horsetail. However, dichlobenil is persistent in the environment with the label stating that it should only be used near water channels if they remain dry for two months after application. Cultivation, fire and slashing are considered ineffective as new stems emerge quickly from the rhizomes. Lowering the water table may give some control (Parsons et. al. 1992). Mulching with a leaf compost or black plastic may give some benefit but is expensive. Small areas can be removed by digging out all plant material, including the rhizomes. In Tasmania infestations of *E. hyemale* have been eradicated by excavation followed by deep burial of the material onsite (CRC Weed Management 2003a). Extensive infestations of *E. ramosissimum* in New South Wales have been brought under control by excavation and follow-up chemical control with herbicide (Ibid.).

Equisetums (all species) are listed under the National Pest Plant Accord and therefore their propagation, sale and distribution is restricted. The Department of Conservation (DOC) has assigned it a weediness score of 21 to 23[40] with a relatively low 'biological success rating' component of nine. The weedy behaviour of several horsetail species overseas provides a warning as to their potential threat to production and natural values.

[40] Scoring system for weediness developed by Doc assigning scores based on "Effect on system" (EoS) and Biological Success Rating (BSR). As a reference for horsetail (Doc weediness score 21 to 23), Clematis vitalba (old mans beard) has a DoC weediness score of 33 and kikuyu grass 29.

Pest management strategy

The analysis undertaken is qualitative. There is insufficient information available upon which to base the likelihood or mechanism of horsetails spread and its effect on production or natural values. Whilst the costs of control are unknown it can be assumed that they will be high for anything other than localised infestations.

No RPMS

Whilst not currently present in the region, Environment Waikato has identified 555,000 ha that could potentially host horsetail. Without a pest management strategy horsetail may find its way into the region through such mechanisms as deliberate planting, movement of soil or road metal, gardening waste, hay etc. Its subsequent control would be reliant on the voluntary action of those affected.

With RPMS – Potential Pest Strategy

The strategy's objective is to prevent the distribution and propagation of the organism and to facilitate early intervention in order to secure eradication if it becomes established in the region. Under this scenario the regional council expends funds in education, inspection, enforcement and monitoring as part of its weed surveillance activities. The strategy is assumed to be successful in maintaining a pest free status with respect to horsetail or securing early intervention and eradication whilst the infestation is small in scale.

Section 72(a)

If the council is satisfied that the retention of native biodiversity and protection of production values exceeds the cost of surveillance proposed under the strategy, then section 72(a) will have been satisfied. Given the likely difficulty associated with its control, if horsetail were to become established in the region the cost of control along with potential production losses and diminution of natural values is likely to be significantly greater than the cost of the proposed strategy. Harris and Timmins' (2000) study of fifty-eight weeds showed that there is significant benefit to be gained from the early intervention and eradication of weeds. The alternative option of no RPMS and reliance on voluntary control will result in significant additional costs to the community with respect to production losses and diminution of natural values and the cost of future control. On this basis the benefits of the proposed strategy will outweigh its costs.

Section 72(b)

The values protected by the strategy are largely regional values, as they arise as a result of protecting native biodiversity and production values that are not currently affected by horsetail. If the council is satisfied that the requirements of section 72(a) have been met, then the requirements of section 72(b) will also have been met.

Section 72(c)

Horsetail is capable of having a significant impact on conservation and production values. An RPMS in respect of this pest will therefore satisfy section 72(c) parts (i) and (iv).

Section 72(ba)

The values protected by the RPMS include production, conservation and biodiversity values. However because the degree to which each of these will be affected is uncertain, a charge against the regional community will be most appropriate and will satisfy the requirements of section 72(ba).

5.19 Horse nettle (*Solanum carolinense*) (2002)

Description and biological capability	
Form	• Prickly, herbaceous shrub up to 1m tall. Purple flowers.
Habitat	• Grows in pasture, tolerating a wide range of soil types
Regional distribution	• Limited, few known sites
Biological success	
Dispersal method	• Cultivation of earth spreads roots which form new plants. Seed also dispersed by birds
Reproductive ability	• Unknown.
Competitive ability	• Strongly competitive in pasture situations
Other considerations	
Toxicity	• Berries are poisonous to stock and humans.
Resistance to control	• Can be difficult to control due to its rhizomatous roots. These can remain dormant for several years before resprouting.

Impact evaluation				
	Current impact (Y\N)	**Current level of impact (Nil, L, M, H)**	**Potential impact (Y\N)**	**Potential level of impact (Nil, L, M, H)**
Endangered Species	N	-	N	-
Species Diversity	N	-	Y	L
Soil resources	Y	L	Y	L
Water Quality	N	-	N	
Human Health	N	-	Y	L
Māori Culture	N	-	N	-
Production	Y	L	Y	H
Recreation	N	-	N	-
International trade	N	-	N	-

Assessment of effects status: Moderate/Major

Scenario: No RPMS

Assumptions		
Initial area infested (ha)	(IAI)	1
Total area potentially infested	(TAPI)	5,000
Years to infest all of TAPI (years)	(YI)	60
Weighted average gross margin for infested land ($/ha)	(WAGM)	3,641.00
Annual cost of control for land occupier ($/ha affected)	(ACCL)	50
Proportion of land occupiers controlling pests (%)	(PLCP)	90
Proportion of production loss from infested land (%)	(PPLIL)	2
Proportion of infested land to which conservation values apply (%)	(PILCV)	5
Any benefits provided by the weed	(BPBW)	0
Discount rate	(DRATE)	8
Calculations		
Multiplier: work out using "RPMS guidelines - Do Nothing.xls" (IAI. TAPI, YI, DRATE)	(MDN)	0.528
Loss of production from initial area infested = IAI X WAGM X (1 - (PLCP/100)) X PPLIL	(LOPIAI)	4
Loss of production in year Y1 =WAGM X TAPI X (1 - (PLCP/100)) X PPLIL	(LOP)	36,410
Costs of control in initial area = IAI x ACCL x (PLCP/100)	(COCIAI)	23
Costs of control in Year Y1 = TAPI X ACCL X (PLCP/100)	(COC)	225,000
Total damage in No RPMS Scenario ($/annum) = (LOP + COC - BPBW)	(TDDNS)	261,410
Net present value No RPMS = TDDNS X MDN	(NPVDN)	138,024
Area of conservation and other regional damages = PILCV/100 X (1 - (PLCP/100)) X TAPI (ha)	(ACORD)	25

Scenario: Eradication

1. Annual regional costs (inspection, monitoring, enforcement, administration etc) converted to present day terms

Year	Regional cost (A)	8% discount rate multiplier (B)	NPV (A x B)	
1	9,600	1.000	9600.000	
2	9,600	0.926	8889.600	
3	9,600	0.857	8227.200	
4	9,600	0.794	7622.400	
5	9,600	0.735	7056.000	
6	9,600	0.681	6537.600	
7	9,600	0.630	6048.000	
8	9,600	0.583	5596.800	
9	9,600	0.540	5184.000	
Year 10 onward	9,600	6.253	60028.800	
	Total Sum NPV Column		**$ 124,790**	**(TRC)**

2. Annual cost of control for pest weed converted to present day terms

Year	Control cost (A)	8% discount rate multiplier (B)	NPV (A x B)	
1	50	1.000	50	
2	45	0.926	42	
3	41	0.857	35	
4	36	0.794	29	
5	33	0.735	24	
6	30	0.681	20	
7	27	0.630	17	
8	24	0.583	14	
9	22	0.540	12	
Year 10 onward	19	6.253	121	
	Total Sum NPV Column		**$363**	**(TCC)**

Assumptions		
Current area infested (ha)	(CAI)	1
Current density (area displaced ha/ha) %	(DCY)	2
Year strategy objectives achieved	(YOA)	5
Area infested if strategy objectives achieved (ha)	(AISOA)	-
Average density if strategy objectives achieved (area displaced ha/ha) %	(DSOA)	2
Any benefits provided by weed (total $ / annum)	(BPBW)	-
Calculations		
Multiplier: "RPMS Guideline - Scenarios.xls"	(MRPMS)	2.592
Loss of production in current year = WAGM x CAI x DCY	(LOPC)	73
Loss of production in YOA = WAGM x AISOA x DSOA	(LOPYOA)	0
Total damage in RPMS Scenario ($/annum) = LOPC x MRPMS	(TDRPMS)	189
Area of conservation and other regional damages = PILCV/100 x AISOA	(ACORDRRPMS)	0
Total cost RPMS scenario = TDRPMS + TCC + TRC	(NPVRPMS)	125,342
CALCULATIONS: SECTION 72(A)		
Net benefit of RPMS Scenario = NPVDN - NPVRPMS ($)	(NBRPMS)	12,682
Prevented damage to regional values ACORD - ACORDRPMS (ha)	(APDCV)	25
Cost/ha of preventing damage to regional values = NBRPMS / APDCV	(CVHA)	507

CALCULATIONS: SECTION 72(B)		
Damage on initially infested area = (LOPIAI + COCIAI) / Multiplier ($)	(DOIAI)	327
Costs of spill over = NPVDN - DOIAI	(COS)	137,698
Net regional benefit = COS - TRC	(NRB)	12,907
Area spill over prevented = TAPI - IAI	(ASP)	5,000

Cost benefit analysis summary

Two scenarios for control of horse nettle have been considered:

1. do nothing
2. eradication.

The "do nothing" scenario results in total regional damage of $261,410 NPV.

The "eradication" scenario has costs of $9,650 per annum. The cost to the region is $125,342 NPV. This results in a positive benefit of $12,682 NPV and therefore it does meet the requirements of section 72 (1)(a) of the Act.

Eradication is the preferred option as it produces a positive net benefit. The regional net benefit is $12,907, therefore the requirements of section 72(1)(b) of the Act are met.

5.20 Japanese knotweed (*Reynoutria japonica*) (2007)

ASSUMPTIONS

Initial area infested (ha)
A total of 3 ha at six known sites within the region.

Weighted average gross margin ($/ha)
N/A

Proportion of production loss from infested land (%)
Up to 50% is assumed.

Total area potentially infested (TAPI) (ha)
GIS calculations show a theoretical 1,607,322 ha within the region as capable of sustaining infestations of this pest plant if no control is undertaken. The current reality is that known infestations have responded positively to chemical control and are showing yearly reductions at all sites. The plant is not known to set seed in New Zealand and movement is thought to be by way of plant fragments by site transference of dirt.

Years to infest all TAPI
Japanese knotweed is a woody, rhizomatous shrub 2 metres or more tall. This pest plant is seen as a very serious invasive weed of parts of Europe and an aggressive coloniser of disturbed areas, rough pastures and riparian zones proving difficult to control. Mainly spread by human activities, var 'Compacta' still offered for sale, but limited ornamental appeal. Hybridisation between this and other Reynoutria or Fallopia species could result in seed production with further threats to spread. This plant is on the National Plant Pest Accord “banned from sale or propagation” list. It has been assumed for the purposes of this analysis that it would take 100 years for this pest plant to establish in all available habitats if no control was undertaken.

Annual cost of control for landholder ($/ha)
$125 ha assumed from control costs at current known sites.

Proportion of land over which pests voluntarily controlled (%)
Assumed to be 5% for the purposes of this analysis.

Proportion of land to which conservation values apply (%)
Assumed to be a maximum of 10% for this pest plant.

Any benefits provided by the weed ($p.a.)
Nil

Biocontrol ($p.a.)
Not available

Year strategy objectives achieved (eradication)
Assumed at 20 years for the purposes of this analysis.

RESULTS

PLANT PEST		Japanese knotweed	
	No RPMS	**Containment**	**Eradication**
Cost and losses under option	**$273,015**	**$0**	**$84,499**
Section 72(a) NPV		**$273,015**	**$188,516**
Section 72(a) regional values cost/ha		**$2**	**$1**
Section 72(b) NPV (*NRB*)		**$272,815**	**$253,315**
Section 72(b) area of spillover prevented (ha)		**1,607,320**	**1,607,320**

Base Assumptions

Discount Rate		**8%**	
Initial Area Infested (ha)	(IAI)	**3**	**(ha)**
Weighted Average Gross Margin for Infested Land ($/ha)	(WAGM)	**$0**	**($/ha)**
Proportion of Production Loss from Infested Land (%)	(PPLIL)	**50%**	**(%)**
Total Area Potentially Infested	(TAPI)	**1,607,322**	**(ha)**
Years to Infest all of TAPI (years)	(YI)	**100**	**(Years)**
Annual Cost of Control for Landholder ($/ha affected)	(ACCL)	**$125**	**($/ha)**
Proportion of Landholders Controlling Pests (%)	(PLCP)	**5.0%**	**(%)**
Proportion of Infested Land to which Conservation Values Apply (%)	(PILCV)	**10%**	**(%)**
Any Benefits Provided by Weed (total $ / annum)	(BPBW)		**($)**

Containment Assumptions			
Biocontrol ($/annum)			**($)**
Year Strategy objectives Achieved	(YOA)		**(Years)**
Area Infested if Strategy Objectives Achieved (ha)	(AISOA)		**(ha)**
Proportion of Production Loss from Infested Land when Strategy Objectives Achieved(%)	(PPLSOA)		**(%)**

Eradication Assumptions			
Year Strategy objectives Achieved	(YOA)	**20**	**(Years)**

Regional Council Costs		
Year	**Containment**	Eradication
1		$1,500
2		$1,500
3		$1,500
4		$1,500
5		$1,500
6		$1,500
7		$1,500
8		$1,500
9		$1,500
Year 10 onward		$1,500
NPV	**$0**	**$19,500**

Control Costs		
Year	Containment	Eradication
1		$5,000
2		$5,000
3		$5,000
4		$5,000
5		$5,000
6		$5,000
7		$5,000
8		$5,000
9		$5,000
Year 10 onward		$5,000
NPV	**$0**	**$64,999**

CONCLUSIONS

The Regional Pest Management Strategy objective for this pest plant is eradication.

The outcome in the no RPMS scenario is a loss of $10,045,763 per annum in 100 years as a result of production losses and additional costs of control. This is equivalent to a NPV of approximately $273,015. In addition there are 152,695 ha on which damages to regionally significant conservation, amenity, Māori or soil and water values will occur.

The outcome of the eradication scenario is a NPV of $19,500 for administration, inspection, monitoring and enforcement, a NPV of $64,999 for costs of control, and loss of $0 per annum in 20 years as a result of production losses. This is a total cost in present day terms (NPV) of approximately $84,499 at a discount rate of 8%. In addition there will be no damages to regionally significant conservation, amenity, Māori or soil and water values from this pest once eradication has been achieved.

The net outcome for eradication when compared with the no RPMS scenario is $188,516 in NPV terms. This option protects significant regional biodiversity values on 152,695ha through the prevention of spread of this organism. Eradication is preferred since it produces the highest net benefit, and best satisfies the requirements of section 72(a) of the Biosecurity Act 1993.

The net regional benefits exceed the individual benefits by $272,815 because the strategy prevents the spread of the pest onto 1,607,319ha. The strategy also prevents damage to regional values on 152,695ha, and eradication therefore satisfies the requirements of section 72(b).

If the requirements of section 72(a) and (b) are deemed by council to have been met, then the costs of the strategy can be charged to the regional community as beneficiaries and the benefits received will exceed the costs. Those on whose property the pest currently exists are exacerbators, and can reasonably be charged the cost of control, satisfying section 72(ba) of the Biosecurity Act 1993.

5.21 Kudzu vine (*Pueraria Montana*) (2007)

Description and background

Kudzu vine (*Pueraria montana*) is a semi-woody vine, a legume, with a twining and trailing growth habit that can form dense infestations covering ground and trees (Photograph 0-1) and as such has the potential to suppress indigenous species and impact on production and commercial values. Environment Waikato is proposing that kudzu vine is included in its 2007 to 2012 RPMS as a 'potential' plant pest.

A native of Asia it is reported as being naturalised in Europe (Italy and Switzerland)[41], Ukraine, Caucasus, South Africa, United States (including Hawaii), Hispaniola and Panama[42]. It has proven highly invasive in the Eastern United States where it is reported to infest some 2 to 3 million hectares resulting in estimated loses of USD500 million/annum in land productivity and control costs[43]. Its distribution is reported as being as far north as Pennsylvania, Illinois, and Connecticut and from eastern Texas to central Oklahoma in the west. Kudzu vine is classified as noxious or prohibited in 13 states, however it is not listed on the Federal Noxious Plants List.

Photograph 0-1:
Kudzu kills trees by shading them and spreads inexorably, mostly through soil movement and vegetative growth

Source: Kerry Britton, USDA Forest Service, www.insectimages.org

Kudzu vine has been nominated by the ISSG of the IUCN Species Survival Commission as among 100 of the "world's worst" invaders. The American experience demonstrates the threat that it can pose to biodiversity and conservation values as well as production values and utilities such as telephone and power lines. In response to the American experience with kudzu vine the European and Mediterranean Plant Protection Organization (EPPO) Secretariat has included the species in its Alert List stating:

[41] European and Mediterranean Plant Protection Organization (EPPO) http://www.eppo.org/QUARANTINE/Alert_List/invasive_plants/PUELO.htm accessed 10 January 2007

[42] United States Department of Agriculture Agricultural Research Service, Beltsville Area, Germplasm Resources Information Network http://www.ars-grin.gov/cgi-bin/npgs/html/taxon.pl?30355 accessed 10 January 2007

[43] Global Invasive Species Database, http://www.issg.org/database/species/ecology.asp?si=81&fr=1&sts= accessed 10 January 2007

…considering the highly invasive potential of kudzu in parts of USA, it seems desirable to survey kudzu populations in Europe and try to avoid any further introduction and spread.[44].

Whilst seed viability is considered low vegetative reproduction ensures the species continued spread. Vectors for its spread include but are not limited to:

- Animal movement and consumption/excretion
- Road vehicles
- Translocation of machinery/equipment; and
- Water currents[45].

In New Zealand kudzu vine has, to our knowledge, only been reported in three locations in the Bay of Plenty. It is listed under Environment Bay of Plenty's (EBOP) Regional Pest Management Strategy as an eradication plant pest (EBOP 2003). The species is not listed in the BSNZ's National Pest Plant Accord and it is not assigned a score within DOC's weediness database. Despite this lack of recognition in New Zealand the international experience confirms the invasive potential of kudzu vine. The Auckland Regional Council has proposed kudzu vine for inclusion as a total control pest within its 2007 to 2012 RPMS.

The largest infestation of kudzu vine in the Bay of Plenty is at rural Pahoia near Tauranga where it has spread from roadside to neighbouring pasture and affects some 3 000 sq m of shrubs and trees. A second area of 1 000 sq m is alongside State Highway 2 near Te Puke. A smaller area in a Matata garden has been controlled. Control at Matata was effected by the removal of the tubers and to date appears effective (pers. comm. Murray Severinsen, Plant Pest Officer EBOP). The two larger areas are the subject of ongoing control using Tordon Brushkiller. Initial control at these sites included the cutting of vines and the painting of cut stems with Tordon* Brushkiller for an estimated cost of $5,000/ha. Control has been conducted at these two sites for four to five years and it is anticipated that control will be required for a further three years (pers. comm. Walter Stahel, Plant Pest Officer EBOP).

Pest management strategy

The analysis undertaken employs a simple spread sheet model that considers the 'No RPMS' and 'With RPMS' scenarios.

No RPMS

Whilst not currently considered present in the region, Environment Waikato has identified as 20,000 ha that could potentially be infested by kudzu vine. The area identified is the same habitat threatened by old man's beard. The analysis of the 'No RPMS' assumes that:

- kudzu vine finds its way to the region and infests 0.5ha.
- its subsequent spread infests the area identified by Environment Waikato within 60 years.
- 80% of area affected possesses conservation values.
- control is implemented voluntarily in 5% of the area infested at a cost of $1 000/ha/annum; and
- no production losses are assumed.

Under the no RPMS scenario the ongoing costs of control associated with 5% of the infested area is estimated as possessing a value $NPV_{8\%}$ of $353 000.

With RPMS – Potential Pest

The strategy's objective is to prevent the distribution and propagation of kudzu vine and to facilitate early intervention in order to secure eradication if it becomes established in the

[44] http://www.eppo.org/QUARANTINE/Alert_List/invasive_plants/PUELO.htm accessed 10 January 2007
[45] http://www.issg.org/database/species/ecology.asp?si=81&fr=1&sts= accessed 10 January 2007

region. Given that the no RPMS scenario results in a $NPV_{8\%}$ regional cost of $353 000, Environment Waikato can be neutral about incurring costs at this level to ensure that the region remains free of kudzu vine. This cost level is equivalent to the annual expenditure of $28,200/annum in perpetuity at a discount rate of 8%.

On the basis of the assumptions employed in the analysis presented Environment Waikato can justify the expenditure of $28,200/annum in education, inspection, enforcement, monitoring and the cost of control of initial incursions to ensure the region's pest free status with regard to kudzu vine remains.

Section 72(a) conclusion
If the council considers the assumptions used here to be reasonable, the successful exclusion of kudzu vine from the region delivers a net benefit in $NPV_{8\%}$ terms when compared with the no RPMS scenario's reliance on voluntary control[46] if annual expenditure made by Environment Waikato to ensure the pest free status of kudzu vine is less than $28,200/annum .

Assuming it is technically feasible, maintenance of the pest free status of kudzu vine in the region or the early intervention and eradication of the organism for an expenditure by Environment Waikato of up to $28,200/annum provides a higher net present value of benefits than the no RPMS scenario and thus the requirements of section 72(a) are satisfied if expenditure is contained within this level. The strategy protects some 16 000ha of land possessing conservation values at an $NPV_{8\%}$ cost of $22/ha.

Section 72(b) conclusion
The American experience suggests that the values potentially compromised by the infestation of kudzu vine include but are not limited to:

- biodiversity and conservation values through the loss of indigenous species and habitat
- landscape and visual amenity values through the covering of existing vegetation by a blanket of kudzu vine
- production values both in pastoral and production forestry settings; and
- possibly commercial values associated with utilities such as telephone and power transmission lines.

The values protected by the proposed strategy are regional values. If the council considers that the assumptions employed in this analysis are robust the strategy will satisfy section 72(b). Essentially the alternative option of the no RPMS and its reliance on voluntary control will result in significant additional costs to the community with respect to lost natural values and the cost of control.

Section 72(c)
Kudzu vine is capable of having a significant impact on Māori cultural values, biodiversity, conservation, recreation, amenity values and commercial values. A RPMS in respect of this pest will therefore satisfy section 72(c) parts (i), (ii), (iv) and (v).

Section 72(ba)
The beneficiaries of the proposed strategy are the wider community. If the council considers that section 72(a) and 72(b) have been satisfied and that exclusion/eradication can be achieved, then the strategy can be funded through a charge on the regional community. The requirements of section 72(ba) will then have been met.

[46] The 'No RPMS' scenario assumes that some control will be required when the organism arrives in the region and that control costs will be incurred.

5.22 Manchurian wild rice (*Zizania latifolia*) (2002)

Description and biological capability	
Form	• Perennial grass growing up to 3-4m tall, far spreading rhizomes, aquatic plant.
Habitat	• Margins of water courses and ponds in fresh and saline water, invading swamps and farmland.
Regional distribution	• One known site in the Waihou River at Turua.
Biological success	
Dispersal method	• Seed dispersal by birds and water. • Rhizome fragments by machinery, water and large floating mats which take root and form new infestations.
Reproductive ability	• Irregular seeder with large amounts of seeds being produced in some seasons.
Competitive ability	• Displaces all species including tall native sedges. • Shade trees will inhibit its growth and stop its spread (pines, flax).
Other considerations	
Toxicity	• Nil/unknown.
Resistance to control	• Can be restricted on accessible land by regular mowing. • No effective herbicide yet known, however, there is promising research underway mixing metsulfuron and haloxyfop.

Impact evaluation				
	Current impact (Y\N)	**Current level of impact (Nil, L, M, H)**	**Potential impact (Y\N)**	**Potential level of impact (Nil, L, M, H)**
Endangered Species	Y	L	Y	M
Species Diversity	Y	L	Y	H
Soil resources	Y	L	Y	H
Water Quality	Y	L	Y	H
Human Health	N	-	N	-
Māori Culture	Y	N	Y	M
Production	Y	L	Y	H
Recreation	Y	L	Y	M
International trade	N	-	N	-

Notes:

1 Causes land to become waterlogged by intensifying the wetness, forming swampy areas - rhizomes can destroy stopbanks.

2 Invades pasture adjacent to waterways, decreasing stocking rates. Obstructs access to waterways for stock.

Assessment of effects status: Major

Scenario: No RPMS

Assumptions		
Initial area infested (ha)	(IAI)	1
Total area potentially infested	(TAPI)	65,500
Years to infest all of TAPI (years)	(YI)	50
Weighted average gross margin for infested land ($/ha)	(WAGM)	-
Annual cost of control for land occupier ($/ha affected)	(ACCL)	575
Proportion of land occupiers controlling pests (%)	(PLCP)	1
Proportion of production loss from infested land (%)	(PPLIL)	-
Proportion of infested land to which conservation values apply (%)	(PILCV)	80
Any benefits provided by the weed	(BPBW)	0
Discount rate	(DRATE)	8
Calculations		
Multiplier: work out using "RPMS guidelines - Do Nothing.xls" (IAI. TAPI, YI, DRATE)	(MDN)	0.564
Loss of production from initial area infested = IAI X WAGM X (1 - (PLCP/100)) X PPLIL	(LOPIAI)	0
Loss of production in year Y1 =WAGM X TAPI X (1 - (PLCP/100)) X PPLIL	(LOP)	0
Costs of control in initial area = IAI x ACCL x (PLCP/100)	(COCIAI)	3
Costs of control in Year Y1 = TAPI X ACCL X (PLCP/100)	(COC)	376,625
Total damage in No RPMS Scenario ($/annum) = (LOP + COC - BPBW)	(TDDNS)	376,625
Net present value No RPMS = TDDNS X MDN	(NPVDN)	212,417
Area of conservation and other regional damages = PILCV/100 X (1 - (PLCP/100)) X TAPI (ha)	(ACORD)	51,876

Scenario: Eradication

1. Annual regional costs (inspection, monitoring, enforcement, administration etc) converted to present day terms

Year	Regional cost (A)	8% discount rate multiplier (B)	NPV (A x B)	
1	15,076	1.000	15076.000	
2	15,076	0.926	13960.376	
3	15,076	0.857	12920.132	
4	15,076	0.794	11970.344	
5	15,076	0.735	11080.860	
6	15,076	0.681	10266.756	
7	15,076	0.630	9497.880	
8	15,076	0.583	8789.308	
9	15,076	0.540	8141.040	
Year 10 onward	15,076	6.253	94270.228	
	Total Sum NPV Column		**$195,973**	**(TRC)**

2. Annual cost of control for pest weed converted to present day terms

Year	Control cost (A)	8% discount rate multiplier (B)	NPV (A x B)	
1	575	1.000	575	
2	518	0.926	479	
3	466	0.857	399	
4	419	0.794	333	
5	377	0.735	277	
6	340	0.681	231	
7	306	0.630	193	
8	275	0.583	160	
9	248	0.540	134	
Year 10 onward	223	6.253	1393	
	Total Sum NPV Column		**$4,174**	**(TCC)**

Assumptions		
Current area infested (ha)	(CAI)	1
Current density (area displaced ha/ha) %	(DCY)	90
Year strategy objectives achieved	(YOA)	8
Area infested if strategy objectives achieved (ha)	(AISOA)	-
Average density if strategy objectives achieved (area displaced ha/ha) %	(DSOA)	-
Any benefits provided by weed (total $ / annum)	(BPBW)	-
Calculations		
Multiplier: "RPMS Guideline - Scenarios.xls"	(MRPMS)	4.186
Loss of production in current year = WAGM x CAI x DCY	(LOPC)	0
Loss of production in YOA = WAGM x AISOA x DSOA	(LOPYOA)	0
Total damage in RPMS Scenario ($/annum) = LOPC x MRPMS	(TDRPMS)	0
Area of conservation and other regional damages = PILCV/100 x AISOA	(ACORDRRPMS)	0
Total cost RPMS Scenario = TDRPMS + TCC + TRC	(NPVRPMS)	200,147
CALCULATIONS: SECTION 72(A)		
Net benefit of RPMS Scenario = NPVDN - NPVRPMS ($)	(NBRPMS)	12,269
Prevented damage to regional values ACORD - ACORDRPMS (ha)	(APDCV)	51,876
Cost/ha of preventing damage to regional values = NBRPMS / APDCV	(CVHA)	0

CALCULATIONS: SECTION 72(B)		
Damage on initially infested area = (LOPIAI + COCIAI) / Multiplier ($)	(DOIAI)	36
Costs of spill over = NPVDN - DOIAI	(COS)	212,381
Net regional benefit = COS - TRC	(NRB)	16,408
Area spill over prevented = TAPI - IAI	(ASP)	65,500

Cost benefit analysis summary

Two scenarios for control of Manchurian wild rice have been considered:

1. do nothing
2. eradication.

The "do nothing" scenario results in total regional damage of $376,625 NPV.

The "eradication" scenario has costs of $15,651 per annum. The cost to the region is $200,147 NPV. This results in a positive benefit of $12,269 NPV and therefore it does meet the requirements of section 72 (1)(a) of the Act. Council considers that the value of land protected is greater than $4 per hectare.

Eradication is the preferred option as it produces a positive net benefit. The regional net benefit is $16,408, therefore the requirements of section 72(1)(b) of the Act are met.

5.23 Marshwort (*Nymphoides geminata*) (2007)

Description and background

Marshwort (*Nymphoides geminata*) is a bottom-rooted, aquatic perennial. It is most readily distinguished from other aquatic plants with floating leaves in New Zealand by its bright yellow, five-lobed, frilly flowers, which are borne above the water margin. The flowers have a 2.5–3.5 centimetre span, and can be observed from November to April, although they only last one day. However, Marshwort has not been observed to set seed in New Zealand (Clayton and Tanner 1985).

The National Pest Plant Accord Manual[47] describes Marshwort as being able to rapidly colonise "shallow water, forming dense mats which block waterways and smother other aquatic plants". These mats can affect recreational values such as fishing, swimming and boating.[48]

In Lake Okareka Clayton et. al. observed that an initial planting of Marshwort totalling some 4 m^2 had spread to occupy ≈ 40 m^2 seven years later. Furthermore, adventitious spread from plant fragments had resulted in the establishment of a further three colonies totalling some 240 m^2. The potential for Marshwort to spread naturally to other water bodies or catchments is unknown, although dispersal as ornamental plants (Clayton et. al) or by water appears possible. In terms of 'weediness' Marshwort scores 58 on Champion and Clayton's (2000) weed score whilst by comparison Hydrilla scores 74. Whilst undeniably weedy, based on this score Marshwort is not considered to be as weedy or to possess the invasive potential of Hydrilla.

Little information is available on the control of Marshwort. The Global Invasive Species Database[49] mentions the herbicide Rodeo® (active ingredient Glyphosate) as having potential to control the organism, as it is used to treat other water lilies Other techniques described include cutting, harvesting and covering with weed mat (Ibid.). In New Zealand Marshwort has been successfully eradicated through the use of shading techniques in two ponds of less than 1 ha on the Coromandel Peninsula.[50] Similar techniques have been employed successfully on a pond of 30m^2 in the Tasman District.[51] Glyphosate has also been used in Tasman District on a regular basis over five years to control Marshwort in an ornamental pond[51]. Clayton and Tanner (1995) describe propagation resulting from fragmentation following the use of Glyphosate in an attempt to control the organism at Lake Okareka.

As described earlier (Section 0) it is unlikely that a single type of weed control will remedy an aquatic weed problem (NIWA 2002); generally a combination of methods is required.

Pest management strategy

The analysis undertaken employs a matrix type model that spreads the pest into new cells at a specified age and then grows the infestation within each cell. The details of this model are provided in Annex I. The assumptions used are detailed in Annex II.

No RPMS

Whilst not currently present in the region, Environment Waikato has identified 12,000ha that could potentially be infested by Marshwort. Analysis of the no RPMS assumes that:

[47] http://www.biosecurity.govt.nz/files/pests-diseases/nppa/nppa-pest-plant-accord-manual.pdf [Accessed 17 October 2006]
[48] http://www.wapms.org/plants/nymphoides.html [Accessed 21 October 2006]
[49] http://www.issg.org/database/species/management_info.asp?si=225&fr=1&sts=sss [Accessed 17 October 2006]
[50] pers. comm. Paul Champion NIWA, 5 October 2006
[51] pers. comm.. Robin Van Zoelen, Tasman District Council, 9 October 2006.

- Marshwort finds its way to the region and infests 1ha. Its subsequent spread infests the area identified by Environment Waikato as possessing the potential to be infested to a maximum density of 30%.
- 90% of maximum density is reached within five to twenty years.
- The rate of vegetative spread is between 5 and 25 m/annum.
- Control is implemented voluntarily in 5% of the area infested at a cost of $3 000/ha/annum.

The outcome of the no RPMS scenario has a $NPV_{8\%}$ in the range of –$0.3 to –$3.6 million as a result of ongoing control costs associated with 5% of the infested area. The range is dependent on assumptions made with regard to the rate of spread by vegetative growth of the organism and the time taken to reach 90% of maximum density. The assumptions employed are respectively:

- rate of spread through vegetative growth – 5 metres/annum, years to 90% of maximum density – 20 years; and
- rate of spread through vegetative growth – 25 metres/annum, years to 90% of maximum density – 5 years.

With RPMS – Potential Pest
The strategy's objective is to prevent the distribution and propagation of the organism and to facilitate early intervention in order to secure eradication if it becomes established in the region. Under this scenario the regional council expends $20,000/annum in education, inspection, enforcement and monitoring. The strategy is assumed to be successful in maintaining a pest free status with respect to Marshwort. The $NPV_{8\%}$ of the costs of the strategy are estimated as $300 000.

Section 72(a) conclusion
The successful exclusion of Marshwort from the region delivers a net benefit in $NPV_{8\%}$ terms when compared with the no RPMS scenario in the range of $0.1 million to $3.3 million through avoiding the costs of control associated with its presence in the region. The benefit range illustrated is dependent on assumptions with regard to the rate of spread of the organism and the time taken to reach 90% of maximum density (see above).

Assuming it is technically feasible, maintenance of the pest free status of Marshwort in the region or early intervention and eradication of the organism provides a higher net present value of benefits than the no RPMS scenario's reliance on voluntary control[52] and thus satisfies the requirements of section 72(a).

Section 72(b) conclusion
The literature suggests that the values potentially compromised by the infestation of Marshwort in the region include but are not limited to:

- biodiversity and conservation – loss of indigenous species and habitat
- recreational – fishing, swimming, boating, etc
- flood protection – siltation and clogging of ditches/waterways; and
- commercial – property values, tourism, navigation and possibly additional costs to hydro-electric generation facilities.

The values protected by the proposed strategy are regional values. If the council considers that the assumptions employed in this analysis are robust the strategy will satisfy section 72(b). Essentially the alternative option of the no RPMS scenario will result in significant additional costs to the community with respect to lost natural values and the increased cost of control in the future.

[52] The 'No RPMS' scenario assumes that some control will be required when the organism arrives in the region and that control costs will be incurred.

Section 72(c)
Marshwort is capable of having a significant impact on Māori cultural values, biodiversity, conservation, recreation and amenity values. An RPMS in respect of this pest will therefore satisfy section 72(c) parts (ii), (iv) and (v).

Section 72(ba)
The beneficiaries of the proposed strategy are the wider community. If the council considers that section 72(a) and 72(b) have been satisfied and exclusion/eradication can be achieved, then the strategy can be funded through a charge on the regional community. The requirements of section 72(ba) will then have been met.

5.24 Mignonette Vine (Madeira Vine) *(Andredera cordifolia*) (2002)

Description and biological capability	
Form	• Tall perennial climber, arising from a fleshy rhizome. Stem produces masses of aerial tubers that fall from the plant over winter and can regenerate new plants.
Habitat	• Coastal hedgerows, shrub lands, gardens, bush margins
Regional distribution	• Extent of distribution unknown.
Biological success	
Dispersal method	• Usually by humans or by moving top soil containing tubers. If growing on a stream side situation, water could disperse the tubers.
Reproductive ability	• Does not currently set seed in New Zealand.
Competitive ability	• Plant grows very rapidly and can quickly smother canopy and sub-canopy trees.
Other considerations	
Toxicity	• Unknown.
Resistance to control	• Plants very hard to kill because of tubers. Also the viscous exudate of cut stems makes cutting and painting ineffective.

