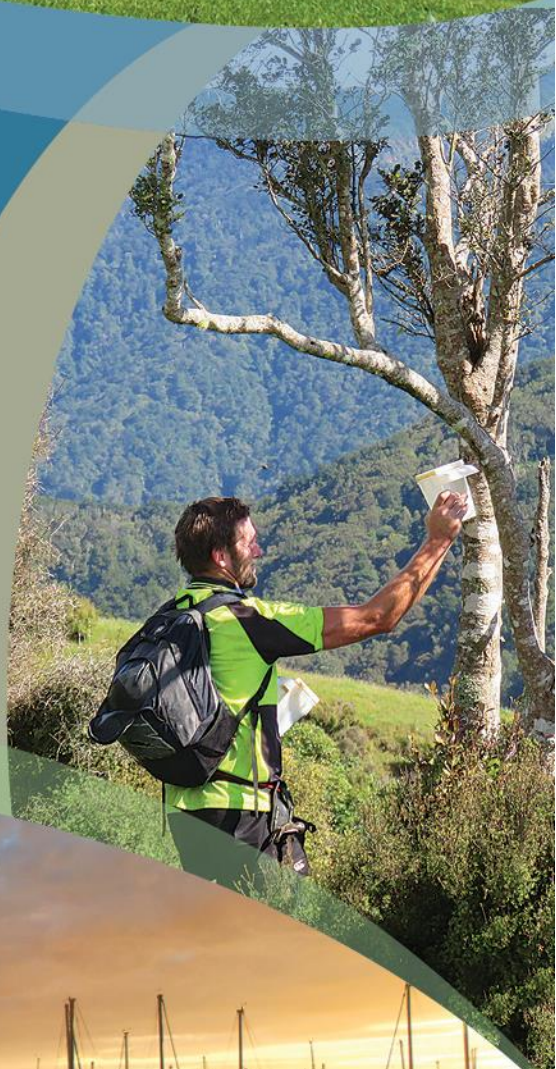
HAWKE'S BAY
REGIONAL COUNCIL

PROPOSED
REGIONAL PEST MANAGEMENT PLAN
2018-2038

COST-BENEFIT ANALYSIS AND COST ALLOCATION REPORT



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Wildlands

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INTRODUCTION

Background

Under sections 70 and 71 of the *New Zealand Biosecurity Act (1993)*, a regional council is required to be cognisant of, and evaluate and document the benefits, costs, funding arrangements and adverse effects associated with the management of pests prior to the notification of a proposed Regional Pest Management Plan (RPMP) (Appendix 1). Section 76 of the Act requires that a proposed RPMP must present the costs and benefits of each pest (76k) under different management programmes (76l).

Amendments to the Biosecurity Act in 2012 reformed the law relating to the exclusion, eradication, and effective management of pests and unwanted organisms, including:

- New policy instruments such as the *National Policy Direction for Pest Management* (NPD, finalised in August 2015*)* and pathway management plans;
- 'Good Neighbour Rules' and a requirement that the Crown comply with such rules in a regional management plan;
- Changes to the development and review process for pest management plans.

The NPD contains directions on programme objectives and terminology and specifies the requirements for analysing costs and benefits (Appendix 2).

Scope

This report assesses the impacts of pest plants and animals being considered for inclusion in a proposed RPMP for Hawke's Bay, and provides a quantitative assessment of the detrimental effects and any known beneficial effects of each pest, and a cost-benefit analysis (CBA) comparing "no regional management" to one or more proposed regional pest management programmes. The results of these assessments provide an indication of whether the benefits of the proposed regional investment in managing a pest are likely to be greater than the costs and whether the inclusion of the pest in the RPMP is justified. This assessment is required to satisfy Sections 70 and 71 of the Biosecurity Act. It also meets the requirements of section 6(1) of the NPD by conducting the cost-benefit analyses at an appropriate level in relation to the level and quality of data available and the cost of the proposed programme.

Management Options

A number of different management options are potentially available for managing adverse and unintended impacts of pests in the region:

- Exclusion
- Eradication
- Sustained Control
- Progressive Containment
- Site-led

METHODS

Overview of cost-benefit analyses

Cost-benefit analyses (CBAs) are an economic tool to estimate all relevant costs and benefits in the same currency, usually in current dollars (termed the net present value, or NPV). In this report, the cost-benefit analysis ascertains whether the benefit of each proposed pest management programme outweighs the cost.

The cost-benefit analyses are, with some modifications, based upon similar CBA exercises undertaken by regional councils. The CBAs undertaken in this report allow for the inclusion of a range of ecological values where a precise number is unknown (e.g. the potential rate of pest spread) and for the inclusion of non-production costs.

The CBA provides a monetary assessment of the benefits and costs based upon:

- The extent of the pest.
- Its preferred (and less preferred) habitats.
- The values received from the land that the pest impacts upon.
- The cost of control.

This report provides a monetary estimate of all relevant programme costs and benefits in the same currency - all future costs and benefits are 'discounted' by the amount a dollar could earn if invested now rather than spent. This is the foundation of the CBA approach; current investment made to avoid future pest impacts is considered uneconomical if the same money invested now would be worth more than the impact cost when those impacts occur.

A discount rate of 8% was used in previous cost-benefit analyses for RPMS reviews (e.g. Severinsen 2003, Auckland Regional Council 2006, Sullivan and Hutchison 2010), however we have used a 4% discount rate for the CBAs in this report, as recommended by Auckland Council, following their review of discount rates for RPMPs (Imogen Bassett pers. comm.). With an annual compounding interest rate of 8%, $1 invested today will have grown to $46.90 in 50 years. For this reason, for it to be economically sensible to spend $10,000 today on pest control to prevent impacts in 50 years' time, those impacts would need to be worth at least $469,000. By comparison, if using a discount rate of 4% (annual compounding), $1 today equals $7.11 in 50 years, so the decision to invest would depend on the pest impacts being at least $71,067. A lower discount rate gives greater weight to future costs and benefits than a higher discount rate.

Cost-benefit analysis results can give the illusion of being precise and providing robust estimates of future costs and benefits. However, there are significant data limitations in terms of how much we know about the impacts and spread of pests and the costs of their control over future decades. Because of this, there is an unknown but undoubtedly large amount of uncertainty around any CBA estimates applied to pest management.

Cost-benefit estimates are monetarised. There are, however, non-monetarised values that are relevant such as pest impacts on biodiversity, amenity and other environmental, social and cultural values. Accordingly, for environmental pests, the monetarised net benefit of regional intervention (or otherwise) is likely to be an underestimate.
For each pest species, we assessed its impacts in the region and undertook a cost-benefit analysis, comparing no coordinated regional management with one or more options under the proposed Hawke's Bay RPMP, i.e. Exclusion, Eradication, Progressive Containment, Sustained Control, or Site-led. We used data from Council staff and reviewed published information to summarise the known impacts of pest plants and animals on production values as well as environmental, social, and cultural values.

We used a modified version of the 'Harris Model' for the CBAs (see Appendix 3 for more information on the methods used and assumptions of our model)[1]. Our modifications to the Harris Model are designed to make it more flexible and less precise in its data requirements, and more capable of incorporating the diverse range of pest impacts in the Hawke's Bay Region, while retaining its robust economic foundations.

General assumptions for cost-benefit analyses

Cost-benefit analyses for pest control programmes require the adoption of a number of assumptions. These assumptions, which were generally applied to all of the proposed pest management programmes, are described below:

- When dealing with newly-established and or expanding pest populations, early action is by far the most cost effective approach even when there is inadequate knowledge of impacts (Harris and Timmins 2009).

- The economic impacts of pests scale linearly with the area of infestation e.g. twice as much area of weeds means twice as much impact on the region.

[1] Developed in 2000 by economist Simon Harris specifically for RPMS reviews.

- Costs and obligations to undertake pest control through the RPMP will only be imposed on landowners and the community in circumstances where effective control is dependent upon the Council accessing the regulatory powers [Part 6] of the Act.

Management of pests in 'defined areas'

Some proposed pest management programmes only apply to a subset of the Region. Depending on the pest, this means they will only be controlled in particular defined areas, or they will be controlled everywhere except for particular areas. For example, one of the proposed programmes assessed for the proposed Hawke's Bay RPMP was Site-led control of old man's beard (*Clematis vitalba*) in the northern part of the Region only. For such programmes, the cost-benefit calculations are restricted to the current and potential extent of the pest within the defined area (costs and benefits outside this area are not considered).