Impact evaluation				
	Current impact (Y\N)	**Current level of impact (Nil, L, M, H)**	**Potential impact (Y\N)**	**Potential level of impact (Nil, L, M, H)**
Endangered Species	Y	L	Y	H
Species Diversity	Y	L	Y	H
Soil resources	N	-	N	-
Water Quality	N	-	N	-
Human Health	Y	L	Y	L
Māori Culture	Y	L	Y	M
Production	N	-	N	-
Recreation	N	-	N	-
International trade	N	-	N	-

Notes:

1 Can topple and kill small trees due to the weight of the growth.

2 Can block succession in some situations by forming pure colonies, e.g. forest margins, disturbed forests.

Assessment of effects status: Major

Scenario: No RPMS

Assumptions		
Initial area infested (ha)	(IAI)	3
Total area potentially infested	(TAPI)	43,000
Years to infest all of TAPI (years)	(YI)	50
Weighted average gross margin for infested land ($/ha)	(WAGM)	-
Annual cost of control for land occupier ($/ha affected)	(ACCL)	873
Proportion of land occupiers controlling pests (%)	(PLCP)	5
Proportion of production loss from infested land (%)	(PPLIL)	-
Proportion of infested land to which conservation values apply (%)	(PILCV)	50
Any benefits provided by the weed	(BPBW)	0
Discount rate	(DRATE)	8
Calculations		
Multiplier: work out using "RPMS guidelines - Do Nothing.xls" (IAI. TAPI, YI, DRATE)	(MDN)	0.627
Loss of production from initial area infested = IAI X WAGM X (1 - (PLCP/100)) X PPLIL	(LOPIAI)	0
Loss of production in year Y1 =WAGM X TAPI X (1 - (PLCP/100)) X PPLIL	(LOP)	0
Costs of control in initial area = IAI x ACCL x (PLCP/100)	(COCIAI)	131
Costs of control in Year Y1 = TAPI X ACCL X (PLCP/100)	(COC)	1,876,950
Total damage in No RPMS Scenario ($/annum) = (LOP + COC - BPBW)	(TDDNS)	1,876,950
Net present value No RPMS = TDDNS X MDN	(NPVDN)	1,176,848
Area of conservation and other regional damages = PILCV/100 X (1 - (PLCP/100)) X TAPI (ha)	(ACORD)	20,425

Scenario: Containment Control

1. Annual regional costs (inspection, monitoring, enforcement, administration etc) converted to present day terms

Year	Regional cost (A)	8% discount rate multiplier (B)	NPV (A x B)	
1	26,862	1.000	26862	
2	26,862	0.926	24874	
3	26,862	0.857	23021	
4	26,862	0.794	21328	
5	26,862	0.735	19744	
6	26,862	0.681	18293	
7	26,862	0.630	16923	
8	26,862	0.583	15661	
9	26,862	0.540	14505	
Year 10 onward	26,862	6.253	167968	
	Total Sum NPV Column		**$349,179**	**(TRC)**

2. Annual cost of control for pest weed converted to present day terms

Year	Control cost (A)	8% discount rate multiplier (B)	NPV (A x B)	
1	210	0.926	194	
2	210	0.857	180	
3	210	0.794	166	
4	210	0.735	154	
5	210	0.681	143	
6	210	0.630	132	
7	210	0.583	122	
8	210	0.540	113	
9	210	6.253	1310	
Year 10 onward				
	Total Sum NPV Column			**(TCC)**

Assumptions		
Current area infested (ha)	(CAI)	3
Current density (area displaced ha/ha) %	(DCY)	80
Year strategy objectives achieved	(YOA)	5
Area infested if strategy objectives achieved (ha)	(AISOA)	2
Average density if strategy objectives achieved (area displaced ha/ha) %	(DSOA)	70
Any benefits provided by weed (total $ / annum)	(BPBW)	-
Calculations		
Multiplier: "RPMS Guideline - Scenarios.xls"	(MRPMS)	9.247
Loss of production in current year = WAGM x CAI x DCY	(LOPC)	0
Loss of production in YOA = WAGM x AISOA x DSOA	(LOPYOA)	0
Total damage in RPMS Scenario ($/annum) = LOPC x MRPMS	(TDRPMS)	0
Area of conservation and other regional damages = PILCV/100 x AISOA	(ACORDRR PMS)	1
Total cost RPMS Scenario = TDRPMS + TCC + TRC	(NPVRPMS)	351,903
CALCULATIONS: SECTION 72(A)		
Net benefit of RPMS Scenario = NPVDN - NPVRPMS ($)	(NBRPMS)	824,945
Prevented damage to regional values ACORD - ACORDRPMS (ha)	(APDCV)	20,424
Cost/ha of preventing damage to regional values = NBRPMS / APDCV	(CVHA)	40

CALCULATIONS: SECTION 72(B)		
Damage on initially infested area = (LOPIAI + COCIAI) / Multiplier ($)	(DOIAI)	1,637
Costs of spill over = NPVDN - DOIAI	(COS)	1,175,211
Net regional benefit = COS - TRC	(NRB)	826,032
Area spill over prevented = TAPI - IAI	(ASP)	42,997

Scenario: Eradication

1. Annual regional costs (inspection, monitoring, enforcement, administration etc) converted to present day terms

Year	Regional cost (A)	8% discount rate multiplier (B)	NPV (A x B)	
1	26,862	1.000	26862.000	
2	26,862	0.926	24874.212	
3	26,862	0.857	23020.734	
4	26,862	0.794	21328.428	
5	26,862	0.735	19743.570	
6	26,862	0.681	18293.022	
7	26,862	0.630	16923.060	
8	26,862	0.583	15660.546	
9	26,862	0.540	14505.480	
Year 10 onward	26,862	6.253	167968.086	
	Total Sum NPV Column		**$349,179**	**(TRC)**

2. Annual cost of control for pest weed converted to present day terms

Year	Control cost (A)	8% discount rate multiplier (B)	NPV (A x B)	
1	2,619	1.000	2619	
2	2,357	0.926	2183	
3	2,121	0.857	1818	
4	1,909	0.794	1516	
5	1,718	0.735	1263	
6	1,546	0.681	1053	
7	1,392	0.630	877	
8	1,253	0.583	730	
9	1,127	0.540	609	
Year 10 onward	1,015	6.253	6345	
	Total Sum NPV Column		**$19,012**	**(TCC)**

Assumptions		
Current area infested (ha)	(CAI)	3
Current density (area displaced ha/ha) %	(DCY)	80
Year strategy objectives achieved	(YOA)	5
Area infested if strategy objectives achieved (ha)	(AISOA)	-
Average density if strategy objectives achieved (area displaced ha/ha) %	(DSOA)	-
Any benefits provided by weed (total $ / annum)	(BPBW)	-
Calculations		
Multiplier: "RPMS Guideline - Scenarios.xls"	(MRPMS)	2.592
Loss of production in current year = WAGM x CAI x DCY	(LOPC)	0
Loss of production in YOA = WAGM x AISOA x DSOA	(LOPYOA)	0
Total damage in RPMS Scenario ($/annum) = LOPC x MRPMS	(TDRPMS)	0
Area of conservation and other regional damages = PILCV/100 x AISOA	(ACORDRRPMS)	0
Total cost RPMS Scenario = TDRPMS + TCC + TRC	(NPVRPMS)	368,192
CALCULATIONS: SECTION 72(A)		
Net benefit of RPMS Scenario = NPVDN - NPVRPMS ($)	(NBRPMS)	808,656
Prevented damage to regional values ACORD - ACORDRPMS (ha)	(APDCV)	20,425
Cost/ha of preventing damage to regional values = NBRPMS / APDCV	(CVHA)	40

CALCULATIONS: SECTION 72(B)		
Damage on initially infested area = (LOPIAI + COCIAI) / Multiplier ($)	(DOIAI)	1,637
Costs of spill over = NPVDN - DOIAI	(COS)	1,175,211
Net regional benefit = COS - TRC	(NRB)	826,032
Area spill over prevented = TAPI - IAI	(ASP)	42,997

Cost benefit analysis summary

Three scenarios for control of mignonette vine have been considered:

1. do nothing
2. eradication
3. containment control.

The "do nothing" scenario results in total regional damage of $1,876,950 NPV.

The "eradication" scenario has costs of $29,481 per annum. The cost to the region is $368,192 NPV. This results in a positive benefit of $808,656 NPV and therefore it does meet the requirements of section 72 (1)(a) of the Act.

The "containment control" scenario has costs of $27,072 per annum. The cost to the region is $351,903 NPV. The result of this scenario is a positive benefit of $824,945 NPV and therefore it meets the requirements of section 72 (1)(a) of the Act. Council considers that the value of land protected is greater than $18 per hectare.

Containment control is the preferred option as it produces a positive net benefit at a lower cost. The regional net benefit is $826,032, therefore the requirements of section 72(1)(b) of the Act are met.

5.25 Mile-a-minute (*Dipogon lignosus*) (2007)

ASSUMPTIONS

Initial area infested (ha)
One known site in Hamilton under 1ha.

Weighted average gross margin ($/ha)
N/A

Proportion of production loss from infested land (%)
Assumed for this analysis to be 5%.

Total area potentially infested (TAPI) (ha)
GIS modelling shows that potentially there is 64,911ha of suitable habitat available within the region. The current reality is that there is one known site in the region receiving regular surveillance/control and that significant spread as modelled should be considered highly unlikely.

Years to infest all TAPI
A climbing perennial herb with pea-like purple, red, pink or whitish flowers this is a vigorous, scrambling vine that smothers vegetation from ground to mid canopy. The plant has wide environmental tolerance. Habitats at risk include coastal forest, dune lands, secondary and low forest. Self propelled seed viable for many years. This plant is on the NPPA “banned from sale or propagation” list. It has been assumed that it would take 50 years to infest all suitable habitats if no control was undertaken.

Annual cost of control for landholder ($/ha)
$100 ha derived from staff knowledge.

Proportion of land over which pests voluntarily controlled (%)
Assumed as being no more than 5%.

Proportion of land to which conservation values apply (%)
Because of the nature of the suitable habitats this is assumed to be up to 50%.

Any benefits provided by the weed ($p.a.)
N/A

Biocontrol ($p.a.)
None available

Year strategy objectives achieved (eradication)
Assumed as being 20 years.

RESULTS

PLANT PEST		Mile a minute	
	No RPMS	Containment	Eradication
Cost and losses under option	**$178,320**	**$**	**$45,499**
Section 72(a) NPV		**$**	**$132,821**
Section 72(a) regional values cost/ha		**$**	**$4**
Section 72(b) NPV (*NRB*)		**$**	**$145,784**
Section 72(b) area of spillover prevented (ha)		**64,911**	**64,911**

Base Assumptions			
Discount Rate		**8%**	
Initial Area Infested (ha)	(IAI)	**1**	**(ha)**
Weighted Average Gross Margin for Infested Land ($/ha)	(WAGM)	**$0**	**($/ha)**
Proportion of Production Loss from Infested Land (%)	(PPLIL)	**5%**	**(%)**
Total Area Potentially Infested	(TAPI)	**64,911**	**(ha)**
Years to Infest all of TAPI (years)	(YI)	**50**	**(Years)**
Annual Cost of Control for Landholder ($/ha affected)	(ACCL)	**$100**	**($/ha)**
Proportion of Landholders Controlling Pests (%)	(PLCP)	**5.0%**	**(%)**
Proportion of Infested Land to which Conservation Values Apply (%)	(PILCV)	**50%**	**(%)**
Any Benefits Provided by Weed (total $ / annum)	(BPBW)		**($)**

Containment Assumptions			
Biocontrol ($/annum)			**($)**
Year Strategy objectives Achieved	(YOA)		**(Years)**
Area Infested if Strategy Objectives Achieved (ha)	(AISOA)		**(ha)**
Proportion of Production Loss from Infested Land when Strategy Objectives Achieved(%)	(PPLSOA)		**(%)**

Eradication Assumptions			
Year Strategy objectives Achieved	(YOA)	**20**	**(Years)**

Regional Council Costs		
Year	**Containment**	Eradication
1		$2,500
2		$2,500
3		$2,500
4		$2,500
5		$2,500
6		$2,500
7		$2,500
8		$2,500
9		$2,500
Year 10 onward		$2,500
NPV	**$0**	**$32,499**

Control Costs		
Year	Containment	Eradication
1		$1,000
2		$1,000
3		$1,000
4		$1,000
5		$1,000
6		$1,000
7		$1,000
8		$1,000
9		$1,000
Year 10 onward		$1,000
NPV	**$0**	**$13,000**

CONCLUSIONS

The desired Regional Pest Management Strategy outcome for this pest plant is eradication.

The outcome in the no RPMS scenario is a loss of $324,555 per annum in 50 years as a result of production losses and additional costs of control. This is equivalent to a NPV of approximately $178,320. In addition there are 30,832ha on which damages to regionally significant conservation, recreation, amenity, Māori or soil and water values will occur.

The outcome of the eradication scenario is a NPV of $32,499 for administration, inspection, monitoring and enforcement, a NPV of $13,000 for costs of control, and loss of $0 per annum in 20 years as a result of production losses. This is a total cost in present day terms (NPV) of approximately $45,499 at a discount rate of 8%. In addition there will be no damages to regionally significant conservation, recreation, amenity, Māori or soil and water values from this pest once eradication has been achieved.

The net outcome for eradication when compared with the no RPMS scenario is $132,821 in NPV terms. This option protects significant regional biodiversity values on 30,832ha through the prevention of spread of this organism. Eradication is preferred since it produces the highest net benefit, and best satisfies the requirements of section 72(a) of the Biosecurity Act 1993.

The net regional benefits exceed the individual benefits by $178,283 because the strategy prevents the spread of the pest onto 64,910ha. The strategy also prevents damage to regional values on 30,832ha, and eradication therefore satisfies the requirements of section 72(b).

If the requirements of section 72(a) and (b) are deemed by council to have been met, then the costs of the strategy can be charged to the regional community as beneficiaries and the benefits received will exceed the costs. Those on whose property the pest currently exists are exacerbators, and can reasonably be charged the cost of control, satisfying section 72(ba) of the Biosecurity Act 1993.

5.26 Monkey apple (*Acmena smithii*) (2007)

ASSUMPTIONS

Initial area infested (ha)
26 sites across the region at Hauraki, Hamilton, Thames-Coromandel, Ngaruawahia, Tuakau. The various sites in total make up an area of around 5ha based on staff experience and contractor reports.

Weighted average gross margin ($/ha)

N/A

Proportion of production loss from infested land (%)
Nil

Total area potentially infested (TAPI) (ha)
GIS modelling shows a potential 172,393 ha of regional habitat capable of supporting this pest plant. However current sites are controlled and the plant is nationally banned from sale or propagation. The reality is that the regime of surveillance and control as necessary means that at worst regional infestations would be contained at current levels.

Years to infest all TAPI
Monkey apple is a long lived invasive tree that grows up to 20 metres. In the past it has been widely planted as a hedge plant or as a food source for native birds, which feed on the fruit and flowers. Monkey apple may germinate and grow in a range from full sunlight to shade and can eventually completely replace native forest. Spread mostly by birds eating the fruit and distributing seeds in their droppings. It has also been widely planted as a specimen tree and seedlings are often found close to the parent plants. Seedlings are shade tolerant and form dense masses under the forest canopy. When a canopy gap forms (due to windfall or possum damage) Monkey apple will grow to become the permanent canopy. Monkey apple can form pure stands, suppressing and displacing desirable species, outgrowing other native canopy trees, e.g. Puriri and Taraire. Hedges, shelterbelts, gardens, and roadsides are common seed sources. This plant is on the NPPA “banned from sale or propagation” list. It is assumed for this analysis that infestation of available habitats could occur over 100 years if no control is undertaken.

Annual cost of control for landholder ($/ha)
Assumed as $100 ha from staff and contractor reports.

Proportion of land over which pests voluntarily controlled (%)
5%

Proportion of land to which conservation values apply (%)
5%

Any benefits provided by the weed ($p.a.)
Nil

Biocontrol ($p.a.)
Not available

Year strategy objectives achieved (eradication)
Assumed as being 20 years for purposes of this analysis.

RESULTS

PLANT PEST		Monkey apple tree	
	No RPMS	**Containment**	**Eradication**
Cost and losses under option	**$43,608**	**$**	**$29,250**
Section 72(a) NPV		**$**	**$14,358**
Section 72(a) regional values cost/ha		**$**	**$2**
Section 72(b) NPV (*NRB*)		**$**	**$23,796**
Section 72(b) area of spillover prevented (ha)		**172,388**	**172,388**

Base Assumptions

Discount Rate		**8%**	
Initial Area Infested (ha)	(IAI)	**5**	**(ha)**
Weighted Average Gross Margin for Infested Land ($/ha)	(WAGM)	**$0**	**($/ha)**
Proportion of Production Loss from Infested Land (%)	(PPLIL)	**0%**	**(%)**
Total Area Potentially Infested	(TAPI)	**172,393**	**(ha)**
Years to Infest all of TAPI (years)	(YI)	**100**	**(Years)**
Annual Cost of Control for Landholder ($/ha affected)	(ACCL)	**$100**	**($/ha)**
Proportion of Landholders Controlling Pests (%)	(PLCP)	**5.0%**	**(%)**
Proportion of Infested Land to which Conservation Values Apply (%)	(PILCV)	**5%**	**(%)**
Any Benefits Provided by Weed (total $ / annum)	(BPBW)		**($)**

Containment Assumptions			
Biocontrol ($/annum)			**($)**
Year Strategy objectives Achieved	(YOA)		**(Years)**
Area Infested if Strategy Objectives Achieved (ha)	(AISOA)		**(ha)**
Proportion of Production Loss from Infested Land when Strategy Objectives Achieved (%)	(PPLSOA)		**(%)**

Eradication Assumptions			
Year Strategy objectives Achieved	(YOA)	**20**	**(Years)**

Regional Council Costs		
Year	**Containment**	Eradication
1		$1,500
2		$1,500
3		$1,500
4		$1,500
5		$1,500
6		$1,500
7		$1,500
8		$1,500
9		$1,500
Year 10 onward		$1,500
NPV	**$0**	**$19,500**

Control Costs		
Year	Containment	Eradication
1		$750
2		$750
3		$750
4		$750
5		$750
6		$750
7		$750
8		$750
9		$750
Year 10 onward		$750
NPV	**$0**	**$9,750**

CONCLUSIONS

The Regional Pest Management Strategy objective for this pest plant is eradication.

The outcome in the no RPMS scenario is a loss of $861,965 per annum in 100 years as a result of production losses and additional costs of control. This is equivalent to a NPV of approximately $43,608. In addition there is 8,188ha on which damages to regionally significant conservation, amenity or Māori values will occur.

The outcome of the eradication scenario is a NPV of $19,500 for administration, inspection, monitoring and enforcement, a NPV of $9,750 for costs of control, and loss of $0 per annum in 20 years as a result of production losses. This is a total cost in present day terms (NPV) of approximately $29,250 at a discount rate of 0.08%. In addition there will be no damages to regionally significant conservation, amenity or Māori values from this pest once eradication has been achieved.

The net outcome for eradication when compared with the no RPMS scenario is $14,358 in NPV terms. This option protects significant regional biodiversity values on 8,188ha through the prevention of spread of this organism. Eradication is preferred since it produces the highest net benefit, and best satisfies the requirements of section 72(a) of the BSA 1993.

The net regional benefits exceed the individual benefits by $43,296 because the strategy prevents the spread of the pest onto 172,388ha. The strategy also prevents damage to regional values on 8,188ha, and eradication therefore satisfies the requirements of section 72(b).

If the requirements of section 72(a) and (b) are deemed by council to have been met, then the costs of the strategy can be charged to the regional community as beneficiaries and the benefits received will exceed the costs. Those on whose property the pest currently exists are exacerbators, and can reasonably be charged the cost of control, satisfying section 72(ba) of the Biosecurity Act 1993.

5.27 Moth plant (Kapok Vine) (*Araujia sericifera*) (2002)

Description and biological capability	
Form	• Slender evergreen climber to 6m with short tap root. Prolific white and pink flowers, forming choko-like fruit with wind-dispersed seeds.
Habitat	• Warm climate, temperate plant establishing most freely in semi-shade and reaching into full light on canopy of shrubs, hedges and small trees. Tolerates considerable exposure. Scrub forest margins, openlands, disturbed or low forest.
Regional distribution	• Isolated patches - extent unknown.
Biological success	
Dispersal method	• Seed can be blown several kilometres (up to at least 40km). Can be dispersed by water.
Reproductive ability	• Can produce many seed pods per plant, each containing approximately 400 seeds. There does not seem to be a specialist pollinator in New Zealand, but seed is quite viable.
Competitive ability	• Very high as an adult - completely smothers low shrubs.
Other considerations	
Toxicity	• Plant is poisonous and sap has an irritant effect.
Resistance to control	• Effectively controlled with various herbicides but treatment can kill host species.

Impact evaluation				
	Current impact (Y\N)	**Current level of impact (Nil, L, M, H)**	**Potential impact (Y\N)**	**Potential level of impact (Nil, L, M, H)**
Endangered Species	Y	L	Y	H
Species Diversity	Y	L	Y	H
Soil resources	N	-	N	-
Water Quality	N	-	N	-
Human Health	Y	L	Y	L
Māori Culture	Y	L	Y	M
Production	N	-	N	-
Recreation	N	-	N	-
International trade	N	-	N	-

Notes: Rated as the most highly “weedy” species in Northland and Auckland regions.

Assessment of effects status: Major

Scenario: No RPMS

Assumptions		
Initial area infested (ha)	(IAI)	25
Total area potentially infested	(TAPI)	50,000
Years to infest all of TAPI (years)	(YI)	15
Weighted average gross margin for infested land ($/ha)	(WAGM)	-
Annual cost of control for land occupier ($/ha affected)	(ACCL)	873
Proportion of land occupiers controlling pests (%)	(PLCP)	2
Proportion of production loss from infested land (%)	(PPLIL)	-
Proportion of infested land to which conservation values apply (%)	(PILCV)	80
Any benefits provided by the weed	(BPBW)	0
Discount rate	(DRATE)	8
Calculations		
Multiplier: work out using "RPMS guidelines - Do Nothing.xls" (IAI. TAPI, YI, DRATE)	(MDN)	5.064
Loss of production from initial area infested = IAI X WAGM X (1 - (PLCP/100)) X PPLIL	(LOPIAI)	0
Loss of production in year Y1 =WAGM X TAPI X (1 - (PLCP/100)) X PPLIL	(LOP)	0
Costs of control in initial area = IAI x ACCL x (PLCP/100)	(COCIAI)	437
Costs of control in Year Y1 = TAPI X ACCL X (PLCP/100)	(COC)	873,000
Total damage in No RPMS Scenario ($/annum) = (LOP + COC - BPBW)	(TDDNS)	873,000
Net present value No RPMS = TDDNS X MDN	(NPVDN)	4,420,872
Area of conservation and other regional damages = PILCV/100 X (1 - (PLCP/100)) X TAPI (ha)	(ACORD)	39,200

Scenario: Containment Control

1. Annual regional costs (inspection, monitoring, enforcement, administration etc) converted to present day terms

Year	Regional cost (A)	8% discount rate multiplier (B)	NPV (A x B)	
1	28,391	1.000	28391	
2	28,391	0.926	26290	
3	28,391	0.857	24331	
4	28,391	0.794	22542	
5	28,391	0.735	20867	
6	28,391	0.681	19334	
7	28,391	0.630	17886	
8	28,391	0.583	16552	
9	28,391	0.540	15331	
Year 10 onward	28,391	6.253	177529	
	Total Sum NPV Column		**$369,055**	**(TRC)**

2. Annual cost of control for pest weed converted to present day terms

Year	Control cost (A)	8% discount rate multiplier (B)	NPV (A x B)	
1	978	1.000	978	
2	978	0.926	905	
3	978	0.857	838	
4	978	0.794	776	
5	978	0.735	719	
6	978	0.681	666	
7	978	0.630	616	
8	978	0.583	570	
9	978	0.540	528	
Year 10 onward	978	6.253	6114	
	Total Sum NPV Column		**$12,710**	**(TCC)**

Assumptions		
Current area infested (ha)	(CAI)	14
Current density (area displaced ha/ha) %	(DCY)	80
Year strategy objectives achieved	(YOA)	5
Area infested if strategy objectives achieved (ha)	(AISOA)	12
Average density if strategy objectives achieved (area displaced ha/ha) %	(DSOA)	80
Any benefits provided by weed (total $ / annum)	(BPBW)	-
Calculations		
Multiplier: "RPMS Guideline - Scenarios.xls"	(MRPMS)	11.148
Loss of production in current year = WAGM x CAI x DCY	(LOPC)	0
Loss of production in YOA = WAGM x AISOA x DSOA	(LOPYOA)	0
Total damage in RPMS Scenario ($/annum) = LOPC x MRPMS	(TDRPMS)	0
Area of conservation and other regional damages = PILCV/100 x AISOA	(ACORDRRPMS)	10
Total cost RPMS Scenario = TDRPMS + TCC + TRC	(NPVRPMS)	381,765
CALCULATIONS: SECTION 72(A)		
Net benefit of RPMS Scenario = NPVDN - NPVRPMS ($)	(NBRPMS)	4,039,107
Prevented damage to regional values ACORD - ACORDRPMS (ha)	(APDCV)	39,190
Cost/ha of preventing damage to regional values = NBRPMS / APDCV	(CVHA)	103

CALCULATIONS: SECTION 72(B)		
Damage on initially infested area = (LOPIAI + COCIAI) / Multiplier ($)	(DOIAI)	5,456
Costs of spill over = NPVDN - DOIAI	(COS)	4,415,416
Net regional benefit = COS - TRC	(NRB)	4,046,361
Area spill over prevented = TAPI - IAI	(ASP)	49,975

Scenario: Eradication

1. Annual regional costs (inspection, monitoring, enforcement, administration etc) converted to present day terms

Year	Regional cost (A)	8% discount rate multiplier (B)	NPV (A x B)	
1	28,391	1.000	28391.000	
2	28,391	0.926	26290.066	
3	28,391	0.857	24331.087	
4	28,391	0.794	22542.454	
5	28,391	0.735	20867.385	
6	28,391	0.681	19334.271	
7	28,391	0.630	17886.330	
8	28,391	0.583	16551.953	
9	28,391	0.540	15331.140	
Year 10 onward	28,391	6.253	177528.923	
	Total Sum NPV Column		**$369,055**	**(TRC)**

2. Annual cost of control for pest weed converted to present day terms

Year	Control cost (A)	8% discount rate multiplier (B)	NPV (A x B)	
1	12,222	1.000	12222	
2	11,000	0.926	10186	
3	9,900	0.857	8484	
4	8,910	0.794	7074	
5	8,019	0.735	5894	
6	7,217	0.681	4915	
7	6,495	0.630	4092	
8	5,846	0.583	3408	
9	5,261	0.540	2841	
Year 10 onward	4,735	6.253	29608	
	Total Sum NPV Column		**$88,724**	**(TCC)**

Assumptions		
Current area infested (ha)	(CAI)	14
Current density (area displaced ha/ha) %	(DCY)	80
Year strategy objectives achieved	(YOA)	5
Area infested if strategy objectives achieved (ha)	(AISOA)	-
Average density if strategy objectives achieved (area displaced ha/ha) %	(DSOA)	-
Any benefits provided by weed (total $ / annum)	(BPBW)	-
Calculations		
Multiplier: "RPMS Guideline - Scenarios.xls"	(MRPMS)	2.592
Loss of production in current year = WAGM x CAI x DCY	(LOPC)	0
Loss of production in YOA = WAGM x AISOA x DSOA	(LOPYOA)	0
Total damage in RPMS Scenario ($/annum) = LOPC x MRPMS	(TDRPMS)	0
Area of conservation and other regional damages = PILCV/100 x AISOA	(ACORDRRPMS)	0
Total cost RPMS Scenario = TDRPMS + TCC + TRC	(NPVRPMS)	457,779
CALCULATIONS: SECTION 72(A)		
Net benefit of RPMS Scenario = NPVDN - NPVRPMS ($)	(NBRPMS)	3,963,093
Prevented damage to regional values ACORD - ACORDRPMS (ha)	(APDCV)	39,200
Cost/ha of preventing damage to regional values = NBRPMS / APDCV	(CVHA)	101

CALCULATIONS: SECTION 72(B)		
Damage on initially infested area = (LOPIAI + COCIAI) / Multiplier ($)	(DOIAI)	5,456
Costs of spill over = NPVDN - DOIAI	(COS)	4,415,416
Net regional benefit = COS - TRC	(NRB)	4,046,361
Area spill over prevented = TAPI - IAI	(ASP)	49,975

Cost benefit analysis summary

Three scenarios for control of moth plant have been considered:

1. do nothing
2. eradication
3. containment control

The "do nothing" scenario results in total regional damage of $873,000 NPV.

The "eradication" scenario has costs of $40,613 per annum. The cost to the region is $457,779 NPV. This results in a positive benefit of $3,963,093 NPV and therefore it does meet the requirements of section 72 (1)(a) of the Act.

The "containment control" scenario has costs of $29,369 per annum. The cost to the region is $381,765 NPV. The result of this scenario is a positive benefit of $4,039,107 NPV and therefore it meets the requirements of section 72 (1)(a) of the Act. Council considers that the value of land protected is greater than $10 per hectare.

Containment control is the preferred option as it produces a positive net benefit at a lower cost. The regional net benefit is $4,046,361, therefore the requirements of section 72(1)(b) of the Act are met.

5.28 Nassella tussock (*Nassella trichotoma*) (2002)

Description and biological capability	
Form	• Perennial tussock forming grass growing to a height of 50cm with a 25cm base. Plants have a distinctive purple appearance when flowering and a golden colour when seeds are ripening.
Habitat	• Prefers open sites such as sunny dry pasture, stream margins, roadsides, wasteland. • Tolerates a wide range of climates. Seedlings tolerate some shading.
Regional distribution	• Only known at two sites in Coromandel. Both sites are treated and under surveillance.
Biological success	
Dispersal method	• Primarily by wind but also stock, machinery, water, hay and as a seed impurity.
Reproductive ability	• Can produce up to 100,000 seeds per plant. Seeds can lie dormant for more than 15 years.
Competitive ability	• Can form a complete cover in pasture situations, lateral spread by filling.
Other considerations	
Toxicity	• Can affect sheep forced to eat it, as it forms indigestible balls in the stomach. Seeds spoil fleece.
Resistance to control	• Can regrow from burning. • Can be contained by pasture management. Difficult to control due to large seed back. • Can be costly to control.

Impact evaluation				
	Current impact (Y\N)	**Current level of impact (Nil, L, M, H)**	**Potential impact (Y\N)**	**Potential level of impact (Nil, L, M, H)**
Endangered Species	N	-	Y	H
Species Diversity	N	-	Y	H
Soil resources	Y	L	Y	M
Water Quality	N	-	N	-
Human Health	N	-	N	-
MāoriMāori Culture	N	-	N	-
Production	Y	L	Y	L-H
Recreation	N	-	N	-
International trade	N	-	N	-

Notes: If nassella became established in the central plateau, it could force out native tussocks and other plants.

Assessment of effects status: Major

Scenario: No RPMS

Assumptions		
Initial area infested (ha)	(IAI)	3
Total area potentially infested	(TAPI)	5,000
Years to infest all of TAPI (years)	(YI)	30
Weighted average gross margin for infested land ($/ha)	(WAGM)	402.00
Annual cost of control for land occupier ($/ha affected)	(ACCL)	351
Proportion of land occupiers controlling pests (%)	(PLCP)	50
Proportion of production loss from infested land (%)	(PPLIL)	10
Proportion of infested land to which conservation values apply (%)	(PILCV)	5
Any benefits provided by the weed	(BPBW)	0
Discount rate	(DRATE)	8
Calculations		
Multiplier: work out using "RPMS guidelines - Do Nothing.xls" (IAI. TAPI, YI, DRATE)	(MDN)	2.28
Loss of production from initial area infested = IAI X WAGM X (1 - (PLCP/100)) X PPLIL	(LOPIAI)	56
Loss of production in year Y1 =WAGM X TAPI X (1 - (PLCP/100)) X PPLIL	(LOP)	100,500
Costs of control in initial area = IAI x ACCL x (PLCP/100)	(COCIAI)	491
Costs of control in Year Y1 = TAPI X ACCL X (PLCP/100)	(COC)	877,500
Total damage in No RPMS Scenario ($/annum) = (LOP + COC - BPBW)	(TDDNS)	978,000
Net present value No RPMS = TDDNS X MDN	(NPVDN)	2,229,840
Area of conservation and other regional damages = PILCV/100 X (1 - (PLCP/100)) X TAPI (ha)	(ACORD)	125

Scenario: Eradication

1. Annual regional costs (inspection, monitoring, enforcement, administration etc) converted to present day terms

Year	Regional cost (A)	8% discount rate multiplier (B)	NPV (A x B)	
1	15,076	1.000	15076.000	
2	15,076	0.926	13960.376	
3	15,076	0.857	12920.132	
4	15,076	0.794	11970.344	
5	15,076	0.735	11080.860	
6	15,076	0.681	10266.756	
7	15,076	0.630	9497.880	
8	15,076	0.583	8789.308	
9	15,076	0.540	8141.040	
Year 10 onward	15,076	6.253	94270.228	
	Total Sum NPV Column		**$195,973**	**(TRC)**

2. Annual cost of control for pest weed converted to present day terms

Year	Control cost (A)	8% discount rate multiplier (B)	NPV (A x B)	
1	1,053	1.000	1053	
2	948	0.926	878	
3	853	0.857	731	
4	768	0.794	610	
5	691	0.735	508	
6	622	0.681	423	
7	560	0.630	353	
8	504	0.583	294	
9	453	0.540	245	
Year 10 onward	408	6.253	2551	
	Total Sum NPV Column		**$7,644**	**(TCC)**

Assumptions		
Current area infested (ha)	(CAI)	3
Current density (area displaced ha/ha) %	(DCY)	2
Year strategy objectives achieved	(YOA)	10
Area infested if strategy objectives achieved (ha)	(AISOA)	-
Average density if strategy objectives achieved (area displaced ha/ha) %	(DSOA)	-
Any benefits provided by weed (total $ / annum)	(BPBW)	-
Calculations		
Multiplier: "RPMS Guideline - Scenarios.xls"	(MRPMS)	4.186
Loss of production in current year = WAGM x CAI x DCY	(LOPC)	29
Loss of production in YOA = WAGM x AISOA x DSOA	(LOPYOA)	0
Total damage in RPMS Scenario ($/annum) = LOPC x MRPMS	(TDRPMS)	121
Area of conservation and other regional damages = PILCV/100 x AISOA	(ACORDRRPMS)	0
Total cost RPMS Scenario = TDRPMS + TCC + TRC	(NPVRPMS)	203,738
CALCULATIONS: SECTION 72(A)		
Net benefit of RPMS Scenario = NPVDN - NPVRPMS ($)	(NBRPMS)	2,026,102
Prevented damage to regional values ACORD - ACORDRPMS (ha)	(APDCV)	125
Cost/ha of preventing damage to regional values = NBRPMS / APDCV	(CVHA)	16,209

CALCULATIONS: SECTION 72(B)		
Damage on initially infested area = (LOPIAI + COCIAI) / Multiplier ($)	(DOIAI)	6,846
Costs of spill over = NPVDN - DOIAI	(COS)	2,222,994
Net regional benefit = COS - TRC	(NRB)	2,027,021
Area spill over prevented = TAPI - IAI	(ASP)	4,997

Cost benefit analysis summary

Two scenarios for control of nassella tussock and fine stemmed needle grass have been considered:

1. do nothing
2. eradication

The "do nothing" scenario results in total regional damage of $2,229,840 NPV.

The "eradication" scenario has costs of $16,129 per annum. The cost to the region is $203,738 NPV. This results in a positive benefit of $2,026,102 NPV and therefore it does meet the requirements of section 72 (1)(a) of the Act.

Eradication is the preferred option as it produces a positive net benefit. The regional net benefit exceeds individual benefit by $2,027,021 through prevention of spread, therefore the requirements of section 72(1)(b) of the Act are met.

5.29 Nodding thistle (*Carduus nutans*) (2002)

Description and biological capability	
Form	• An erect annual or biennial herb growing to 1.6m high. The flowers are pink, red, purple, mauve or occasionally white and droop at end of branches. The root is a branched and fleshy tap root growing to 40cm deep.
Habitat	• Pasture, roadsides, wasteland, lucerne crops, hill country grassland. • Prefers light, free draining soils with low to medium rainfall (<1000mm/pa).
Regional distribution	• Widespread throughout the region with the highest infestations in Taupō, Rotorua, Waitomo, Otorohanga and parts of Waikato districts.
Biological success	
Dispersal method	• Seeds germinate mostly in late summer, autumn and early winter. Seed spread is its only means of dispersal. Studies have shown that 91% of seed fell within 1-2m of the parent plant. The seeds detach very easily from the thistle down. Seeds can be transported by stock, water, hay and equipment.
Reproductive ability	• Each plant can produce 7,000 viable seeds although 20,000 seeds have been recorded. Seeds buried 5-20cm can survive at least 10 years.
Competitive ability	• Nodding thistles grow in dense patches and can completely exclude other species.
Other considerations	
Toxicity	• Fragments and spines may injure stock and contaminate wool.
Resistance to control	• Nodding thistle can become resistant to sprays. Plants which have been damaged usually produce multi-stemmed, bushy regrowth.

Impact evaluation				
	Current impact (Y\N)	**Current level of impact (Nil, L, M, H)**	**Potential impact (Y\N)**	**Potential level of impact (Nil, L, M, H)**
Endangered Species	N	-	N	-
Species Diversity	N	-	N	-
Soil resources	N	-	N	-
Water Quality	N	-	N	-
Human Health	N	-	N	-
MāoriMāori Culture	N	-	N	-
Production	Y	L-H	Y	L-H
Recreation	Y	L	Y	L
International trade	N	-	N	-

Notes:

1 Dense mature stands, including rosettes, can seriously reduce stock carrying capacity. Presence of nodding thistles can also discourage animals from grazing next to plants.

2 Dense infestations of nodding thistle can restrict access to certain areas for recreational purposes.

Assessment of effects status: Minor/Moderate

Proposal
Environment Waikato proposes property clearance of nodding and plumeless thistle on all properties in the nominated zones and a boundary clearance regime of 50m in other parts of the region.

Analysis – No RPMS
Nodding thistle is present throughout the region, and the strategy is unlikely therefore to prevent infestation of clear areas. Under the no strategy scenario there will be a loss of production on those properties where control is not undertaken which is considered only likely to occur on hill country properties or equivalent (LUC Class 4 – 6), and nodding thistle infestations may reach 13% density on these properties. This loss on the 20% of properties where it is estimated control will not take place would amount to $40 million NPV at an 8% discount rate.

Without the strategy a number of situations will occur where nodding thistle causes spillover costs for a neighbour. Environment Waikato currently receives approximately 5 complaints per annum regarding nodding thistle, although because there is a requirement for control on all properties in parts of the region the number of adversely affected land occupiers (or neighbours) in a No RPMS situation will exceed this number.

Nodding thistle gall fly is likely to become established in the region over time, although this will take longer and be less effective than a managed introduction.