CBA duration

Ten years is the standard CBA duration for a Regional Pest Management Plan. We have also included a 50-year assessment because pests typically take many decades to reach their full extent in a region, therefore pests at early stages of their invasion will incur the majority of their impacts well beyond the standard 10-year assessment duration.

Pest attributes and distribution

A brief description of the biological characteristics of each pest species is provided, followed by a table identifying the land use/habitat types that the pest currently occupies in the Region (or defined area) and those it could potentially invade if allowed to spread.

Relevant biology

The form, preferred habitats, competitive ability, reproductive ability, resistance to control, and dispersal methods (plants only) of each pest were determined from the literature. Information on the current regional distribution of each pest was provided by Hawke's Bay Regional Council.

Land use/habitat types

The Hawke's Bay Region was categorised into 11 different land use/habitat types for the cost-benefit analyses (Table 1).

Table 1: Land use/habitat types used in the cost-benefit analyses. 'Production' land use/habitat types are highlighted in orange, 'non-production' types are highlighted in green.

LAND USE/HABITAT TYPE	DESCRIPTION
Dairy	Dairy farms
Sheep/Beef/Deer	Sheep, beef, deer, and goat farms
Horticulture	Arable cropping and orchards
Forestry	Timber producing plantations and woodlots
Aquaculture	Marine aquaculture
Urban	Cities, towns, industrial land
Native terrestrial	Native forest, shrubland, wetland vegetation, grassland
Coastal land	Beaches, sand dunes, coastal cliffs (land within *c.*50 m of coastline)
Estuarine	Harbours and estuaries (saltwater)
Freshwater	Waterways, lakes, and ponds
Marine	The ocean (within Hawke's Bay Region)

The total area of each land use/habitat type in the region (or defined area) was estimated by Hawke's Bay Regional Council. The New Zealand Land Cover Database Version 4.1 (LCDB4, Ministry for the Environment 2015) was used to estimate the area of each of the nine terrestrial land use types by assigning the relevant LCDB land cover classes to the different CBA land use types (Table 2)[1].

The total area of coastal land was estimated from the area of Sand and Gravel in LCDB4, however this is likely to be an underestimate, as we defined the coastal land use type as land within 50 metres of the coastline, including coastal cliffs. The total area of freshwater in the Region is likely to be an underestimate, as small waterways (less than 20 metres wide) and lakes (less than one hectare) were not identified in LCDB4 (due to the resolution of the satellite imagery).

[1] Several of the LCDB4 classes were not assigned to our CBA land use types because they did not correspond clearly to one land use type (i.e. Gorse and/or Broom, Gravel and Rock, Landslide, Major Shelterbelts, Mixed Exotic Shrubland, Surface Mines and Dumps). These classes cover a relatively small proportion of the region (*c.*1%).

Table 2: Total area of each CBA land use/habitat type in Hawke's Bay Region[1] and the land cover classes (from the New Zealand Land Cover Database Version 4.1, LCDB4) assigned to the nine terrestrial land use/habitat types. 'Production' land use types are highlighted in orange, 'non-production' types are highlighted in green.

LAND USE/HABITAT TYPE	AREA IN HAWKE'S BAY REGION (ha)	LAND COVER CLASS (from LCDB4)
Dairy	30,171	High Producing Exotic Grassland
SheepBeefDeer	821,815	Low Producing Grassland
Horticulture	22,081	Orchard Vineyard and Other Perennial Crops
		Short-rotation Cropland
Forestry	191,431	Deciduous Hardwoods
		Exotic Forest
		Forest - Harvested
Aquaculture	100	*
Urban	22,720	Built-up Area (settlement)
		Urban Parkland/Open Space
Native terrestrial	299,192	Alpine Grass/Herbfield
		Broadleaved Indigenous Hardwoods
		Depleted grassland
		Fernland
		Flaxland
		Indigenous Forest
		Manuka and/or Kanuka
		Matagouri or Grey Scrub
		Tall Tussock Grassland
Coastal land	1,424	Sand and Gravel
Estuarine	1,498	Estuarine Open Water
		Herbaceous Saline Vegetation
		Mangrove
Freshwater	13,935	Herbaceous Freshwater Vegetation
		Lake and Pond
		River
Marine	770,000	

* There is no aquaculture in Hawke's Bay Region at present, therefore we estimated the potential area of aquaculture in Hawke's Bay in 10 years' time.

Current and potential land use types occupied by each pest

Current Land Use Types Occupied

Land use/habitat types currently occupied by each pest were identified and each land use type in the Region (or defined area) was categorised as:

- Primary habitat for the pest (most infested currently), or
- Secondary habitat for the pest (less infested currently), or
- Not currently occupied by the pest (N.B. some land use types may be potentially suitable for the pest but have not yet been invaded).

[1] The model assumes that the area of each land use/habitat type in the region (or defined area) does not change over the duration of the CBA (i.e. the next 10-50 years).

Land use types currently occupied by each pest were determined by Hawke's Bay Regional Council.

Potential Land Use Types Occupied

Land use types potentially occupied by each pest were identified and categorised as:

- Primary habitat for the pest (most suitable/preferred), or
- Secondary habitat for the pest (less suitable/preferred), or
- Unsuitable for the pest.

Land use types potentially occupied by each pest were determined by Hawke's Bay Regional Council and reviewed by Wildland Consultants, based on information in the literature and expert opinion. If a land use type is currently categorised as a primary habitat for a pest, then it must be categorised as primary habitat for the pest in future.

An example for rooks (*Corvus frugilegus*) in Hawke's Bay is provided in Table 3.

Table 3: Current and potential land use types occupied by rooks in Hawke's Bay.
High = land use is a primary habitat for the pest (i.e. most infested/preferred),
Low = land use is a secondary habitat for the pest (i.e. less infested/preferred),
- = the pest is not currently present in that land use or the land use/habitat is unsuitable for the pest.

LAND USE/HABITAT TYPE	CURRENT INFESTATION	POTENTIAL INFESTATION
Dairy	Low	High
Sheep/Beef/Deer	Low	High
Horticulture	Low	High
Forestry	-	High
Aquaculture	-	-
Urban	Low	Low
Native terrestrial	-	-
Coastal land	Low	Low
Estuarine	-	-
Freshwater	-	Low
Marine	-	-

Current area infested

The total area (number of hectares) in the Region (or defined area) currently infested by each pest was determined by Hawke's Bay Regional Council.

In general, data for the current area infested are considered to be reasonably accurate for Eradication pests, as the distributions of these species are relatively limited and reasonably well-known, whereas accurate distribution information is often not available for the more widespread Progressive Containment, Sustained Control, and Site-led pests, in which case the current area infested has to be estimated.

For Exclusion programmes, the current area infested is always zero, as it is assumed that the pest species is not currently present in the Region (or if the proposed programme is Exclusion from a defined area, then the pest species may be present in the Region but is not present within the defined area in which the Exclusion programme applies).

For some widespread animal pests, their overall distribution/extent in the Region (or defined area) may be known but this is not an accurate measure of the number of hectares they actually impact upon as they are mobile and their densities vary. In order to estimate the current area infested for such pests, we used the following two parameters:

- Current area infested: current extent/distribution of the pest in the Region (or defined area) (i.e. total number of hectares).

- Proportion of maximum density: current proportion of the maximum density that the pest may be able to reach if uncontrolled, averaged across its entire distribution in the Region (or defined area).

Current area impacted by the pest = Current area infested (in ha) x Proportion of maximum density.

For example, feral cats (*Felis catus*) are estimated to occupy 898,212 hectares in Hawke's Bay at present, but are only estimated to be at 5.45% of the maximum density they could reach, therefore the current area impacted is estimated as follows:

Current area impacted by feral cats in Hawke's Bay = 898,212 ha $\times$ 0.0545 = 48,952.5 hectares.

Potential area infested

In order to estimate potential impacts of the pest in future we need to estimate the maximum extent (number of hectares) a pest would be capable of occupying in the Region (or defined area) in the absence of regional control.

To calculate the number of hectares potentially infested by each pest we used information on the potential land use types occupied (see Section 2.5.3). If a land use/habitat type is a primary habitat for a pest, it was assumed that the pest could potentially infest **5-25%** of the total area of that land use type in the region (or defined area). If a land use type is a secondary habitat for a pest, then that pest could potentially infest **1-4%** of the regional area of that land use type (see Table 2).

In each CBA, the area of each land use potentially infested by each pest type (in the Region or defined area) was estimated by multiplying the area of each land use type by its habitat suitability for that pest, i.e.