Analysis – RPMS
In this scenario the spread of nodding thistle between neighbouring properties will be reduced. In addition there will be no loss of production from nodding thistle and plumeless thistle in the property clearance zones. The cost of this strategy is estimated at $43,000[53] for management, monitoring and enforcement, and a further $1.43 million for control. This represents a NPV of $18 million at a discount rate of 8%.

In addition Environment Waikato is proposing to spend $30,000 per annum for biocontrol to spread the thistle gall fly. This is expected to improve the rate of spread and distribution of the insect through the region.

Section 72(a)

Property clearance zones
Nodding/Plumeless Thistle:
The requirement for property clearance for both plumeless and nodding thistle produces a net benefit of $18 – $22 million above the no RPMS scenario, primarily because it is assumed that 20% of properties receive a benefit in excess of their control costs from being required to control nodding thistle. While this assumption has some problems, particularly a lack of understanding of the true opportunity cost of the pest control expenditure, it is likely that the strategy will satisfy the requirements of section 72(a) of the BSA 1993.

Plumeless Thistle only
Where property clearance for plumeless thistle only is required, the strategy produces a benefit relative to the no RPMS scenario of approximately $5 million NPV, again primarily because it is assumed that 20% of properties receive a benefit in excess of their costs from being required to control nodding thistle. It is likely that the RPMS for Plumeless thistle will meet the requirements of section 72(a) of the BSA 1993.

[53] This has been apportioned 80% to property clearance, and 20% to boundary control areas. Within the property clearance area it is assumed that the costs for nodding and plumeless management are averaged across the entire property clearance area, with the addition property clearance area for plumeless thistle costing a similar amount to manage on a per ha basis.

Boundary control zones
Modelling of the variety of boundary control scenarios shows that the 50m boundary control strip produces a net benefit only in respect of heavily infested deer properties. A universal requirement for boundary control of nodding thistle is unlikely to satisfy the requirements of section 72(a), although a more tightly targeted control regime may do so.

Biocontrol
If the council considers that better spread of the nodding thistle biocontrol agent exceeds the cost of $30,000 per annum, then the spending on biocontrol will meet the requirements of section 72(a).

Section 72(b)

Property clearance
The requirement of property clearance does not produce a net regional benefit in excess of the individual benefit except in respect of the strip around the boundary of the property where adjoining neighbours are also pastoral farming. Therefore unless the council considers that the requirement for property clearance produces other regional benefits, this part of the strategy is unlikely to satisfy the requirements of section 72(b) of the BSA.

Boundary control
The boundary control requirement will satisfy section 72(b) if a 2.5km of boundary is affected by spillover of nodding thistle. The nodding thistle boundary control strategy is likely to satisfy the requirements of section 72(b) in the case of larger properties and affected boundaries, or if the council can reduce the cost of its inspection per complaint.

Section 72(ba)
As all the benefits of the strategy in respect of nodding and plumeless thistle arise to the rural community in less intensive sheep and beef production, a strategy which charges this group for the costs of monitoring and enforcement of thistle control, together with the biocontrol costs, will meet the requirements of section 72(ba) of the BSA 1993.

As those harbouring the pest can be considered to be contributing to the problem, a charge for control costs against responsible land occupiers where these can be identified will also satisfy the requirements of section 72(ba).

Cost benefit analysis summary

Three scenarios for control of nodding and plumeless thistle have been considered:

1. do nothing
2. eradication
3. containment control.

The "do nothing" scenario results in identifiable regional damage.

The requirement for property clearance for both nodding and plumeless thistle produces a net benefit of $18-22 million above the do nothing scenario, primarily because it is assumed that 20% of properties receive a benefit in excess of their control costs. It is likely that this strategy will satisfy the requirements of section 72(1)(a).

Modelling of a variety of boundary control scenarios shows that the 50m boundary control strip produced a net benefit only with regard to heavily infested deer properties. A universal, mandatory boundary control policy for nodding and plumeless thistle does not satisfy section 72(1)(a) requirements.

Under section 72(1)(b) tests the requirement of eradication does not produce a net regional benefit in excess of individual benefit. However, a boundary control policy will satisfy section 72(1)(b) if a 2.5km boundary is affected by spillover of nodding and plumeless thistle.

Council has exercised its discretion and opted for a boundary control policy over the whole region but based on a complaints basis only. Further, council considers that the spread of nodding thistle biocontrol agents exceeds the cost of $30,000 per annum.

5.30 Noogoora bur (*Xanthium occidentale*) (2002)

Description and biological capability	
Form	• Erect annual herb usually growing to 1m high. Has two growth forms - erect single stemmed plants or very branched spreading plants. Flowers are inconspicuous and fruit are woody brown ellipsoid burs. The burs form in clusters and are covered in hooked spines. Each bur contains two seeds.
Habitat	• Prefers warm situations in temperate regions on fertile soil.
Regional distribution	• Isolated areas. Several sites known in South Waikato.
Biological success	
Dispersal method	• Burs are well equipped for dispersal due to their hooked spines which easily entangle in wool etc. Air cavities around the spine assists the burs to float on water and hence spread along waterways. Burs are also commonly spread in agricultural seeds, road gravel and equipment.
Reproductive ability	• Produces up to 11,000 seeds per plant. Seeds are paired in a woody case with the lower seed germinating prior to the upper seed (upper seed may be delayed for two to three years).
Competitive ability	• An extensive root system and rapid growth rate makes these plants strong competitors both in pasture and summer crops. The plant has allopathic chemicals that may contribute to its competitiveness.
Other considerations	
Toxicity	• Seeds and seedlings are poisonous to stock, pigs and cattle especially. • Burs easily stick to wool.
Resistance to control	• Plants generally easy to control with chemicals and if infestation is low, hand pulling can be successful. • Can regenerate from slashed plants if not cut low enough. Seeds ripen on slashed plants.

Impact evaluation				
	Current impact (Y\N)	**Current level of impact (Nil, L, M, H)**	**Potential impact (Y\N)**	**Potential level of impact (Nil, L, M, H)**
Endangered Species	N	-	N	-
Species Diversity	N	-	N	-
Soil resources	N	-	N	-
Water Quality	N	-	N	-
Human Health	N	-	N	-
MāoriMāori Culture	N	-	N	-
Production	Y	L-M	Y	M
Recreation	N	-	N	-
International trade	N	-	N	-

Assessment of effects status: Moderate

Scenario: No RPMS

Assumptions		
Initial area infested (ha)	(IAI)	10
Total area potentially infested	(TAPI)	3,000
Years to infest all of TAPI (years)	(YI)	60
Weighted average gross margin for infested land ($/ha)	(WAGM)	2,000
Annual cost of control for land occupier ($/ha affected)	(ACCL)	50
Proportion of land occupiers controlling pests (%)	(PLCP)	60
Proportion of production loss from infested land (%)	(PPLIL)	15
Proportion of infested land to which conservation values apply (%)	(PILCV)	-
Any benefits provided by the weed	(BPBW)	0
Discount rate	(DRATE)	8
Calculations		
Multiplier: work out using "RPMS guidelines - Do Nothing.xls" (IAI. TAPI, YI, DRATE)	(MDN)	0.775
Loss of production from initial area infested = IAI X WAGM X (1 - (PLCP/100)) X PPLIL	(LOPIAI)	1,200
Loss of production in year Y1 =WAGM X TAPI X (1 - (PLCP/100)) X PPLIL	(LOP)	360,000
Costs of control in initial area = IAI x ACCL x (PLCP/100)	(COCIAI)	300
Costs of control in year Y1 = TAPI X ACCL X (PLCP/100)	(COC)	90,000
Total damage in No RPMS Scenario ($/annum) = (LOP + COC - BPBW)	(TDDNS)	450,000
Net present value No RPMS = TDDNS X MDN	(NPVDN)	348,750
Area of conservation and other regional damages = PILCV/100 X (1 - (PLCP/100)) X TAPI (ha)	(ACORD)	0

Scenario: Eradication

1. Annual regional costs (inspection, monitoring, enforcement, administration etc) converted to present day terms

Year	Regional cost (A)	8% discount rate multiplier (B)	NPV (A x B)	
1	15,076	1.000	15076.000	
2	15,076	0.926	13960.376	
3	15,076	0.857	12920.132	
4	15,076	0.794	11970.344	
5	15,076	0.735	11080.860	
6	15,076	0.681	10266.756	
7	15,076	0.630	9497.880	
8	15,076	0.583	8789.308	
9	15,076	0.540	8141.040	
Year 10 onward	15,076	6.253	94270.228	
	Total Sum NPV Column		**$195,973**	**(TRC)**

2. Annual cost of control for pest weed converted to present day terms

Year	Control cost (A)	8% discount rate multiplier (B)	NPV (A x B)	
1	500	1.000	500	
2	450	0.926	417	
3	405	0.857	347	
4	365	0.794	289	
5	328	0.735	241	
6	295	0.681	201	
7	266	0.630	167	
8	239	0.583	139	
9	215	0.540	116	
Year 10 onward	194	6.253	1211	
	Total Sum NPV Column		**$3,630**	**(TCC)**

Assumptions		
Current area infested (ha)	(CAI)	10
Current density (area displaced ha/ha) %	(DCY)	90
Year strategy objectives achieved	(YOA)	5
Area infested if strategy objectives achieved (ha)	(AISOA)	-
Average density if strategy objectives achieved (area displaced ha/ha) %	(DSOA)	-
Any benefits provided by weed (total $ / annum)	(BPBW)	-
Calculations		
Multiplier: "RPMS Guideline – Scenarios.xls"	(MRPMS)	2.592
Loss of production in current year = WAGM x CAI x DCY	(LOPC)	18,000
Loss of production in YOA = WAGM x AISOA x DSOA	(LOPYOA)	0
Total damage in RPMS Scenario ($/annum) = LOPC x MRPMS	(TDRPMS)	46,656
Area of conservation and other regional damages = PILCV/100 x AISOA	(ACORDRRPMS)	0
Total cost RPMS Scenario = TDRPMS + TCC + TRC	(NPVRPMS)	246,259
CALCULATIONS: SECTION 72(A)		
Net benefit of RPMS Scenario = NPVDN – NPVRPMS ($)	(NBRPMS)	102,491
Prevented damage to regional values ACORD – ACORDRPMS (ha)	(APDCV)	0
Cost/ha of preventing damage to regional values = NBRPMS / APDCV	(CVHA)	0
CALCULATIONS: SECTION 72(B)		
Damage on initially infested area = (LOPIAI + COCIAI) / Multiplier ($)	(DOIAI)	18,750
Costs of spill over = NPVDN - DOIAI	(COS)	330,000
Net regional benefit = COS - TRC	(NRB)	134,027
Area spill over prevented = TAPI - IAI	(ASP)	2,990

Cost benefit analysis summary

Two scenarios for control of noogoora bur have been considered:

1. do nothing
2. eradication.

The "do nothing" scenario results in total regional damage of $450,000 NPV.

The "eradication" scenario has costs of $15,576 per annum. The cost to the region is $246,259 NPV. This results in a positive benefit of $102,451 NPV and therefore it does meet the requirements of section 72 (1)(a) of the Act.

Eradication is the preferred option as it produces a positive net benefit. The regional net benefit is $134,027, therefore the requirements of section 72(1)(b) of the Act are met.

5.31 Old man's beard (*Clematis vitalba*) (2002)

Description and biological capability	
Form	• Deciduous woody vine which grows along the ground or over trees and shrubs. Prolific white flowers.
Habitat	• Scrub, wasteland, among willows, forest remnants, hedgerows, roadsides, river banks, in gardens, disturbed native bush, shelter belts. Prefers well-drained soils.
Regional distribution	• There are approximately 50 known sites in the region, with infestations recorded in the King Country and scattered sites in the Waikato and Hauraki districts.
Biological success	
Dispersal method	• Usually spread by wind over short distances, or water over long distances, also can be spread in road gravel.
Reproductive ability	• Produces greater than 10,000 seeds per square metre which remain viable on the vine over winter. • Germination rate greater than 80% and the seed has an awn that enables it to bury into the soil for germination.
Competitive ability	• Plant can completely shade out canopy species, preferring well-drained alluvial soil. Light demanding in the seedling stages.
Other considerations	
Toxicity	• Nil.
Resistance to control	• Difficult to eradicate but mature vines can be treated by cut and paint techniques using clopyralid, glyphosate or metsulfuron. • Use of herbicides compromised by plants' climbing nature. • Two biological control agents are available in New Zealand and are having some success at reducing plant vigour and killing seedlings

Impact evaluation				
	Current impact (Y\N)	**Current level of impact (Nil, L, M, H)**	**Potential impact (Y\N)**	**Potential level of impact (Nil, L, M, H)**
Endangered Species	Y	N	Y	H
Species Diversity	Y	L	Y	H
Soil resources	N	-	N	-
Water Quality	N	-	N	-
Human Health	N	-	N	-
MāoriMāori Culture	Y	L	Y	M
Production	Y	L	Y	M
Recreation	N	-	N	-
International trade	N	-	N	-

Assessment of effects status: Major

Scenario: No RPMS

Assumptions		
Initial area infested (ha)	(IAI)	107
Total area potentially infested	(TAPI)	20,600
Years to infest all of TAPI (years)	(YI)	40
Weighted average gross margin for infested land ($/ha)	(WAGM)	-
Annual cost of control for land occupier ($/ha affected)	(ACCL)	873
Proportion of land occupiers controlling pests (%)	(PLCP)	10
Proportion of production loss from infested land (%)	(PPLIL)	-
Proportion of infested land to which conservation values apply (%)	(PILCV)	80
Any benefits provided by the weed	(BPBW)	0
Discount rate	(DRATE)	8
Calculations		
Multiplier: work out using "RPMS guidelines - Do Nothing.xls" (IAI. TAPI, YI, DRATE)	(MDN)	4.41
Loss of production from initial area infested = IAI X WAGM X (1 - (PLCP/100)) X PPLIL	(LOPIAI)	0
Loss of production in year Y1 =WAGM X TAPI X (1 - (PLCP/100)) X PPLIL	(LOP)	0
Costs of control in initial area = IAI x ACCL x (PLCP/100)	(COCIAI)	9,341
Costs of control in Year Y1 = TAPI X ACCL X (PLCP/100)	(COC)	1,798,380
Total damage in No RPMS Scenario ($/annum) = (LOP + COC - BPBW)	(TDDNS)	1,798,380
Net present value No RPMS = TDDNS X MDN	(NPVDN)	7,930,856
Area of conservation and other regional damages = PILCV/100 X (1 - (PLCP/100)) X TAPI (ha)	(ACORD)	14,832

Scenario: Eradication

1. Annual regional costs (inspection, monitoring, enforcement, administration etc) converted to present day terms

Year	Regional cost (A)	8% discount rate multiplier (B)	NPV (A x B)	
1	49,138	1.000	49138.000	
2	49,138	0.926	45501.788	
3	49,138	0.857	42111.266	
4	49,138	0.794	39015.572	
5	49,138	0.735	36116.430	
6	49,138	0.681	33462.978	
7	49,138	0.630	30956.940	
8	49,138	0.583	28647.454	
9	49,138	0.540	26534.520	
Year 10 onward	49,138	6.253	307259.914	
	Total Sum NPV Column		**$638,745**	**(TRC)**

2. Annual cost of control for pest weed converted to present day terms

Year	Control cost (A)	8% discount rate multiplier (B)	NPV (A x B)	
1	93,411	1.000	93411	
2	84,070	0.926	77849	
3	75,663	0.857	64843	
4	68,097	0.794	54069	
5	61,287	0.735	45046	
6	55,158	0.681	37563	
7	49,642	0.630	31275	
8	44,678	0.583	26047	
9	40,210	0.540	21714	
Year 10 onward	36,189	6.253	226292	
	Total Sum NPV Column			**(TCC)**

Assumptions		
Current area infested (ha)	(CAI)	107
Current density (area displaced ha/ha) %	(DCY)	80
Year strategy objectives achieved	(YOA)	15
Area infested if strategy objectives achieved (ha)	(AISOA)	-
Average density if strategy objectives achieved (area displaced ha/ha) %	(DSOA)	-
Any benefits provided by weed (total $ / annum)	(BPBW)	-
Calculations		
Multiplier: "RPMS Guideline - Scenarios.xls"	(MRPMS)	5.441
Loss of production in current year = WAGM x CAI x DCY	(LOPC)	0
Loss of production in YOA = WAGM x AISOA x DSOA	(LOPYOA)	0
Total damage in RPMS Scenario ($/annum) = LOPC x MRPMS	(TDRPMS)	0
Area of conservation and other regional damages = PILCV/100 x AISOA	(ACORDRRPMS)	0
Total cost RPMS Scenario = TDRPMS + TCC + TRC	(NPVRPMS)	1,316,853
CALCULATIONS: SECTION 72(A)		
Net benefit of RPMS Scenario = NPVDN - NPVRPMS ($)	(NBRPMS)	6,614,003
Prevented damage to regional values ACORD - ACORDRPMS (ha)	(APDCV)	14,832
Cost/ha of preventing damage to regional values = NBRPMS / APDCV	(CVHA)	446

CALCULATIONS: SECTION 72(B)		
Damage on initially infested area = (LOPIAI + COCIAI) / Multiplier ($)	(DOIAI)	116,764
Costs of spill over = NPVDN - DOIAI	(COS)	7,814,092
Net regional benefit = COS - TRC	(NRB)	7,175,347
Area spill over prevented = TAPI - IAI	(ASP)	20,493

Cost benefit analysis summary

Two scenarios for control of old man’s beard have been considered:

1. do nothing
2. eradication.

The "do nothing" scenario results in total regional damage of $1,798,380 NPV.

The "eradication" scenario has costs of $142,549 per annum. The cost to the region is $1,316,853 NPV. This results in a positive benefit of $6,614,003 NPV and therefore it does meet the requirements of section 72 (1)(a) of the Act. Council considers that the value of the land protected is greater than $88 per hectare.

Eradication is the preferred option as it produces a positive net benefit. The regional net benefit is $7,175,347, therefore the requirements of section 72(1)(b) of the Act are met.

5.32 Pampas (common and purple) *(Cortaderia jubata, C. selloana* and cultivars*)* (2002)

Description and biological capability	
Form	• A tall tussock grass with sharp leaves mostly developing from the base. Grows to a height of 4m. Purple pampas has a large purple plume whereas in yellow pampas the flower is yellow.
Habitat	• Spread from subtropical to temperate regions. Prefers disturbed areas and river banks. Common in forestry blocks. Occurs in geothermal areas in the Central North Island.
Regional distribution	• Widespread in Waikato with extensive colonies in the Franklin, Thames-Coromandel, Waikato and Waipa Districts.
Biological success	
Dispersal method	• Seed dispersed primarily by wind (10-25km) however gravel, vehicles and animals can also carry seed.
Reproductive ability	• Up to 100,000 seeds can be produced per flower head.
Competitive ability	• Is a major problem in forestry areas. • The root system of a single plant can occupy as much as 103 cubic metres of soil. • *C. jubata* is generally considered the worse pest.
Other considerations	
Toxicity	• Nil.
Resistance to aontrol	• Can be controlled using herbicides but is difficult. Size of mature plants makes mechanical removal difficult. • Sometimes grazed by stock.

Impact evaluation				
	Current impact (Y\N)	**Current level of impact (Nil, L, M, H)**	**Potential impact (Y\N)**	**Potential level of impact (Nil, L, M, H)**
Endangered Species	Y	L	Y	M
Species Diversity	Y	L-M	Y	H
Soil resources	N	-	N	-
Water Quality	N	-	N	-
Human Health	N	-	N	-
MāoriMāori Culture	Y	M	Y	M
Production	Y	L	Y	L
Recreation	N	M	N	M
International trade	N	-	N	-

Assessment of effects status: Moderate/Major

Section 72(c)
Pampas is capable of serious effects on forestry and biodiversity, and therefore is likely to satisfy section 72(c) of the BSA 1993.

Proposal
Environment Waikato propose control of pampas throughout the region in a staged manner. Areas which under the previous RPMS will be required to control all pampas from the beginning of the strategy (July 2002), with other areas required to control pampas from July 2004 following a period of advice and education.

Analysis – No RPMS
In this scenario the range of pampas will increase from its current estimated 60,000ha to 97,000ha, including coastal dunes and cliffs, roadsides, disturbed soils, exotic forestry, forest margins, and quarries. Modelling using various rates of spread suggest that this spread will happen reasonably quickly, if it has not done so already. Its density within currently infested areas is estimated at 5%, and given the length of time it has been present in the region and lack of control it is assumed that this represents its maximum density in affected areas.

Modelling indicatively suggests that the financial losses in this scenario will amount to in the order of $1.1 million. In addition a further 30% of the area affected (28,000 ha) will suffer a loss in biodiversity and conservation values. Some costs in terms of reduced visibility on roadsides may also be incurred.

Analysis – RPMS
In this scenario pampas will be controlled throughout the region, and no financial losses or damage to 28,000 ha on which biodiversity and conservation values are important will occur. The cost of this is estimated at approximately $5 million in NPV terms at a discount rate of 8%. It should be noted that a scenario where all pampas is controlled and no financial losses or damage to conservation values are incurred is considered very difficult to achieve, and some doubt is held about this scenario.

Control at sites with conservation values and in forestry
In this scenario no attempt is made to prevent spread, and control is only undertaken in sites where conservation values occur or where forestry is affected. The cost of this in NPV terms is $3.8 million at a discount rate of 8%. There will also be some additional costs in terms of roadside visibility and spread is likely to be faster if roadsides are not controlled, although the extent and cost of these factors is uncertain.

Section 72(a)
Modelling using a range of assumptions shows that the universal control of pampas has a net outcome of -$3.8 million in relation to the no control scenario. This option would only meet the requirements of section 72(a) if the region ascribes to the conservation and biodiversity values protected a capital value in excess of $2700 per ha or $200/ha/annum affected directly by pampas.

However the alternate scenario, where control is undertaken in these areas as required, shows that these values can be protected at a considerably lower cost of $850/ha or $70/ha/annum. The original RPMS proposal would need to attach considerable value to roadside visibility ($1.2 million) in order to be worthwhile, and is unlikely to meet the requirements of section 72(a) unless there are other unquantified values not addressed here.

If the density of pampas across the region is uniform, then the conclusions would be the same for control in a more limited area within the region. However if densities are lower in some parts of the region, and containment is a realistic option, the net benefits from an area specific property clearance regime may be greater than has been indicated here.

Section 72(b)
The control of pampas creates regional benefit through a reduction in spillover costs for forestry owners, and the protection of conservation and biodiversity values. In quantifiable terms the regional costs exceed the benefits by $430,000, but there are also 28 000ha of land where pampas may cause damage to conservation and biodiversity values. If the

council considers that the requirements of section 72(a) have been met, then the requirements of section 72(b) will also have been met.

Section 72(ba)
The values protected by the control of pampas are a mixture of benefits to forestry land occupiers and to the regional community. A charge against these beneficiaries in proportion to their benefit for inspection and regulatory costs will therefore satisfy the requirements of section 72(ba).

As those harbouring the pest can be considered to be contributing to the problem, a charge for control costs against responsible land occupiers where these can be identified will also satisfy the requirements of section 72(ba).

Cost benefit analysis summary

Three scenarios for control of pampas have been considered:

1. do nothing
2. eradication
3. containment control.

Modelling suggests that under the “do nothing scenario”, the financial losses will amount to $1.1 million. In addition a further 30% of the area affected (28,000ha) will suffer a loss in biodiversity and conservation values. Some costs in terms of reduced visibility on roadsides may also be incurred.

Under the “eradication, region wide scenario”, pampas will be controlled throughout the region, and no financial losses or damage to 28,000ha on which biodiversity and conservation values are important will occur. The cost of this is an estimated $5 million in terms of NPV. The universal control of pampas has a net outcome of -$3.8 million in relation to the do nothing scenario. This option would only meet the requirements of section 72(a) if the region ascribes to the conservation values protected in excess of $2700 per ha or $200/ha/annum. Council considers this cost to be too high.

Under “containment control”, at sites with conservation values and in forestry, no attempt is made to prevent spread, and control is only undertaken in sites where conservation values occur or where forestry is affected. The cost of this is $3.8 million NPV. There will also be some additional costs in terms of roadside visibility and spread is likely to be faster if roadsides are not controlled, although the extent and cost of these factors is uncertain. Under this option, these values can be protected at a considerably lower cost of $850/ha or $70/ha/annum.

Council considers containment control to be a viable option. The control of pampas creates regional benefit through a reduction in spillover costs for forestry owners, and the protection of conservation values. The regional costs exceed the benefits by $430,000, but there are also 28 000ha of land where pampas may cause damage to conservation and biodiversity values. Council considers that the requirements of section 72(a) have been met, with regard to containment control, so the requirements of section 72(b) are also met.

5.33 Pinus contorta (*Pinus contorta*) (2002)

Description and biological capability	
Form	• Large shrub or small to medium sized pine tree.
Habitat	• Grows on a wide range of sites • Shade intolerant.
Regional distribution	• Grows in a large part of the central plateau (Waiouru, Karioi, National Park) and in and around the southern boundary of the Waikato region.
Biological success	
Dispersal method	• Seed spread mainly by wind (up to at least 8km). • Has been planted as a forestry plant in the past.
Reproductive ability	• Fallen trees can release seed.
Competitive ability	• An aggressive coloniser particularly when planted at higher altitudes. • Once established, trees can replace most other species. • Seedlings can not compete with introduced grasses.
Other considerations	
Toxicity	• None.
Resistance to control	• Can be controlled by hand or herbicides. • Fire increases seedling numbers. • Regrowth can occur from inadequately slashed plants.

Impact evaluation				
	Current impact (Y\N)	**Current level of impact (Nil, L, M, H)**	**Potential impact (Y\N)**	**Potential level of impact (Nil, L, M, H)**
Endangered Species	Y	L	Y	M
Species Diversity	Y	M	Y	M-H
Soil resources	N	-	N	-
Water Quality	N	-	N	-
Human Health	Y	L	Y	L
MāoriMāori Culture	Y	L	Y	L-M
Production	Y	L	Y	L
Recreation	Y	L-M	Y	M
International trade	N	-	Y	L

Notes:

1 Is capable of changing tussock ecosystems into exotic pine ecosystems

2 Ecosystem changes may also impact on tourism on the Central Plateau

Assessment of effects status: Major

Wilding conifers are those trees which occur through natural regeneration beyond planted stands, and *Pinus contorta* is one of the worst of these. Wilding spread and establishment is limited by a number of factors. Spread is limited by location of seed sources, prevailing winds, and seed size. Establishment is limited by altitude, climatic conditions, soil types, vegetation, and grazing. In particular Ledgard[54] notes the periodic nature of establishment of outlier trees with climatic factors likely to be important in the success of establishment.

Economic impacts[55]

Pastoral production

Wilding conifers displace pasture on favourable country, and this displacement results in a loss of pastoral production from those land types. Typically wilding conifers invade pasture which are of low development status and only lightly grazed. Benecke (1962)[56] undertook trials which indicated that at sheep densities higher than 0.6 sheep per ha less than 2% of seedlings were healthy survivors. In a high country situation sheep will graze selectively, following sunnier, moister and better vegetated areas (O'Connor, 1978)[57], and even in relatively heavily stocked areas there will be areas of lower grazing intensity where wilding conifers are able to become established. Establishment is also assisted by scrub and rock cover, which makes young seedlings inaccessible to sheep. In less desirable situations mob stocking is likely to be the only mechanism for controlling the development of wilding conifers.

There is mainly anecdotal evidence that rabbits and hares also play a part in suppressing wildings, with an increase in establishment noted following control operations. Certainly these pests are noted as of concern in forestry establishment[58], and it is likely that their effects on seedlings extend to wildings.

Pinus contorta is likely to invade only that land which is of lower value for pastoral production. The average stocking rate on high country properties in the South Island where invasion by contorta occurs is approximately 0.8 su/ha[59], but the stocking rate on the country affected by wilding conifers is likely to be considerably lower. It is considered that there are few pastoral agriculture systems in the Waikato region with a sufficiently low stocking rate to allow invasion by contorta, and therefore no significant loss by contorta to pastoral agriculture is anticipated.

Timber production value

The conifer species are important production species in New Zealand. Stumpage is affected by growth rate and form, distance from mill, and the difficulty of harvest. For wilding trees it will also be affected by the type of spread, with dense fringe spread producing more valuable timber than distant spread trees. Stumpage for pulp wood may amount to between $0 and $5,000 per ha depending on the volume and access, and for Pinus contorta the value of pulpwood would need to increase by 50% from its current price of $35/tonne to over $50/tonne for this to be achieved[60]. On steeper sites it is unlikely that there will ever be an economic return from harvesting this species. The conclusion for Pinus contorta is therefore that the net economic impact of wilding spread is likely to be neutral, with no major benefits from extraction of timber.

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[54] Nick Ledgard, FRI , pers comm.

[55] Impacts of Pinus contorta have been largely derived from work undertaken in Harris, S. 2000. "Meeting the requirement of the Biosecurity Act 1993 : Economic evaluation of options for regional pest management strategies for animal pests Round II." Report prepared for Environment Canterbury.

[56] Benecke, U. 1967. The Weed Potential of Lodgepole Pine, Tussock Grassland and Mountain Lands Institute, "Review" No 13, reprinted, New Zealand Forest Service Reprint No 266.

[57] O'Connor, K.F., 1978, The rational use of high mountain resources in pastoral systems. In" The Use of High Mountains of the World. International Union for Conservation of Nature and Natural Resources. Department of Lands and Survey and Tussock Grasslands and Mountain Lands Institute, Christchurch.

[58] Harris 1994. Economic Analysis of Regional Pest Management Strategies for Rabbits. Brown Copeland and Co. Ltd. Report Prepared for the Canterbury Regional Council.

[59] New Zealand Meat and wool Boards' Economic Service, New Zealand Sheep and Beef Farm Survey 1994 – 95.

[60] Assuming 20% domestic sawlog content, a steep site and 200km to the mill, harvest and transport costs of 50/tonne. All prices and costs from AgriFax June 1999.

Conservation values

The damage to conservation values are detailed in Ledgard (1999)[61]. These include out-competing and terminally smothering indigenous plant communities, altering environments favourable to indigenous fauna and flora, and drying out wetlands and riparian areas. The threat to conservation values can usefully be divided into communities above and below tree line.

Above tree line wildings are a significant problem as they are capable of growing at altitudes above the native forest communities. The potential exists therefore for them to replace native alpine scrub and alpine tussock communities, with resulting severe damage to these ecosystems. Typically wildings would not be expected to establish in healthy dense scrub or tussock grasslands, although opportunities for invasion will be presented by the dynamic nature of these communities with slips and erosion creating bare ground openings for colonising plants. Subsequent seed pressure and the ability to overtop will eventually lead to a general conversion of these habitat types to conifer canopies. While species such as Pinus contorta are an early coloniser, above the tree line no alternate native species is likely to eventually overtop it, and the likelihood is that introduced conifers above native treeline will form the canopy species.

Below treeline the situation is more complex because the majority of the vegetation types which are invaded by wildings are not climax communities and have been maintained as low grassland or scrub communities by continual intervention such as grazing or burning, and/or by the absence of seed sources for successional species. In these situations wildings are successional species, and since they are not shade tolerant it is likely that they will eventually be replaced by other, preferably native, species. In the case of P. contorta this succession may begin to take place in as little as 50 years. The creation of a conifer forest in previous tussock grassland has a number of implications.

- If native seed sources are available it may hasten succession toward native forest of some sort, although this native forest may not be of a type if a natural succession involving only native species were involved.

- The native communities which are replaced represent important communities both as climax communities such as wetlands, and as part of natural seral succession pathways, albeit because of the extent of Polynesian and European burning their extent is greater than may have previously existed. These native communities therefore are valuable reservoirs of indigenous biodiversity, and may contain threatened species such as native wetas and grasshoppers. The key issue with biodiversity is that the full range of New Zealand's biodiversity is not understood, and the only certain way of retaining as much as possible is to retain whole ecosystems. Loss of ecosystems results in a loss of an unknown level of biodiversity, even if key, known species are retained.

- Exotic forests are not biological deserts, and may be important habitats for native species, particularly insectivorous species. Clout and Gaze (1984)[62] found that between 35% and 53% of bird species were indigenous in northern South Island exotic plantations, and Allen et al (1995)[63] found a high proportion of indigenous plant species in North Island plantations. Ledgard (1995)[64] in a survey of native birds in exotics in the high country noted that exotic plantations offered bird habitat which would otherwise be unavailable in the treeless parts of the high country. Evidence from Kaingaroa suggests that mature forests contain the greatest levels of biodiversity, and this level of maturity may not be achieved in the high country until 30+ years. However Clout and Gaze found

[61] Ledgard, N.J. 1999 Report on the adverse effects of introduced conifer wildings. Unpublished report for the Canterbury Regional Council.

[62] Clout, M.N. and Gaze, P.D. 1984. "Effects of plantation forestry on Birds in New Zealand". Journal of Applied Ecology 21:795-815

[63] Allen, R, Platt, K and Wiser, S. 1995. "Biodiversity in New Zealand Plantations" New Zealand Forestry, February 1995.

[64] Ledgard, N.J. 1995. "Native Birds in South Island High Country exotic conifers" New Zealand Forestry, 39(4) Feb 1995. 37 – 38.

that the diversity of indigenous bird species in the exotics was not as high as in native forests, and in particular fruit eating or nectar feeders and hole nesters did not find plantations suitable habitats.

- The lands affected by wildings are typically already considerably altered by human disturbance. Fire of both Polynesian and European origin has removed much of the original forest cover, and tussock grasslands have been invaded by a range of introduced grasses and herbs. Some of these, such as Hieracium, have caused significant changes to the composition of the grasslands. Grazing would continue in the absence of wilding cover, and this will maintain the system in its current state. Stephens[65] estimates that induced grasslands retain 50% of their original biodiversity, as opposed to 30% for exotic forests. We should therefore note that below the treeline the loss in conservation values is a marginal effect rather than a total loss of a pristine environment.

In summary the impact of Pinus contorta on conservation values can in balance be seen as negative. While they do provide some benefits in terms of increasing the habitats for some species, and a potential successional pathway for forest communities, this is likely to be outweighed by damage to alpine, subalpine, wetland, riparian and remnant communities in areas invaded by these conifers. Even in grazed tussock grassland they are considered to disturb a significant proportion of the remaining natural biodiversity.

Landscape values

Landscape values are difficult to define let alone quantify. Swaffield (1991)[66] gives three major categories of meaning for landscape:

- Landscape as land – physical features, territory, type of setting, as environment and as a system.
- Interactive landscape, in which landscape is social construct where social activity gives meaning to land – this includes planned or improved land, landscape as a code which describes past activities, and landscape as a symbol for a range of values and attitudes.
- Perceptual landscape, which is the human perception or experience of land – landscape as an experience, landscape as a picture, a view, as scenery, and as visual environment.

The issues surrounding landscape values are therefore doubly complex because each individual has a different meaning for the word landscape as well as ascribing a different set of values to any location. We can nevertheless operate within the broad set of meanings ascribed to the word landscape without disallowing any of the values which might be given to a particular landscape.

Two studies have been undertaken specifically on the issue of landscape and forestry in the high country: Swaffield (1991) and Fairweather et al (1994)[67]. While these studies both concentrated on production forestry, many of the landscape issues are applicable to the spread of wildings, since the effect is almost identical in landscape terms.

Fairweather et al identified three distinctive themes of preference for land use options in the Mackenzie Basin. These were:

- Plantations – the important feature is the role of large plantations for production on the hills and lower slopes, and for conservation on the higher rainfall flats.

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[65] Stephens, T. 1999. "Measuring Conservation Achievement" Biodiversity now! Joint Societies conference, Wellington. 29 June – 3 July 1997. Selected Papers. Department of Conservation.

[66] Swaffield, S.R. (1991), Roles and Meanings of Landscape. Unpublished PhD thesis, Lincoln University, Canterbury, New Zealand.

[67] Fairweather, J.R., Swaffield, S. Langer, L., Bowring, J., Ledgard, N. 1994. Preferences for Land Use Options in the Mackenzie/Waitaki Basin: A Q-method Analysis of Stakeholders' Preferences for Visual Images of Six Land Uses on Four Land Forms. Research Report No 224, AERU, Lincoln University.

- Grazing/trees theme - a combination of trees and grazing for production, comprising plantations and grazing on the hills and shelterbelts on the lower slopes and higher rainfall flats.
- Conservation – small plantations and conservation on the hills, larger plantations and conservation on the lower slopes, and retention of views on the higher rainfall flats. Includes destocking.

Importantly this study incorporated economic and ecological effects associated with each of the landscape scenarios studied. This highlighted the degree to which different parties weighted a range of non visual factors in assessing the landscape. Trees in this landscape were assessed not only on their visual appeal, but also on their appropriateness in that environment. Thus conservationists may object to conifers as "non natural" in the high country landscape[68], and runholders[69] may regard trees as threatening their preferred lifestyle of extensive merino sheep grazing. MāoriMāori in both of these studies expressed a preference for trees which were seen to "clothe" the land and which provide employment and economic gain.

In pure visual terms trees may enhance the landscape, and in the Fairweather report scenery without trees received lower rankings than scenes with trees in an overall Q sort ranking. Uzzel (1991)[70] in a review of environmental psychological research discusses among other approaches psychophysical models of landscape assessment. These methods suggest a number of factors about landscapes which may enhance their attractiveness. These include the presence of vantage points and refuge, the possibility of gaining further information. Kaplan (1985)[71] concludes that assessment of landscape is heavily influenced by the potential for functioning in the setting. Thus indications of the possibility of entering the setting, of acquiring information, and of maintaining one's orientation emerge as consistently vital attributes. Wide open, undifferentiated vistas, and dense, impenetrable forests both fail to provide information about one's whereabouts, and both are less preferred. Scenes where the ground texture suggests the potential for humans to operate in the setting, or where there are suggestions of pathways, provide information about accessibility and function. These factors consistently ranked above a range of other variables in landscape setting as contributing to preference. She concludes that the landscape is preferred when way-finding is more likely, when there are elements that invite one to go deeper into the scene, and when the landscape is legible.