Potential area infested = Area of each land use type (in the region or defined area) × Habitat suitability (primary, secondary, or unsuitable)

Exclusion programmes

For pests not currently in the region (or defined area), in order to carry out the cost-benefit analysis it has been assumed that the pest arrives in the Region in the first year of the RPMP i.e. one square metre is infested in year one (0.0001 ha). Spread of the pest is then modelled in the same way as pests that are already present in the Region.

Estimation of pest spread rates

A key part of the CBA is estimating the number of years a pest will take to reach its maximum extent in the Region (or defined area). To do this, pest life forms are matched to average times to reach maximum extent from the year they are first discovered in the wild (Table 4), based on information available in the scientific literature. For pest animals, the default value was 50 years (i.e. the model assumes that it will take 50 years for a pest animal to spread into all suitable habitat in the Region).

For pest plants, each species was categorised using one of four life forms:

- Short-lived (annual and biennial) herb.
- Long-lived (perennial) herb.
- Short-lived woody plant (woody vines and shrubs).
- Long-lived woody plant (trees).

A potential spread rate (time to reach maximum extent in the region) was then assigned to each pest according to their life form (based on data for the entire naturalised flora of New Zealand, from Gatehouse 2008). Potential spread rate was then adjusted according to the dispersal ability of the species (Table 5). An uncertainty rating has not been assigned to these estimated spread rates, but uncertainty is captured in the maximum potential area a pest is expected to infest within these time frames.

Table 4: Estimated times for pests of different life forms to reach Their maximum extent in the Hawke's Bay Region from the year first found wild.

LIFE FORM	TIME TO REACH MAXIMUM EXTENT IN THE REGION
Pest animals	50 years
Short-lived herb	75 years
Long-lived herb	100 years
Short-lived woody	125 years
Long-lived woody	150 years

Table 5: Adjustment to the anticipated spread time for pest plants of different life forms based on their dispersal capabilities

DISPERSAL RATE	ADJUSTMENT
Low	-25 years
Moderate	+0 years
High	+ 25 years

Estimating the outcome of the proposed management programme

Calculation of the costs and benefits of the proposed regional management requires both estimation of costs of the proposed management and the likely effect of this management in reducing the impacts of the pest. Estimation of the likely effectiveness of the proposed management is inherently more difficult that anticipating the costs of the programme.

We follow the Harris Model in assuming that each proposed management option (i.e. Exclusion, Eradication, Progressive Containment, Sustained Control, or Site-led) will result in a linear change in the pest extent. For most programmes, the expected outcome is a reduction in the pest over the duration of the RPMP, however for some programmes (e.g. Site-led programmes) there may still be an increase in extent or density, but this is a lesser increase than would have happened without regional management.

The expected outcome of each pest management programme (i.e. proportional rate of change in the area impacted by the pest) was estimated by Hawke's Bay Regional Council staff, based on the area to be controlled each year and their experience in controlling these pests. A minimum and maximum value was estimated, to allow for uncertainty in the expected outcome (i.e. a best-case and worse-case outcome). The model uses the average of the minimum and maximum rate of change.

Impact assessment

Qualitative impact assessment

Firstly, a qualitative assessment of the impacts of each pest in the Hawke's Bay Region was completed using the available literature and information provided by Hawke's Bay Regional Council. The assessments follow the general structure of impact assessments in other previous RPMP reviews, e.g. Severinsen 2003; Auckland Regional Council 2006. For each species a broad assessment was made of their current and potential impacts on the following aspects of the Hawke's Bay Region:

- **Production**: impacts on dairy, sheep/beef/deer farming, forestry, horticulture, viticulture, aquaculture, international trade, or other production.
- **Soil resources**: causes soil loss or erosion, alters soil fertility or moisture levels.

- **Water quality**: increases siltation or sedimentation, reduces oxygenation of water, or reduces water supply.
- **Native species diversity**: impacts on the diversity, abundance, or composition of indigenous species.
- **Threatened species**: impacts on Threatened or At Risk indigenous species (according to the New Zealand Threat Classification System, Townsend *et al.* 2008).
- **Human health**: species that are poisonous or known to sting or bite.
- **Recreation**: impacts on recreation or amenity values (prevents or restricts recreational use, causes toxic algal blooms in water ways etc.).
- **Māori culture**: impacts on food gathering, hunting, tourism, or recreation, or impacts on important cultural sites (e.g. marae, urupa) or water purity (life force, mauri).

These impacts are based upon those identified in Section 71 of the Biosecurity Act and are detrimental in nature. For each pest species, the impacts were summarised and a "Low", "Moderate", or "High" impact value was assigned to each type of impact[1]. The sources of this information are referenced for each pest.

Then the different types of impacts were assigned to different land use types (Table 6). For example, if a pest has a High impact on dairy production and occurs on Dairy land, then it is assumed that the pest has a High impact on the Dairy land use/habitat type; if a pest has a Low impact on water quality and occurs in Freshwater, then it is assumed to have a Low impact on the Freshwater land use/habitat type.

Table 6: Types of impacts associated with different land use/habitat types in Hawke's Bay. 'Production' land uses are highlighted in orange, 'non-production' land uses are highlighted in green.

LAND USE/HABITAT TYPE	IMPACT TYPE (FROM QUALITATIVE IMPACT ASSESSMENT
Dairy	Dairy
Sheep/Beef/Deer	Sheep/Beef/Deer
Horticulture	Horticulture
Forestry	Forestry
Aquaculture	Marine aquaculture
Urban	Human health
Native terrestrial	Species diversity
Coastal land	Soil resources + Water quality + Recreation + Species diversity
Estuarine	Soil resources + Water quality + Species diversity
Freshwater	Water quality + Recreation + Species diversity
Marine	Species diversity

Economic values of different land use/habitat types

Annual economic values (minimum and maximum) per hectare were estimated for each of the land use/habitat types in the Hawke's Bay Region (see Table 7).

Production land use/habitat types

Economic values for Horticultural land were provided by Hawke's Bay Regional Council – these estimates were based on data available for the Pipfruit (MPI 2017) and Viticulture (Anon. 2017) industries.

Economic values for the Dairy, Sheep and Beef, Forestry, and Aquaculture land use/habitat types came from values estimated by Bay of Plenty Regional Council for the Bay of Plenty RPMP cost-benefit analyses (Wildland Consultants 2018). These values are based on the direct, indirect, and induced contribution of each sector to regional gross domestic product (GDP). Region-specific economic values for these productive sectors were not available for the

[1] Note that current impacts may be categorised as 'Low' when impacts have not actually been documented in Hawkes Bay but published information from elsewhere suggests that impacts are likely.

Hawkes Bay Region (for instance Hawkes Bay does not have any Aquaculture production at present), however we consider that the Bay of Plenty values are appropriate for the Hawkes Bay RPMP CBAs, as both regions are broadly similar in terms of these productive sectors, and the Bay of Plenty values are likely to be as accurate (or more so) than using national figures (e.g. national dairy monitoring statistics from the Ministry for Primary Industries).

Non-production land use/habitat types

The non-market valuations of the other land use/habitat types (i.e. Native terrestrial, Coastal land, Estuarine, Freshwater, Marine, and Urban) are inherently more difficult to quantify, however this is essential for evaluating the economic impacts of pest species that occur primarily in non-production lands/habitats (and the potential economic benefits for the region in managing them).

In the CBAs carried out for previous RPMP reviews, relatively conservative estimates of economic values were used for non-production lands, based on the relatively small number of relevant studies listed in Geoff Kerr's New Zealand non-market valuation database (www2.lincoln.ac.nz/nonmarketvaluation). For example, Coastal land was assigned an economic value of $10-$200/hectare per year in the CBAs carried out for the Bay of Plenty RPMS review in 2010 (Sullivan and Hutchison 2010). These non-market values were based on New Zealand studies of recreation values, existence values, and ecosystem services of natural areas. Coastal and Estuarine values were based on recreation and amenity values, which have additional economic contributions to fisheries and water purification. Freshwater values were based primarily on recreation (including tourism) but also existence values of high water quality.

Table 7: Estimated annual economic value per hectare of different land use/habitat types in the Hawke's Bay Region. Values were sourced from Bay of Plenty Regional Council Pest Management CBA and Hawke's Bay Regional Council. 'Production' land use/habitat types are highlighted in orange, 'non-production' types are highlighted in green.

LAND USE/HABITAT TYPE	ECONOMIC VALUE ($) PER HA PER ANNUM		EXPLANATION
	Min	Max	
Dairy	5,463	6,677	Average per hectare contribution to regional GDP, including direct, indirect and induced effects. Bay of Plenty average per hectare income, plus value-added in the regional economy. [1,2,3]
Sheep/Beef/Deer	739	903	Average per hectare contribution to regional GDP, including direct, indirect and induced effects. Bay of Plenty average per hectare income, plus value-added in the regional economy. [1,2,3]
Horticulture	10,511	19,760	Average per hectare income estimated using data from the 2016 Pipfruit Monitoring Programme for Hawke's Bay (MPI 2017) and 2016 Viticulture Gross Margin Benchmarking Report for Hawke's Bay (Anon. 2017). [1,4]
Forestry	1,747	2,135	Average per hectare contribution to regional GDP, including direct, indirect and induced effects. Bay of Plenty average per hectare income, plus value-added in the regional economy. [1,2,3]
Aquaculture	3,305	4,039	There is no aquaculture production in Hawke's Bay Region at present. The estimated economic values are based on potential production from aquaculture in the Bay of Plenty. [1,2,3]
Urban	533	1401	Hawke's Bay urban land values. [1,4]
Native terrestrial	556	680	Economic values for native terrestrial ecosystems were based on estimated ecosystem service values in Patterson and Cole (2013). The estimate was based on the value for 'forest' minus the value of 'raw materials' (i.e. assuming no extractive use of native forests). [3]
Coastal land	1,247	1,525	Economic values were based on estimated values in Patterson and Cole (2013). Assuming that the main economic value of sand dunes is recreation, we used the recreational values from similar ecosystems: the minimum value came from the recreational value of 'lakes' and the maximum came from the recreational value of 'rivers'. [3]
Estuarine	6,024	7,362	Based on ecosystem service values for estuaries in Patterson and Cole (2013). [3]
Freshwater	19,070	27,310	Based on ecosystem service values for freshwater ecosystems in Patterson and Cole (2013). [3]
Marine	81	99	Based on cultural and biodiversity values estimated for New Zealand continental shelf areas by van den Belt and Cole (2014). [3]

[1] Values for production land use/habitat types do not include ecosystem service values.
[2] The range for each sector estimate was defined as plus/minus 10% of the point estimate.
[3] Values provided by Bay of Plenty Regional Council.
[4] Values provided by Hawke's Bay Regional Council.

Two recent publications on the economic values of New Zealand land-based (Patterson and Cole 2013) and marine (van den Belt and Cole 2014) ecosystems have quantified the total economic values of ecosystem services i.e. supporting services, regulating services, provisioning services, cultural services, and passive values. Data in these

publications were used to estimate the economic values of non-production land use/habitat types for the Hawke's Bay RPMP CBAs.

The non-market valuations used for RPMP CBAs would benefit from further development. We are not aware of any studies that have attempted to estimate the economic values of 'non-production' land use/habitat types specifically for Hawke's Bay.

Estimating quantitative impacts

Quantitative impacts of each pest (current and potential) were estimated from the proportional impact of the pest on the economic value of each land use/habitat type in the region (or defined area) (see Appendix 3, Point 8). For example, a *low* impact on a particular land use type was calculated as a 1-4% reduction in the annual economic value per hectare of that land use type (see Table 8). The assumptions used in the CBAs were:

- **Low** impact = 1-4% reduction in annual economic value per hectare.
- **Moderate** impact = 5-9% reduction in annual economic value per hectare.
- **High** impact = 10-50% reduction in annual economic value per hectare.

For most pests, there is relatively little information on their economic impacts on different land use or habitat types. The standardised percentages we have used to quantify pest impacts are based on the limited information that is available, as well as the technical opinion of the report authors and Hawke's Bay Regional Council staff. For example, giant buttercup, which is considered to have a high impact on dairy farming, was estimated to reduce overall farm profit on a typical Golden Bay dairy farm by up to 36% (AgPest website http://agpest.co.nz/? pesttypes=giant-buttercup).

Table 8: Reduction in the annual economic value (in dollars) per hectare of land use/habitat types in the Hawke's Bay Region in relation to the level of pest impact.

LAND USE/HABITAT TYPE	REDUCTION IN ANNUAL ECONOMIC VALUE ($) PER HECTARE IN RELATION TO THE LEVEL OF PEST IMPACT					
	LOW IMPACT (1-4%)		MODERATE IMPACT (5-9%)		HIGH IMPACT (10-50%)	
	Min	Max	Min	Max	Min	Max
Dairy	54.63	267.08	273.15	600.93	546.30	3,338.50
Sheep/Beef/Deer	7.39	36.12	36.95	81.27	73.90	451.50
Horticulture	105.11	790.40	525.55	1,778.40	1,051.10	9,880.00
Forestry	17.47	85.40	87.35	192.15	174.70	1,067.50
Aquaculture	33.05	161.56	165.25	363.51	330.50	2,019.50
Urban	5.33	56.05	26.64	126.11	53.29	700.61
Native terrestrial	5.56	27.20	27.80	61.20	55.60	340.00
Coastal land	12.47	61.00	62.35	137.25	124.70	762.50
Estuarine	60.24	294.48	301.20	662.58	602.40	3,681.00
Freshwater	190.70	1,092.40	953.50	2,457.90	1,907.00	13,655.00
Marine	0.81	3.96	4.05	8.91	8.10	49.50

In order to quantify the total impact of each pest on the Hawke's Bay Region we need to know how many hectares of each land use/habitat type are infested by the pest and what level of impact the pest in having on each land use. Although it is possible for Regional Council staff to estimate the overall area currently infested by each pest in the Region (or defined area), it is much more difficult to estimate how much of the current area infested occurs in each land use/habitat type, as this requires much more accurate distributional data for each species.

Instead, data on the current and potential land use types occupied (i.e. whether a land use is a primary, secondary or unsuitable habitat for each pest) were used to estimate pest impacts on each land use type. This is not ideal but the true value is still likely to lie within the minimum and maximum range.

From the estimated impacts per land use/habitat type (Table 8), the total annual per hectare impact of a pest in the Region was calculated by weighting the impact on each land use by its relative proportion of the pest's total infestation area (across all land use/habitat types), using the following equation:

Weighted impact on each land use type = Economic value of land use × Impact level × Extent in each land use

Estimating costs and benefits

The costs of implementing each pest management programme are divided into three categories:

- Regional Council costs.
- Agency compliance costs.
- Landowner (private) compliance costs.

Regional Council costs

These are costs borne directly by Hawke's Bay Regional Council in managing the proposed programme and include costs incurred to support, undertake or provide pest control, surveillance, monitoring, research, advice and information, as well as administration and governance. The total annual expenditure by the Council on each of the proposed programmes was provided by Hawke's Bay Regional Council.

In the CBAs, if the proposed management programme results in eradication of the pest (within 50 years or less), Council costs are assumed to be $1000 per year for the subsequent 20 years after the pest is eradicated, as ongoing monitoring and surveillance will be required (if Council costs in year one are less than $1000, then the costs are the same as in year one), then after this Council costs are assumed to be zero.

Agency compliance costs

These are costs borne by agencies such as the Department of Conservation (DOC) and Land Information New Zealand (LINZ) who manage Crown-owned land in the Hawke's Bay Region. Agency compliance costs are additional costs that are incurred by agencies in order to comply with the requirements of the proposed RPMP. The total annual agency compliance costs for each pest management programme (where relevant) were estimated by Hawke's Bay Regional Council staff.

In the CBAs, agency compliance costs were included in the calculations for the first 10 years, but were not estimated for subsequent years as compliance costs are difficult to estimate beyond this period and are likely to decrease over time.

Landowner compliance costs

One of the important but difficult to quantify aspects of each CBA is estimating the cost of pest control carried out by private landowners in order to comply with the requirements of the proposed RPMP. Some pest management programmes do not incur private landowner costs; for example the costs of Exclusion and Eradication pest management programmes are normally entirely met by the Council (sometimes in conjunction with agencies). Landowner compliance costs for each pest management programme were estimated by Hawke's Bay Regional Council staff.

Benefits provided by pests

Potential economic benefits arising from each pest were identified (see the Relevant Biology table in the outputs for each pest), however the annual economic value provided by a pest to the Region was unknown for most species. Benefits were quantified only for pests for which the benefit to the Region was considered to be of moderate or greater economic value (i.e. at least $0.50/hectare per year). The annual benefit per hectare was estimated using available literature. For example, a report on the possum fur industry in Taranaki stated that the income for possum control contractors from possum fur was estimated at $3-5 per hectare (Warburton 2008).