While it is difficult to draw strong conclusions relating these studies to the landscape effects of wildings, it is clear that the question is not a simple trees/no trees preference – neither within individuals nor across groups of individuals. Indeed in some situations and for some individuals wildings will enhance the landscape values, while in others they will be viewed detrimentally. While it is difficult to draw uniform conclusions about landscape preferences therefore, it seems reasonable to conclude that in some situations such as trees obscuring views along state highways, there will be negative landscape values associated with wilding spread. It is not possible to conclude that all wilding spread is bad for landscape values.

Proposal
Environment Waikato proposes control of contorta on all non production forestry areas, and within production forestry control will be undertaken to prevent spread.

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68 Swaffield 1991, p 170.

69 *"There is a variety of aims and objectives amongst the land occupiers, but the overarching aim of them all is to be able to stay on their land and to continue to farm and live in the high country. Living and farming in the high country is highly valued in its own right as a tradition that ought to continue and be preserved. Most would also prefer to continue the high country tradition of (comparatively) extensive farming of fine woolled sheep. Amongst land occupiers merino farming is the most highly valued and desired land use, and new land occupiers in the area say that they chose to buy properties in the [Mackenzie] Basin because of the high country system of extensive sheep farming."* P 47, in Investigating Community: Imperatives for but constraints against land use change in the Mackenzie/Waitaki Basin. Morris, C., Fairweather, J.R., and Swaffield, S.R. 1997. Research Report No 236, AERU. Lincoln University, Canterbury, New Zealand.

70 Uzzell, D.L. Environmental Psychological Perspectives on Landscape. Landscape Research, 1991, 16(1).

71 Kaplan, R. 1985. "The Analysis of Perception Via Preference: A Strategy for Studying How the Environment is Experienced" Landscape Planning, 12:161-176

Analysis[72] – No RPMS
Pinus contorta is allowed to spread with no intervention on the part of the regional council. In this scenario it is assumed that DOC, the army, some land occupiers and volunteers will undertake control of their own, but that no control will be undertaken on a 10,000 ha of forestry land with contorta, and a further 14,000ha of land likely to be affected in the vicinity of the Desert Rd/Tongariro and Kaimanawa Parks. While voluntary control will keep some areas clear of wildings, it will not prevent their continued spread and additional control costs will continue to be incurred by other land occupiers attempting to keep their land clear.

This spread of contorta will affect any remaining conservation values associated with areas where control is not undertaken.

Containment
The costs of containment for wildings are estimated at $550,000 initially over five years on the 10,000 ha of forestry land[73] with follow up costs of a similar amount every three years. A cost of $90,000 is estimated for the 15,000ha of land in the Desert Road vicinity every three years to control new seedlings. A further $22,000 per annum are required for monitoring, enforcement, advice and management. The total cost of this option represents a NPV of $3.1 million at a discount rate of 8%.

This control may have some effect on a reduction of control costs in areas which are clear or being cleared, although much of the infestation pressure appears to be coming from outside the region. There will however be no loss in conservation values on those areas where contorta is being removed.

Eradication
The alternative option of eradication is not considered feasible in the case of P. contorta in the Waikato region because of the costs involved and the proximity of seed sources outside the region.

Section 72(a)
The containment strategy will cost approximately $3.1 million more than the no RPMS scenario[74]. Therefore if the council considers that the value of preventing damage to conservation values on 18,000ha of tussock country is greater than $3.1 million, and provided it is satisfied that the risk of further spread can be eliminated, then the containment strategy will met the requirements of section 72(a). This is equivalent to $170/ha or $14/ha/annum.

Section 72(b)
As the values protected by this strategy are largely regional values and if the requirements of section 72(a) are deemed to have been met then the requirements of section 72(b) will also be met by this strategy.

Section 72(ba)
The values protected by the control of *P. contorta* are largely regional values. A charge against the regional community for inspection and regulatory costs and control costs will therefore satisfy the requirements of section 72(ba).

As those harbouring the pest can be considered to be contributing to the problem, a charge for control costs against responsible land occupiers where these can be identified will also satisfy the requirements of section 72(ba).

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72 Assuming a cost of $55/ha for control at 1 – 100 stems/ha, and $2/ha for scattered seedlings (1/10 ha). Costs and outcomes from Ledgard, N.J., 1999. The spread of exotic conifers at Mid Dome/Cupola, Southland." Forest Research Contract Report prepared for the Mid Dome Wilding Tree Management Group.
73 Nick Ledgard, ibid.
74 Assuming it takes 200 years to occupy 50% of the tussock grassland.

Scenario: No RPMS

Assumptions		
Initial area infested (ha)	(IAI)	10,000
Total area potentially infested	(TAPI)	18,015
Years to infest all of TAPI (years)	(YI)	30
Weighted average gross margin for infested land ($/ha)	(WAGM)	-
Annual cost of control for land occupier ($/ha affected)	(ACCL)	400
Proportion of land occupiers controlling pests (%)	(PLCP)	65
Proportion of production loss from infested land (%)	(PPLIL)	-
Proportion of infested land to which conservation values apply (%)	(PILCV)	85
Any benefits provided by the weed	(BPBW)	0
Discount rate	(DRATE)	8
Calculations		
Multiplier: work out using "RPMS guidelines - Do Nothing.xls" (IAI. TAPI, YI, DRATE)	(MDN)	9.027
Loss of production from initial area infested = IAI X WAGM X (1 - (PLCP/100)) X PPLIL	(LOPIAI)	0
Loss of production in year Y1 =WAGM X TAPI X (1 - (PLCP/100)) X PPLIL	(LOP)	0
Costs of control in initial area = IAI x ACCL x (PLCP/100)	(COCIAI)	2,600,000
Costs of control in Year Y1 = TAPI X ACCL X (PLCP/100)	(COC)	4,683,900
Total damage in No RPMS Scenario ($/annum) = (LOP + COC - BPBW)	(TDDNS)	4,683,900
Net present value No RPMS = TDDNS X MDN	(NPVDN)	42,281,565
Area of conservation and other regional damages = PILCV/100 X (1 - (PLCP/100)) X TAPI (ha)	(ACORD)	5,359

Scenario: Containment Control

1. Annual regional costs (inspection, monitoring, enforcement, administration etc) converted to present day terms

Year	Regional cost (A)	8% discount rate multiplier (B)	NPV (A x B)	
1	37,878	1.000	37878	
2	37,878	0.926	35075	
3	37,878	0.857	32461	
4	37,878	0.794	30075	
5	37,878	0.735	27840	
6	37,878	0.681	25795	
7	37,878	0.630	23863	
8	37,878	0.583	22083	
9	37,878	0.540	20454	
Year 10 onward	37,878	6.253	236851	
	Total Sum NPV Column		**$492,376**	**(TRC)**

2. Annual cost of control for pest weed converted to present day terms

Year	Control cost (A)	8% discount rate multiplier (B)	NPV (A x B)	
1	32,000	1.000	32000	
2	32,000	0.926	29632	
3	32,000	0.857	27424	
4	32,000	0.794	25408	
5	32,000	0.735	23520	
6	32,000	0.681	21792	
7	32,000	0.630	20160	
8	32,000	0.583	18656	
9	32,000	0.540	17280	
Year 10 onward	32,000	6.253	200096	
	Total Sum NPV Column		**$415,968**	**(TCC)**

Assumptions		
Current area infested (ha)	(CAI)	10,000
Current density (area displaced ha/ha) %	(DCY)	10
Year strategy objectives achieved	(YOA)	5
Area infested if strategy objectives achieved (ha)	(AISOA)	10,000
Average density if strategy objectives achieved (area displaced ha/ha) %	(DSOA)	5
Any benefits provided by weed (total $ / annum)	(BPBW)	-
Calculations		
Multiplier: "RPMS Guideline - Scenarios.xls"	(MRPMS)	12.574
Loss of production in current year = WAGM x CAI x DCY	(LOPC)	0
Loss of production in YOA = WAGM x AISOA x DSOA	(LOPYOA)	0
Total damage in RPMS Scenario ($/annum) = LOPC x MRPMS	(TDRPMS)	0
Area of conservation and other regional damages = PILCV/100 x AISOA	(ACORDRRPMS)	8,500
Total cost RPMS Scenario = TDRPMS + TCC + TRC	(NPVRPMS)	908,344
CALCULATIONS: SECTION 72(A)		
Net benefit of RPMS Scenario = NPVDN - NPVRPMS ($)	(NBRPMS)	41,373,221
Prevented damage to regional values ACORD - ACORDRPMS (ha)	(APDCV)	(3,141)
Cost/ha of preventing damage to regional values = NBRPMS / APDCV	(CVHA)	41,376,362

CALCULATIONS: SECTION 72(B)		
Damage on initially infested area = (LOPIAI + COCIAI) / Multiplier ($)	(DOIAI)	32,500,000
Costs of spill over = NPVDN - DOIAI	(COS)	9,781,565
Net regional benefit = COS - TRC	(NRB)	9,289,189
Area spill over prevented = TAPI - IAI	(ASP)	8,015

Scenario: Eradication

1. Annual regional costs (inspection, monitoring, enforcement, administration etc) converted to present day terms

Year	Regional cost (A)	8% discount rate multiplier (B)	NPV (A x B)	
1	37,878	1.000	37878.000	
2	37,878	0.926	35075.028	
3	37,878	0.857	32461.446	
4	37,878	0.794	30075.132	
5	37,878	0.735	27840.330	
6	37,878	0.681	25794.918	
7	37,878	0.630	23863.140	
8	37,878	0.583	22082.874	
9	37,878	0.540	20454.120	
Year 10 onward	37,878	6.253	236851.134	
	Total Sum NPV Column		**$492,376**	**(TRC)**

2. Annual cost of control for pest weed converted to present day terms

Year	Control cost (A)	8% discount rate multiplier (B)	NPV (A x B)	
1	4,000,000	1.000	4000000	
2	3,600,000	0.926	3333600	
3	3,240,000	0.857	2776680	
4	2,916,000	0.794	2315304	
5	2,624,400	0.735	1928934	
6	2,361,960	0.681	1608495	
7	2,125,764	0.630	1339231	
8	1,913,188	0.583	1115388	
9	1,721,869	0.540	929809	
Year 10 onward	1,549,682	6.253	9690161	
	Total Sum NPV Column		**$29,037,603**	**(TCC)**

Assumptions		
Current area infested (ha)	(CAI)	10,000
Current density (area displaced ha/ha) %	(DCY)	10
Year strategy objectives achieved	(YOA)	5
Area infested if strategy objectives achieved (ha)	(AISOA)	-
Average density if strategy objectives achieved (area displaced ha/ha) %	(DSOA)	-
Any benefits provided by weed (total $ / annum)	(BPBW)	-
Calculations		
Multiplier: "RPMS Guideline - Scenarios.xls"	(MRPMS)	2.592
Loss of production in current year = WAGM x CAI x DCY	(LOPC)	0
Loss of production in YOA = WAGM x AISOA x DSOA	(LOPYOA)	0
Total damage in RPMS Scenario ($/annum) = LOPC x MRPMS	(TDRPMS)	0
Area of conservation and other regional damages = PILCV/100 x AISOA	(ACORDRRPMS)	0
Total cost RPMS Scenario = TDRPMS + TCC + TRC	(NPVRPMS)	29,529,979
CALCULATIONS: SECTION 72(A)		
Net benefit of RPMS scenario = NPVDN - NPVRPMS ($)	(NBRPMS)	12,751,586
Prevented damage to regional values ACORD - ACORDRPMS (ha)	(APDCV)	5,359
Cost/ha of preventing damage to regional values = NBRPMS / APDCV	(CVHA)	2,379

CALCULATIONS: SECTION 72(B)		
Damage on initially infested area = (LOPIAI + COCIAI) / Multiplier ($)	(DOIAI)	32,500,000
Costs of spill over = NPVDN - DOIAI	(COS)	9,781,565
Net regional benefit = COS - TRC	(NRB)	9,289,189
Area spill over prevented = TAPI - IAI	(ASP)	8,015

Cost benefit analysis summary

Three scenarios for control of *Pinus contorta* have been considered:

1. do nothing
2. eradication
3. containment control.

The "do nothing" scenario results in total regional damage of $4,683,900 NPV.

The "eradication" scenario has costs of $4,037,878 per annum. The cost to the region is $29,529,979 NPV. This results in a positive benefit of $12,751,586 NPV and therefore it does meet the requirements of section 72 (1)(a) of the Act.

The "containment control" scenario has costs of $69,878 per annum. The cost to the region is $908,344 NPV. The result of this scenario is a positive benefit of $41,373,221 NPV and therefore it meets the requirements of section 72 (1)(a) of the Act. Council considers that the value of land protected is greater than $91 per hectare.

Containment control is the preferred option as it produces a positive net benefit at a lower cost. The regional net benefit is $9,289,189, therefore the requirements of section 72(1)(b) of the Act are met.

5.34 Purple loosestrife (*Lythrum salicaria*) (2007)

Description and background

Purple loosestrife (*Lythrum salicaria*) is an erect perennial herb with a woody stem and whorled leaves, it has the ability to reproduce prolifically by both seed dispersal and vegetative propagation. The international experience suggests that sunny or partly shaded wetland is vulnerable to purple loosestrife invasion and as such it poses a threat to biodiversity and amenity values. Purple loosestrife is thought to be restricted to a very small area (10 m^2) in the Waikato region[75].

Purple loosestrife is native to Europe (extending from Great Britain to central Russia), Japan, Manchuria China, south-eastern Asia, and northern India[76]. It is reported as being naturalised in Canada, the United States, Ethiopia, Australia and New Zealand and has been nominated by the Invasive Species Specialist Group (ISSG) of the IUCN Species Survival Commission as among 100 of the "world's worst" invaders. The species is assigned a weediness score of 31[77] within DOC's weediness database. It scores 54 on Champion and Clayton's (2001) weed score whilst by comparison Hydrilla scores 74.

Purple loosestrife is listed in BSNZ's National Pest Plant Accord where its invasiveness and impact on indigenous biota is described as:

> *This plant rapidly invades damp ground, wetlands and shallow water. It overtops native species with dense bushy growth, is long-lived and produces millions of long-lived highly viable seeds from an early age. It tolerates hot or cold conditions and low to high nutrient levels in the water, but is intolerant of salt water (BSNZ 2006).*

The ISSG[76] database describes of purple loosestrife as:

- Being able to out-compete native plants for habitat and nutrients.
- Capable of forming dense homogeneous stands that restrict native wetland plant species.
- Having the ability to overrun wetlands and almost entirely eliminate open water habitat if left untreated.
- Diminishing recreational and aesthetic value of wetlands and waterways as dense stands as waterways and reduce biodiversity and modify hydrology.

Purple loosestrife is listed for inclusion in the Auckland Regional Council's 2007 to 2012 RPMS (2006), Greater Wellington Regional Council's RPMS and pest management review (2006) and Horizons Regional Council's proposed RPMS (2006) as a 'total control' pest plant.

Various authors report that small infestations of young purple loosestrife plants may be pulled by hand, preferably before seed set. For older plants, spot treating with a glyphosate type herbicide (approved for wetland use) on the cut stump or as a foliar application is suggested. Horizons Regional Council assigns purple loosestrife a practicality score of 8 out of 10 (Horizons 2006). Under this scoring method the greater the number the more practical control is considered to be.

[75] Pers. comm. David Stephens, Environment Waikato, 5 December 2006.

[76] Global Invasive Species Database, http://www.issg.org/database/species/ecology.asp?si=93&fr=1&sts=sss accessed 15 January 2007

[77] Scoring system for weediness developed by DoC assigning scores based on 'Effect on system' (EoS) and 'Biological Success Rating' (BSR). As a reference for purple loosestrife's score (31) *Equisetum hyemale* (horse tail) has a DoC weediness score of 23.

Pest management strategy

The analysis undertaken employs a simple spread sheet model that considers the 'No RPMS' and 'With RPMS' scenarios.

No RPMS

Environment Waikato has identified some 65 000ha that could potentially be infested by purple loosestrife. The area identified is the same habitat threatened by Manchurian wild rice. The analysis of the no RPMS assumes that:

- the initial infestation spreads to infest the area identified by Environment Waikato within 80 years
- 80% of area affected possesses conservation values
- control is implemented voluntarily in 5% of the area infested at a cost of $575/ha/annum; and
- no production losses are assumed.

Under the no RPMS scenario the ongoing costs of control associated with 5% of the infested area is estimated as possessing a value $NPV_{8\%}$ of $120 000.

With RPMS – Potential Pest

The strategy's objective is to prevent the distribution and propagation of the organism and to facilitate early intervention in order to secure eradication if it becomes established in the region. Given that the no RPMS scenario results in a $NPV_{8\%}$ regional cost of $120 000, Environment Waikato can be neutral about incurring costs at this level to ensure that the region remains free of purple loosestrife. This cost level is equivalent to the annual expenditure of $9,600/annum in perpetuity at a discount rate of 8%.

On the basis of the assumptions employed in the analysis presented Environment Waikato could justify the expenditure of $9,600/annum in education, inspection, enforcement, monitoring and the cost of control of initial incursions to ensure the region's pest free status with regard to purple loosestrife. This level of expenditure is unlikely to be required. Horizons Regional Council is currently budgeting $8 000/annum[78] to manage 30ha of purple loosestrife with a view to achieving zero-density by 2011 (Horizons 2006). The current known infestation of purple loosestrife in the region is small (reportedly 10m^2).

Section 72(a) conclusion

If the council considers the assumptions used here to be reasonable, the successful exclusion of purple loosestrife from the region delivers a net benefit in $NPV_{8\%}$ terms when compared with the no RPMS scenario if annual expenditure made by Environment Waikato to ensure the eradication and subsequent pest free status of purple loosestrife is less than $9,600/annum.

Assuming it is technically feasible the early intervention, eradication and subsequent maintenance of a pest free status of the organism in the region for an expenditure by Environment Waikato of up to $9,600/annum provides a higher net present value of benefits than the no RPMS scenario's reliance on voluntary control and thus the requirements of section 72(a) are satisfied if expenditure is contained within this level. The strategy protects some 52 000ha of land possessing conservation values for an $NPV_{8\%}$ cost of $2.30/ha.

Section 72(b) conclusion

The literature review suggests that the values potentially compromised by the infestation of purple loosestrife in the region include but are not limited to biodiversity, conservation and amenity values through the loss of indigenous species and habitat.

[78] Pers. comm. David Stephens, Environment Waikato, 5 December 2006

The values protected by the proposed strategy are regional values. If the council considers that the assumptions employed in this analysis are robust the strategy will satisfy section 72(b).

Section 72(c)
Purple loosestrife is capable of having a significant impact on MāoriMāori cultural values, biodiversity, conservation, recreation and amenity values. A RPMS in respect of this pest will therefore satisfy section 72(c) parts (ii), (iii), (iv) and (v).

Section 72(ba)
The beneficiaries of the proposed strategy are the wider community. If the council considers that section 72(a) and 72(b) have been satisfied and that exclusion/eradication can be achieved, then the strategy can be funded through a charge on the regional community. The requirements of section 72(ba) will then have been met.

5.35 Ragwort (*Senecio jacobaea*) (2002)

Description and biological capability	
Form	• An erect biennial or perennial herb, usually growing to 45-60cm. Single or several stems arise from a crown, with dark green leaves. Flowers are bright yellow and clustered at the end of the branches.
Habitat	• Waste places and pasture, also riverbeds, open forest, swamps. • Occurs in humid temperate regions with annual rainfall greater than 750mm. Tolerates frost and can flower all year around.
Regional Distribution	• Widespread throughout region. • Most problematic in dairying districts because of higher rainfall and unpalability to cattle.
Biological success	
Dispersal method	• Wind provides the main method of seed spread. New Zealand study showed bulk of seed fell to ground within 5m of the parent plant and virtually none was blown more than 37m.
Reproductive ability	• A well developed plant may produce about 250,000 seeds per year of which 80% may be viable. Seed can be viable for at least eight years and germinate when brought to the surface.
Competitive ability	• Establishment is poor in pasture but good in disturbed soil. Early growth is slow and seedling mortality high.
Other considerations	
Toxicity	• Alkaloids present are toxic to horses, cattle, and deer.
Resistance to control	• Plants can become resistant to chemical control as a result of poor application. • Plant regenerates after flowering. Mutilation by grazing, mowing, grubbing and spraying can produce multi-headed plants. • The Ragwort Flea Beetle is widespread throughout the region.

Impact evaluation				
	Current impact (Y\N)	**Current level of impact (Nil, L, M, H)**	**Potential impact (Y\N)**	**Potential level of impact (Nil, L, M, H)**
Endangered Species	N	-	N	-
Species Diversity	N	-	N	-
Soil resources	N	-	N	-
Water Quality	N	-	N	-
Human Health	N	-	N	-
MāoriMāori Culture	N	-	N	-
Production	Y	L-H	Y	L-H
Recreation	N	-	N	-
International trade	N	-	N	-

Notes: Ragwort can have an effect on animal health which may result in production losses and, in extreme cases, death.

Assessment of effects status: Minor/Moderate

Proposal
The Environment Waikato strategy for ragwort is a mixture of control over entire properties in the more dairying oriented parts of the region, and for a 50m boundary control strip in the remainder of the region.

Analysis – No RPMS
In this scenario ragwort will not increase its range, since it is present throughout the region. Its density may however increase on dairy and beef farms depending on the number of properties undertaking control. Some cross boundary costs are anticipated where control is not undertaken.

Modelling of ragwort costs and benefits was undertaken assuming 5% of land occupiers likely to suffer an economic loss do not control ragwort in the absence of a strategy. This estimate is likely to be high given that in the last year only 2 properties have been served notices requiring control of this weed.

Analysis – RPMS
In this scenario ragwort will be controlled in the intensively farmed dairying areas, and boundary control will be undertaken in the less intensively farmed areas. No losses from ragwort within a property in the intensive farmed total control areas, or across boundaries in other areas are anticipated. It should be noted that this scenario which includes the total and boundary controls is considered very difficult to achieve, and some costs will continue to be incurred.

Section 72(a)
Modelling using a range of assumptions shows that the total control ragwort strategy in areas of intensive dairy type land uses produces a net positive benefit of approximately $19 - $28 million. This part of the strategy therefore satisfies section 72(a) of the BSA 1993.

For the boundary control part of the strategy, separate modelling of individual farm scenarios shows that at a cost of $175 per inspection requiring boundary clearance, there is not likely to be any benefit in relation to section 72(a) for any properties other than where the offending land is heavily infested and is in dairy use. In order for this part of the strategy to satisfy section 72(a), the council would need to consider that there were other benefits to boundary control in non dairy properties in order to proceed with a boundary control regime. In non dairy land use types losses would be less if the control were required on a complaints only basis.

Section 72(b)
The benefits ascribed to total control in section 72(a) are all individual benefits. There is no reason to expect that the regional benefits of the total control regime will exceed the individual benefits other than for the strip of land around the boundary of a property, where cross boundary issues may occur. The total control strategy will therefore only satisfy section 72(b) of the BSA 1993 if the council considers that there is some other regional benefit not considered here from requiring land occupiers to control ragwort on their property, or possibly if it believes that the only way to prevent spillover is to control the entire property.[79] A boundary control regime for ragwort in dairying areas however will pass section 72(b) as discussed in the next paragraph.

[79] Given that a boundary control strip prevents a large proportion of seed landing outside a property, and that the total control can still leave 2 – 3 plants/ha, there is not a strong argument that total control is the only means of preventing spillover between properties. The origins of any windblown seed causing new infestations where plants are present on both the clear and infested property is uncertain. Furthermore plant establishment where no very heavy seed source is present becomes driven by opportunity such as ground cover disturbance rather than be sheer weight of seed arrival. (Susan Timmins, DoC, pers. comm.)

The boundary control regime, where it meets the requirements of section 72(a) in respect of heavily infested dairy farms, will prevent costs to neighbours and in these situations the regional benefits of boundary control outweigh the individual benefits where there is more than 700m of boundary affected. The total boundary length of an 83ha[80] dairy farm would be approximately 3600m, so boundary control of heavily infested dairy properties is also likely to meet the requirements of section 72(a).

Section 72(ba)
The values protected by the control of ragwort are entirely associated with rural land occupiers, primarily in intensive dairy, beef or deer land uses. A charge against the intensive land classes for inspection and regulatory costs will therefore satisfy the requirements of section 72(ba).

As those harbouring the pest can be considered to be contributing to the problem, a charge for control costs against responsible land occupiers where these can be identified will also satisfy the requirements of section 72(ba).

Cost benefit analysis summary

Three scenarios for control of ragwort have been considered:

1. do nothing
2. eradication
3. containment control.

Under the "eradication" scenario ragwort control in areas of intensive dairy type land uses produces a net positive benefit of approximately $19 - $28 million This part of the strategy therefore satisfies section 72(1)(a).

For the "containment control" scenario, separate modelling of individual farm scenarios shows that at a cost of $175 per inspection requiring boundary clearance, there is not likely to be any benefit in relation to section 72(1)(a) for any properties other than where the offending land is heavily infested and is in dairy use. Council considers that there are other benefits to boundary control in non dairy properties in order to proceed with a boundary control regime. In non dairy land use types losses would be less if control was required on a complaints only basis.

The benefits ascribed to eradication in section 72(1)(a) are all individual benefits. There is no reason to expect that the regional benefits of the eradication regime will exceed the individual benefits.

The containment control scenario will prevent costs to neighbours and in these situations the regional benefits of boundary control outweigh the individual benefits where there is more than 700m of boundary affected. The total boundary length of an 83ha dairy farm would be approximately 3,600 m, so boundary control of heavily infested dairy properties is also likely to meet the requirements of section 72(1)(a).

Taking the above factors into account, council has exercised its discretion and notes that while eradication in intensive farming areas may be beneficial, a policy of boundary control across the whole region on a complaint only basis is more appropriate and results in lower strategy costs.

[80] MAF 2000 Dairy Monitoring Report model farm size.

5.36 Reed sweet grass (*Glyceria maxima)* (2007)

Description and background

Reed sweet grass (*Glyceria maxima*) is a perennial and rhizomatous grass that prefers wet and nutrient-rich soils. Stems are unbranched and can erect to 100-250 cm high. It can form large, dense monospecific stands that are capable of crowding out indigenous wetland vegetation. It can be a troublesome drainage weed and although palatable it has been implicated in the cyanide poisoning of livestock[81]. Environment Waikato is proposing that reed sweet grass is included in its 2007 to 2012 RPMS as a 'potential' plant pest in support of DOC's initiatives to control the species in the Lake Taupō environ.

Reed sweet grass is native to Europe and temperate Asia, it has been intentionally introduced as livestock forage in seasonally inundated pastures, to temperate North America, New Zealand and Australia[82]. In New Zealand NIWA report its distribution as being "scattered but locally common in the Waikato and Hauraki plains as well as parts of Otago"[81]. The species is assigned a weediness score of 28[83] within DOC's weediness database. It scores 51 on Champion and Clayton's (2001) weed score whilst by comparison Hydrilla scores 74 and purple loosestrife 54. It is not listed in BSNZ's National Pest Plant Accord.

Reed sweet grass is described by various authors (NIWA 2005, ISSG[82] etc…) as possessing the potential to threaten biodiversity and conservation values in wetlands as dense mono-specific reduce biodiversity and modify hydrology. Reed sweet grass is listed for inclusion in the Auckland Regional Council's 2007 to 2012 RPMS (2006) as a 'surveillance' plant pest whilst within Southland Regional Council's RPMS Review (2006) it is proposed that the status of weed is changed from 'surveillance' to 'containment'.

Reed sweet grass can be propagated from seed and rhizome fragments. Contaminated machinery, livestock, soil movement, dumped vegetation, eel nets, boats and trailers can spread seed and rhizome fragments into new catchments, pasture, and drains[84]. The review of the literature suggests that the foliar application of glyphosate appears the most likely method of control.

Pest management strategy

The analysis undertaken employs a simple spread sheet model that considers the no RPMS and with RPMS scenarios.

No RPMS

The strategy proposed by Environment Waikato is focused solely on control of the species in Lake Taupō in support of the Department of Conservation's initiative to control the species there. Environment Waikato has identified some 54ha at Lake Taupō that could potentially be infested by reed sweet grass. The analysis of the 'no regional pest management strategy' assumes that:

- the initial 1ha infestation spreads to infest the 54ha in Lake Taupō identified by Environment Waikato within 30 years
- 100% of area affected possesses conservation values; and
- control is implemented voluntarily in 80% of the area infested at a cost of $575/ha/annum.

[81] Aquatic plants, Aquatic plant species guide Marginal plants http://www.niwascience.co.nz/ncabb/aquaticplants/outreach/species/emergent accessed 15 January 2006

[82] Global Invasive Species Database, http://www.issg.org/database/species/ecology.asp?si=891&fr=1&sts=sss accessed 15 January 2007

[83] As a reference for reed sweet grass (*Glyceria maxima*) score (28) *Equisetum hyemale* (horse tail) has a DoC weediness score of 23.

[84] http://www.weedbusters.org.nz/weed_info/detail.asp?WeedID=10

Under the no RPMS scenario the ongoing costs of control associated with 80% of the infested area is estimated as possessing a value $NPV_{8\%}$ of $144 000.

With RPMS – Potential Pest

The strategy's objective is to eradicate the species in Lake Taupō. Given that the no RPMS scenario results in a $NPV_{8\%}$ regional cost of $144 000, Environment Waikato can be neutral about incurring costs at this level to eradicate the species and to ensure the pest free status of reed sweet grass in Lake Taupō. This cost level is equivalent to the annual expenditure of $11,500/annum in perpetuity at a discount rate of 8%.

On the basis of the assumptions employed in the analysis presented Environment Waikato could justify the expenditure of $11,500/annum education, inspection, enforcement, monitoring and the cost of control of initial incursions to ensure the pest free status with regard to reed sweet grass in Lake Taupō. However, this level of expenditure can only be justified if it prevents costs being incurred by the 80% of land owners that would control in the absence of a strategy.

Section 72(a) conclusion

If the council considers the assumptions used here to be reasonable, the successful eradication and exclusion of reed sweet grass from Lake Taupō delivers a net benefit in $NPV_{8\%}$ terms when compared with the no RPMS scenario's reliance on voluntary control if annual expenditure made by Environment Waikato to ensure the eradication and subsequent pest free status of reed sweet grass in Lake Taupō is less than $11,500/annum.

Assuming it is technically feasible the early intervention, eradication and subsequent maintenance of a pest free status of the organism in Lake Taupō for an expenditure by Environment Waikato of up to $11,500/annum provides a higher net present value of benefits than the no RPMS scenario's reliance on voluntary control and thus the requirements of section 72(a) are satisfied if expenditure is contained within this level. The strategy protects some 54ha of land possessing conservation values at an $NPV_{8\%}$ cost of $2,700/ha.

Section 72(b) conclusion

The literature review suggests that the values potentially compromised by the infestation of reed sweet grass in Lake Taupō include but are not limited to biodiversity, conservation and amenity values through the loss of indigenous species and habitat and impeded drainage.

The values protected by the proposed strategy are restricted to Lake Taupō. The species is reported as being present elsewhere in the Waikato district. Given the vectors that have the potential to spread the species control of reed sweet grass at Lake Taupō is unlikely to ensure the weed free status of the species elsewhere in the greater Waikato region. If the council is satisfied that the values protected by the strategy are regionally significant the strategy is likely to satisfy section 72(b).

Section 72(c)

Reed sweet grass is capable of having a significant impact on MāoriMāori cultural values, biodiversity, conservation, recreation and amenity values. A RPMS in respect of this pest will therefore satisfy section 72(c) parts (ii), (iii), (iv) and (v).

Section 72(ba)

The beneficiaries of the proposed strategy are the wider community. If the council considers that section 72(a) and 72(b) have been satisfied and that exclusion/eradication can be achieved, then the strategy can be funded through a charge on the regional community. The requirements of section 72(ba) will then have been met.

5.37 *Rhododendron ponticum* (2007)

ASSUMPTIONS

Initial area infested (ha)
There is one known site in Taupō covering something under 1 ha.

Weighted average gross margin ($/ha)
N/A

Proportion of production loss from infested land (%)
Assumed as 0% for the purposes of this analysis and knowledge of the known infestation.

Total area potentially infested (TAPI) (ha)
GIS modelling shows a potential 64,190 ha of potential habitat for this pest plant. Currently control is proving effective and staff reports that effective spread beyond current infestations is extremely unlikely.

Years to infest all TAPI

R ponticum thrives in milder, wet climatic conditions, where there are poor, acidic soils. Unless established stands are constantly kept in check, they will expand into adjacent areas, rapidly eliminating the majority of native plant species.

R ponticum invades areas both vegetatively and via seed. Established plants spread by lateral horizontal growth of the branches. A single plant may eventually end up covering many metres of ground with thickly interlaced, impenetrable branches. Where the horizontal branches touch the ground, they will root, continually extending the area of *R ponticum* cover. For the same reason, streams can become completely overgrown and shaded out by *R ponticum* growing on the banks. This severely affects animal life in the stream. Fish such as trout depend upon invertebrates which fall off native bank side vegetation for 80% of their food. The seeds are tiny and hence wind dispersed. Each flower head can produce between three and seven thousand seeds, so that a large bush can produce several million seeds per year. Of course not all the seeds will grow successfully, but given the right conditions, a good many will germinate. A timeframe of 50 years has been assumed for all available habitats to become infested if no control were undertaken.

Annual cost of control for landholder ($/ha)
Assumed as $150 for chemical application.

Proportion of land over which pests voluntarily controlled (%)
Assumed to be no more than 5% for this analysis.

Proportion of land to which conservation values apply (%)
Assumed to be around 40% derived from the current known infestation.

Any benefits provided by the weed ($p.a.)
Nil

Biocontrol ($p.a.)
Not available

Year strategy objectives achieved (eradication)
Assumed for this analysis to be 20 years

RESULTS

PLANT PEST		Rhododendron ponticum	
	No RPMS	Containment	Eradication
Cost and losses under option	$275,167	$0	$29,250
Section 72(a) NPV		$0	$245,917
Section 72(a) regional values cost/ha		$0	$10
Section 72(b) NPV (*NRB*)		$0	$255,567
Section 72(b) area of spillover prevented (ha)		64,910	64,910

Base Assumptions

Discount Rate		8%	
Initial Area Infested (ha)	(IAI)	1	(ha)
Weighted Average Gross Margin for Infested Land ($/ha)	(WAGM)	$0	($/ha)
Proportion of Production Loss from Infested Land (%)	(PPLIL)	0%	(%)
Total Area Potentially Infested	(TAPI)	64,911	(ha)
Years to Infest all of TAPI (years)	(YI)	50	(Years)
Annual Cost of Control for Landholder ($/ha affected)	(ACCL)	$150	($/ha)
Proportion of Landholders Controlling Pests (%)	(PLCP)	5.0%	(%)
Proportion of Infested Land to which Conservation Values Apply (%)	(PILCV)	40%	(%)
Any Benefits Provided by Weed (total $ / annum)	(BPBW)		($)

Containment Assumptions			
Biocontrol ($/annum)			($)
Year Strategy objectives Achieved	(YOA)		(Years)
Area Infested if Strategy Objectives Achieved (ha)	(AISOA)		(ha)
Proportion of Production Loss from Infested Land when Strategy Objectives Achieved(%)	(PPLSOA)		(%)

Eradication Assumptions			
Year Strategy objectives Achieved	(YOA)	20	(Years)

Regional Council Costs		
Year	**Containment**	Eradication
1		$1,500
2		$1,500
3		$1,500
4		$1,500
5		$1,500
6		$1,500
7		$1,500
8		$1,500
9		$1,500
Year 10 onward		$1,500
NPV	**$0**	**$19,500**

Control Costs		
Year	Containment	Eradication
1		$750
2		$750
3		$750
4		$750
5		$750
6		$750
7		$750
8		$750
9		$750
Year 10 onward		$750
NPV	**$0**	**$9,750**

CONCLUSIONS

The desired Regional Pest Management Strategy outcome for this pest plant is eradication.

The outcome in the no RPMS scenario is a loss of $486,833 per annum in 50 years as a result of production losses and additional costs of control. This is equivalent to a NPV of approximately $275,167. In addition there are 24,666ha on which damages to regionally significant conservation, recreation, amenity, MāoriMāori or soil and water values will occur.

The outcome of the eradication scenario is a NPV of $19,500 for administration, inspection, monitoring and enforcement, a NPV of $9,750 for costs of control, and loss of $0 per annum in 20 years as a result of production losses. This is a total cost in present day terms (NPV) of approximately $29,250 at a discount rate of 8%. In addition there will be no damages to regionally significant conservation, recreation, amenity, Māori or soil and water values from this pest once eradication has been achieved.

The net outcome for eradication when compared with the no RPMS scenario is $245,917 in NPV terms. This option protects significant regional biodiversity values on 24,666 ha through the prevention of spread of this organism. Eradication is preferred since it produces the highest net benefit, and best satisfies the requirements of section 72(a) of the Biosecurity Act 1993.

The net regional benefits exceed the individual benefits by $275,067 because the strategy prevents the spread of the pest onto 64,910ha. The strategy also prevents damage to regional values on 24,666ha, and eradication therefore satisfies the requirements of section 72(b).

If the requirements of section 72(a) and (b) are deemed by council to have been met, then the costs of the strategy can be charged to the regional community as beneficiaries and the benefits received will exceed the costs. Those on whose property the pest currently exists are exacerbators, and can reasonably be charged the cost of control, satisfying section 72(ba) of the Biosecurity Act 1993.

5.38 Sagittaria (*Sagittaria gramines spp. Platyphylla*) (2007)

ASSUMPTIONS

Initial area infested (ha)
Four known sites across region from staff and contractor knowledge totalling less than 1 ha.