Parameters used in the cost-benefit analyses

Discount rate: 4%

Extent Parameters

Even abundant and widespread pests do not typically occupy every hectare of available habitat in a region. Each land use/habitat type is categorised as being a primary habitat (most infested/preferred)), secondary habitat (less infested/preferred), or unsuitable for the pest. The model uses the following proportions when it estimates the number of hectares of each land use/habitat type that a pest will potentially occupy if it is not managed under the RPMP:

- Primary habitat for a pest (minimum proportion of area impacted): 0.05
- Primary habitat for a pest (maximum proportion of area impacted): 0.25
- Secondary habitat for a pest (minimum proportion of area impacted): 0.01
- Secondary habitat for a pest (maximum proportion of area impacted): 0.04

Impact Parameters

Each pest is assessed as having a Low, Moderate, or High impact on each land use/habitat type. The model interprets these categories as meaning that the pest reduces the annual economic value of that land use/habitat type per hectare (e.g. annual net production of dairy farms) by the following amounts:

LOW impact on a land use/habitat type

- Minimum proportion of value removed): 0.01
- Maximum proportion of value removed: 0.04

MODERATE impact on a land use/habitat type

- Minimum proportion of value removed): 0.05
- Maximum proportion of value removed): 0.09

HIGH impact on a land use/habitat type

- Minimum reduction in economic value by the pest: 0.1
- Maximum reduction in economic value by the pest: 0.5

Landowner (private) and Agency Costs

Private (landowner) and Agency (DOC, NZTA, LINZ) costs are not scaled according to pest impact per land use/habitat type. The costs imposed on landowners by the RPMP are applied irrespective of whether a pest has high, moderate, or low impacts on a land use/habitat type. (The alternative option, not used here, is to assume that it will be economic for landowners to already be controlling high impact pests so in these land uses an RPMP rule won't impose additional control costs on these landowners.)

EXCLUSION PESTS

MEDITERRANEAN FANWORM
Sabella spallanzanii

EXCLUSION

Relevant biology

ATTRIBUTE	DESCRIPTION
Form	Builds conspicuous leathery tubes (normally 100–500 mm, up to 1000 mm long) projecting from subtidal hard structures. From the tube it extends a spiral crown of delicate, flexible radioles (the fan), which varies in colour - most often brown/cream with black and/or white bands
Habitat	Subtidal, found attached to hard structures (e.g. rocks, boats, wharf pilings, pontoons) to approx 30 m depth. Usually in estuaries or sheltered sites. Density decreases with depth. Demonstrates clear preference for sheltered, nutrient-rich waters.
Regional distribution	Not currently present in Hawke's Bay.
Competitive ability	Very competitive - forms dense monospecific groups that competes with and excludes native species. Can reach approx. 1000 individuals per square metre.
Reproductive ability	Highly robust organisms, can regenerate from fragments (caused naturally or by trauma), resulting in reproduction by fission. Sexual maturity is at approx 50 mm body length. Very fecund - approx 50,000 eggs can be produced by a female of approx 300 mm body length. Appears to have an annual spawning cycle, gametes released in midwinter in Melbourne, Australia. Larvae can remain in the water column for 14 days.
Resistance to control	Highly resistant to control. Chemical control is difficult as *S. spallanzanii* is found subtidally. Manual search and removal is difficult as small individuals are challenging to locate amongst other fouling organisms. Despite a large search and cull effort in Lyttelton and Waitemata harbours, elimination efforts were abandoned two years after first detection.
Benefits	None

Land use/habitats occupied in Hawke's Bay

LAND USE TYPE	CURRENT INFESTATION	POTENTIAL INFESTATION
Dairy	-	-
Sheep and beef	-	-
Forestry	-	-
Horticulture	-	-
Aquaculture	-	High
Urban	-	-
Native terrestrial	-	-
Coastal land	-	-
Freshwater	-	-
Estuarine	-	-
Marine	-	High

High = Most infested/preferred land use(s), Low = Less infested/preferred land use(s), - = Unsuitable land use

Qualitative impact assessment

CATEGORY	CURRENT	POTENTIAL	COMMENT	SOURCE

Production				
Dairy	-	-		
Sheep and beef	-	-		
Forestry	-	-		1, 2, 3
Horticulture	-	-		
Aquaculture	-	H	Dense beds of Mediterranean fanworm clog recreational and commercial fishing gear. Also has negative impacts on aquaculture due to dense fouling on structures and on farmed shellfish.	
Other	-	-		
International trade	-	L	May impact volume and quality of exported seafood, e.g. oysters, mussels.	
Environment				
Soil resources	-	-		
Water quality	-	L	Mediterranean fanworm prefers waters with high nutrient levels. Thus the presence of this organism may also be an indicator of poor water quality. May displace other more effective filter feeders, resulting in a negative impact on water quality. Mediterranean fanworm excretes nitrogen in the form of ammonia, further increasing nutrient loads in the surrounding water. Also has high potential to disrupt established nutrient pathways.	3, 4
Species diversity	-	H	Major potential for Mediterranean fanworm to smother and outcompete other organisms.	1, 2, 3
Threatened species	-	L	Unknown if Mediterranean fanworm will impact threatened species (little is known about threatened species that occupy the same habitat).	1, 2, 3
Social/Cultural				
Human health	-	-	Not consumed by humans.	
Recreation	-	M	Will likely impact recreational seafood collection (e.g. mussels, oysters). Can also clog recreational scallop dredges. Will rapidly settle on and foul the hulls of recreational vessels.	1, 3
Māori culture	-	M	See Recreation. Will impact seafood collection from traditional mahinga kai areas.	

L = low, M = moderate, H = high
source 1: Read et al. (2011), 2: MPI (2016), 3: Currie et al. (2000), 4: MPI (2013)

Estimated quantitative impacts

Quantitative annual impacts per hectare are calculated as the current or anticipated proportional impact on land value across the region. All amounts are in net present value (NPV, $).

Calculation: **Economic value per land use/habitat type** × **Impact level**

Impact level
Low = 1–4% reduction in annual economic value per hectare
Moderate = 5–9% reduction in annual economic value per hectare
High = 10–50% reduction in annual economic value per hectare

Reduction in annual economic value ($) per hectare

LAND USE/HABITAT TYPE	CURRENT IMPACT PER HA	POTENTIAL IMPACT PER HA
Production		
Dairy	0	0

Sheep and beef	0	0
Forestry	0	0
Horticulture	0	0
Aquaculture	0	330.50–2,019.50
Environment/Social/Cultural		
Urban	0	0
Native terrestrial	0	0
Coastal	0	0
Freshwater	0	0
Estuarine	0	0
Marine	0	8.10–49.50

Cost-benefit analysis results

Proposed management programme: **Exclusion**

Area of Programme: **181,900 ha**

Proposed annual expenditure by Council: **$20,750**

Assumptions

ASSUMPTIONS	VALUES	ASSUMPTIONS	VALUES
Current area infested	0 ha	Time to reach maximum extent†	50 yrs
Current impacts★	$0/ha	Potential extent in the region°	27,285 ha
Current benefits	$0/ha	Discount rate	4%

★ Current annual impact of the pest averaged across all land uses currently occupied.

° The potential extent the pest is predicted to achieve in the absence of regional management.

† The time a pest is predicted to take between first going wild in the region and reaching its maximum extent.

10 year assessment

The cost-benefit analysis indicates that the benefits of the proposed management programme over the next 10 years will be of net benefit to the region.

SCENARIO	PEST IMPACTS★	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNER COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$39,936,310	$0		$0	$0	$0	
	min: 6,753,091						
	max: 205,852,408						
Exclusion	$0	$0	$39,936,310	$4,218	$4,218	$0	$39,927,874
	min: 0		min: 6,753,091		min: 4,218		min: 6,744,655
	max: 0		max: 205,852,408		max: 4,218		max: 205,843,972

★ Includes economic, environmental and social costs.

° The estimated economic benefit provided by the pest.

† Administration and implementation costs incurred by the Council through the programme.

‡ Costs of control imposed on landowners through the programme, over and above the costs already being paid by landowners, as estimated by the Council. They are applied for the 10 years of the Plan.

50 year assessment

The longer-term cost-benefit analysis indicates that the monetised benefits over the next 50 years of the proposed management programme will be of net benefit to the region. Additional non-monetised benefits associated with the protection of biodiversity values are also anticipated.

SCENARIO	PEST IMPACTS★	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNER COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$27,371,971,317	$0		$0	$0	$0	
	min: 4,619,149,304						
	max: 141,136,081,382						
Exclusion	$0	$0	$27,371,971,317	$11,171	$4,218	$0	$27,371,955,928
	min: 0		min: 4,619,149,304		min: 4,218		min: 4,619,133,915
	max: 0		max: 141,136,081,382		max: 4,218		max: 141,136,065,993

CBA statement and risks to success

Should the species remain unmanaged, it may be spread by human activities beyond the scope of normal species spread, and have a significant impact on species diversity and the marine farming industry. Attempted control of the effects of a widely expanded population would be significantly more costly than the preventative management of the current populations.

The proposed programme focusses on education and targeting high risk vessels. Not all vessels entering Hawke's Bays waters will be inspected. There is a risk that a vessel with *sabella* on its hull may go detected. International vessels entering Hawke's Bay waters are Ministry for Primary Industries responsibility.

The benefits of regional intervention, focused on excluding *Sabella* from the region, outweigh the cost and exceed the benefit of an individual's intervention.

Risks of the programme being unsuccessful in achieving objectives

RISK	LEVEL OF RISK	EXPLANATION
Technical risk	Meduim	Sabella could enter enter Hawke's Bay waters on a hull and not be detected
Operational risk	Low	
Legal risk	Low	
Socio-political risk	Low	
Other risks	Low	

Who should pay?

Beneficiaries and exacerbators

GROUP	BENEFICIARY	EXACERBATOR	CHANGE BEHAVIOUR	ASSESS COSTS & BENEFITS	CONTROL COST EFFECTIVELY
Marine Industry	Major	Major	Yes	Yes	Yes
Recreational Marine users	Major	Major	Yes	Yes	Yes
Regional community	Major	Minor	No	Yes	Yes

Who should pay for the proposed management approach?

Sabella is a major threat to production and conservation values in the Hawke's Bay marine system. Currently there is no active aquaculture being undertaken in Hawke's Bay but there are areas consented for this purpose. It is proposed that the general rate funds this programme.

CLUBBED TUNICATE
Styela clava

EXCLUSION

Relevant biology

ATTRIBUTE	DESCRIPTION
Form	Club–shaped body on a tough stalk, can reach 200 mm length. Leathery and conical, warty swellings at the top near the siphons. Short siphons are close together at the top of the body. Posterior half creased longitudinally. Colour brownish–white, yellowish–brown or reddish-brown.
Habitat	Low–tidal and sub–tidal, down to approx 25 m. Attaches to hard substrates (e.g. rocks, boats, wharf pilings, pontoons). Found in relatively sheltered environments with near–normal marine salinity.
Regional distribution	Not currently present in Hawke's Bay.
Competitive ability	Multiplies rapidly in suitable sites and competes strongly with other filter feeders for food and space. At overseas sites *S. clava* reaches densities of 500–1500 individuals per square metre.
Reproductive ability	Hermaphroditic. Reproductive for most of the year, not reproducing when water temperature is less than 15degC. Larvae are mobile in the water column for approximately 24 hours before settling on a surface.
Resistance to control	Manual removal is most effective, albeit time–consuming and labourous. Dessication and extreme temperature is also used. Chemical methods have also been attempted (high salinity, hydrated lime and acetic acid). The chemical medetomidine inhibits larval mobility.
Benefits	Consumed by humans in Korea in a dish called mideodok–chim.

Land use/habitats occupied in Hawke's Bay

LAND USE TYPE	CURRENT INFESTATION	POTENTIAL INFESTATION
Dairy	-	-
Sheep and beef	-	-
Forestry	-	-
Horticulture	-	-
Aquaculture	-	High
Urban	-	-
Native terrestrial	-	-
Coastal land	-	-
Freshwater	-	-
Estuarine	-	-
Marine	-	High

High = Most infested/preferred land use(s), Low = Less infested/preferred land use(s), - = Unsuitable land use

Qualitative impact assessment

CATEGORY	CURRENT	POTENTIAL	COMMENT	SOURCE
Production				
Dairy	-	-		
Sheep and beef	-	-		
Forestry	-	-		1
Horticulture	-	-		
Aquaculture	-	H	Clubbed tunicate is a major fouling organism on aquaculture gear and stock (e.g. oysters, mussels). This increases handling times, maintenance costs, cost of control efforts, and diminishes financial returns. May also influence the abundance and distribution of recreational fisheries. Also may alter aesthetics of local dive sites, potentially impacting tourism activities.	
Other	-	-		
International trade	-	L	May impact volume and quality of exported seafood, e.g. oysters, mussels	
Environment				
Soil resources	-	-		
Water quality	-	L	As a filter feeder, clubbed tunicate may have a positive impact on water quality. However, there may be negative impacts from displacement of other more effective filter feeders.	1
Species diversity	-	H	Has potential to form monospecific stands that outcompete native organisms for space, severely reducing biodiversity.	1
Threatened species	-	L	Unknown if clubbed tunicate will impact threatened species (little is known about threatened species that occupy the same habitat).	1
Social/Cultural				
Human health	-	L	Appears to be safe to consume. However, caution is advisable during periods of toxic algae blooms as clubbed tunicate is a filter feeder that can uptake toxins into tissues.	2
Recreation	-	M	Will likely impact recreational seafood collection (e.g. mussels, oysters). May have aesthetic impact on recreational diving. May also impact recreational vessels (increased cost of managing biofouling).	1, 2
Māori culture	-	M	See Human Health and Recreation, particularly regarding seafood collection from traditional areas.	

L = low, M = moderate, H = high
source 1: Grayling (2015), 2: NIWA (2016)

Estimated quantitative impacts

Quantitative annual impacts per hectare are calculated as the current or anticipated proportional impact on land value across the region. All amounts are in net present value (NPV, $).

Calculation: **Economic value per land use/habitat type** × **Impact level**

Impact level
Low = 1–4% reduction in annual economic value per hectare
Moderate = 5–9% reduction in annual economic value per hectare
High = 10–50% reduction in annual economic value per hectare

Reduction in annual economic value ($) per hectare

LAND USE/HABITAT TYPE	CURRENT IMPACT PER HA	POTENTIAL IMPACT PER HA
Production		
Dairy	0	0
Sheep and beef	0	0
Forestry	0	0
Horticulture	0	0
Aquaculture	0	330.50–2,019.50
Environment/Social/Cultural		
Urban	0	0
Native terrestrial	0	0
Coastal	0	0
Freshwater	0	0
Estuarine	0	0
Marine	0	8.10–49.50

Cost-benefit analysis results

Proposed management programme: **Exclusion**

Area of Programme: **181,900 ha**

Proposed annual expenditure by Council: **$20,750**

Assumptions

ASSUMPTIONS	VALUES	ASSUMPTIONS	VALUES
Current area infested	0 ha	Time to reach maximum extent†	50 yrs
Current impacts★	$0/ha	Potential extent in the region°	27,285 ha
Current benefits	$0/ha	Discount rate	4%

★ Current annual impact of the pest averaged across all land uses currently occupied.

° The potential extent the pest is predicted to achieve in the absence of regional management.

† The time a pest is predicted to take between first going wild in the region and reaching its maximum extent.

10 year assessment

The cost-benefit analysis indicates that the benefits of the proposed management programme over the next 10 years will be of net benefit to the region.

SCENARIO	PEST IMPACTS★	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNERS COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$39,936,310	$0		$0	$0	$0	
	min: 6,753,091						
	max: 205,852,408						
Exclusion	$0	$0	$39,936,310	$4,218	$4,218	$0	$39,927,874
	min: 0		min: 6,753,091		min: 4,218		min: 6,744,655
	max: 0		max: 205,852,408		max: 4,218		max: 205,843,972

★ Includes economic, environmental and social costs.

° The estimated economic benefit provided by the pest.

† Administration and implementation costs incurred by the Council through the programme.

‡ Costs of control imposed on landowners through the programme, over and above the costs already being paid by landowners, as estimated by the Council. They are applied for the 10 years of the Plan.

50 year assessment

The longer-term cost-benefit analysis indicates that the monetised benefits over the next 50 years of the proposed management programme will be of net benefit to the region. Additional non-monetised benefits associated with the protection of biodiversity values are also anticipated.

SCENARIO	PEST IMPACTS★	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNERS COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$27,371,971,317	$0		$0	$0	$0	
	min: 4,619,149,304						
	max: 141,136,081,382						
Exclusion	$0	$0	$27,371,971,317	$11,171	$4,218	$0	$27,371,955,928
	min: 0		min: 4,619,149,304		min: 4,218		min: 4,619,133,915
	max: 0		max: 141,136,081,382		max: 4,218		max: 141,136,065,993

CBA statement and risks to success

Should the species remain unmanaged, it may be spread by human activities beyond the scope of normal species spread, and have a significant impact on species diversity and the marine farming industry. Attempted control of the effects of a widely expanded population would be significantly more costly than the preventative management of the current populations.