Weighted average gross margin ($/ha)
N/A

Proportion of production loss from infested land (%)
Nil

Total area potentially infested (TAPI) (ha)
GIS modelling of suitable habit for this pest plant reveals a potential 1,526,483ha within the region. In reality there is only one known naturalised infestation and eradication is therefore a completely realistic goal. Wider infestation is considered by knowledgeable staff to be extremely unlikely.

Years to infest all TAPI
This plant is a marginal aquatic perennial growing to 80cm tall. A thick vertical basal rhizome produces buds. Stems are 3-sided, soft and spongy. Submerged leaves are strap-like, mostly on young plants. Emergent leaves are distinct arrowhead-shaped, up to 25cm long. The flower head is a leafless stem. Flowers are white with a purple patch at the base, in whorls of 2-12, male flowers above females. Grows fast and matures quickly, producing widely-dispersed, frost-hardy seed within 6 months. Shades and crowds out native species. Seeds spread by water flow and possibly waterfowl. It potentially escapes from ponds in flood, is intentionally planted, and is spread by contaminated diggers and livestock. The plant displaces most native marginal species, blocks waterways and can contribute to flooding. Typical habitats are flowing or still shallow water, marshes, swamps, streams; potentially throughout NZ. This plant is on the National "banned from sale or propagation" list. Only one known naturalised site at present (Tairua), others are in ornamental ponds. This analysis assumed a period of 100 years to infest all available habitats if no control was undertaken.

Annual cost of control for landholder ($/ha)
Assumed as $150 ha

Proportion of land over which pests voluntarily controlled (%)
Assumed to be not more than 5%.

Proportion of land to which conservation values apply (%)
Because of the nature of the habitat infested assumed for this analysis to be 40%.

Any benefits provided by the weed ($p.a.)
Nil

Biocontrol ($p.a.)
Not available

Year strategy objectives achieved (eradication)
Assumed for this analysis to be 20 years.

RESULTS

PLANT PEST		Sagittaria	
	No RPMS	**Containment**	**Eradication**
Cost and losses under option	**$278,677**	**$0**	**$29,250**
Section 72(a) NPV		**$0**	**$249,427**
Section 72(a) regional values cost/ha		**$0**	**$0**
Section 72(b) NPV (*NRB*)		**$0**	**$259,077**
Section 72(b) area of spillover prevented (ha)		**1,526,482**	**1,526,482**

Base Assumptions

Discount Rate		**8%**	
Initial Area Infested (ha)	(IAI)	**1**	**(ha)**
Weighted Average Gross Margin for Infested Land ($/ha)	(WAGM)	**$0**	**($/ha)**
Proportion of Production Loss from Infested Land (%)	(PPLIL)	**0%**	**(%)**
Total Area Potentially Infested	(TAPI)	**1,526,483**	**(ha)**
Years to Infest all of TAPI (years)	(YI)	**100**	**(Years)**
Annual Cost of Control for Landholder ($/ha affected)	(ACCL)	**$150**	**($/ha)**
Proportion of Landholders Controlling Pests (%)	(PLCP)	**5.0%**	**(%)**
Proportion of Infested Land to which Conservation Values Apply (%)	(PILCV)	**40%**	**(%)**
Any Benefits Provided by Weed (total $ / annum)	(BPBW)		**($)**

Containment Assumptions			
Biocontrol ($/annum)			**($)**
Year Strategy objectives Achieved	(YOA)		**(Years)**
Area Infested if Strategy Objectives Achieved (ha)	(AISOA)		**(ha)**
Proportion of Production Loss from Infested Land when Strategy Objectives Achieved (%)	(PPLSOA)		**(%)**

Eradication Assumptions			
Year Strategy objectives Achieved	(YOA)	**20**	**(Years)**

Regional Council Costs		
Year	**Containment**	Eradication
1		$1,500
2		$1,500
3		$1,500
4		$1,500
5		$1,500
6		$1,500
7		$1,500
8		$1,500
9		$1,500
Year 10 onward		$1,500
NPV	**$0**	**$19,500**

Control Costs		
Year	Containment	Eradication
1		$750
2		$750
3		$750
4		$750
5		$750
6		$750
7		$750
8		$750
9		$750
Year 10 onward		$750
NPV	**$0**	**$9,750**

CONCLUSIONS

The desired Regional Plant Pest Strategy objective for this plant pest is eradication.

The outcome in the no RPMS scenario is a loss of $11,448,623 per annum in 100 years as a result of production losses and additional costs of control. This is equivalent to a NPV of approximately $278,677. In addition there is 580,063ha on which damages to regionally significant conservation, recreation, amenity, MāoriMāori or soil and water values will occur.

The outcome of the eradication scenario is a NPV of $19,500 for administration, inspection, monitoring and enforcement, a NPV of $9,750 for costs of control, and loss of $0 per annum in 20 years as a result of production losses. This is a total cost in present day terms (NPV) of approximately $29,250 at a discount rate of 0.08%. In addition there will be no damages to regionally significant conservation, recreation, amenity, MāoriMāori or soil and water values from this pest once eradication has been achieved.

The net outcome for eradication when compared with the no RPMS scenario is $249,427 in NPV terms. This option protects significant regional biodiversity values on 580,063ha through the prevention of spread of this organism. Eradication is preferred since it produces the highest net benefit, and best satisfies the requirements of section 72(a) of the BSA 1993.

The net regional benefits exceed the individual benefits by $278,577 because the strategy prevents the spread of the pest onto 1,526,482ha. The strategy also prevents damage to regional values on 580,063ha, and eradication therefore satisfies the requirements of section 72(b).

If the requirements of section 72(a) and (b) are deemed by council to have been met, then the costs of the strategy can be charged to the regional community as beneficiaries and the benefits received will exceed the costs. Those on whose property the pest currently exists are exacerbators, and can reasonably be charged the cost of control, satisfying section 72(ba) of the Biosecurity Act 1993.

5.39 Senegal tea (*Gymnocoronis spilanthoides*) (2002)

Description and biological capability	
Form	• Perennial aquatic herb, forming mats with scrambling, floating stems which produce roots at nodes. • Stems erect when flowering up to 1.5m tall.
Habitat	• Tropics to warm temperate zone in wet marshy soils often spreading out from still or flowing water margins to form a floating mat.
Regional distribution	• Widely distributed through the aquarium trade, sold as “costata”.
Biological success	
Dispersal method	• Spreads by stem fragmentation and seed dispersed by water movement, humans and machinery.
Reproductive ability	• Few seeds produced in New Zealand, however seeds are highly fertile.
Competitive ability	• Dominates shorter herbaceous vegetation and floating mats shade out submerged species.
Other considerations	
Toxicity	• Nil.
Resistance to control	• Mechanical control unsuccessful as it spreads fragmented plants. • Trials undertaken using herbicides.

Impact evaluation	Current impact (Y\N)	Current level of impact (Nil, L, M, H)	Potential impact (Y\N)	Potential level of impact (Nil, L, M, H)
Endangered Species	N	-	Y	L
Species Diversity	N	-	Y	M
Soil resources	N	-	Y	M
Water Quality	N	-	Y	M
Human Health	N	-	N	-
MāoriMāori Culture	N	-	Y	M
Production	N	-	N	-
Recreation	N	-	Y	M
International trade	N	-	N	-

Notes:

1 Has the potential to invade habitats of endangered species either displacing them or their food source. Has the ability to displace native species in wetlands and in natural waterways.

2 Dense mats alter flowing streams and wetlands and can cause sedimentation.

Assessment of effects status: Moderate/Major

Scenario: No RPMS

Assumptions		
Initial area infested (ha)	(IAI)	1
Total area potentially infested	(TAPI)	10,000
Years to infest all of TAPI (years)	(YI)	60
Weighted average gross margin for infested land ($/ha)	(WAGM)	-
Annual cost of control for land occupier ($/ha affected)	(ACCL)	575
Proportion of land occupiers controlling pests (%)	(PLCP)	1
Proportion of production loss from infested land (%)	(PPLIL)	-
Proportion of infested land to which conservation values apply (%)	(PILCV)	80
Any benefits provided by the weed	(BPBW)	0
Discount rate	(DRATE)	8
Calculations		
Multiplier: work out using "RPMS guidelines - Do Nothing.xls" (IAI. TAPI, YI, DRATE)	(MDN)	3.573
Loss of production from initial area infested = IAI X WAGM X (1 - (PLCP/100)) X PPLIL	(LOPIAI)	0
Loss of production in year Y1 =WAGM X TAPI X (1 - (PLCP/100)) X PPLIL	(LOP)	0
Costs of control in initial area = IAI x ACCL x (PLCP/100)	(COCIAI)	6
Costs of control in Year Y1 = TAPI X ACCL X (PLCP/100)	(COC)	57,500
Total damage in No RPMS Scenario ($/annum) = (LOP + COC - BPBW)	(TDDNS)	57,500
Net present value No RPMS = TDDNS X MDN	(NPVDN)	205,448
Area of conservation and other regional damages = PILCV/100 X (1 - (PLCP/100)) X TAPI (ha)	(ACORD)	7,920

Scenario: Eradication

1. Annual regional costs (inspection, monitoring, enforcement, administration etc) converted to present day terms

Year	Regional cost (A)	8% discount rate multiplier (B)	NPV (A x B)	
1	9,599	1.000	9599.000	
2	9,599	0.926	8888.674	
3	9,599	0.857	8226.343	
4	9,599	0.794	7621.606	
5	9,599	0.735	7055.265	
6	9,599	0.681	6536.919	
7	9,599	0.630	6047.370	
8	9,599	0.583	5596.217	
9	9,599	0.540	5183.460	
Year 10 onward	9,599	6.253	60022.547	
	Total Sum NPV Column		**$124,777**	**(TRC)**

2. Annual cost of control for pest weed converted to present day terms

Year	Control cost (A)	8% discount rate multiplier (B)	NPV (A x B)	
1	575	1.000	575	
2	518	0.926	479	
3	466	0.857	399	
4	419	0.794	333	
5	377	0.735	277	
6	340	0.681	231	
7	306	0.630	193	
8	275	0.583	160	
9	248	0.540	134	
Year 10 onward	223	6.253	1393	
	Total Sum NPV Column		**$4,174**	**(TCC)**

Assumptions		
Current area infested (ha)	(CAI)	1
Current density (area displaced ha/ha) %	(DCY)	80
Year strategy objectives achieved	(YOA)	5
Area infested if strategy objectives achieved (ha)	(AISOA)	-
Average density if strategy objectives achieved (area displaced ha/ha) %	(DSOA)	-
Any benefits provided by weed (total $ / annum)	(BPBW)	-
Calculations		
Multiplier: "RPMS Guideline - Scenarios.xls"	(MRPMS)	2.592
Loss of production in current year = WAGM x CAI x DCY	(LOPC)	0
Loss of production in YOA = WAGM x AISOA x DSOA	(LOPYOA)	0
Total damage in RPMS Scenario ($/annum) = LOPC x MRPMS	(TDRPMS)	0
Area of conservation and other regional damages = PILCV/100 x AISOA	(ACORDRRPMS)	0
Total cost RPMS Scenario = TDRPMS + TCC + TRC	(NPVRPMS)	128,952
CALCULATIONS: SECTION 72(A)		
Net benefit of RPMS Scenario = NPVDN - NPVRPMS ($)	(NBRPMS)	76,496
Prevented damage to regional values ACORD - ACORDRPMS (ha)	(APDCV)	7,920
Cost/ha of preventing damage to regional values = NBRPMS / APDCV	(CVHA)	10

CALCULATIONS: SECTION 72(B)		
Damage on initially infested area = (LOPIAI + COCIAI) / Multiplier ($)	(DOIAI)	72
Costs of spill over = NPVDN - DOIAI	(COS)	205,376
Net regional benefit = COS - TRC	(NRB)	80,598
Area spill over prevented = TAPI - IAI	(ASP)	9,999

Cost benefit analysis summary

Two scenarios for control of Senegal tea have been considered:

1. do nothing
2. eradication.

The "do nothing" scenario results in total regional damage of $57,500 NPV.

The "eradication" scenario has costs of $10,174 per annum. The cost to the region is $128,952 NPV. This results in a positive benefit of $76,496 NPV and therefore it does meet the requirements of section 72 (1)(a) of the Act. Council considers that the value of the land protected is greater than $16 per hectare.

Eradication is the preferred option as it produces a positive net benefit. The regional net benefit is $80,598, therefore the requirements of section 72(1)(b) of the Act are met.

5.40 Spartina (*Spartina alterniflora, S. anglica*) (2002)

Description and biological capability	
Form	• Robust erect perennials growing up to 1m tall.
Habitat	• Grows mainly in saline wetlands, especially in estuaries where it forms dense mats in inter-tidal zones. Prefers deep, soft fertile mud with a sandy loam texture.
Regional distribution	• Found in most eastern harbours of the Coromandel Peninsula, a number of estuaries/mudflat areas on the western side of the Peninsula and in the Aotea, Kawhia and Raglan Harbours and at Port Waikato on the west coast.
Biological success	
Dispersal method	• Seed and vegetative fragments carried by sea water. • Planted to assist salt march reclamation.
Reproductive ability	• *S. anglica* reproduces by seed. • *S. alterniflora* rarely flowers in New Zealand.
Competitive ability	• Generally does not grow with other plants except mangroves. • Lateral landward spread is limited by competition with mangroves. • Competitiveness weakened by cattle grazing. • Once established, forms dense clumps which may spread at a rate of 2% per annum.
Other considerations	
Toxicity	• Nil.
Resistance to control	• Mechanical removal ineffective and costly. • Chemical control requires high and costly application rates and does not give complete control.

Impact evaluation				
	Current impact (Y\N)	**Current level of impact (Nil, L, M, H)**	**Potential impact (Y\N)**	**Potential level of impact (Nil, L, M, H)**
Endangered Species	Y	L	Y	H
Species Diversity	Y	L	Y	H
Soil resources	Y	M	Y	H
Water Quality	Y	M	Y	H
Human Health	N	-	N	-
MāoriMāori Culture	Y	L	Y	M
Production	N	-	N	-
Recreation	Y	L	Y	M
International trade	N	-	N	-

Assessment of effects status: Major
Generally occurs on public land (in the foreshore), and the Department of Conservation, for this reason should be the lead agency for control of this pest.

Scenario: No RPMS

Assumptions		
Initial area infested (ha)	(IAI)	25
Total area potentially infested	(TAPI)	7,072
Years to infest all of TAPI (years)	(YI)	100
Weighted average gross margin for infested land ($/ha)	(WAGM)	402.00
Annual cost of control for land occupier ($/ha affected)	(ACCL)	575
Proportion of land occupiers controlling pests (%)	(PLCP)	-
Proportion of production loss from infested land (%)	(PPLIL)	2
Proportion of infested land to which conservation values apply (%)	(PILCV)	100
Any benefits provided by the weed	(BPBW)	0
Discount rate	(DRATE)	8
Calculations		
Multiplier: work out using "RPMS guidelines - Do Nothing.xls" (IAI. TAPI, YI, DRATE)	(MDN)	0.313
Loss of production from initial area infested = IAI X WAGM X (1 - (PLCP/100)) X PPLIL	(LOPIAI)	201
Loss of production in year Y1 =WAGM X TAPI X (1 - (PLCP/100)) X PPLIL	(LOP)	56,859
Costs of control in initial area = IAI x ACCL x (PLCP/100)	(COCIAI)	0
Costs of control in Year Y1 = TAPI X ACCL X (PLCP/100)	(COC)	0
Total damage in No RPMS Scenario ($/annum) = (LOP + COC - BPBW)	(TDDNS)	56,859
Net present value No RPMS = TDDNS X MDN	(NPVDN)	17,797
Area of conservation and other regional damages = PILCV/100 X (1 - (PLCP/100)) X TAPI (ha)	(ACORD)	7,072

Scenario: Eradication

1. Annual regional costs (inspection, monitoring, enforcement, administration etc) converted to present day terms

Year	Regional cost (A)	8% discount rate multiplier (B)	NPV (A x B)	
1	4,381	1.000	4381.000	
2	4,381	0.926	4056.806	
3	4,381	0.857	3754.517	
4	4,381	0.794	3478.514	
5	4,381	0.735	3220.035	
6	4,381	0.681	2983.461	
7	4,381	0.630	2760.030	
8	4,381	0.583	2554.123	
9	4,381	0.540	2365.740	
Year 10 onward	4,381	6.253	27394.393	
	Total Sum NPV Column		**$56,949**	**(TRC)**

2. Annual cost of control for pest weed converted to present day terms

Year	Control cost (A)	8% discount rate multiplier (B)	NPV (A x B)	
1	14,375	1.000	14375	
2	13,225	0.926	12246	
3	12,167	0.857	10427	
4	11,194	0.794	8888	
5	10,298	0.735	7569	
6	9,474	0.681	6452	
7	8,716	0.630	5491	
8	8,019	0.583	4675	
9	7,378	0.540	3984	
Year 10 onward	6,787	6.253	42441	
	Total Sum NPV Column		**$116,549**	**(TCC)**

Assumptions		
Current area infested (ha)	(CAI)	25
Current density (area displaced ha/ha) %	(DCY)	100
Year strategy objectives achieved	(YOA)	10
Area infested if strategy objectives achieved (ha)	(AISOA)	-
Average density if strategy objectives achieved (area displaced ha/ha) %	(DSOA)	-
Any benefits provided by weed (total $ / annum)	(BPBW)	-
Calculations		
Multiplier: "RPMS Guideline - Scenarios.xls"	(MRPMS)	4.186
Loss of production in current year = WAGM x CAI x DCY	(LOPC)	10,050
Loss of production in YOA = WAGM x AISOA x DSOA	(LOPYOA)	0
Total damage in RPMS Scenario ($/annum) = LOPC x MRPMS	(TDRPMS)	42,069
Area of conservation and other regional damages = PILCV/100 x AISOA	(ACORDRRPMS)	0
Total cost RPMS Scenario = TDRPMS + TCC + TRC	(NPVRPMS)	215,567
CALCULATIONS: SECTION 72(A)		
Net benefit of RPMS Scenario = NPVDN - NPVRPMS ($)	(NBRPMS)	(197,770)
Prevented damage to regional values ACORD - ACORDRPMS (ha)	(APDCV)	7,072
Cost/ha of preventing damage to regional values = NBRPMS / APDCV	(CVHA)	(28)

CALCULATIONS: SECTION 72(B)		
Damage on initially infested area = (LOPIAI + COCIAI) / Multiplier ($)	(DOIAI)	2,513
Costs of spill over = NPVDN - DOIAI	(COS)	15,284
Net regional benefit = COS - TRC	(NRB)	43,533
Area spill over prevented = TAPI - IAI	(ASP)	7,047

Cost benefit analysis summary

Two scenarios for control of spartina have been considered:

1. do nothing
2. eradication.

The "do nothing" scenario results in total regional damage of $56,859 NPV.

The "eradication" scenario has costs of $18,756 per annum. The cost to the region is $215,567 NPV. If successful, the eradication scenario will protect 5000 hectares with biodiversity and conservation values, at a present cost of $43 per hectare.

Eradication is the preferred option as it produces a greater net benefit. The regional net benefit is $43,533, therefore the requirements of section 72(1)(b) of the Act are met.

5.41 Variegated thistle (*Silybum marianum*) (2002)

Description and biological capability	
Form	• Annual or biennial thistle growing up to 2m high. The leaves are very prickly. The stem is hollow without spines. Flowers are large (7cm in diameter) and are red/purple in colour, there is only one flower per stem.
Habitat	• Roadsides, pastures, gardens, wasteland. Grows best on high fertility soils.
Regional distribution	• Limited distribution, but sometimes grown as a herbal remedy so there may be scattered plants throughout the region..
Biological success	
Dispersal method	• By wind or by inclusion in hay bales.
Reproductive ability	• Flowers produce large number of seeds which may remain viable for years.
Competitive ability	• Is very aggressive, forming dense impenetrable stands.
Other considerations	
Toxicity	• Prickles may damage stock and can cause nitrate poisoning in sheep and cattle.
Resistance to control	• Spread of germination times increases difficulty of control but is susceptible to several herbicides especially in seedling and rosette stage.

Impact evaluation				
	Current impact (Y\N)	**Current level of impact (Nil, L, M, H)**	**Potential impact (Y\N)**	**Potential level of impact (Nil, L, M, H)**
Endangered Species	N	-	N	-
Species Diversity	N	-	N	-
Soil resources	N	-	N	-
Water Quality	N	-	N	-
Human Health	N	-	N	-
MāoriMāori Culture	N	-	N	-
Production	Y	L-H	Y	L-H
Recreation	N	-	Y	L-H
International trade	N	-	N	-

Assessment of effects status: Moderate/major

Scenario: No RPMS

Assumptions		
Initial area infested (ha)	(IAI)	75
Total area potentially infested	(TAPI)	20,000
Years to infest all of TAPI (years)	(YI)	50
Weighted average gross margin for infested land ($/ha)	(WAGM)	3,641.00
Annual cost of control for land occupier ($/ha affected)	(ACCL)	50
Proportion of land occupiers controlling pests (%)	(PLCP)	80
Proportion of production loss from infested land (%)	(PPLIL)	2
Proportion of infested land to which conservation values apply (%)	(PILCV)	5
Any benefits provided by the weed	(BPBW)	0
Discount rate	(DRATE)	8
Calculations		
Multiplier: work out using "RPMS guidelines - Do Nothing.xls" (IAI. TAPI, YI, DRATE)	(MDN)	1.197
Loss of production from initial area infested = IAI X WAGM X (1 - (PLCP/100)) X PPLIL	(LOPIAI)	1,092
Loss of production in year Y1 =WAGM X TAPI X (1 - (PLCP/100)) X PPLIL	(LOP)	291,280
Costs of control in initial area = IAI x ACCL x (PLCP/100)	(COCIAI)	3,000
Costs of control in Year Y1 = TAPI X ACCL X (PLCP/100)	(COC)	800,000
Total damage in No RPMS Scenario ($/annum) = (LOP + COC - BPBW)	(TDDNS)	1,091,280
Net present value No RPMS = TDDNS X MDN	(NPVDN)	1,306,262
Area of conservation and other regional damages = PILCV/100 X (1 - (PLCP/100)) X TAPI (ha)	(ACORD)	200

Scenario: Eradication

1. Annual regional costs (inspection, monitoring, enforcement, administration etc) converted to present day terms

Year	Regional cost (A)	8% discount rate multiplier (B)	NPV (A x B)	
1	12,895	1.000	12895.000	
2	12,895	0.926	11940.770	
3	12,895	0.857	11051.015	
4	12,895	0.794	10238.630	
5	12,895	0.735	9477.825	
6	12,895	0.681	8781.495	
7	12,895	0.630	8123.850	
8	12,895	0.583	7517.785	
9	12,895	0.540	6963.300	
Year 10 onward	12,895	6.253	80632.435	
	Total Sum NPV Column		**$167,622**	**(TRC)**

2. Annual cost of control for pest weed converted to present day terms

Year	Control cost (A)	8% discount rate multiplier (B)	NPV (A x B)	
1	3,750	1.000	3750	
2	3,375	0.926	3125	
3	3,038	0.857	2603	
4	2,734	0.794	2171	
5	2,460	0.735	1808	
6	2,214	0.681	1508	
7	1,993	0.630	1256	
8	1,794	0.583	1046	
9	1,614	0.540	872	
Year 10 onward	1,453	6.253	9085	
	Total Sum NPV Column		**$27,223**	**(TCC)**

Assumptions		
Current area infested (ha)	(CAI)	75
Current density (area displaced ha/ha) %	(DCY)	80
Year strategy objectives achieved	(YOA)	5
Area infested if strategy objectives achieved (ha)	(AISOA)	-
Average density if strategy objectives achieved (area displaced ha/ha) %	(DSOA)	-
Any benefits provided by weed (total $ / annum)	(BPBW)	-
Calculations		
Multiplier: "RPMS Guideline - Scenarios.xls"	(MRPMS)	2.592
Loss of production in current year = WAGM x CAI x DCY	(LOPC)	218,460
Loss of production in YOA = WAGM x AISOA x DSOA	(LOPYOA)	0
Total damage in RPMS Scenario ($/annum) = LOPC x MRPMS	(TDRPMS)	566,248
Area of conservation and other regional damages = PILCV/100 x AISOA	(ACORDRRPMS)	0
Total cost RPMS Scenario = TDRPMS + TCC + TRC	(NPVRPMS)	761,093
CALCULATIONS: SECTION 72(A)		
Net benefit of RPMS Scenario = NPVDN - NPVRPMS ($)	(NBRPMS)	545,169
Prevented damage to regional values ACORD - ACORDRPMS (ha)	(APDCV)	200
Cost/ha of preventing damage to regional values = NBRPMS / APDCV	(CVHA)	2,726

CALCULATIONS: SECTION 72(B)		
Damage on initially infested area = (LOPIAI + COCIAI) / Multiplier ($)	(DOIAI)	51,154
Costs of spill over = NPVDN - DOIAI	(COS)	1,255,108
Net regional benefit = COS - TRC	(NRB)	1,087,486
Area spill over prevented = TAPI - IAI	(ASP)	19,925

Cost benefit analysis summary

Two scenarios for control of variegated thistle have been considered:

1. do nothing
2. eradication.

The "do nothing" scenario results in total regional damage of $1,091,280 NPV.

The "eradication" scenario has costs of $16,645 per annum. The cost to the region is $761,093 NPV. This results in a positive benefit of $545,169 NPV and therefore it does meet the requirements of section 72 (1)(a) of the Act.

Eradication is the preferred option as it produces a positive net benefit. The regional net benefit is $1,087,486, therefore the requirements of section 72(1)(b) of the Act are met.

5.42 Water poppy (*Hydrocleys nymphoides*) (2002)

Description and biological capability	
Form	• Stoloniferous perennial with tufts of thick, shining leaves and a distinctive solitary yellow flower.
Habitat	• Grows well in warm, well-lit, nutrient-rich habitats. Aggressive coloniser of ponds, streams, farm dams and lake margins where it can spread to depths of 2m. • Grows best in tropical to sub-tropical regions but can also grow in temperate and cool temperate regions.
Regional distribution	• Pond areas: Te Poi, Tokanui, Matamata and on the Coromandel Peninsula.
Biological success	
Dispersal method	• Solely vegetative. Plantlets produced along stolons which detach and float to surface and eventually take root. • Mostly spread as a pond plant.
Reproductive ability	• Seed is seldom, if ever, produced in New Zealand.
Competitive ability	• Completely replaces natural vegetation with surface blanket vegetation.
Other considerations	
Toxicity	• Nil.
Resistance to control	• Adequate control with herbicides giving total eradication. • Mechanical control likely to promote spread of plant.

Impact evaluation				
	Current impact (Y\N)	**Current level of impact (Nil, L, M, H)**	**Potential impact (Y\N)**	**Potential level of impact (Nil, L, M, H)**
Endangered Species	N	-	N	-
Species Diversity	Y	L	Y	M
Soil resources	Y	L	Y	M
Water Quality	Y	L	Y	M
Human Health	N	-	N	-
MāoriMāori Culture	Y	L	Y	M
Production	N	-	N	-
Recreation	Y	L	Y	M
International trade	N	-	N	-

Notes:

1 Has the ability to displace native species in wetlands and in waterways.
2 Blocks waterways and restricts recreational access to water bodies.

Assessment of effects status: Moderate

Scenario: No RPMS

Assumptions		
Initial area infested (ha)	(IAI)	1
Total area potentially infested	(TAPI)	10,000
Years to infest all of TAPI (years)	(YI)	50
Weighted average gross margin for infested land ($/ha)	(WAGM)	-
Annual cost of control for land occupier ($/ha affected)	(ACCL)	575
Proportion of land occupiers controlling pests (%)	(PLCP)	5
Proportion of production loss from infested land (%)	(PPLIL)	-
Proportion of infested land to which conservation values apply (%)	(PILCV)	50
Any benefits provided by the weed	(BPBW)	0
Discount rate	(DRATE)	8
Calculations		
Multiplier: work out using "RPMS guidelines - Do Nothing.xls" (IAI. TAPI, YI, DRATE)	(MDN)	0.642
Loss of production from initial area infested = IAI X WAGM X (1 - (PLCP/100)) X PPLIL	(LOPIAI)	0
Loss of production in year Y1 =WAGM X TAPI X (1 - (PLCP/100)) X PPLIL	(LOP)	0
Costs of control in initial area = IAI x ACCL x (PLCP/100)	(COCIAI)	29
Costs of control in Year Y1 = TAPI X ACCL X (PLCP/100)	(COC)	287,500
Total damage in No RPMS Scenario ($/annum) = (LOP + COC - BPBW)	(TDDNS)	287,500
Net present value No RPMS = TDDNS X MDN	(NPVDN)	184,575
Area of conservation and other regional damages = PILCV/100 X (1 - (PLCP/100)) X TAPI (ha)	(ACORD)	4,750

Scenario: Eradication

1. Annual regional costs (inspection, monitoring, enforcement, administration etc) converted to present day terms

Year	Regional cost (A)	8% discount rate multiplier (B)	NPV (A x B)	
1	10,694	1.000	10694.000	
2	10,694	0.926	9902.644	
3	10,694	0.857	9164.758	
4	10,694	0.794	8491.036	
5	10,694	0.735	7860.090	
6	10,694	0.681	7282.614	
7	10,694	0.630	6737.220	
8	10,694	0.583	6234.602	
9	10,694	0.540	5774.760	
Year 10 onward	10,694	6.253	66869.582	
	Total Sum NPV Column		**$139,011**	**(TRC)**

2. Annual cost of control for pest weed converted to present day terms

Year	Control cost (A)	8% discount rate multiplier (B)	NPV (A x B)	
1	575	1.000	575	
2	518	0.926	479	
3	466	0.857	399	
4	419	0.794	333	
5	377	0.735	277	
6	340	0.681	231	
7	306	0.630	193	
8	275	0.583	160	
9	248	0.540	134	
Year 10 onward	223	6.253	1393	
	Total Sum NPV Column		**$4,174**	**(TCC)**

Assumptions		
Current area infested (ha)	(CAI)	1
Current density (area displaced ha/ha) %	(DCY)	80
Year strategy objectives achieved	(YOA)	5
Area infested if strategy objectives achieved (ha)	(AISOA)	-
Average density if strategy objectives achieved (area displaced ha/ha) %	(DSOA)	-
Any benefits provided by weed (total $ / annum)	(BPBW)	-
Calculations		
Multiplier: "RPMS Guideline - Scenarios.xls"	(MRPMS)	2.592
Loss of production in current Year = WAGM x CAI x DCY	(LOPC)	0
Loss of production in YOA = WAGM x AISOA x DSOA	(LOPYOA)	0
Total damage in RPMS Scenario ($/annum) = LOPC x MRPMS	(TDRPMS)	0
Area of conservation and other regional damages = PILCV/100 x AISOA	(ACORDRRPMS)	0
Total cost RPMS Scenario = TDRPMS + TCC + TRC	(NPVRPMS)	143,185
CALCULATIONS: SECTION 72(A)		
Net benefit of RPMS Scenario = NPVDN - NPVRPMS ($)	(NBRPMS)	41,390
Prevented damage to regional values ACORD - ACORDRPMS (ha)	(APDCV)	4,750
Cost/ha of preventing damage to regional values = NBRPMS / APDCV	(CVHA)	9

CALCULATIONS: SECTION 72(B)		
Damage on initially infested area = (LOPIAI + COCIAI) / Multiplier ($)	(DOIAI)	359
Costs of spill over = NPVDN - DOIAI	(COS)	184,216
Net regional benefit = COS - TRC	(NRB)	45,204
Area spill over prevented = TAPI - IAI	(ASP)	9,999

Cost benefit analysis summary

Two scenarios for control of water poppy have been considered:

1. do nothing
2. eradication.

The "do nothing" scenario results in total regional damage of $287,500 NPV.

The "eradication" scenario has costs of $11,269 per annum. The cost to the region is $143,185 NPV. This results in a positive benefit of $41,390 NPV and therefore it does meet the requirements of section 72 (1)(a) of the Act. Council considers that the value of the land protected is greater than $29 per hectare.

Eradication is the preferred option as it produces a positive net benefit. The regional net benefit is $45,204, therefore the requirements of section 72(1)(b) of the Act are met.

5.43 White bryony (*Bryonia cretica ssp. Dioica*) (2002)

Description and biological capability	
Form	• A soft green climbing vine that can reach 6m tall. Has a large, persistent tuber.
Habitat	• Limited in distribution so habitat preferences are unclear, but probably requires reasonably high light levels.
Regional distribution	• Found in the Aria/Mokauiti Valley areas, possibly other scattered plants in the region.
Biological success	
Dispersal method	• Humans have planted it, but dispersal mainly by birds
Reproductive ability	• Sets viable seed
Competitive ability	• Aggressive, fast growing plant, that has potential to out-compete many native species.
Other considerations	
Toxicity	• Moderate- sap may cause skin blistering
Resistance to control	• Likely to be controlled by metsulfuron.

Impact evaluation				
	Current impact (Y\N)	**Current level of impact (Nil, L, M, H)**	**Potential impact (Y\N)**	**Potential level of impact (Nil, L, M, H)**
Endangered Species	N	-	Y	H
Species Diversity	N	-	Y	H
Soil resources	N	-	N	-
Water Quality	N	-	N	-
Human Health	N	-	Y	L
MāoriMāori Culture	N	-	Y	M
Production	N	-	N	-
Recreation	N	-	N	-
International trade	N	-	N	-

Notes: Has been used as a medicinal plant (a purgative), but seems to have fallen from favour due to its strength.

Assessment of effects status: Major

Scenario: No RPMS

Assumptions		
Initial area infested (ha)	(IAI)	150
Total area potentially infested	(TAPI)	8,600
Years to infest all of TAPI (years)	(YI)	50
Weighted average gross margin for infested land ($/ha)	(WAGM)	-
Annual cost of control for land occupier ($/ha affected)	(ACCL)	873
Proportion of land occupiers controlling pests (%)	(PLCP)	10
Proportion of production loss from infested land (%)	(PPLIL)	-
Proportion of infested land to which conservation values apply (%)	(PILCV)	10
Any benefits provided by the weed	(BPBW)	0
Discount rate	(DRATE)	8
Calculations		
Multiplier: work out using "RPMS guidelines - Do Nothing.xls" (IAI. TAPI, YI, DRATE)	(MDN)	1.737
Loss of production from initial area infested = IAI X WAGM X (1 - (PLCP/100)) X PPLIL	(LOPIAI)	0
Loss of production in year Y1 =WAGM X TAPI X (1 - (PLCP/100)) X PPLIL	(LOP)	0
Costs of control in initial area = IAI x ACCL x (PLCP/100)	(COCIAI)	13,095
Costs of control in Year Y1 = TAPI X ACCL X (PLCP/100)	(COC)	750,780
Total damage in No RPMS Scenario ($/annum) = (LOP + COC - BPBW)	(TDDNS)	750,780
Net present value No RPMS = TDDNS X MDN	(NPVDN)	1,304,105
Area of conservation and other regional damages = PILCV/100 X (1 - (PLCP/100)) X TAPI (ha)	(ACORD)	774

Scenario: Eradication

1. Annual regional costs (inspection, monitoring, enforcement, administration etc) converted to present day terms

Year	Regional cost (A)	8% discount rate multiplier (B)	NPV (A x B)	
1	12,885	1.000	12885.000	
2	12,885	0.926	11931.510	
3	12,885	0.857	11042.445	
4	12,885	0.794	10230.690	
5	12,885	0.735	9470.475	
6	12,885	0.681	8774.685	
7	12,885	0.630	8117.550	
8	12,885	0.583	7511.955	
9	12,885	0.540	6957.900	
Year 10 onward	12,885	6.253	80569.905	
	Total Sum NPV Column		**$167,492**	**(TRC)**

2. Annual cost of control for pest weed converted to present day terms

Year	Control cost (A)	8% discount rate multiplier (B)	NPV (A x B)	
1	130,950	1.000	130950	
2	117,855	0.926	109134	
3	106,070	0.857	90902	
4	95,463	0.794	75797	
5	85,916	0.735	63148	
6	77,325	0.681	52658	
7	69,592	0.630	43843	
8	62,633	0.583	36515	
9	56,370	0.540	30440	
Year 10 onward	50,733	6.253	317232	
	Total Sum NPV Column		**$950,619**	**(TCC)**

Assumptions		
Current area infested (ha)	(CAI)	150
Current density (area displaced ha/ha) %	(DCY)	80
Year strategy objectives achieved	(YOA)	5
Area infested if strategy objectives achieved (ha)	(AISOA)	-
Average density if strategy objectives achieved (area displaced ha/ha) %	(DSOA)	-
Any benefits provided by weed (total $ / annum)	(BPBW)	-
Calculations		
Multiplier: "RPMS Guideline - Scenarios.xls"	(MRPMS)	2.592
Loss of production in current year = WAGM x CAI x DCY	(LOPC)	0
Loss of production in YOA = WAGM x AISOA x DSOA	(LOPYOA)	0
Total damage in RPMS Scenario ($/annum) = LOPC x MRPMS	(TDRPMS)	0
Area of conservation and other regional damages = PILCV/100 x AISOA	(ACORDRRPMS)	0
Total cost RPMS Scenario = TDRPMS + TCC + TRC	(NPVRPMS)	1,118,111
CALCULATIONS: SECTION 72(A)		
Net benefit of RPMS Scenario = NPVDN - NPVRPMS ($)	(NBRPMS)	185,994
Prevented damage to regional values ACORD - ACORDRPMS (ha)	(APDCV)	774
Cost/ha of preventing damage to regional values = NBRPMS / APDCV	(CVHA)	240

CALCULATIONS: SECTION 72(B)		
Damage on initially infested area = (LOPIAI + COCIAI) / Multiplier ($)	(DOIAI)	163,688
Costs of spill over = NPVDN - DOIAI	(COS)	1,140,417
Net regional benefit = COS - TRC	(NRB)	972,925
Area spill over prevented = TAPI - IAI	(ASP)	8,450

Cost benefit analysis summary

Two scenarios for control of white bryony have been considered:

1. do nothing
2. eradication.

The "do nothing" scenario results in total regional damage of $750,780 NPV.

The "eradication" scenario has costs of $143,835, per annum. The cost to the region is $1,118,111 NPV. This results in a positive benefit of $185,994 NPV and therefore it does meet the requirements of section 72 (1)(a) of the Act. Council considers that the value of the land protected is greater than $1398 per hectare, but more importantly, white bryony is a very low incidence, high threat pest and eradication should be attempted.

Eradication is the preferred option as it produces a positive net benefit. The regional net benefit is $972,925, therefore the requirements of section 72(1)(b) of the Act are met.

5.44 Wild ginger (kahili and yellow) (*Hedychium flavescens and H. gardnerianum*) (2002)

Description and biological capability	
Form	• Both gingers have large green leaves with spikes and scented flowers and can grow up to 2-3m tall, with massive branching surface rhizomes. • The flowers of Kahili ginger are yellow with red stamens. Yellow ginger has creamy flowers.
Habitat	• Thrives in warm damp areas, very shade tolerant.
Regional distribution	• Particularly abundant on the Coromandel Peninsula with other infestations on the west coast between Raglan and Mokau.
Biological success	
Dispersal method	• Kahili ginger produces seed, dispersal of which is bird spread. • Spread also by dumping garden waste.
Reproductive ability	• Kahili ginger produces up to 100 seeds per head. Yellow ginger does not produce seed.
Competitive ability	• Both gingers spread rapidly from large rhizomes which form into thick mats up to 1m deep in the soil. • Can suppress 90% of native vegetation.
Other considerations	
Toxicity	• Nil.
Resistance to control	• Can be controlled using herbicides. • Removal by hand difficult due to size of rhizomes.

Impact evaluation				
	Current impact (Y\N)	**Current level of impact (Nil, L, M, H)**	**Potential impact (Y\N)**	**Potential level of impact (Nil, L, M, H)**
Endangered Species	Y	L	Y	H
Species Diversity	Y	L-H	Y	H
Soil resources	N	-	N	-
Water Quality	N	-	Y	M
Human Health	N	-	N	-
MāoriMāori Culture	Y	L-H	Y	L-H
Production	N	-	N	-
Recreation	Y	L-H	Y	M
International trade	N	-	N	-

Notes: A high threat pest which can be relatively easily controlled in many situations. Major infestations may require some Environment Waikato assistance.

Assessment of effects status: Major

Proposal
Environment Waikato is proposing that Wild Ginger be a containment pest plant with occupiers required to control all plants that occur on their land.

Analysis – No RPMS
In this scenario wild ginger will continue to spread throughout the region. While it is currently more successful in warmer and coastal areas, it is expected that over time it will continue to expand into a range of other habitats. Environment Waikato estimates that wild ginger will eventually infest 131,000 ha at a density of 20%. This will result in the loss of conservation values where wild ginger displaces vegetation with conservation and biodiversity values estimated by Environment Waikato to represent 60% of the potentially affected area (79,000 ha).

Analysis – RPMS
In this scenario wild ginger is controlled over the entire region wherever it occurs. This prevents further spread, and reduces damages so that no damage to conservation values occurs. This scenario is estimated to cost $1.4 million per annum for control of wild ginger, and a further $45,000 per annum for monitoring, enforcement, and management. This represents a NPV of $17.8 million at a discount rate of 8%.

Control in areas with conservation values only
In this scenario control is undertaken only in those locations where conservation values exist – estimated by Environment Waikato to be 60% of the potentially infested land. The spread of the wild ginger is not halted, and the costs of the scenario therefore depend on the rate of spread. The cost of this scenario is estimated at a NPV of between $14 million and $28 million depending on the rate of spread.

Section 72(a)
The RPMS scenario represents a cost to the region in quantified terms of $15 – $17 million. Therefore the council would need to consider that the conservation values in areas infested by wild ginger $190- 215/ha or $15 - $17/ha/annum in order for the RPMS to satisfy the requirements of the BSA.

The RPMS only produces a higher NPV than the alternative scenario of controlling the weed in conservation important areas if the council considers that:

- it is able to prevent spread of the weed
- control would be necessary on all land with conservation values where wild ginger is present if it were to spread throughout the region; and
- the rate of spread of wild ginger is likely to be at the high end of expectations.

Section 72(b)
As the values protected by the strategy are regional values, if the strategy satisfies section 72(a) then it will also satisfy the requirements of section 72(b).

Section 72(ba)
The values protected by the control of wild ginger are largely regional. A charge against the regional community for the conservation and biodiversity values protected will therefore satisfy the requirements of section 72(ba).

As those harbouring the pest can be considered to be contributing to the problem, a charge for control costs against responsible land occupiers where these can be identified will also satisfy the requirements of section 72(ba).

Scenario: No RPMS

Assumptions		
Initial area infested (ha)	(IAI)	20,300
Total area potentially infested	(TAPI)	131,021
Years to infest all of TAPI (years)	(YI)	60
Weighted average gross margin for infested land ($/ha)	(WAGM)	-
Annual cost of control for land occupier ($/ha affected)	(ACCL)	341
Proportion of land occupiers controlling pests (%)	(PLCP)	20
Proportion of production loss from infested land (%)	(PPLIL)	5
Proportion of infested land to which conservation values apply (%)	(PILCV)	60
Any benefits provided by the weed	(BPBW)	0
Discount rate	(DRATE)	8
Calculations		
Multiplier: work out using "RPMS guidelines - Do Nothing.xls" (IAI. TAPI, YI, DRATE)	(MDN)	3.957
Loss of production from initial area infested = IAI X WAGM X (1 - (PLCP/100)) X PPLIL	(LOPIAI)	0
Loss of production in year Y1 =WAGM X TAPI X (1 - (PLCP/100)) X PPLIL	(LOP)	0
Costs of control in initial area = IAI x ACCL x (PLCP/100)	(COCIAI)	1,384,460
Costs of control in Year Y1 = TAPI X ACCL X (PLCP/100)	(COC)	8,935,632
Total damage in No RPMS Scenario ($/annum) = (LOP + COC - BPBW)	(TDDNS)	8,935,632
Net present value No RPMS = TDDNS X MDN	(NPVDN)	35,358,297
Area of conservation and other regional damages = PILCV/100 X (1 - (PLCP/100)) X TAPI (ha)	(ACORD)	62,890

Scenario: Containment Control

1. Annual regional costs (inspection, monitoring, enforcement, administration etc) converted to present day terms

Year	Regional cost (A)	8% discount rate multiplier (B)	NPV (A x B)	
1	44,822	1.000	44822	
2	44,822	0.926	41505	
3	44,822	0.857	38412	
4	44,822	0.794	35589	
5	44,822	0.735	32944	
6	44,822	0.681	30524	
7	44,822	0.630	28238	
8	44,822	0.583	26131	
9	44,822	0.540	24204	
Year 10 onward	44,822	6.253	280272	
	Total Sum NPV Column		**$582,641**	**(TRC)**

2. Annual cost of control for pest weed converted to present day terms

Year	Control cost (A)	8% discount rate multiplier (B)	NPV (A x B)	
1	55,378	1.000	55378	
2	55,378	0.926	51280	
3	55,378	0.857	47459	
4	55,378	0.794	43970	
5	55,378	0.735	40703	
6	55,378	0.681	37713	
7	55,378	0.630	34888	
8	55,378	0.583	32286	
9	55,378	0.540	29904	
Year 10 onward	55,378	6.253	346281	
	Total Sum NPV Column		**$719,864**	**(TCC)**

Assumptions		
Current area infested (ha)	(CAI)	20,300
Current density (area displaced ha/ha) %	(DCY)	20
Year strategy objectives achieved	(YOA)	5
Area infested if strategy objectives achieved (ha)	(AISOA)	20,300
Average density if strategy objectives achieved (area displaced ha/ha) %	(DSOA)	5
Any benefits provided by weed (total $ / annum)	(BPBW)	-
Calculations		
Multiplier: "RPMS Guideline - Scenarios.xls"	(MRPMS)	12.574
Loss of production in current year = WAGM x CAI x DCY	(LOPC)	0
Loss of production in YOA = WAGM x AISOA x DSOA	(LOPYOA)	0
Total damage in RPMS Scenario ($/annum) = LOPC x MRPMS	(TDRPMS)	0
Area of conservation and other regional damages = PILCV/100 x AISOA	(ACORDRR PMS)	12,180
Total cost RPMS Scenario = TDRPMS + TCC + TRC	(NPVRPMS)	1,302,505
CALCULATIONS: SECTION 72(A)		
Net benefit of RPMS Scenario = NPVDN - NPVRPMS ($)	(NBRPMS)	34,055,792
Prevented damage to regional values ACORD - ACORDRPMS (ha)	(APDCV)	50,710
Cost/ha of preventing damage to regional values = NBRPMS / APDCV	(CVHA)	34,005,082

CALCULATIONS: SECTION 72(B)		
Damage on initially infested area = (LOPIAI + COCIAI) / Multiplier ($)	(DOIAI)	17,305,750
Costs of spill over = NPVDN - DOIAI	(COS)	18,052,547
Net regional benefit = COS - TRC	(NRB)	17,469,905
Area spill over prevented = TAPI - IAI	(ASP)	110,721

Scenario: Eradication

1. Annual regional costs (inspection, monitoring, enforcement, administration etc) converted to present day terms

Year	Regional cost (A)	8% discount rate multiplier (B)	NPV (A x B)	
1	44,822	1.000	44822.000	
2	44,822	0.926	41505.172	
3	44,822	0.857	38412.454	
4	44,822	0.794	35588.668	
5	44,822	0.735	32944.170	
6	44,822	0.681	30523.782	
7	44,822	0.630	28237.860	
8	44,822	0.583	26131.226	
9	44,822	0.540	24203.880	
Year 10 onward	44,822	6.253	280271.966	
	Total Sum NPV Column		**$582,641**	**(TRC)**

2. Annual cost of control for pest weed converted to present day terms

Year	Control cost (A)	8% discount rate multiplier (B)	NPV (A x B)	
1	6,922,300	1.000	6922300	
2	6,230,070	0.926	5769045	
3	5,607,063	0.857	4805253	
4	5,046,357	0.794	4006807	
5	4,541,721	0.735	3338165	
6	4,087,549	0.681	2783621	
7	3,678,794	0.630	2317640	
8	3,310,915	0.583	1930263	
9	2,979,823	0.540	1609105	
Year 10 onward	2,681,841	6.253	16769551	
	Total Sum NPV Column		**$50,251,750**	**(TCC)**

Assumptions		
Current area infested (ha)	(CAI)	20,300
Current density (area displaced ha/ha) %	(DCY)	20
Year strategy objectives achieved	(YOA)	5
Area infested if strategy objectives achieved (ha)	(AISOA)	-
Average density if strategy objectives achieved (area displaced ha/ha) %	(DSOA)	-
Any benefits provided by weed (total $ / annum)	(BPBW)	-
Calculations		
Multiplier: "RPMS Guideline - Scenarios.xls"	(MRPMS)	2.592
Loss of production in current year = WAGM x CAI x DCY	(LOPC)	0
Loss of production in YOA = WAGM x AISOA x DSOA	(LOPYOA)	0
Total damage in RPMS Scenario ($/annum) = LOPC x MRPMS	(TDRPMS)	0
Area of conservation and other regional damages = PILCV/100 x AISOA	(ACORDRR PMS)	0
Total cost RPMS Scenario = TDRPMS + TCC + TRC	(NPVRPMS)	50,834,391
CALCULATIONS: SECTION 72(A)		
Net benefit of RPMS Scenario = NPVDN - NPVRPMS ($)	(NBRPMS)	(15,476,094)
Prevented damage to regional values ACORD - ACORDRPMS (ha)	(APDCV)	62,890
Cost/ha of preventing damage to regional values = NBRPMS / APDCV	(CVHA)	(246)

CALCULATIONS: SECTION 72(B)		
Damage on initially infested area = (LOPIAI + COCIAI) / Multiplier ($)	(DOIAI)	17,305,750
Costs of spill over = NPVDN - DOIAI	(COS)	18,052,547
Net regional benefit = COS - TRC	(NRB)	17,469,905
Area spill over prevented = TAPI - IAI	(ASP)	110,721

Cost benefit analysis summary

Three scenarios for control of wild ginger have been considered:

1. do nothing
2. eradication
3. containment control.

The "do nothing" scenario results in total regional damage of $8,935,632 NPV.

The "eradication" scenario has costs of $6,967,122 per annum. The cost to the region is $50,834,391 NPV. This results in a negative benefit of $15,476,094 NPV and therefore it does not meet the requirements of section 72 (1)(a) of the Act.

The "containment control" scenario has costs of $100,200 per annum. The cost to the region is $1,302,505 NPV. The result of this scenario is a positive benefit of $34,055,792 NPV and therefore it meets the requirements of section 72 (1)(a) of the Act.

Containment control is the preferred option as it produces a positive net benefit at a lower cost. The regional net benefit is $17,469,905, therefore the requirements of section 72(1)(b) of the Act are met. Council considers that the value of land protected is greater than $65 per hectare.

5.45 Willow: grey and crack *(Salix fragilis* and *S. Cinerea*) (2007)

Description and background

Grey willow and crack willow are widespread throughout New Zealand. Naturalised in the 1880s and 1925[85] respectively crack willow and grey willow, amongst other willows, have been favoured by river engineers in stabilising river banks. It is the weedy characteristics of willows (suckering, coppicing and rapid growth) "that make them so useful and cost effective (in the short term) for stabilizing banks" (Stanley 2002). However, willows can create problems in smaller, lower energy rivers by blocking channels and reducing flood capacity (ibid).

Whilst useful in stabilising river banks both crack willow and grey willow possess the ability to compromise biodiversity values associated with river and lake margins as well as in wetlands through the displacement of indigenous species. Instream values may also be compromised. Within a range of 12-34, grey willow is assigned a weediness score of 32[86] within DOC's weediness database. Crack willow is considered the less weedy of the two as it only reproduces vegetatively in New Zealand with its spread by stem fragments (BSNZ 2006). Crack willow is assigned a score of 28 within DOC's weediness database. Grey willow sets seed which is wind dispersed (BSNZ 2006). Both willows are listed in BSNZ's National Pest Plant Accord where their invasiveness and impact on indigenous biota is described as follows:

> *This plant replaces native species in wetlands, and forms vast dense stands and thickets. It causes blockages, flooding and structural changes in waterways. (BSNZ 2006).*

Australia possesses the most well documented international example of willows as weeds. In Australia willows are recognised as being among the worst weeds because of their invasiveness, potential for spread, and economic and environmental impacts. They have invaded riverbanks and wetlands in temperate Australia, occupying thousands of kilometres of streams and numerous wetland areas, shading out and displacing native vegetation. The recognition of willow as weeds led to the development in 2000 of a National Weeds Strategy for willows (ARMCANZ 2000). The strategy document reports that the management of willow is "to reduce flooding and related hydrological impacts by river management authorities [and] has been calculated at $2,000,000 per annum in Victoria; while in Tasmania, a large proportion of the current $2,000,000 Rivercare grants are for willow removal. The environmental costs – to biodiversity and other natural values – are immense but poorly quantified or documented" (ibid.).

The strategy document developed in support of the Australian National Weeds Strategy for willows provides for a detailed description of the impacts of willows on riparian areas. Despite reporting the Australian experience it is considered pertinent to the New Zealand context and the potential of willows as weeds. The strategy document describes the impact of willows as weeds as follows:

> ***Willows as invaders of waterways***
> *Willows colonise river and stream beds by vegetative or sexual reproduction, with potentially severe environmental and biological effects through formation of dense stands of structurally unstable trees or shrubs with extensive, dense, root mats. Impacts include:*

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[85] http://www.nzpcn.org.nz/exotic_plant_life_and_weeds/detail.asp?WeedID=592 (accessed 31 May 2007)

[86] Scoring system for weediness developed by DoC assigning scores based on 'Effect on system' (EoS) and 'Biological Success Rating' (BSR). As a reference for grey willow's score (32) *Cytisus scoparius* (broom) has a DoC weediness score of 25.

- *modification of stream morphology, hydrology and stability, causing blockage/obstruction, avulsion, increased erosion and sedimentation and increased flooding*
- *increased water-use in streams resulting from higher transpiration rates than indigenous vegetation*
- *severe damage to infrastructure where willow debris obstructs stream channels during floods (eg loss of bridges and roads)*
- *alterations to ecological processes in streams, including energy fluxes and nutrient cycling (timing, quality and consistency of organic matter inputs), water temperature modifications (through intense shading) and water quality via anoxic conditions produced (biological oxygen demand) during breakdown of the massed autumn leaf fall*
- *dense shading by willow canopies alter (or decrease) primary production, impacting on higher order consumers such as invertebrates and fish*
- *destruction of instream and streambank indigenous vegetation communities and dependent faunal communities by intense shading*
- *destruction of significant flora and fauna species and populations of streams and streambeds*
- *visual degradation by the introduction of discordant exotic elements in high-quality landscapes dominated by indigenous vegetation eg Snowy River National Park, Victoria, and Kosciuszko National Park, NSW*
- *reduction in amenity values associated with streams, for example reduced access for fishing, canoeing and rafting on streams densely vegetated with willows.*

Willows as invaders of off-stream wetlands
Willows which reproduce by seed (which is wind dispersed over long distances), most significantly grey sallow (S. cinerea) and black willow (S. nigra), are able to invade all non-saline wetlands including streams from sea level to alpine bogs. Impacts are similar to those on streams outlined above, but generally without the adverse impacts on stream morphology and hydrology, except excess water use. Willows seriously threaten biodiversity of wetlands communities…

(ARMCANZ 2000)

Crack and grey willow are listed for inclusion in the Auckland Regional Council's 2007 to 2012 RPMS (ARC 2006) as 'surveillance' plant pests. Horizons Regional Council's proposed RPMS (Horizons 2006) lists grey willow as a 'containment' pest plant whilst crack willow is listed under Horizon's 'site-led programme'. In conjunction with DOC, Environment Waikato is seeking the ability to conduct control work on crack and grey willows in the region on an as needs basis. No landowner compliance rules/obligations are proposed. Environment Waikato are proposing that the crack willow is included in its RPMS as a 'containment' plant pest.

Pest management strategy

The analysis undertaken employs a simple spread sheet model that considers the no RPMS and with RPMS scenarios. The analysis presented considers both species in conjunction as Environment Waikato are not able to delineate the extent of the current infestation or the potential area of infestation by individual species. Given the differing dispersal mechanisms it is likely that grey willow occupies a more diverse range of sites than crack willow. Furthermore, willow species hybridise making it difficult to accurately define species.

No RPMS
Environment Waikato estimate that the existing infestation of comprises 45 000ha and that the potential area of infestation by crack and grey willow is 60 000ha. The area identified includes river and lake margins and wetlands. The analysis of the no RPMS assumes that:

- the initial infestation of 45 000ha spreads to infest the area identified by Environment Waikato within 50 years
- 80% of area affected possesses conservation values
- control is implemented voluntarily in 1% of the area infested at a cost of $550/ha
- no production losses are assumed.

Under the no RPMS scenario the ongoing costs of control associated with 1% of the infested area is estimated as possessing a value $NPV_{8\%}$ of $3.3 million. Under the no RPMS scenario crack willow may still be utilised in river bank stabilisation projects.

With RPMS – Potential Pest
The strategy's objective is to facilitate the containment of existing infestations and to prevent further distribution and propagation of crack willow. Given that the no RPMS scenario results in a $NPV_{8\%}$ regional cost of $3.3 million, Environment Waikato can be neutral about incurring costs at this level to ensure the containment of existing infestations and the prevention of further infestations. This level of expenditure includes operational control costs and is equivalent to the annual expenditure of $270,000/annum in perpetuity at a discount rate of 8%. This cost level assumes that the control programme implemented replaces the voluntary control being conducted in the existing are of infestation.

Under the with RPMS scenario alternative species that do not replicate the weediness represented by crack willow will be required for river bank stabilisation projects. It is uncertain as to whether this would add significantly to the cost of such projects.

Section 72(a) conclusion
If the council considers the assumptions used here to be reasonable, the successful containment of existing infestations of crack willow and grey willow delivers a net benefit in $NPV_{8\%}$ terms when compared with the no RPMS scenario if annual expenditure (including control operations) made by Environment Waikato to ensure containment and control of current infestations is less than $270,000/annum.

Assuming it is technically feasible and the assumptions used are considered reasonable, the control of existing infestations and the prevention of further infestations occurring in the region for an expenditure by Environment Waikato of up to $270,000/annum provides a higher net present value of benefits than the no RPMS scenario's reliance on voluntary control and thus the requirements of section 72(a) are satisfied if expenditure is contained within this level.

Section 72(b) conclusion
The literature review suggests that the values potentially compromised by the infestation of crack and grey willow in the region include but are not limited to biodiversity, conservation and amenity values through the loss of indigenous species and habitat and the threat to infrastructure/economic well-being through the clogging of low energy rivers and reduced flood capacity.

The values protected by the proposed strategy are regional values. If the council considers that the assumptions employed in this analysis are robust the strategy will satisfy section 72(b).

Section 72(c)
Crack and grey willow are capable of having a significant impact on MāoriMāori cultural values, biodiversity, conservation, recreation, amenity values and economic well-being. A RPMS in respect of this pest will therefore satisfy section 72(c) parts (i), (ii), (iii), (iv) and (v).

Section 72(ba)
The beneficiaries of the proposed strategy are the wider community. If the council considers that section 72(a) and 72(b) have been satisfied and that containment can be achieved, then the strategy can be funded through a charge on the regional community. The requirements of section 72(ba) will then have been met.

5.46 Yellow flag (*Iris pseudocorus*) (2007)

ASSUMPTIONS

Initial area infested (ha)
Fourteen ha at known regional sites, scattered mainly on riparian margins along the Waikato River.

Weighted average gross margin ($/ha)
N/A

Proportion of production loss from infested land (%)
Nil

Total area potentially infested (TAPI) (ha)
GIS modelling shows a potential 34,135ha of regional habitat capable of supporting this pest plant. However current sites are controlled and the plant is nationally banned from sale or propagation. The reality is that the regime of surveillance and control as necessary means at worst regional infestations would be contained at current levels.

Years to infest all TAPI
Yellow flag is an evergreen semi-aquatic iris that favours the margins of lakes, rivers or drains. It is very leafy and grows in clumps up to one metre high, producing conspicuous yellow flowers in spring. Flowers are produced after one or two years. Up to 200 seeds are produced per plant and are spread by water movement. Vegetative spread, through clumps being eroded and dispersed by flood waters, or by human cultivation, are the major means of spread to new sites. Most infestations are the result of deliberate ornamental plantings. It grows to form dense floating mats that completely exclude native plant and animal communities. Invasive of low-lying pasture, it is toxic to livestock which generally avoid grazing the plant. Infestations can trap silt and encourage flooding when growing in flowing water. Yellow flag also has the potential to adversely affect estuarine habitats and salt marsh vegetation. Dense stands hinder access to water bodies. This pest plant is in the National "banned from sale or propagation" list. It has been assumed for this analysis that available habitats would be infested within 50 years if no control was undertaken.

Annual cost of control for landholder ($/ha)
$150 ha assumed from staff operational knowledge.

Proportion of land over which pests voluntarily controlled (%)
Assumed to be a maximum of 5%.

Proportion of land to which conservation values apply (%)
Because of the nature of infested habitats assumed to be 100%.

Any benefits provided by the weed ($p.a.)
Nil

Biocontrol ($p.a.)
Not available

Year strategy objectives achieved (containment)
Assumed as 20 years for purposes of analysis.

Area infested if objectives (containment) achieved (ha)
Assumed as 20 years for purposes of analysis.

Proportion of production loss from infested land when strategy objectives (containment) achieved (%)
Assumed as a minimal 1% for purposes of analysis

Year strategy objectives achieved (eradication)
Assumed as 20 years for purposes of analysis.

RESULTS

PLANT PEST		Yellow flag iris	
	No RPMS	**Containment**	**Eradication**
Cost and losses under option	**$202,224**	**$77,998**	**$103,998**
Section 72(a) NPV		**$124,226**	**$98,226**
Section 72(a) regional values cost/ha		**$4**	**$3**
Section 72(b) NPV (*NRB*)		**$161,913**	**$161,913**
Section 72(b) area of spillover prevented (ha)		**34,121**	**34,121**

Base Assumptions

Discount Rate		**8%**	
Initial Area Infested (ha)	(IAI)	**14**	**(ha)**
Weighted Average Gross Margin for Infested Land ($/ha)	(WAGM)	**$0**	**($/ha)**
Proportion of Production Loss from Infested Land (%)	(PPLIL)	**0%**	**(%)**
Total Area Potentially Infested	(TAPI)	**34,135**	**(ha)**
Years to Infest all of TAPI (years)	(YI)	**50**	**(Years)**
Annual Cost of Control for Landholder ($/ha affected)	(ACCL)	**$150**	**($/ha)**
Proportion of Landholders Controlling Pests (%)	(PLCP)	**5.0%**	**(%)**
Proportion of Infested Land to which Conservation Values Apply (%)	(PILCV)	**100%**	**(%)**
Any Benefits Provided by Weed (total $ / annum)	(BPBW)		**($)**

Containment Assumptions			
Biocontrol ($/annum)		**$**	**($)**
Year Strategy objectives Achieved	(YOA)	**20**	**(Years)**
Area Infested if Strategy Objectives Achieved (ha)	(AISOA)	**10**	**(ha)**
Proportion of Production Loss from Infested Land when Strategy Objectives Achieved (%)	(PPLSOA)	**1%**	**(%)**

Eradication Assumptions			
Year Strategy objectives Achieved	(YOA)	**20**	**(Years)**

Regional Council Costs		
Year	**Containment**	Eradication
1	$3,000	$3,000
2	$3,000	$3,000
3	$3,000	$3,000
4	$3,000	$3,000
5	$3,000	$3,000
6	$3,000	$3,000
7	$3,000	$3,000
8	$3,000	$3,000
9	$3,000	$3,000
Year 10 onward	$3,000	$3,000
NPV	**$38,999**	**$38,999**

Control Costs		
Year	Containment	Eradication
1	$3,000	$5,000
2	$3,000	$5,000
3	$3,000	$5,000
4	$3,000	$5,000
5	$3,000	$5,000
6	$3,000	$5,000
7	$3,000	$5,000
8	$3,000	$5,000
9	$3,000	$5,000
Year 10 onward	$3,000	$5,000
NPV	**$38,999**	**$64,999**

CONCLUSIONS

The desired Regional Pest Management Strategy outcome for this pest plant is containment with a direct control option at selected sites.

The outcome in the no RPMS scenario is a loss of $256,013 per annum in 50 years as a result of production losses and additional costs of control. This is equivalent to a NPV of approximately $202,224. In addition there are 32,428 ha on which damages to regionally significant conservation, recreation, amenity, MāoriMāori or soil and water values will occur.

The outcome of the containment scenario is a NPV of $38,999 for administration, inspection, monitoring and enforcement, a NPV of $38,999 for costs of control, and loss of $0 per annum in 20 years as a result of production losses. This is a total cost in present day terms (NPV) of approximately $77,998 at a discount rate of 8%. In addition there will be a total of 10ha on which damages to regionally significant conservation, recreation, amenity, MāoriMāori or soil and water values will occur.

The outcome of the eradication scenario is a NPV of $38,999 for administration, inspection, monitoring and enforcement, a NPV of $64,999 for costs of control, and loss of $0 per annum in 20 years as a result of production losses. This is a total cost in present day terms (NPV) of approximately $103,998 at a discount rate of 8%. In addition there will be no damages to regionally significant conservation, recreation, amenity, MāoriMāori or soil and water values from this pest once eradication has been achieved.

The net outcome for containment when compared with the no RPMS approach produces a net positive benefit of $124,226 in NPV terms because the costs of undertaking the strategy are less than the likely losses in production and control costs if the organisms were allowed to spread. For eradication the net benefits when compared with the no RPMS scenario is $98,226 in NPV terms. Both options protect significant regional biodiversity values on 32,418ha through the prevention of spread of this organism. Containment is preferred since it produces the highest net benefit, and best satisfies the requirements of section 72(a) of the Biosecurity Act 1993.

The net regional benefits exceed the individual benefits by $161,913 because the strategy prevents the spread of the pest onto 34,121ha. The strategy also prevents damage to regional values on 32,418ha, and eradication therefore satisfies the requirements of section 72(b).

If the requirements of section 72(a) and (b) are deemed by council to have been met, then the costs of the strategy can be charged to the regional community as beneficiaries and the benefits received will exceed the costs. Those on whose property the pest currently exists are exacerbators, and can reasonably be charged the cost of control, satisfying section 72(ba) of the Biosecurity Act 1993.

5.47 Dama wallaby

Environment Waikato proposes dama wallabies be controlled throughout the region. The aim is for a zero density of wallabies, and Environment Waikato considers that wallabies have been eradicated from some areas in the previous strategy.

Analysis – No RPMS
In this scenario wallabies are allowed to become re-established in Waikato and no attempt is made to control them. They occupy an estimated 16,900 ha in the Rotorua District part of the Waikato Region, and it is estimated that they would spread to a further 35,000ha in the region, with distribution limited by the Waikato River. It is unknown how long it would take for wallabies to re-establish themselves within this habitat, but over the 40 year period from their introduction they had reached densities of concern and had inhabited 30,000 to 40,000ha. An estimate of 30 – 50 years to reach high densities and inhabit most of the 35,000ha in Waikato does not appear unreasonable therefore.

Dama wallabies have not been recorded as having any significant impact on agricultural values. Even in locations where wallaby numbers have been high, there has been no apparent competition with farm stock or reports of farmer concern[87]. The primary impact of wallabies is to indigenous forest. While early reports indicated that they remain largely at the forest/pasture interface, later information suggests that wallabies were frequenting the interior of forest and have a major impact on regenerating palatable species[88]. No effect on soil erosion, and only minor effects on forest establishment are recorded from dama wallabies.

Therefore the no RPMS scenario, in which wallabies are allowed to spread without intervention, is expected to result in damage to indigenous forest values within that 35,000ha of habitat.

Analysis – RPMS
Environment Waikato undertakes control and holds wallabies at or close to zero density. This control also prevents re-introduction from the Bay of Plenty Region. The costs of this are estimated at $11,600 per annum over the period of the strategy, and it is assumed that this level of costs will continue indefinitely to prevent reintroduction. This represents a NPV of $140,000 at a discount rate of 8%.

Section 72(a)
If the council considers that the protection of damage to conservation and biodiversity values in forest areas as well as minor damage to agricultural and exotic forestry values, within the wallaby's estimated 35,000ha of potential habitat and within 30 – 50 years in Waikato is worth $140,000 in current terms, then the requirements of section 72(a) will have been satisfied.

Section 72(b)
The values protected by the RPMS are all regional values because of the limited distribution of wallabies and the fact that they are mostly conservation and biodiversity benefits. If the requirements of section 72(a) have been met, then the requirements of section 72(b) will also have been met.

Section 72(ba)
As the benefits of the strategy are largely in terms of conservation and biodiversity values, a charge against the regional community for the costs of the strategy will satisfy section 72(ba).

[87] Warburton, B. 1986. "Wallabies in New Zealand: History, Current Status, Research, and Management Needs." FRI Bulletin No. 114, Forest Research Institute. Page 13.
[88] Warburton, B. *ibid.*

Cost benefit analysis summary

Two scenarios for control of dama wallaby have been considered:

1. do nothing
2. eradication.

The “do nothing” scenario results in damage to indigenous forest values over 35,000ha.

In an “eradication” scenario Environment Waikato undertakes control and holds wallabies at or close to zero density. This control also prevents re-introduction from the Bay of Plenty region. The costs of this are estimated at $11,600 per annum over the period of the strategy, and it is assumed that this level of costs will continue indefinitely to prevent reintroduction. This represents a NPV of $140,000.

Council considers that the protection to conservation and biodiversity values in forest areas, as well as minor damage to agricultural and exotic forestry values, within the wallaby’s estimated 35,000ha of potential habitat and within 30–50 years in Waikato is worth $140,000 in current terms, and satisfies the requirements of section 72(a). This is equivalent to ascribing a price of $4/ha or $0.32/ha/annum to those values protected.

The values protected by the RPMS are all regional values because of the limited distribution of wallabies and the fact that they are mostly conservation and biodiversity benefits. If the requirements of section 72(a) have been met, then the requirements of section 72(b) will also have been met.

5.48 Feral goldfish (*Carassius auratus*)

Description and background
Goldfish (*Carassius auratus*) are an introduced fish used primarily for ornamental purposes in aquariums and ponds. However they have also become established in waterways and lakes within the Waikato region through a combination of accidental and deliberate releases. In a survey of the Waikato River, goldfish were the second most abundant species in both number and biomass terms after koi carp, and were generally found in the same locations (Hicks et al, 2005).

Goldfish are found in most North Island lakes. It is thought they have similar spawning requirements to rudd and tench, relying on vegetation and spawning several times a year. Hicks (2007) suggests that because juvenile goldfish are found at all times of the year, they may not experience the same temperature limitations on spawning as do koi carp. There are no known studies of their feeding habits in New Zealand, but it is expected that juveniles are omnivorous, and adults are mainly herbivorous with occasional feeding on detritus. The stomach contents of goldfish from the Vasse River in West Australia showed they consumed detritus largely comprised of cyanobacteria, diatoms, nematodes, anisopteran larvae, coleopteran larvae, and dipteran larvae (Morgan and Beattie, 2004).

Goldfish are reported to be associated with an increase in turbidity in lakes and ponds in the Montreal region of Canada. The high levels of turbidity were generated by foraging goldfish in mud pools and a decrease in aquatic vegetation was associated with their herbivory. Rowe (2007) showed that the introduction of exotic fish caused reduced water clarity in North Island lakes. The Morgan and Beattie (2004) report discuses concerns that goldfish may be associated with increase in cyanobacterial algal blooms, a decline in native fish population, an increase in turbidity and a reduction in aquatic vegetation although these associations were not proven in their study.

Pest management strategy

No RPMS
In this approach no action will be taken by Environment Waikato in relation to goldfish. There will be no major changes in existing distribution of goldfish, although there may be some locations where they are not currently present which could become infested through accidental or deliberate release. There will be a continued decline in regional conservation and amenity values associated with goldfish infested lakes.

With RPMS
In this scenario Environment Waikato will declare the release of goldfish illegal, and will undertake control in areas where they have been newly introduced, in addition to requiring control in isolated ponds, wetlands and ditches in some circumstances.

It is expected that this will not greatly change the abundance of goldfish, since illegal releases of coarse fish are difficult to detect and prevent. However it will allow control to be undertaken in sensitive areas where they have been illegally released.

Costs of control in such circumstances are difficult to define with any accuracy, and data is scarce. Poisoning with rotonene is possible, and in examples are available of this having been undertaken in the USA and Australia. Removal of fish from Strawberry Reservoir and its tributaries in Utah, USA required 1000 days of staff time, 400 tonnes of rotonene and considerable machinery costs. This was estimated to have cost in the order of "millions of dollars" to cover 1800ha of lake and 250km of tributary stream.[89] No costs are available for the Australian examples. However permission to undertake large scale poisoning in the New Zealand situation may be difficult to obtain because of problems with by-kill. Therefore physical removal is more likely, either through electric fishing, netting or draining. The only example of costings for this is a cost of $45,000 to drain and clear a 0.4ha pond in the Nelson botanic gardens.[90] This equates to approximately $100,000 per ha, which would probably be at the upper end of cost estimates since it reportedly also included some clearance of silt from the pond.

No other additional resources are expected as a result of the inclusion of goldfish since the regional council's actions are required already in respect of koi carp, brown bullheaded catfish, and gambusia.

There may be some slight reduction in coarse fishing recreational values associated with the removal of goldfish from sensitive water bodies where they have been released, but because of the wide current distribution of goldfish this reduction is not expected to be significant. Killing goldfish in any location is almost certain to have some by-catch implications and possible disturbance of any indigenous ecosystems. The extent and nature of this will depend on the circumstances and choice of control technology.

Section 72(a)
If the council considers that the values in water bodies where control of goldfish is undertaken exceed up to $100,000 per ha, the requirements of section 72(a) will have been met.

Section 72(b)
The regional benefits of the programme arise through protection of conservation and biodiversity values. If the council is satisfied that the requirements of section 72(a) have been met, then the requirements of section 72(b) will also have been met.

Section 72(ba)
If the council is satisfied that the proposed strategy generates sufficient biodiversity and conservation benefits to satisfy section 72(a), then a charge against the regional community for any control costs as beneficiaries will satisfy section 72(ba). A charge against landholders on whose properties goldfish are present could also be justified as a charge based on their contribution to the problem (exacerbator charge).

Section 72(c)
As goldfish pose a significant threat to conservation and biodiversity values a strategy for its control is will satisfy section 72(c) (iv) of the BSA.

[89] Sanger , A and Koehn, J. 1996 " Use of chemicals for carp control" In Roerts, J and Tolzey, R "Controlling Carp: exploring the options for Australia" Proceedings of a workshop, 22 – 24 October, 1996, Albury, Australia. Published by CSIRO Land and Water.
[90] Hilhorst, M. 2002. "Koi Carp" Unpublished DOC report.

5.49 Feral goat *(Capra hircus)*

Proposal
Environment Waikato proposes controlling goats within and adjacent to regionally significant conservation and ecological areas.