The proposed programme focusses on education and targeting high risk vessels. Not all vessels entering Hawke's Bays waters will be inspected. There is a risk that a vessel with *styela* on its hull may go detected. International vessels entering Hawke's Bay waters are Ministry for Primary Industries responsibility.

The benefits of regional intervention, focused on excluding *Styela* from the region, outweigh the cost and exceed the benefit of an individual's intervention.

Risks of the programme being unsuccessful in achieving objectives

RISK	LEVEL OF RISK	EXPLANATION
Technical risk	Medium	Styela could enter enter Hawke's Bay waters on a hull and not be detected
Operational risk	Low	
Legal risk	Low	
Socio-political risk	Low	
Other risks	Low	

Who should pay?

Beneficiaries and exacerbators

GROUP	BENEFICIARY	EXACERBATOR	CHANGE BEHAVIOUR	ASSESS COSTS & BENEFITS	CONTROL COST EFFECTIVELY
Land occupiers (Crown and private)	Major	Major	Yes	Yes	Yes
Marine users	Major		No	Yes	Yes
Regional community	Major		No	Yes	Yes

Who should pay for the proposed management approach?

Styela is a major threat to production and conservation values in the Hawke's Bay marine system. Currently there is no active aquaculture being undertaken in Hawke's Bay but there are areas consented for this purpuse. It is proposed that the general rate funds this programme.

WALLABY
Macropus eugenii, M. parma, M. rufogriseus

EXCLUSION

Relevant biology

ATTRIBUTE	DESCRIPTION
Form	Dama wallaby (*Macropus eugenii*) stands 0.5 m high and weigh approximately 4–7 kg. Grey-brown in colour with reddish shoulders. Nocturnal.
Habitat	Prefers forested or scrubby habitat with access to pasture (bush-pasture margins), using dense vegetation for shelter and cover during the day.
Regional distribution	Not currently present in Hawke's Bay.
Competitive ability	Impacts on native vegetation by selectively browsing palatable plant species. Competes with other pastoral grazers and damages young tree crops.
Reproductive ability	Female are mature after 1 year and can produce one offspring per year (twins are rare).
Resistance to control	Controlled with poisons, trapping and shooting. No predators in New Zealand.
Benefits	Export trade in joeys and adults as pets. Some species are endangered in their native range in Australia.

Land use/habitats occupied in Hawke's Bay

LAND USE TYPE	CURRENT INFESTATION	POTENTIAL INFESTATION
Dairy	-	Low
Sheep and beef	-	High
Forestry	-	High
Horticulture	-	High
Aquaculture	-	-
Urban	-	Low
Native terrestrial	-	High
Coastal land	-	Low
Freshwater	-	-
Estuarine	-	-
Marine	-	-

High = Most infested/preferred land use(s), Low = Less infested/preferred land use(s), - = Unsuitable land use

Qualitative impact assessment

CATEGORY	CURRENT	POTENTIAL	COMMENT	SOURCE
Production				
Dairy	-	L	Grazing of pasture by wallabies can lower food availability for livestock. Potential reservoir host of bovine Tb, but no reported cases.	
Sheep and beef	-	L	Grazing of pasture by wallabies can lower food availability for livestock. Potential reservoir host of bovine Tb, but no reported cases.	
Forestry	-	M	Causes damage to newly planted radiata pine plantations.	1, 2, 3
Horticulture	-	L	May browse crops that are close to suitable cover.	
Aquaculture	-	-		
Other	-	-		
International trade	-	-	Could cause a problem if they become a reservoir host for bovine Tb.	
Environment				
Soil resources	-	M	Removal of vegetation through browsing and trampling causes erosion.	1, 2, 4
Water quality	-	M	Erosion of soil can lead to increased sedimentation in waterways.	1
Species diversity	-	H	Browses native forest seedlings and destroys understorey. Favoured species include kamahi and māhoe, also hangehange, pigeonwood, mānuka, kānuka and ferns.	2, 4
Threatened species	-	L		1, 5
Social/Cultural				
Human health	-	L	Direct transmission of bovine Tb to humans is highly unlikely, however wallaby-cattle-human transmission route is a very slight possibility.	
Recreation	-	-		
Māori culture	-	M	Can destroy ground vegetation at culturally important sites (e.g. wāhi tapu, urupa) and eat culturally important plants (e.g. koromiko).	

L = low, M = moderate, H = high

source 1: Severinsen (2003), 2: Auckland Regional Council (2004), 3: Environment Canterbury (2015), 4: Department of Conservation (2015), 5: Ritchie (2014)

Estimated quantitative impacts

Quantitative annual impacts per hectare are calculated as the current or anticipated proportional impact on land value across the region. All amounts are in net present value (NPV, $).

Calculation: **Economic value per land use/habitat type** × **Impact level**

Impact level
Low = 1–4% reduction in annual economic value per hectare
Moderate = 5–9% reduction in annual economic value per hectare
High = 10–50% reduction in annual economic value per hectare

Reduction in annual economic value ($) per hectare

LAND USE/HABITAT TYPE	CURRENT IMPACT PER HA	POTENTIAL IMPACT PER HA
Production		
Dairy	0	54.63–267.08
Sheep and beef	0	7.39–36.12
Forestry	0	87.35–192.15
Horticulture	0	105.11–790.40
Aquaculture	0	0
Environment/Social/Cultural		
Urban	0	5.33–56.05
Native terrestrial	0	55.60–340.00
Coastal	0	124.70–762.50
Freshwater	0	0
Estuarine	0	0
Marine	0	0

Cost-benefit analysis results

Proposed management programme: **Exclusion**
Area of Programme: **whole region ha**
Proposed annual expenditure by Council: **$500**

Assumptions

ASSUMPTIONS	VVALUES	ASSUMPTIONS	VALUES
Current area infested	0 ha	Time to reach maximum extent†	50 yrs
Current impacts★	$0/ha	Potential extent in the region°	201,536 ha
Current benefits	$0/ha	Discount rate	4%

★ Current annual impact of the pest averaged across all land uses currently occupied.

° The potential extent the pest is predicted to achieve in the absence of regional management.

† The time a pest is predicted to take between first going wild in the region and reaching its maximum extent.

10 year assessment

The cost-benefit analysis indicates that the benefits of the proposed management programme over the next 10 years will be of net benefit to the region.

SCENARIO	PEST IMPACTS★	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNERS COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$2,204,625,249	$0		$0	$0	$0	
	min: 484,442,517						
	max: 10,791,649,518						
Exclusion	$0	$0	$2,204,625,249	$4,218	$0	$0	$2,204,621,031
	min: 0		min: 484,442,517				min: 484,438,299
	max: 0		max: 10,791,649,518				max: 10,791,645,300

★ Includes economic, environmental and social costs.

° The estimated economic benefit provided by the pest.

† Administration and implementation costs incurred by the Council through the programme.

‡ Costs of control imposed on landowners through the programme, over and above the costs already being paid by landowners, as estimated by the Council. They are applied for the 10 years of the Plan.

50 year assessment

The longer-term cost-benefit analysis indicates that the monetised benefits over the next 50 years of the proposed management programme will be of net benefit to the region. Additional non-monetised benefits associated with the protection of biodiversity values are also anticipated.

SCENARIO	PEST IMPACTS★	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNERS COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$1.512067e+12	$0		$0	$0	$0	
	min: 332,199,360,372						
	max: 7.401881e+12						
Exclusion	$0	$0	$1.512067e+12	$11,171	$0	$0	$1.512067e+12
	min: 0		min: 332,199,360,372				min: 332,199,349,201
	max: 0		max: 7.401881e+12				max: 7.401881e+12

CBA statement and risks to success

There is a risk of intentional liberations of wallaby, despite regulations to prevent it. Having the options through rules in the Plan to be able to respond rapidly to intentional or feral incursions is a valuable tool to ensure wallaby populations never reach economically or environmentally harmful levels. While the benefits are difficult to estimate, based on the pest management concerns of other regional councils that have wallaby, some form of future control would be desired, either regulated or voluntary. The costs for these controls will be far in excess of the cost of the exclusion programme.

The plan is more appropriate than relying on voluntary action because there is likely to be a delay between the arrival of wallaby and action before the obvious effects of this pest is felt, by which time these species will be harder to eradicate. The benefits of regional intervention, focused on excluding wallabies from the region, outweigh the cost of the programme.

Risks of the programme being unsuccessful in achieving objectives

RISK	LEVEL OF RISK	EXPLANATION
Technical risk	Low	
Operational risk	Low	
Legal risk	Low	
Socio-political risk	Low	
Other risks	Low	No unintended adverse effects identified

Who should pay?