Analysis – No RPMS
Goats are social animals, they disperse slowly, and do not voluntarily cross large rivers. This results in patchy distribution and allows land managers to consider local eradication. They do however have high birth rates in good conditions, and goat populations colonising new areas or recovering from control may roughly double every two years. Major causes of mortality are hunting, although kids may be preyed on by feral pigs. Goats have been present in Waikato for a number of years, and have probably occupied most of the suitable habitat. No increase in range is expected and density is expected to continue to be regulated by hunting and voluntary control (e.g. DOC operations).

Goats have few economic impacts, although they may occasionally compete with sheep for feed, and they have a wide range of parasites and diseases in common with sheep. Their range is limited however and they are relatively easily controlled, so it is not considered that they have any significant economic impact.

Goats are browsing generalists and feed on woody species in forests. While typically a few species dominate their diet[91], a wide range of plant species are eaten, including some toxic to other ungulates. Goats impact on indigenous ecosystems through their concentrated browsing and trampling. Even in low numbers their impacts on forest and scrublands can be serious – they destabilise forest ecosystems, and defoliate and eat the stems of palatable understorey species, bark saplings, and prevent regeneration of seedlings. Unpalatable shrubs increase and in some islands forest ecosystems have been converted to grassland. A survey[92] of the impact of goats indicates that within a short period goats are capable of reducing the numbers and diversity of understorey species, opening the canopy and influencing the regeneration of the forest. Goats may also affect native vertebrate and invertebrate populations by competition for food and by modifying forest habitats.

The impact of the No RPMS scenario is therefore expected to be continued localised degradation of ecological values in indigenous habitat. This includes areas which otherwise would be controlled by other parties, but where without the strategy no ability to control surrounding land is available.

Analysis – RPMS
The RPMS will require control in areas adjacent to conservation areas where goats are part of the complex of pests affecting the habitat and are being controlled by DOC. The costs of this strategy are estimated at approximately $50,000 per annum, with this amount assumed to be continued to be required on an ongoing basis. This represents a NPV of $630,000 at a discount rate of 8%. The control will cover between 500 and 900 ha each year.

Section 72(a)
If the council considers that the prevention of damage to conservation and biodiversity values by goats to regionally important conservation and ecological areas exceeds $630,000 or $50,000 per annum, then the requirements of section 72(a) will have been met. This is equivalent to ascribing a price of $55 - $100/ha or $4 - $8/ha/annum to those values protected by the strategy.

91 In the Orongorongo valley near Wellington 120 plant species were eaten, but 40 species made up 98% of their diet, and three species made up 50% of their diet. (Rundge, M.R. 1990 Feral Goat. In King, C.M. ed. The handbook of New Zealand Mammals. Auckland, Oxford University Press. Pp 406-423.)

92 Jacobs, D.T. 1990. Feral Goats in Banks Peninsula. A Comparative Survey and Assessment of the Impact on Indigenous Vegetation. B.For.Sc. Dissertation. University of Canterbury.

Section 72(b)
The values protected by the RPMS are all regional values because the strategy provides primarily conservation and biodiversity benefits. If the requirements of section 72(a) have been met, then the requirements of section 72(b) will also have been met.

Section 72(ba)
As the benefits of the strategy are largely in terms of conservation and biodiversity values, a charge against the regional community for the costs of the strategy will satisfy section 72(ba).

Cost benefit analysis summary

Two scenarios for control of feral goat have been considered:

1. do nothing
2. containment control.

The impact of a “do nothing” scenario is expected to be continued, localised degradation of ecological values in indigenous habitat. This includes areas which otherwise would be controlled by other parties, but where, without the strategy, no ability to control surrounding land is available.

A “containment control” scenario requires control in areas adjacent to high priority conservation areas where goats are a serious threat. The costs of this strategy are estimated at approximately $50,000 per annum, with this amount assumed to be continued to be required on an ongoing basis. This represents a NPV of $630,000. The control will cover between 500 and 900 ha each year.

Council considers that the prevention of damage to conservation and biodiversity values by goats to regionally important ecological areas exceeds $630,000 or $50,000 per annum, and satisfies the requirements of section 72(a). This is equivalent to ascribing a price of $55 - $100/ha or $4 - $8/ha/annum to those values protected by the strategy.

The values protected by the RPMS are all regional values because the strategy provides primarily conservation and biodiversity benefits. If the requirements of section 72(a) have been met, then the requirements of section 72(b) will also have been met.

5.50 Magpie *(Gymnorhina species)*

Proposal
Environment Waikato proposes requiring control of magpies by land occupiers on a complaint basis.

Analysis – No RPMS
In this scenario magpies have reached the extent of their habitat, and possibly of density, so no change in distribution of abundance of magpies is expected. Some local nuisance value is expected to occur where magpies harass humans during breeding season. Environment Waikato currently receives an average of 50 complaints per annum which would go unresponded.

Analysis – RPMS
In this scenario Environment Waikato responds to complaints and requires control to be undertaken by land occupiers where magpies are causing problems for humans. This is estimated to cost $30,000 in the first year, then $23,000 per annum thereafter for monitoring, advice and management, with a further $50 – 100 per control operation[93]. Assuming 50% of enquiries require some action, this represents a NPV of costs to the region of $300,000 at a discount rate of 8%.

Section 72(a)
If the council considers that the benefits of reduced distress to humans from magpies in thebreeding season in 25 cases of nuisance to humans exceeds $24,000 per annum then the requirements of section 72(a) will have been met. This is equivalent to valuing the reduction in local nuisance value from magpies at $950/complaint resolved.

Section 72(b)
As the magpies originate on one property but can cause problems on neighbouring properties, the values protected by the strategy are regional values. Therefore if the proposal meets the requirements of section 72(a) it will also meet the requirements of section 72(b).

Section 72(ba)
The values protected by the strategy are largely regional values. A charge against the regional community for the strategy will therefore satisfy section 72(ba). Land occupiers on whose properties magpies exist can be considered to be contributing to the problem, and a direct charge against these parties for control costs can be justified under section 72(ba).

Cost benefit analysis summary

Two scenarios for control of magpies have been considered:

1. do nothing
2. containment control.

In the "do nothing" scenario magpies have reached the extent of their habitat, and possibly of density, so no change in distribution of abundance of magpies is expected. Some local nuisance value is expected to occur where magpies harass humans during breeding season. Environment Waikato currently receives an average of 50 complaints per annum, to which there would be no response in this scenario.

In a "containment control" scenario Environment Waikato provides information factsheets and responds to complaints and requires control to be undertaken by land occupiers where magpies are causing problems for humans. This is estimated to cost $30,000 in the first year, then $23,000 per annum thereafter for monitoring, advice and management, with a further

[93] Fifty control operations required at a cost of $100/operation = $5,000 per annum in control costs.

$50 – 100 per control operation. Assuming 50% of enquiries require some action, this represents a NPV of $300,000.

Council considers that the benefits of reduced distress to humans from magpies in the breeding season in 25 cases of nuisance to humans exceeds $24,000 per annum and satisfies the requirements of section 72(a). This is equivalent to valuing the reduction in local nuisance from magpies at $950/complaint resolved.

As the magpies originate on one property but can cause problems on neighbouring properties, the values protected by the strategy are regional values. Therefore if the proposal meets the requirements of section 72(a) it will also meet the requirements of section 72(b).

5.51 Mustelids: ferret *(Mustela furo)*, weasel *(Mustela nivalis vulgaris)*, stoat *(Mustela erminea)*

Proposal
Environment Waikato proposes controlling mustelids within and adjacent to regionally significant conservation and ecological areas.

Analysis – No RPMS
Ferrets rely heavily on rabbits as their primary prey species, but they also feed on a variety of indigenous wildlife as secondary prey. Large scale changes in rabbit numbers, such as following control operations, can cause a substantial changes in ferret diets. Stoats are specialised predators of small mammals and birds, although they do take rabbits in riverbeds and tussock grassland. In forested areas their numbers fluctuate in response to beech seeding years.

Ferrets and stoats are capable of having a serious impact on native fauna through direct predation. Little data is available on the benefits of ferret control to native fauna in general. Norbury and Murphy[94] identified native vertebrate species most likely to be at risk of increased predation by rabbit predators as a result of prey switching from rabbits. Ferrets and stoats are variously known to prey on brown kiwi, weka and pigeons in forest/scrub/pasture mosaic. There are a number of vulnerable river bed species including the wrybill, black fronted tern and Caspian tern which are threatened by ferrets, as are the robust grasshopper and giant skinks. Stoats are considered a serious conservation pests because they threaten the long term viability of several species of birds through predation.

In sites where mustelids are abundant, the fauna of indigenous habitats is likely to continue to degrade, possibly with local extinction of species.

Analysis – RPMS
The RPMS will require control in regionally significant conservation and ecological areas where mustelids are part of the complex of pests affecting the habitat. The costs of this strategy are estimated at approximately $22,000 in the first year and $28,000 per annum thereafter, with this amount assumed to be continued to be required on an ongoing basis. This represents a NPV of $340,000 at a discount rate of 8%. This represents control on approximately 130 – 250 ha of land each year.

Section 72(a)
If the council considers that the prevention of damage to conservation and biodiversity values by mustelids in regionally significant conservation and ecological areas exceeds $340,000 or $110 - $210/ha, then the requirements of section 72(a) will have been met.

Section 72(b)
The values protected by the RPMS are all regional values because the strategy provides primarily conservation and biodiversity benefits. If the requirements of section 72(a) have been met, then the requirements of section 72(b) will also have been met.

Section 72(ba)
As the benefits of the strategy are largely in terms of conservation and biodiversity values, a charge against the regional community for the costs of the strategy will satisfy section 72(ba).

[94] Norbury, G and Murphy, E. 1996. "Understanding the Implications of Rabbit Calicivirus Disease for Predator/Prey Interactions in New Zealand : A Review". Landcare Research Contract Report : LC9596/61 Prepared for MAF Policy.

Cost benefit analysis summary

Two scenarios for control of mustelids have been considered:

1. do nothing
2. containment control.

A "do nothing" scenario in sites where mustelids are abundant is likely to continue to degrade the fauna of indigenous habitats, possibly with local extinction of endemic species.

A "containment control" scenario requires control in regionally significant (privately owned) ecological areas where mustelids are a serious threat. The costs of this strategy are estimated at approximately $22,000 in the first year and $28,000 per annum thereafter, with this amount assumed to be continued to be required on an ongoing basis. This represents a NPV of $340,000 that equates to control on approximately 130 – 250 ha of land each year.

Council considers that the prevention of damage to conservation and biodiversity values by mustelids in regionally significant ecological areas exceeds $340,000 or $110 - $210/ha, and satisfies the requirements of section 72(a).

The values protected by the RPMS are all regional values because the strategy provides primarily conservation and biodiversity benefits. If the requirements of section 72(a) have been met, then the requirements of section 72(b) will also have been met.

5.52 Possum *(Trichosurus vulpecula)*

Description and background

Possums are widespread throughout New Zealand, apart from a number of offshore islands and small parts of Fiordland. They are considered by the Department of Conservation to be one of the most serious threats to our natural heritage and biodiversity:

> *"Invasive pests and weeds pose the greatest single threat to biodiversity on land, surpassing even habitat loss. Browsing and grazing animals, such as goats, deer, thar, pigs, cattle, sheep, wallabies, rabbits and, above all, possums, eat our native plants. Introduced predators, such as stoats, ferrets, rats and cats, prey on birds, reptiles, frogs and the larger invertebrates. Many introduced species such as wasps compete with indigenous species, disrupting ecological processes and energy flows. Without sustained pest control, much of New Zealand's protected forests would suffer significant biodiversity losses from browsing animals."*
> (DOC 2000).

Possums are widespread throughout the Waikato. Numbers are moderately high, except in the areas where control work has been undertaken under the National Pest Management Strategy (NPMS) for bovine Tb. In these areas possum numbers are low and have been maintained at these low levels for several years.

Possums have a number of adverse effects including reducing biodiversity by defoliating palatable plant species. They compete with native wildlife by competing for plant food, and will prey on native species, including bird eggs, snails and invertebrates. As a result they impact on traditional MāoriMāori culture and food sources, biodiversity, conservation, soil, water and production values.

Possums are best described as opportunistic herbivores, feeding mainly on leaves. They also take buds, flowers, fruits, ferns, bark, fungi and invertebrates, which at times comprise most of their diet. Cereal and vegetable crops, horticultural produce, and introduced ornamental shrubs and flowers are also eaten. Possums also readily eat meat, especially native birds and their eggs, and land snails; they are routinely trapped in leg hold traps baited with rabbit meat to catch ferrets; and they scavenge deer and pig carcasses, including those infected with bovine Tb (Landcare 2006a).

Despite this wide range, possums are strongly selective browsers and the majority of the diet in any one location consists of only a few species. The species most common in a habitat are not necessarily those most frequently eaten, and this may result in extensive defoliation of favoured plant species and progressive change in forest composition to less favoured species. A long term study in the Orongorongo Valley near Wellington showed that over a 25 year period the composition of the possum's diet had changed markedly. At the start of the study the five most common species in their diet contributed 48% but only 5% at the end of the study due to their virtual elimination from the forest (Fitzgerald 1976).

While as yet no hard data is available on the benefit of controlling possums in forest, there is typically observed to be a dramatic regeneration of palatable species such as mistletoe, five finger, fuchsias and rata following control operations. In addition to regrowth of these palatable species following control, there tends to be an increase in populations of native fauna such as kaka, bellbird, tui and kereru (native pigeon) which rely on food sources for which possums are strong competitors (Greer 2006).

Possums compete with domestic stock on pasture, forest margins, and act as a vector for bovine Tb (Greer 2006). Forest–pasture margins often support very dense populations of up to 25/ha (Landcare 2006a). Damage by possums to the economic value of primary production from pastoral farming, horticulture, the honey industry, and forestry is widely recognised, but remains scarcely quantified. Landcare (2006a) cite the Parliamentary Commissioner for the Environment (1994) estimate of $40–100 million a year as the cost of possum damage and control nationally. The AHB's expenditure on vector control for the year ended 30 June 2006 "was the largest and most successful ever achieved, with possum and ferret control operations being completed over more than nine million hectares at a cost of just under $60 million" (AHB 2006a). Recent work by Greer (2006) has attempted to quantify the economic impact of possums in the Hawke's Bay.

Possums are also considered to have potential as a vector for several other diseases of humans and animals. These include *Giardia*, *Cryptosporiduium, Leptospira balancia* in humans and liver flukes, nematodes and rota virus in farm animals (Greer 2006).

Pest management strategy

No RPMS

In this scenario there is no further spread of possums, since they are already at their full extent in the Waikato region. However with reliance on voluntary control densities are expected to increase to their pre-Tb programme numbers where the land is released from Animal Health Board (AHB) programmes and in the absence of large sale community possum control programmes.

Changes in regional conservation values

Across all forest types in Waikato palatable under storey species will continue to decline or be restricted to inaccessible parts of the forest as a result of possum browsing. The effects of possum browsing on native fauna may be disproportionately high due to competition effects and direct predation by possums on invertebrates. In lowland broadleaf forests with a higher proportion of palatable species wholesale changes in forest composition will continue. A continuing loss of biodiversity is expected under the no intervention scenario.

Changes in regional economic values

Under the AHB strategy for the Waikato region the number of herds infected with Tb is expected to reduce from 0.13% of herds in 2006/07 year to 0.09% by 2008/09 (AHB 2006b). Environment Waikato's RPMS will not affect the NPMS for bovine Tb, and therefore no difference is expected in this level of Tb infection.

Under the no RPMS scenario resulting high levels of possums in the Vector Free Areas (VFA) increases the risk that a herd infection will spread to wildlife, and therefore that an area will be deemed Tb endemic. When an area does become Tb endemic in this fashion the AHB undertakes a BLIP operation which is fully funded through the National Pest Management Strategy (NPMS), and so no additional control costs are incurred. However additional testing and farm management costs are incurred by landholders in those areas. Previous analysis by Harris (2001) suggest that these costs could possess an $NPV_{8\%}$ of $35.00/ha.

Possums also graze pasture. Greer's (2006) study of production losses resulting from possums in the Hawke Bay estimates that at full possum densities they can result in the loss of $2.26/ha/annum on pastoral land. Assuming that the losses increase linearly from the current day to the full loss in 10 years this represents a $NPV_{8\%}$ loss of $18.00/ha.

Production losses associated with a no intervention scenario may result in a $NPV_{8\%}$ loss of $18.00/ha, and this may rise to $53.00/ha (if the area were to become Tb endemic as a result of no possum control being undertaken) on pastoral production land that is not subject to the NPMS for Possums/Tb.

With RPMS
Environment Waikato's proposed RPMS for possums has several facets:

- Land occupiers in a regionally supported large scale community possum control scheme shall, on direction from an authorised person, destroy possums on land occupied, in accordance with the scheme standards set within the operative time period for that scheme.
- All other land occupiers shall (except at high value sites – because Environment Waikato will conduct direct control there) maintain possum densities at a level no greater than 5% trap catch on land occupied.
- Environment Waikato will undertake direct control of possums down to densities on land consistent with the Strategy Objective, at:
  - any site that has in the past five years received Animal Health Board vector control funding
  - any high value conservation site
  - any high value catchment site
  - any site (which need not be contiguous) where Environment Waikato is of the opinion that possum control is necessary for efficient control outcomes in any of these first three category areas.
- Environment Waikato will provide advice and information on the threats of possum to affected land occupiers and other interested parties.

Environment Waikato anticipate that possum control area will grow from 98 378ha (2005) to over 601 000 in 2011 as a result of the release of land from AHB vector control. It is Environment Waikato's intention to maintain the level of control that has been achieved under the AHB control programmes. Environment Waikato's experience with CPCSs and control of ex-AHB areas suggests that ongoing possum control maintenance programmes cost approximately $12.50/ha/annum. This level of cost concurs with that budgeted by the AHB (AHB 2001) for the Waikato region as $12.10/ha to 13.32/ha. Under this cost scenario the control programme proposed by Environment Waikato has a $NPV_{8\%}$ of $73 million or $156/ha for the 601 000ha controlled.

Scale and method of control have a big influence on costs. Ground based control methods can be significantly more expensive than aerial operations, as can operations of smaller scale[95].

Environment Waikato are of the opinion that they will be able to move to an 18 month to bi-yearly control program thus reducing cost whilst still maintaining an adequate residual trap catch (RTC). An 18 month program would reduce costs to $8.33/ha/annum giving an $NPV_{8\%}$ of $103/ha whilst a bi-yearly program would reduce costs to $6.25/ha/annum giving an $NPV_{8\%}$ of $78/ha. The cost of the control programme under these scenarios gives an $NPV_{8\%}$ of $36 million for an 18 monthly programme and $48 million for a bi-yearly program for the 601 000ha controlled. However we consider that it is more prudent for Environment Waikato to plan on approximately $12.50 per ha for control costs as while there may be some cost savings with no requirement for initial knock-down operations, the AHB costs are based on considerable experience and under a wide variety of circumstances.

Landholder control
An alternate scenario is considered in which communities operate self help schemes with assistance from Environment Waikato – essentially this corresponds to the current approach for non-AHB control in the region. Current costings for these schemes provided by Environment Waikato indicate that the council contribution to those schemes is $7/ha, and the total costs including landholder expenditure is $13.30. Furthermore these schemes have a higher RTC threshold at 10% than the rating based schemes, and only 2 out of the 5 schemes are meeting this target. From the information supplied by Environment Waikato it

[95] Pers. comm. Kevin Nicholas, EPRO, Hamilton, 30 October 2006.

appears that self help is both more expensive and less effective than rating based approaches to control.

Theoretically it is possible to make landholder control more effective through an inspection and enforcement regime. Unfortunately possums range over considerable distances, and are rarely confined to a single property. As a result monitoring is only effective over larger areas, and methods other than RTC would have to be used as an enforcement tool. We know of no other approach currently which would be effective.

For these reasons we have not included landholder based control in further considerations on the RPMS, since it will be both more costly and provide less benefit than rating based approaches.

Section 72(a)
The costs associated with an annual control programme have a $NPV_{8\%}$ of $73 million for the total 601 000ha programme or $156/ha of area treated when compared with reliance on voluntary control. The benefits that may accrue to pastoral production within the proposed control area have a $NPV_{8\%}$ of $18/ha of production land protected, although this could rise to $53/ha in the event of the area becoming Tb endemic. In order for the council to be satisfied that the requirements of section 72(a) have been met under this scenario, the council would need to be satisfied that the values protected, other than production values, have a value greater than $NPV_{8\%}$ $138/ha of area treated. These values primarily relate to biodiversity and conservation.

The costs associated with an 18 monthly or bi-yearly program have an $NPV_{8\%}$ of $36 million and $48 million respectively. In order for the council to be satisfied that the requirements of section 72a have been met, the council would need to be satisfied that the values protected, other than production values if protected by the strategy, possess a value greater than the range $NPV_{8\%}$ $42 to $95/ha of area treated. These values primarily relate to biodiversity and conservation. The council would also need to be satisfied that an 18 monthly or bi-yearly programme would maintain the RTC levels and benefits achieved under the AHB vector control programme. However we believe it is more prudent to plan on annual control costs since this is a more reliable cost estimate and based on considerable experience and a wide range of conditions.

Section 72(b)
The regional benefits of the programme arise through:

- protection of conservation and biodiversity values
- prevention of spill over effects; and the
- protection of production values.

If the council is satisfied that the values protected by the proposed strategy are regional values and that the requirements of section 72(a) have been met, then the requirements of section 72(b) will also have been met.

Section 72(ba)
If the tests in section 72(a) and (b) are considered to have been met, then:

- Expenditure on monitoring and assessment can be recovered from the regional community for conservation and biodiversity values, and/or landholders for prevention of spill over between properties and the protection of production values. This allocation would need to be considered on a site by site basis as some control programs initiated may deliver little in the way of the protection of production values.
- Control costs could be recovered from landholders on the basis that they are contributing to the problem by harbouring the pest and from the wider community on the basis of the biodiversity and conservation values that are protected.

- A proportion of control costs could be recovered from the agricultural community that directly benefits from the protection of production values. This amount is in the order of 10% of costs based on production losses.

If the council is satisfied that the proposed strategy generates sufficient biodiversity and conservation benefits, then a charge against the regional community as beneficiaries will satisfy section 72(ba). Where biodiversity and conservation values are not significant but production values are, then a charge against the agricultural community that benefits form the specific control program will satisfy section 72(ba).

Section 72(c)
As possums pose a significant threat to conservation and biodiversity values as well as to economic values, a strategy for its control is will satisfy section 72(c) of the BSA. Possums are capable of having a significant impact on MāoriMāori cultural values, biodiversity, conservation, recreational and production values. An RPMS in respect of this pest will therefore satisfy section 72(c) parts (i), (ii), (iv) and (v).

5.53 Rabbit *(Oryctolagus cuniculus)*

Proposal
Environment Waikato proposes that rabbits are maintained at or below level 4 on the McLean/Gibb scale, with monitoring undertaken on a complaints basis.

Analysis – No RPMS
Rabbits have been present in Waikato for many years, and have reached a state of equilibrium both in terms of range and density. In stable populations densities are largely regulated by disease and predation rather than external control efforts. This is illustrated by the fact that rabbits in areas such as the Waikato produce more offspring per year than rabbits in rabbit prone areas such as Central Otago or the Mackenzie Country. Higher rates of mortality are associated with greater death from diseases associated with wet conditions, and higher rates of predation because predator population levels are supported through winter by a longer rabbit breeding season. Very rabbit prone parts of the country such as Central Otago are by contrast drier, and have a marked breeding slow down in winter which puts pressure on predator population levels.

The assumption is that rabbit populations are currently naturally regulated at low levels. Furthermore even in very rabbit prone parts of the country RCD has been regulating populations.

Analysis – RPMS
The RPMS will ensure that any populations which are potentially causing problems for neighbours will cease to do so. It is noted however that there have been no complaints since the policy was instituted in 1998, and therefore there does not appear to be a significant difference from the no RPMS scenario. The cost of this is $24,000 per annum, or a total NPV of $300,000 at a discount rate of 8%.

Section 72(a)
As there appears to be no difference between the RPMS scenario and no RPMS scenario other than the cost of the RPMS scenario, the rabbit RPMS produces a net negative outcome of $300,000. The RPMS therefore does not satisfy the requirements of section 72(a). This conclusion could be reviewed in future if rabbits were to become a significant problem.

Section 72(b)
As with section 72(a), the lack of difference between the RPMS and no RPMS scenarios means that the RPMS is unlikely to satisfy section 72(b) of the RPMS.

Section 72(ba)
As the rabbit problem is very confined and only affects economic values in the region, a charge against land occupiers in rabbit prone areas would satisfy section 72(ba).

Cost benefit analysis summary

Two scenarios for control of rabbits have been considered:

1. do nothing
2. containment control.

In the “do nothing” scenario it is envisaged that there would be little change in animal density.

A “containment control” scenario will ensure that any populations that are potentially causing problems for neighbours will cease to do so. There have been no complaints since 1998, and therefore there does not appear to be a significant difference from the “do nothing” scenario.

As there appears to be no difference between the containment scenario and the do nothing scenario other than the cost of the “containment control” scenario, which produces a net negative outcome of $300,000. The RPMS therefore does not satisfy the requirements of section 72(a). This conclusion could be reviewed in future if rabbits were to become a significant problem.

As with section 72(a), the lack of difference between the scenarios means that the RPMS is unlikely to satisfy section 72(b) of the Act. However, council considers that having a ‘fall-back’ rule, on a complaints basis is necessary to prevent externalities between properties. This service is relatively cheap to implement. The greater costs involved are provision of advise and information.

5.54 Rainbow lorikeet *(Trichoglossus haemotodus moluccanus)*

Description and biological capability	
Form	• Brightly coloured parrot, with blue faces, red and blue chests and yellow/green backs.
Habitat	• Seem to be restricted to forest edges and open lands, but are very limited in distribution in New Zealand so not much is yet known.
Regional distribution	• Not found in the Waikato region, but a number have been released in Auckland.
Reproductive ability	• Are likely to breed well in New Zealand conditions.
Competitive ability	• Much debated recently, many think that they will compete strongly with many native bird species, while others feel that competition will be low. A known agricultural pest in Australia.
Resistance to control	• As for other birds. Main resistance to control comes from aviarists.

Impact evaluation				
	Current impact (Y\N)	**Current level of impact (Nil, L, M, H)**	**Potential impact (Y\N)**	**Potential level of impact (Nil, L, M, H)**
Endangered Species	N	-	Y	M?
Species Diversity	N	-	Y	M?
Soil resources	N	-	N	-
Water Quality	N	-	N	-
Human Health	N	-	N	-
MāoriMāori Culture	N	-	Y	M?
Production	N	-	Y	M
Recreation	N	-	N	-
International trade	N	-	N	-

Assessment of effects status: Moderate
Should rainbow lorikeets make it into the Waikato region, Environment Waikato would expect the Department of Conservation to take the lead role to contain and control them.

5.55 Rook *(Corvus frugilegis)*

Proposal
Environment Waikato is recommending that the rook is a 'total control' animal pest in the proposed Regional Pest Management Strategy.

Analysis – No RPMS
In this scenario rooks are allowed to become more established in Waikato and no attempt is made to control them. Three rates of expansion were considered, and for the sake of simplicity only the losses to crop production were calculated in these scenarios. Other damages such as to horticulture and pasture were considered to be equal to these crop losses.

Analysis – RPMS
Environment Waikato eradicates the remaining rookeries from the Waikato. The costs of this are estimated at $96,000 in the first year, then $73,000 per annum for the remaining four years of the strategy. Thereafter an estimated $10,000 per annum is required until eradication is achieved.

Section 72(a)
The table below shows the outcomes of a RPMS to control rooks under a variety of rates of expansion. The modelling shows that if Environment Waikato believes that rooks are likely to expand rapidly in the Waikato region to reach their maximum within 50 years, then an eradication programme, if technically achievable given the costs outlined above, has a net positive value and will meet the requirements of section 72(a) of the BSA 1993.

Summary table – financial outcome to control rooks in Waikato (NPV $000's)

	Years to Achieve Eradication			
Rate of expansion	**5**	**10**	**20**	**50**
Linear – 50 years to max	$370,000	$340,000	$310,000	$290,000
Linear – 150 years to max	-$120,000	-$140,000	-$170,000	-$200,000
Theta logistic (S – shaped, 50 years to maximum)	$190,000	$170,000	$140,000	$110,000

Section 72(b)
The damage caused by rooks are, in the context of section 72(b), to regional values because the rooks tend to inhabit one location and cause damage in other locations. Thus the individual will not perceive their full effects in determining whether to undertake control. If the council were satisfied that the requirements of section 72(a) had been met, then the requirements of section 72(b) will also have been met.

Section 72(ba)
The beneficiaries of the rook RPMS are largely rural land occupiers involved in horticulture or cropping as well as some benefits to pastoral farmers in intensively farmed areas. A part charge against land occupiers on the intensively farmed parts of the Waikato region, together with a charge against the regional community for any conservation and amenity values threatened would best satisfy section 72(ba) of the BSA.

Cost benefit analysis summary

Two scenarios for control of rooks have been considered:

1. do nothing
2. eradication.

In the “do nothing” scenario rooks are allowed to become more established in Waikato and no attempt is made to control them. Three rates of expansion were considered, and for the sake of simplicity only the losses to crop production were calculated in these scenarios. Other damages such as to horticulture and pasture was considered to be equal to crop losses.

In an “eradication” scenario the remaining rookeries within the region would be eradicated or at least reduced to zero density. The costs of this are estimated at $96,000 in the first year, then $73,000 per annum for the remaining four years of the strategy. Thereafter an estimated $10,000 per annum is required until eradication is achieved.

Council believes that rooks are likely to expand rapidly in the Waikato region to reach their maximum within 50 years. An eradication programme is technically achievable and has a net positive value, therefore meeting the requirements of section 72(a) of the Act.

The damage caused by rooks are to regional values because the rooks tend to inhabit one location and cause damage in other locations. Thus the individual will not perceive their full effects in determining whether to undertake control. Council is satisfied that the requirements of section 72(b) have also been met.

5.56 Vertebrate pest control at high value catchment and high value biodiversity sites

Description and background

Environment Waikato is proposing an integrated catchment management approach within key catchments in the Waikato region integrating pest management with the regional catchment strategy (RCS). The primary objective of the regional catchment strategy is the prevention of erosion, run-off and flooding and the maintenance/enhancement of biodiversity. Under the RCS catchments are prioritised “on the following criteria: risk to human life/assets and infrastructure, maintaining productive capability of the land and protection enhancement of biodiversity and water quality (the latter two are not core functions of the RCS group but are organizational objectives which are increasingly taken into consideration when planning catchment management programmes within the RCS group)” (EW 2006).

Pest management under the proposed integrated catchment management approach is targeted at the following species either individually or in combination:

- deer
- pigs
- goats
- possums
- hedgehogs
- rats; and
- mustelids.

Northland Regional Council share the view that pests are an important component of catchment management “the damage caused by possums to protection forests on steep erodible areas increases the risk of soil erosion, flooding, property damage, water quality problems and interruption to roading off-site. In combination with goats, deer and rats, possums are one of the most destructive animals in a forest environment” (NRC 2003).

Deer (from Landcare 2006c).
Deer continue to adversely affect regeneration patterns in many forests, although the long-term consequences are yet to be firmly established. The greatest potential for change is in ecosystems dominated by preferred species, which tend to be characteristic of frequently disturbed sites (e.g. slips). The vegetation on stable infertile sites is generally more browse tolerant, so the effect of deer on species composition is less apparent. In forests, deer seldom have any direct effects on established trees and shrubs, but brushtail possums (*Trichosurus vulpecula*) can initiate a catastrophic collapse of the forest canopy, and then the effects of deer on plant succession are accelerated.

Wild red deer are also ‘spill over’ hosts for Tb, which become infected by, for example, investigating terminally ill possums. Nevertheless, deer infected with Tb continue to pose an indirect threat to the beef, dairy and deer farming industries. Most infected deer survive for at least several years, and some are genetically more resistant to Tb than others. Control of deer is not essential for Tb eradication, but could hasten eradication of Tb from wildlife.

Possum (from Landcare 2006a)
The effects of possum browsing are unquestionable, but the consequences for forest dynamics and soil erosion have been debated for decades. The traditional view is that possums will eventually attain a stable equilibrium with native vegetation, entailing the progressive elimination of preferred food species and a consequent decline in carrying capacity. Since the expected equilibrium has apparently not yet been reached anywhere in New Zealand, the extent and acceptability of changes to native flora and fauna at equilibrium levels are still unknown. Recent evidence and interpretations of the dynamic interactions

between possums and forest vegetation do not support the general assumption of an inevitable decline in carrying capacity; on the contrary, palatable opportunistic plants may increase in the face of possum browsing if they are sufficiently fast-growing.

The secondary effects of possum browsing may be less obvious. Canopies weakened by browsing may be more susceptible to windthrow, salt damage, pathogens, insects or climatic extremes. Possums may compete with native birds for seasonal resources, e.g. fruit, with consequent risk to the more fruit eating (frugivorous) species, particularly the wattlebirds. Possum browsing of leaves may reduce the production of flowers and fruit, with consequent effects on native animals; on Kapiti Island, sustained browsing of kohekohe trees prevented any flowering or fruiting for several years before possums were eradicated. Possums may compete for nest sites with hole-nesting birds, such as kiwi, parakeets and saddlebacks. Possums eat eggs, nestlings, or adults of native bird species such as kokako, kiwi, harrier, fantail, kereru, and mutton bird, with effects sufficient to drive some species into decline. Populations of native snails, particularly in infertile or heavily browsed forest where alternative possum foods are scarce, are severely damaged by possums; a single possum is capable of eating >60 *Powelliphanta* snails in a night.

Pigs (Landcare 2006d)
Despite the wide variety of adverse impacts inferred or known to have been caused by feral pigs, pigs seldom appear to be the most critical pests in native ecosystems in mainland New Zealand. Pigs were clearly the critical pest on Aorangi Island – they were the only pest and their removal resulted in recovery of the ecosystem. Similarly, recovery of the Lord Howe Island rail was achieved only after pigs were identified as the critical threat, and the efforts to protect the bird shifted from control of rats (the pest initially blamed) to control of pigs. Pigs have seriously affected a few easily digestible or otherwise vulnerable species such as the megaherbs on Auckland Island, and undoubtedly modify plants' regeneration processes in mainland ecosystems by eating fruit and some soft plant parts, and by disturbing the ground. However, their effects are generally outweighed by those of the possums, deer, or goats that are usually sympatric. Similarly, their effects on the fauna appear to usually be a minor part of the total impacts caused by the suite of introduced predators and rodents.

Loss of production resulting from pigs rooting pasture and grazing on vegetation usually eaten by sheep and cattle can be crudely measured by the resulting reduction in stocking rates. One property in North Canterbury reported a reduction of 500 stock units (SU) per annum due to pig impacts. At $65 per SU, this equates to a $32,500 loss of production for this single property. Another property reported the cost of resowing large blocks (>30 ha) after extensive damage by pigs at about $10,000 (per annum). Lamb predation is known to occur although it is poorly quantified. Historical information suggests losses of up to 50% can occur when pig numbers are high.

Feral pig populations in New Zealand often have a high prevalence of Tb infection in areas where other wildlife is infected (e.g. possums). In New Zealand prevalence of the disease in pigs from infected areas can range from 50% to 90%. Feral pigs are considered a spill over end host that contract the disease and can spread it to ferrets and possibly possums that scavenge infected pig carcasses. However, they will not maintain the disease in the absence of other wildlife vectors, especially possums. In areas with both high pig numbers and high scavenging vector populations (i.e. feral cats, ferrets) a precautionary approach of reducing pig numbers to lower the disease loading in the environment is recommended to break any co-scavenging Tb cycle in wildlife.

Goats (from Landcare 2006e)
Goats, like deer, can alter the composition of native forests by selectively killing seedlings and saplings of palatable plant species. Goats in forest habitats live partly on seedlings and saplings, partly on epicormic shoots of plants such as mahoe, and partly on trees that fall over or branches that fall from the canopy. If the latter two food sources are abundant then

all seedlings and saplings that are more palatable than canopy leaves get eaten across a wide range of goat densities. The implications of this non-linear relationship are that goats must be reduced to very low densities in forests before any benefit to under storey plants can be expected.

Goats can affect the economic well-being of landowners when allowed to reach high densities. They can compete with domestic stock, although their diet in grasslands differs from that of sheep, and under some circumstances running a few goats in poor-quality sheep pasture can improve the pasture for sheep.

On the positive side, feral goats can, under proper management, control woody weeds such as blackberry and gorse. Generally, the goats have to be mob-stocked to have any effect on the weeds and so must be fenced effectively to ensure high densities are maintained.

Rats (from Landcare 2006f)
Ship rats have had and continue to have a major impact on New Zealand's flora and fauna. They consume seeds and foliage, birds, eggs, invertebrates, snails, and lizards and have been responsible for the extinction of a number of native species. Ship rats eat seeds, fruits, flowers and other plant parts, which make up 80% (by volume) of their diet. The damage they cause is difficult to separate out from the damage caused by the suite of other rodents and herbivores also occupying their range.

The climbing ability of the ship rat allows it to easily access a broad range of bird species, preying on adults, chicks or eggs. The extent to which ship rats prey on birds was not appreciated until recently, when the use of night-time time-lapse video cameras enabled nests to be remotely monitored. Ship rats have been shown to be responsible for at least 72% of predation of North Island robins (*Petroica australis longipes*) and tomtits (*Petroica macrocephala toitoi*), at Kaharoa near Rotorua. They are the most frequently recorded predator of North Island kokako (*Callaeas cinerea wilsoni*) and kereru (*Hemiphaga novaeseelandiae*) eggs and chicks and whose populations are unable to increase without rat and possum control. In beech forest periodic irruption of ship rat numbers following red beech masting results in increased mohua (*Mohoua ochrocephala*) predation (Innes 2005 cited in Landcare 2006f).

Insects, including beetles, moths, stick insects, cicadas and especially weta, are always eaten when available. Weta and other arthropods are found in 39–76% of rat stomachs. Only in New Zealand is there a seasonal predominance of arthropods in the diet. In areas where rat control has taken place, increases in insect abundance have been observed.

From a survey of rats in the Waikato region, ship rats were found to have leptospiral infections, but the serotype (*Leptospira interrogens serotype copenhageni*) is not the common cause of leptospirosis in humans and domestic animals.

Stoats (from Landcare 2006g)
Native ground-dwelling and hole-nesting birds are particularly susceptible to predation by stoats because they have evolved few predator-avoidance behaviours. The ranges of mohua, kakariki, kokako, kiwi and kaka populations have all contracted, but in all cases human induced habitat modification and predation are thought responsible. Even in large intact forests, populations of all five taxa have declined to such low levels that further local extinctions are possible. Mohua, kakariki, and kaka nest in tree hollows up to 20 m from the ground. Stoats are agile climbers and are able to access a large proportion of nests. Because the nesting holes only have one entrance, incubating females cannot escape, and are taken along with the eggs or chicks. During years of high mouse abundance, stoat numbers may increase fivefold, but each stoat still takes the same number of birds as it would in non-mouse (low stoat) years: there is no prey-switching to mice when mice are plentiful, so native bird populations experience extraordinarily high mortality due to predation.

Stoats, rats, mice, and possums all interact and single-species control can potentially result in perverse outcomes, so it is important that before control of stoats is carried out that any risks resulting from increases in numbers of other pests is assessed.

Ferrets (from Landcare 2006h)
Ferrets are most commonly found in areas of high rabbit abundance. They are typically found in pastoral habitats including fertile pasture, rough grassland, tussock, and scrubland and the fringes of nearby forest. There is limited information on ferret distribution and densities in the Waikato region. Numbers are not known to be particularly high and the Waikato is not rabbit-prone compared to some areas of New Zealand; however, even at low densities ferrets may have important conservation impacts. Of particular note are the many remnant forest fragments scattered throughout the region; because ferrets are known to make use of habitat edges including forest margins, their presence along these habitat edges (and preference for their use) may compromise conservation and restoration of native biodiversity in these areas. Through large-scale movements, ferrets may also play a role in the spread of bovine Tb.

Few bird remains have been found in ferret diet in North Island forests, probably because few ground-nesting birds survive there and ferrets rarely climb trees. Various skink species are killed by ferrets and common skinks, *Oligosoma nigriplantare maccani*, are vulnerable to ferret predation. Several invertebrate species are probably also at risk, for example the rare robust grasshopper *Brachaspis robustus*, and weta species. Native frogs and kauri snails are also species potentially at risk from ferret predation. For the Waikato region therefore, this means that restoration efforts should take into account the potential impacts of ferrets on ground-dwelling native fauna when prioritising areas for restoration, and should plan predator (including ferret) control as part of restoration efforts.

In terms of the impacts of bovine Tb on the dairy industry in Waikato, much of Waikato is a vector free area, with areas to the south and north being vector risk areas. For the Waikato region therefore, the biggest risk would be from ferrets moving out of VRAs and into Tb-free areas. High levels of surveillance in these areas currently probably reduces this risk considerably.

European hedgehog (from Landcare 2006i)
Hedgehogs are abundant throughout lowland districts of New Zealand, but less numerous in the hills and rare in mountainous areas. They are also scarce or absent in areas with more than 250 frosty days a year, such as the upland Southern Alps and parts of the central North Island plateau, and in areas with more than 2500 mm of rain a year, such as Fiordland. Habitat use by hedgehogs is generally related to the availability of food and dry nest sites so may therefore vary with season. They are abundant on temperate lowland and farmland where frosts are few and mild, and where food is abundant. They are numerous in dairy country, where slugs and beetles are plentiful in long pasture. Lowland stream and river sides are also favoured habitats. Cities and suburbs also support dense populations of hedgehogs, because invertebrates and dry sites for hibernating (hibernacula) are available, as well as extra food purposely provided by householders. Hedgehogs are less common in dry central and upland areas where frosts are harder and there is less invertebrate food available. The lack of dry nest sites keeps hedgehogs out of rainforests, but some survive in very wet broadleaf-podocarp forest of the Ruahine, Tararua and Rimutaka ranges, and in beech forests of the South Island. Hedgehogs were common within indigenous and exotic forests in Pureora Forest Park.

There are few reliable estimates of hedgehog density for New Zealand habitats. However, in Department of Conservation trapping programmes, hedgehogs are often the most frequently trapped species. Hedgehogs are not territorial and their foraging ranges show considerable overlap.

Hedgehogs are mainly insectivorous, but will eat any animal substance and even some plant material. Diets vary depending on site and season, but beetles are important foods in most habitats. In suburban areas and lowland farms, hedgehogs eat mainly slugs, snails, and a great variety of ground insects and larvae (Brockie 1959 cited in Landcare 2006i). Earthworms are commonly eaten in pasture, but rarely in forest or drylands where weta and grasshoppers are more important. Hedgehogs also feed on mice, lizards, frogs, eggs and chicks of ground-nesting birds, and scavenge carrion, e.g. rabbit and sheep carcasses.

The effects of hedgehogs on indigenous fauna in New Zealand have not been quantified although they clearly have the potential to contribute significantly to the decline of numerous taxa including threatened ground-nesting birds. In the Mackenzie Basin between 1994 and 1999, hedgehogs removed eggs from 19% of 172 monitored banded dotterel, black stilt and black-fronted tern nests on braided river beds (Sanders & Maloney 2002). Among sand dunes at Tawharanui, hedgehogs were responsible for two of every three losses of New Zealand dotterel nests (Dowding 1998 cited in Landcare 2006i). Native reptiles and amphibians are also at risk. Remains of native skinks and/or geckoes (often multiple individuals) were found in up to 28% of hedgehog guts from Macraes Flat in Otago (M. Tocher, DOC, unpublished data cited in Landcare 2006i).

Hedgehogs also are a potentially serious threat to indigenous invertebrates, especially threatened species or those showing localised distribution (Brignall-Theyer 1998; Hamilton 1999; Jones et al. 2005; Jones and Norbury, unpublished data, cited in Landcare 2006i). The extensive harvest of invertebrates by a locally dense hedgehog population could be serious for vulnerable native fauna (e.g. kiwi) that also rely on invertebrates. The diets of hedgehogs and of North Island brown kiwi at Boundary Stream Mainland Island overlapped by 70–80% (Berry 1999b cited in Landcare 2006i). Competition from hedgehogs could limit kiwi numbers in the long term, and, because kiwi and hedgehogs nest in similar sites, hedgehogs may compete for nests, disturb incubating kiwi or even damage kiwi chicks.

There are no data describing the relationships between population densities of hedgehogs and any resulting damage to vulnerable fauna, although some of these relationships are currently being investigated by Landcare Research. In spite of this, some broad patterns can be predicted. Most damage due to hedgehog predation is likely to occur where habitats supporting high densities coincide with those containing small native terrestrial fauna. Large hedgehog populations may be maintained by relatively common invertebrate prey, including grass grubs or other “pests,” thus facilitating sustained “incidental” or opportunistic predation pressure on native fauna in the same or adjacent habitats (hedgehogs can easily cover 1–2 km per night when foraging).

The risk to native fauna posed by hedgehogs has only been recognised relatively recently. Hedgehogs have been added to the list of target species in many trapping programmes designed to protect indigenous fauna although there are no estimates of how well trapping regimes can reduce local hedgehog densities and the level of hedgehog control needed to gain any benefit has not been established. Despite this knowledge gap the inclusion of hedgehogs in vertebrate pest management associated with high value biodiversity sites is unlikely to add significant cost to operations and as such the benefits are likely to outweigh the costs.

Hunting values and social perceptions

Deer, pigs and goats are valued by recreational hunters. Fraser (2000) reports that some 12,500 hunting permits were issued in the Waikato and Tongariro/Taupō Department[96] of Conservation conservancies over a twelve month period in 1992/93. This represents approximately 20% of the total permits (63 500) issued nationally over the period. Whilst the data employed by Fraser is dated it does serve to indicate the relative importance of the region to hunters.

[96] The Waikato and Taupo/Tongariro conservancies fall largely but not entirely within Environment Waikato’s regional boundaries.

The reported harvest of animals from ‘hunter permit returns’ in the Waikato and Tongariro/Taupō conservancies for a twelve month period in 1992/1993 was 2 529 deer, 458 pigs and 3 345 goats (Fraser 2000). The harvest reported by ‘hunter permit returns’ and the level of ‘returns’ suggest that the actual harvest of deer in the Waikato and Tongariro/Taupō conservancies over the period may have been as high as 7 000 animals. Nugent (1992) suggests that recreational hunter’s non–capital expenditure for each red deer harvested in 1988 was $240, $269 for each Sika deer and $217 for each fallow deer.

The surprisingly low rate of pig harvest reported in Fraser's (2000) study highlights issues with reliance on ‘hunter permit returns’. The rate of reporting for pigs compromises the ability to assess the economic value of pig hunting. Nugent (1992) reported that the non-capital expenditure for each pig harvested was $77.28 and for goats $17.17; or 31% and 7% respectively of the expenditure associated with each deer harvested. However it should be noted that a lower cost of harvest does not necessarily mean a lower economic value, and these figures should be indicative rather than measures of benefit from hunting these species.

Whilst venison and live deer recovery has been a significant industry in some regions in the past, it has declined from its heyday in the 1970s and 1980s. The Waikato and Tongariro/Taupō conservancies do not appear to have been as important in these terms when compared with other conservancies (Fraser 2000). Commercial deer recovery is not thought to be a significant part of the Waikato economy.

In terms of the wider community a 1994 survey of public attitudes toward introduced wildlife showed that 95% of respondents considered deer as a resource or as a joint pest and resource (Fraser 2001). A similar percentage reportedly enjoyed the experience if they saw a deer in New Zealand bush or high country. Pigs and goats did not fare as well as deer in Fraser’s (2001) study. Approximately 75% of respondents viewed pigs as a resource or as a joint pest and resource whilst goats were viewed in this manner by 70% of respondents. For pigs and goats respectively, 45% and 55% of respondents enjoyed the experience when they saw these species in New Zealand bush or high country. Forty-nine percent of respondents considered that modification of New Zealand’s native forests and grasslands by larger wild animals (deer, chamois, thar, pigs and goats) was not an acceptable price for the recreational opportunities afforded by these species. Thirty two per cent considered that modification of native forests and grasslands was an acceptable price to pay, a further 19% of respondents ‘did not know’. When specifically questioned regarding deer and the farming industry it supports 44% of respondents considered that the modification of native forests and grasslands was not an acceptable trade off, whilst 42% considered the trade off acceptable, a further 13% of respondents ‘did not know’ (Fraser 2001).

The extent to which the proposed strategy may compromise the hunting values associated with deer, pigs and goats is not able to be quantified. The significance of individual catchments to hunters and threshold densities acceptable to Environment Waikato under the strategy will determine the impact of the strategy on hunting values.

Pest management strategy

No RPMS

Under this scenario some voluntary control by individuals and organisations such as the Department of Conservation is undertaken in priority catchments. There is no further spread of the targeted pests since they are already at their full extent in the Waikato region.

Changes in regional conservation values

Within the priority catchments palatable under storey species will continue to decline or be restricted to inaccessible parts of the forest as a result of browsing. A continuing loss of biodiversity is expected under the no intervention scenario with further predation of native birds and invertebrates. The degree of loss in regional conservation values will depend on the level of voluntary control, the species present and their densities.

Changes in regional economic values
Loss of vegetative cover results in reduced interception of precipitation, increased run-off velocity and quantity as well as a loss of soil strength. In a catchment that is typical of the Thames Coast (i.e. steep and susceptible to high intensity rainfall), a full canopy and under storey can result in around 30% of runoff being intercepted and/or transferred to the local groundwater table. Damage to the forest canopy and under storey is likely to reduce this level of interception, with the extreme case of a bare catchment resulting in only around 10% of runoff being intercepted and/or transferred to the local groundwater table (EW 2004a). With further ecosystem decline flood events and soil erosion may increase in magnitude and frequency causing damage to life and regional infrastructure. An example of the magnitude of the costs of such events can be gained from the Thames Coast experience where losses have been "assessed at $38 million for a 100-year event and $10.5 million for a 10-year event. In the past these costs have been met by central Government, local government and the private sector. They total an estimated $56 million in direct, indirect and intangible costs since 1981" (EW 2004b).

Under the no RPMS scenario there is an increased risk of bovine Tb becoming established in a catchment. Hunting opportunities (both recreational and commercial) are improved as deer, pig and goat populations increase to a catchment's carrying capacity.

With RPMS
With pest control as a component of an integrated catchment management approach ecosystem health will be improved, halting a decline in biodiversity and improving vegetative cover. Improved vegetative cover will assist in the amelioration of peak flows during storm events and improve soil stability.

The risk of Tb becoming established in a catchment will be reduced. Hunting opportunities (both recreational and commercial) will decline as the density of deer, pigs and goats is reduced.

It is estimated that control costs may lay in the range from $NPV_{8\%}$ $156/ha to $NPV_{8\%}$ $627/ha[97] to treat vertebrate pests individually or collectively (Table 0-1). This estimate is indicative only and assumes sufficient operational scale. Animal pest control costs associated with an integrated catchment management approach will vary significantly between catchments. Factors contributing to this variation include but are not limited to:

- species targeted and density levels
- terrain
- location
- method (aerial *vs*. ground-based)
- level of community support; and
- scale.

[97] The bottom end of the range ($NPV_{8\%}$ $156/ha) conservatively assumes that aerial control of possums and rats is the minimum intervention undertaken under an integrated catchment approach. The upper end of the range ($NPV_{8\%}$ 627/ha) assumes that all species are controlled and that management synergies allow for a 10% saving on total cost.

Table 0-1: Estimated control costs

Organism	Method of control	$NPV_{8\%}$	Annuity $/ha/annum	Notes (see Annex III)
Possum and rats	Aerial	$156.00	$12.50	Based on control costs discussed in section 14. Approximately equivalent to $33/ha repeated every three years.
Goats	Ground based	$131.00	$10.50	Year 1 $25/ha. Year 3 $20/ha. Each cost repeated at five year intervals.
Mustelids	Ground based	$112.50	$9.00	$9/ha/annum.
Pigs	Mixed aerial and ground based	$104.00	$8.30	$15/ha repeated every two years.
Deer	Mixed aerial and ground based	$193.00	$15.40	Initial knockdown $45/ha, subsequent annual control cost $12/ha/annum.

Note: The control costs given have been distilled from a range of sources; these are detailed in Annex III.

The marginal cost of controlling additional species is such that control programmes that target a combination of species may be the most cost effective method of achieving the desired outcome. Recent research by Landcare (2006b) suggests that "because the protection of biodiversity values at any one site is likely to require the effective management of multiple species, it is critical that a multiple-, rather than a single-species focus is taken. Thus, effective pest management must shift from a single-species focus to a site-based focus where the resources (assets) to be protected are identified as the first step, the threats (biotic and abiotic) to those values are identified, and then the required management action (i.e. how to optimally manage the threats) is agreed to."

Environment Waikato believes that the targeting of pests in combination will:

- best support the goals of the regional catchment strategy; and
- provide for the best ecological outcomes.

Section 72(a)

In order for the council to be satisfied that the requirements of section 72(a) have been met, the council would need to be satisfied that the values protected by the strategy for the control, collectively and individually, of the following species:

- deer
- pigs
- goats
- possums
- hedgehogs
- rats; and
- mustelids,

exceed an $NPV_{8\%}$ from $156 to $627/ha for the area treated, after taking into account the diminishment of hunting values and any reduction in risk of Tb.

It is not possible to determine the extent to which the control of each species individually contributes to the enhancement of catchment management and conservation values beyond the discussion given above.

Section 72(b)
The regional benefits of the programme arise through:

- catchment management and the protection of soil and water values
- protection of conservation and biodiversity; and the
- protection of economic well being.

If the council is satisfied that the values protected by the proposed strategy are regional values and that the requirements of section 72(a) have been met, then the requirements of section 72(b) will also have been met.

Section 72(ba)
Benefits related to economic wellbeing will accrue to the local catchment and therefore a charge against the local community to the extent that the council consider that they receive economic benefit will satisfy section 72(ba). Benefits associated with biodiversity and conservation values are regional and a charge against the regional community for these benefits will satisfy the requirements of section 72(ba).

Section 72(c)
The vertebrates identified are capable of having a significant impact on Māori cultural values, biodiversity, conservation, recreational and soil and water values as well as economic wellbeing. An RPMS in respect of this pest will therefore satisfy section 72(c) parts (i), (ii), (iii), (iv) and (v).

5.57 Wasp

Proposal
Environment Waikato proposes a strategy whereby land occupiers are required to control wasps on their property where they are causing a nuisance to other parties.

Analysis – No RPMS
Wasps have already reached the extent of their habitat in Waikato, but their densities will fluctuate from season to season largely based on weather conditions at the time of queen emergence in November. Some nuisance value will continue to accrue to individuals with associated diminishment of recreational and health values. In the last three years Environment Waikato has averaged 85 enquiries and complaints about wasps.

Analysis – RPMS
In this scenario Environment Waikato enforces control of wasps where they are causing a nuisance to neighbouring properties. This enforcement will only be possible where the location of the wasp nest is able to be clearly identified, and where only a limited number of nests are involved. In more heavily infested areas, the location and control of all wasp nests may not be technically feasible. The cost of this strategy is estimated at $14,000 per annum initially rising to $16,000 per annum for the remaining four years of the strategy. A further $45 - $80 per wasp nest destroyed cost will accrue to the land occupier. Assuming 50% of enquiries require some action, the total cost of the strategy would be a NPV of $220,000 at a discount rate of 8%.

Section 72(a)
If the council considers that the benefits of reduced distress to humans from 17 cases of wasps nuisance per annum exceeds $220,000 then the requirements of section 72(a) will have been met. This is equivalent to valuing the reduction in wasp nuisance at $400/incident resolved.

Section 72(b)
As the wasps originate on one property but in the case of complaints cause problems on neighbouring properties, the values protected by the strategy are regional values. Therefore if the proposal meets the requirements of section 72(a) it will also meet the requirements of section 72(b).

Section 72(ba)
The values protected by the strategy are largely regional values. A charge against the regional community for the strategy will therefore satisfy section 72(ba). Land occupiers on whose properties wasps exist can be considered to be contributing to the problem, and a direct charge against these parties for control costs can be justified under section 72(ba).

Cost benefit analysis summary

Two scenarios for control of wasps have been considered:

1. do nothing
2. containment control.

In the “do nothing” scenario wasps have already reached the extent of their habitat in Waikato, but their densities will fluctuate from season to season largely based on weather conditions at the time of queen emergence in November. Some nuisance value will continue to accrue to individuals with associated diminishment of recreational and health values.

In a “containment control” scenario control of wasps would be enforced where they are causing a nuisance to neighbouring properties. This enforcement will only be possible where the location of the wasp nest can be clearly identified, and where only a limited number of nests are involved. In more heavily infested areas, the location and control of all wasp nests may not be technically feasible.

The cost of this strategy is estimated at $14,000 per annum initially rising to $16,000 per annum for the remaining four years of the strategy. A further $45 - $80 per wasp nest destroyed cost will accrue to the land occupier. Assuming 50% of enquiries require some action, the total cost of the strategy would be a NPV of $220,000.

Council considers that the benefits of reduced distress to humans from 17 cases of wasps nuisance per annum exceeds $22,000 and satisfies the requirements of section 72(a). This is equivalent to valuing the reduction in wasp nuisance at $400 per incident resolved.

As the wasps originate on one property, but in the case of complaints cause problems on neighbouring properties, the values protected by the strategy are regional values. Therefore if the proposal meets the requirements of section 72(a) it will also meet the requirements of section 72(b).

6 Pests added as a result of Environment Court settlements

Three species were made pests as a result of settlements reached in response to appeals to the Environment Court: feral deer, feral pigs and *Phytophthora* taxon Agathis. Each of these is a pest only in the Hunua Ranges Pest Management Area.

To fufill the Biosecurity Act requirements for making wild deer and feral pigs “pests” in the Hunua Ranges Pest Management Area, Waikato Regional Council used information from a cost benefit analysis and assumptions report which was originally created by Auckland Regional Council to support development of its own Regional Pest Management Strategy. The material below is excerpted from that report.

After considering this information, and given that the Waikato Regional Council rules will apply only to the Hunua Ranges where Auckland Council will manage these species, Waikato Regional Council is satisfied that the benefits exceed the costs.

Auckland Council has not done a CBA for *Phytophthora* taxon Agathis (PTA). However a national CBA was prepared for the Ministry of Primary Industries as part of the Government’s decision making around whether to fund a national kauri dieback response. That full report – *Kauri dieback; Total economic valuation of kauri forest for cost benefit analysis of PTA management* – is excerpted below and was considered by Waikato Regional Council as part of its determination that the benefits of PTA management will exceed the costs.

6.1 Feral deer species (*Cervus, Axis, Dama, Odocoileus* or *Elaphurus* species)

Proposal
The Auckland Regional Council RPMS proposal for feral deer has three facets:

- Direct Control – where the ARC will fund control of feral deer in areas of high conservation value.
- Joint programme implementation – the ARC will work co-operatively with the Department of Conservation and other agencies to implement a Department of Conservation Wild Deer Control Programme within the Auckland region.
- Advice and Education - the ARC will provide advice and education on feral deer control and education issues.

Analysis
This section analyses the likely costs and benefits of the proposed approach to managing feral deer. The analysis consists of two scenarios which define the likely situation with the RPMS and without the RPMS, and a discussion of the costs and benefits of each of the scenarios. The scenarios considered are outlined below.

Analysis – No RPMS
In the absence of a RPMS it is envisaged that there will continue to be increases in the feral deer population throughout the region. Currently there are only two area within the Auckland region that have established fallow deer herds, one on the South Kaipara Peninsula and the other on the Awhitu Peninsula. Other populations are establishing from deliberate releases and from farm escapes in various parts of the region.

The Department of Conservation is establishing a Wild Deer Control Programme and have enlisted the support of the ARC.

Changes in Regional Conservation Values
Feral deer browsing removes palatable plant species. A loss of biodiversity would result if there was no intervention. Irreversible changes could eventually occur if deer were left to establish in all parts of the region.

Analysis – RPMS
Direct control, and advice and education involves the direct funding of work in key areas of the region to ensure that ecological values are protected and the general public are provided with advice and information.

The ARC supports the Department of Conservation’s Wild Deer Control Programme. The ARC has agreed to pay $30,000 per annum to help fund the DoC programme. This programme should ensure that large areas of the region that are currently deer free remain so. The benefits of controlling deer in native forest are well known. Deer grazing prohibits forest regeneration as they will eat young seedlings, and can cause localised extinctions of plants.

Section 72 (a) Analysis
Without a strategy and support for a multi-agency deer programme there would be less integration and co-ordination between agencies. This could result in the failure of the programme which would see feral deer numbers increase through illegal releases and escapes. This in turn could ultimately lead to loss of biodiversity and an increased possibility of bovine Tb transmission through feral vectors.

Section 72 (b) Analysis
The option described provides regional benefits that include increased biodiversity and the removal of a pest from clean areas of the entire region.

The proposed strategy meets the requirements for Section72 (b) as the beneficiaries from control are primarily regional benefits. As there are large areas currently free of feral deer there will be many forest ecosystems protected by maintaining their "deer free" status.

Description and Biological Capability	
Form	• Fallow deer are one of the smallest deer in New Zealand. Both sexes have long pointed ears and long tail hair. They have four main colour phases with variations of red-brown, black and white. For full description of the four deer species refer to the 2002 Proposed RPMS.
Habitat	• Most feral deer occupy a wide range of habitats at different altitudes, including indigenous and exotic forest, shrubland, grasslands, pasture etc. Local habitat use depends on the distribution of food plants and the need for shelter from bad weather or when hunted (King 1990).
Regional Distribution	• All four species of deer are present in the region – but fallow deer have the main wild populations (e.g. on the Awhitu Peninsula and South Kaipara).
Reproductive Ability	• Most female feral deer begin breeding from 1-2 years of age and produce a single fawn/year.
Competitive Ability	• No natural predators. They have adapted well to New Zealand conditions. They have strong food preferences and will selectively eat favoured plants first.
Resistance to Control	• Control occurs predominantly through recreational hunting, although DoC is developing a feral deer control programme for the region.
Current Status	• Feral deer are declared as pests in the current Regional Animal Pest Management Strategy.

Impact Evaluation				
	Current Impact (Y/N)	**Current Level Of Impact (Nil, L, M, H)**	**Potential Impact (Y/N)**	**Potential Level of Impact (Nil, L, M, H)**
Endangered Species	Y	L-M	Y	M-H
Species Diversity	Y	L-M	Y	M-H
Soil Resources	Y	?	Y	M
Water Quality	Y	?	Y	M
Human Health	N	Nil	N	Nil
Maori Culture	Y	?	Y	?
Production	?	?	Y	?
Recreation	Y	?	Y	?
International Trade	Y	?	Y	?

Notes:

1. Significant browsing impact in natural areas.
2. Known vectors of bovine TB.
3. Deer are considered a recreational resource by deer hunters.
4. Deer are defined as ‘wild animals’ under the Wild Animal Control Act 1977 which is administered by DoC, who have a number of responsibilities under the Act.

Assessment of Effects Status: Moderate to Major.

Action: Include as a pest. May be controlled as part of a site-led programme in key areas.

6.2 Feral pig (*Sus scrofa*)

Feral pig is included in the existing 2002-2007 RPMS as a Research Organism, however it is noted that control is currently undertaken in some areas as part of an integrated site-led management approach. It is proposed to include feral pig in the proposed 2007-2012 RPMS as a pest, with ARC enhancing control programmes in the Waitakere Ranges, parts of the Hunua Ranges and in other HCV sites, and leading an eradication programme on Waiheke Island. A rule is also proposed to prohibit the release of feral pigs, and feral pigs would be added to the HGCA provisions.

Meister Analysis – Section 72(1)(c)

Feral pig	***Sus scrofa***
Description and Biological Capability	
Form	Pigs are large omnivorous mammals with powerful bodies and coarse hairy coats. Their thick necks, wedge-shaped heads and mobile snouts enable them to root up the ground when feeding. Body size ranges from 1.1 – 2.2 m in total length, with a height of 1m (at the shoulder). May weigh up to 205kg. Hair colour is variable from brown to black. The body shape of the feral pigs is similar to that of domestic pigs, with a few differences that make them distinct. Feral pigs are generally thinner, have coarser hair, and longer tusks than domestic pigs.
Habitat	Can live in a wide variety of habitats including native and exotic forest, thick and extensive areas of bracken or gorse adjacent to improved farmland, regenerating scrubland and forest, river flats and tussock grassland.
Regional Distribution	Great Barrier and Waiheke Island. Scattered on mainland, including Hunua Ranges, Waitakere Ranges, Awhitu Peninsula, Tapora, Dome valley. Often illegally released to create a hunting population.
Biological Success	
Dispersal Method	Spread into many areas by pig hunters wishing to establish a hunting population. Feral pigs are very mobile animals. Adult male feral pigs (boars) may have large home ranges (not fixed in locality), generally roaming alone over an area of up to 43 square kilometres, while females (sows) range over areas smaller than 20 square kilometres.
Reproductive Ability	Feral pigs can breed from the age of 10 12 months, and usually produce one or two litters of about six to ten piglets each year. Feral pig have a 21 day oestrous cycle and a gestation period of 112 to 114 days. In New Zealand it appears that they can breed throughout the year, although mostly in spring and summer.
Competitive Ability	Wide dietary and environmental tolerances, and able to disperse large distances. Compete with a large number of native species by rooting up and destroying the litter habitat. Also feed on a number of native invertebrates and ground nesting species, as well as feeding on native and exotic plants.
Other Considerations	
Toxicity	Not applicable
Resistance to Control	Number of control methods (shooting, trapping, habitat manipulation, poisoning, exclusion fencing), however due to their wide ranges and the topography of many of the areas where they are found, control is difficult.
Current Status	Research Organism in 2002-2007 RPMS; declared as Wild animals under the Wild Animal Control Act; nominated as among 100 of the "World's Worst" invaders[98].
Impact	

[98] http://www.issg.org/database/species/search.asp?st=100ss&fr=1&sts (accessed 01-09-06)

Feral pig	***Sus scrofa***

Pigs damage forests by eating or uprooting tree seedlings as well as other plants with palatable leaves or stems, including ferns and some orchids[99]. They break open tree-fern trunks in searching for starch[100]. A secondary but very significant impact results from their consumption of the fruit of some species of invasive plants such as guava and banana passionfruit; the seeds pass through the gut and into droppings, thus spreading those weeds far more rapidly. Pigs also impact on large native invertebrates, such as earthworms, and land snails[101] many of which are threatened by destroying their habitat, and eating their eggs, juvenile growth stages, or adults. Pigs are very effective predators of both surface-and burrow-nesting seabirds. Pigs probably also eat the eggs and young of other surface-nesting seabirds such as albatrosses, shags and boobies, but adequate documentation is lacking[102].

In addition to their impact on native wildlife and native plant/animal communities, pigs adversely affect agricultural crops. They also damage planted forests by digging up young trees and eating their roots[103]. Their rooting can also cause erosion on steep country. They are also known to kill newborn lambs. They have the potential to spread diseases to other animals, both domestic and native, and are reputed to facilitate attacks on trees by the dieback disease caused by the fungus *Phytophthora cinnamomi*[104]. Can harbour the same diseases as domestic populations (e.g. brucellosis or foot and mouth), and would be a lot harder to eradicate the infection from. Also recognised as a reservoir and vector of bovine TB.

Impact Evaluation

	Current Impact (Y/N)	**Current Level of Impact (Nil, L, M, H)**	**Potential Impact (Y/N)**	**Potential Level of Impact (Nil, L, M, H)**
Endangered Species	Y	M	Y	H
Species Diversity	Y	H	Y	H
Soil Resources	Y	M	Y	H
Water Quality	Y	L	Y	M
Human Health	N	Nil	Y	L
Maori Culture	Y	M	Y	M
Production	Y	L	Y	M
Recreation	Y	L	Y	M
International Trade	N	Nil	Y	M
Assessment of Effects Status:	**Major**			

Cost Benefit Analysis – sections 72(1)(a), (b) and (c)

The proposed provisions with respect to feral pig do not restrict the sale or breeding of the species, and do not require any external parties to undertake control measures. It is therefore considered that the addition of this species to the proposed RPMS will impose little to no costs, except for costs borne by ARC in monitoring and control.

[99] Kirk (1896) cited in http://www.issg.org/database/species/ecology.asp?si=73&fr=1&sts (accessed 01-09-06)

[100] Griffin (1977) cited in http://www.issg.org/database/species/ecology.asp?si=73&fr=1&sts (accessed 01-09-06)

[101] Meads et al. (1984) and Walker, (2003) cited in http://www.issg.org/database/species/ecology.asp?si=73&fr=1&sts (accessed 01-09-06)

[102] Moors and Atkinson (1984) cited in http://www.issg.org/database/species/ecology.asp?si=73&fr=1&sts (accessed 01-09-06)

[103] McIlroy (1990) cited in http://www.issg.org/database/species/ecology.asp?si=73&fr=1&sts (accessed 01-09-06)

[104] Auld & Tisdell (1986) cited in http://www.issg.org/database/species/ecology.asp?si=73&fr=1&sts (accessed 01-09-06)

Based on existing work controlling feral pigs, ARC Biosecurity staff anticipate the ongoing cost of control to be approximately $50,000 per annum, which is similar to the amount currently spent on feral pig control. This equates to a maximum Net Present Value (NPV) of $215,606 over the five years of the strategy (8% discount rate). Council is of the opinion that the benefits of managing this species outweigh a cost of $50,000 per annum; therefore the requirements of section 72(1)(a) of the Biosecurity Act have been met.

As the proposed provisions with respect to this species does not confer any requirement to control the species, if the requirements of section 72(1)(a) are deemed to have been satisfied, then the requirements of section 72(1)(b) are also satisfied.
Exacerbators include people who distribute or release this species. Beneficiaries include the regional community and Crown, through protection of regional biodiversity values. Under section 72(1)(ba) of the Biosecurity Act, it is therefore appropriate for costs associated with monitoring and control to be met from the Biosecurity rate.

6.3 *Phytophthora* taxon Agathis

Cost Benefit Analysis for *Phytophthora* taxon Agathis in the Hunua Ranges Pest Management Area

Introduction
As part of a settlement of an appeal by Auckland Council against the proposed Regional Pest Management Plan, Waikato Regional Council intends to make *Phytophthora taxon* Agathis (PTA – the organism that causes kauri dieback) a pest in the newly created Hunua Ranges Pest Management Area.

Information in this report is presented to help council meet the requirements of section 71 of the Biosecurity Act related to cost benefit analysis.

Background
Auckland Council will be the pest management agency for the Hunua Ranges Pest Management Area and will therefore determine whether there is a need to manage PTA as a pest in that area.

Auckland Council has not done a CBA for PTA; it intends to do one for its upcoming RPMP review. However a national CBA was prepared for the Ministry of Primary Industries (MPI) as part of the Government's decision making around whether to fund a national kauri dieback response. That full report -- *Kauri dieback; Total economic valuation of kauri forest for cost benefit analysis of PTA management* – is available (WRC Docs #2997819) but is summarised here. The report was done in October 2013 by the New Zealand Institute of Economic Research (NZIER).

NZIER Executive Summary
The NZIER report looked at three options taken from a 2009 MPI business case:

- Option 1 – No co-ordinated management
- Option 2 – Co-ordinated long term management by promoting public awareness and hygiene methods
- Option 3 – Co-ordinated long term management through active management at selected sites

In brief, NZIER found that it was effectively impossible to do a detailed CBA for two reasons:

1. existing data deficiencies; and
2. the inherent difficulty of valuing something with intangible values.

NZIER noted that tourism, recreation and carbon sequestration were the <u>tangible</u> values associated with kauri forests. However, there are also many values that were "non-market" based – biodiversity, cultural heritage, etc. Typically, those non-market values are difficult to measure:

> *"The number of non-market valuation studies in New Zealand that can be related to kauri forests is very small, and new ones are costly and time-consuming. Valuing non-market effects is sometimes done using "benefit transfer", which means using results from one study in similar situations elsewhere. But studies have shown non-market value estimates from apparently similar situations can differ markedly, limiting the reliability of benefit transfer."*

NZIER concluded:

> *"If we assume the value of avoidable impact on tourism and recreation... and offset this against the cost of each intervention option, the net benefit of proceeding with the 3 options would be negative: -$7.6m for Option 1, -$16.4m for Option 2 and -$19.2m for Option 3. For the respective options to break-even in economic terms, with benefits greater than costs, the combined value of protecting the unquantifiable effects at stake – biodiversity, cultural heritage, community integrity and landscape – would need to be large enough to cancel out these negative net benefits."*

In essence, the final CBA assessment depends on whether decision makers believe the "combined value of protecting the unquantifiable" exceeds the quantifiable costs.

In its May 2014 budget release, the Government announced about $25 million to combat kauri dieback.

Applicability to the Waikato region

The analysis discussed above was done in a national context. In the Waikato, the confirmed presence of kauri dieback is relatively recent and currently confined to three known sites in the Coromandel.

Waikato Regional Council is part of a national kauri dieback response and one of our staff is seconded to that programme. The sites on the Coromandel are being managed through site specific programmes as necessary.

However, in its RPMP appeal, Auckland Council sought to make PTA a pest and therefore have access to Biosecurity Act powers – if needed -- to combat it in the Hunuas.

The relevant rule in the Hunua Ranges Pest Management Area would be:

Kauri Dieback in the Hunua Ranges Pest Management Area

The organism which causes kauri dieback *Phytophthora* taxon Agathis (or PTA) is declared a pest within the Hunua Ranges Pest Management Area with a management category of exclusion and an intermediate objective, over the lifetime of this plan, of preventing the incursion and establishment of *Phytophthora* taxon Agathis in the area. Should *Phytophthora* taxon Agathis be identified within the Hunua Ranges Pest Management Area then it will be subject to management category of sustained control with an intermediate objective, over the lifetime of this plan, of preventing the spread and minimising the adverse impacts of *Phytophthora* taxon Agathis.

<u>Plan rule 7.5.1</u>

No person shall knowingly communicate, cause to be communicated, release, or cause to be released, or otherwise spread *Phytophthora* taxon Agathis or material contaminated with *Phytophthora* taxon Agathis within the Hunua Ranges Pest Management Area.

A breach of this rule will create an offence under section 154N(19) of the Act and may result in default work under section 128 of the Act.

In practice, most of the Hunua Ranges Pest Management Area is owned by Auckland Council as part of their regional park network. If kauri dieback were found in the Hunuas, it is likely that it would be on Auckland Council land. Auckland Council's operations and management of activities within the park are already designed to prevent the incursion or, in the event Kauri dieback is found within the area, prevent the spread of the disease in any case. The next largest block of land with the area is public conservation land and DOC would be equally concerned about managing kauri dieback.

Costs associated with the rule therefore only arise from activities on private land in the area.

Under the current exclusion regime this rule could be used to stop persons knowingly spreading the disease by bringing in contaminated material (for example soil, kauri trees, or kauri tree material) from outside the area. The probability of such action, and therefore the cost of associated intervention, is considered to be low. In addition the availability of alternative uncontaminated sources for such material means that the cost of complying would likely be low. Therefore the potential costs associated with the rule (for individuals, Auckland Council and the community) are considered to be minimal.

If kauri dieback is identified within the Hunuas, then under a sustained control regime this rule could be used to stop the actions of any person knowingly spreading contaminated material within the area. Again the likelihood of such actions and the availability of alternative sources or disposal sites for material means that the associated cost of the rule are considered to be minimal.

Conclusion
Waikato Regional Council can be satisfied that the benefits of declaring kauri dieback a pest outweigh the potential costs.

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