Beneficiaries and exacerbators

GROUP	BENEFICIARY	EXACERBATOR	CHANGE BEHAVIOUR	ASSESS COSTS & BENEFITS
Land occupiers (Crown and private)	Major	Minor	Yes	Yes
Regional community	Major	Minor	Yes	Yes

Who should pay for the proposed management approach?

There are shared benefits, with both land occupiers and the regional community being beneficiaries of the proposed programme. The cost of the Exclusion programmes is minimal, with the general community benefiting more than individual land occupiers. It is proposed that exclusion programmes will be funded through the general rate.

ALLIGATOR WEED
Alternanthera philoxeroides

EXCLUSION

Relevant biology

Attribute	Description
Form	A floating aquatic, but sometimes terrestrial, perennial herb. Stems are green-brown, hollow and rooting at nodes. Leaves are obovate to narrow-elliptical.
Habitat	Still water to 1.5 m deep, or flowing fresh water. Tolerates up to 30% sea water. Will grow on moist banks, swampy places, damp pasture and cropping land.
Regional distribution	Not currently present in Hawke's Bay.
Competitive ability	Floating mats shade out other plants. Biomass doubles in 50 days. Will out-compete pasture species.
Reproductive ability	No viable seeds are produced.
Dispersal methods	Fragments dispersed by cultivation machinery, as weeds or contaminants of aquatic plant trade.
Resistance to control	Effective control is difficult, even in small waterways, swampy pastures and cropping land. Use of herbicide in and beside waterways makes control difficult.
Benefits	None

Land use/habitats occupied in Hawke's Bay

LAND USE TYPE	CURRENT INFESTATION	POTENTIAL INFESTATION
Dairy	-	High
Sheep and beef	-	High
Forestry	-	Low
Horticulture	-	Low
Aquaculture	-	-
Urban	-	High
Native terrestrial	-	High
Coastal land	-	High
Freshwater	-	High
Estuarine	-	-
Marine	-	-

High = Most infested/preferred land use(s), Low = Less infested/preferred land use(s), - = Unsuitable land use

Qualitative impact assessment

CATEGORY	CURRENT	POTENTIAL	COMMENT	SOURCE
Production				
Dairy	-	L	Can spread through wetlands and waterways. Causes photosensitivity in stock.	
Sheep and beef	-	M	Can spread through wetlands and waterways. Causes photosensitivity in stock.	
Forestry	-	-		1, 2, 3
Horticulture	-	M	Can spread from waterways onto cropping land, out-competes other species.	
Aquaculture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	L	Causes silt accumulation, obstructs water usage, causes flooding. Rotting vegetation degrades habitat for aquatic fauna and flora.	1
Species diversity	-	H	Replaces most other herbaceous species on water and dry land. Causes silt accumulation, obstructs water usage, causes flooding. Rotting vegetation degrades habitat for aquatic fauna and flora.	1
Threatened species	-	H	Replaces most other herbaceous species on water and dry land. Causes silt accumulation, obstructs water usage, causes flooding. Rotting vegetation degrades habitat for aquatic fauna and flora.	1
Social/Cultural				
Human health	-	L		
Recreation	-	M	Obstructs access to waterways for fishing, swimming, kayaking etc.	4
Māori culture	-	H	Could invade culturally important sites (e.g. wāhi tapu, urupa).	

L = low, M = moderate, H = high

source 1: Craw (2000), 2: Roy et al. (2004), 3: Environment Bay of Plenty (2004a), 4: Severinsen (2003)

Estimated quantitative impacts

Quantitative annual impacts per hectare are calculated as the current or anticipated proportional impact on land value across the region. All amounts are in net present value (NPV, $).

Calculation: **Economic value per land use/habitat type** × **Impact level**

Impact level

Low = 1–4% reduction in annual economic value per hectare

Moderate = 5–9% reduction in annual economic value per hectare

High = 10–50% reduction in annual economic value per hectare

Reduction in annual economic value ($) per hectare

LAND USE/HABITAT TYPE	CURRENT IMPACT PER HA	POTENTIAL IMPACT PER HA
Production		
Dairy	0	54.63–267.08
Sheep and beef	0	36.95–81.27
Forestry	0	0
Horticulture	0	525.55–1,778.40
Aquaculture	0	0
Environment/Social/Cultural		
Urban	0	5.33–56.05
Native terrestrial	0	55.60–340.00
Coastal	0	124.70–762.50
Freshwater	0	1,907.00–13,655.00
Estuarine	0	0
Marine	0	0

Cost-benefit analysis results

Proposed management programme: **Exclusion**

Area of Programme: **whole region ha**

Proposed annual expenditure by Council: **$500**

Assumptions

ASSUMPTIONS	VALUES	ASSUMPTIONS	VALUES
Current area infested	0 ha	Time to reach maximum extent †	75 yrs
Current impacts ★	$0/ha	Potential extent in the region °	183,726 ha
Current benefits	$0/ha	Discount rate	4%

★ Current annual impact of the pest averaged across all land uses currently occupied.

° The potential extent the pest is predicted to achieve in the absence of regional management.

† The time a pest is predicted to take between first going wild in the region and reaching its maximum extent.

10 year assessment

The cost-benefit analysis indicates that the benefits of the proposed management programme over the next 10 years will be of net benefit to the region.

SCENARIO	PEST IMPACTS ★	PEST VALUES °	BENEFIT	COUNCIL COSTS †	LANDOWNERS COMPLIANCE COSTS ‡	AGENCY COMPLIANCE COSTS ‡	NET BENEFIT
No intervention	$1,523,503,758	$0		$0	$0	$0	
	min: 308,897,338						
	max: 7,554,434,956						
Exclusion	$0	$0	$1,523,503,758	$4,218	$0	$0	$1,523,499,540
	min: 0		min: 308,897,338				min: 308,893,120
	max: 0		max: 7,554,434,956				max: 7,554,430,738

★ Includes economic, environmental and social costs.

° The estimated economic benefit provided by the pest.

† Administration and implementation costs incurred by the Council through the programme.

‡ Costs of control imposed on landowners through the programme, over and above the costs already being paid by landowners, as estimated by the Council. They are applied for the 10 years of the Plan.

50 year assessment

The longer-term cost-benefit analysis indicates that the monetised benefits over the next 50 years of the proposed management programme will be of net benefit to the region. Additional non-monetised benefits associated with the protection of biodiversity values are also anticipated.

SCENARIO	PEST IMPACTS★	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNERS COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$1.473707e+12	$0		$0	$0	$0	
	min: 298,753,622,110						
	max: 7.307749e+12						
Exclusion	$0	$0	$1.473707e+12	$11,171	$0	$0	$1.473707e+12
	min: 0		min: 298,753,622,110				min: 298,753,610,939
	max: 0		max: 7.307749e+12				max: 7.307749e+12

CBA statement and risks to success

Alligator weed is considered highly invasive and as shown in the above 10 and 50 year assessment, it could have significant negative impacts on our region if it were to establish. It is however, difficult to detect at low densities and can be moved unknowingly into the region through dirty items such as machinery.

The principal means of delivering this programme is through education and active surveillance. Because these pests are declared under the Plan, occupiers are obliged to inform Council of the presence of them, and they are banned from sale and distribution. The benefits of regional intervention, focused on excluding alligator weed from the region, outweigh the cost of the programme.

Risks of the programme being unsuccessful in achieving objectives

RISK	LEVEL OF RISK	EXPLANATION
Technical risk	Low	
Operational risk	Low	
Legal risk	Low	
Socio-political risk	Low	
Other risks	Low	

Who should pay?

Beneficiaries and exacerbators

GROUP	BENEFICIARY	EXACERBATOR	CHANGE BEHAVIOUR	ASSESS COSTS & BENEFITS
Land occupiers (Crown and private)	Major	Major	Yes	Yes
Pond owners…	Major		No	Yes
Regional community	Major		No	Yes

Who should pay for the proposed management approach?

There are shared benefits, with both land occupiers and the regional community being beneficiaries of the proposed programme. The cost of the Exclusion programmes is minimal, with the general community benefiting more than individual land occupiers. It is proposed that exclusion programmes will be funded through the general rate.

MARSHWORT
Nymphoides geminata

EXCLUSION

Relevant biology

ATTRIBUTE	DESCRIPTION
Form	Aquatic perennial with branched stolons up to 1 m long usually just below surface and rounded, floating leaves with V-shaped sinus.
Habitat	Still water of swamps to fast flowing freshwater streams, lake margins and small ponds.
Regional distribution	Not currently present in Hawke's Bay.
Competitive ability	Spreads quickly and out-competes native aquatic plants.
Reproductive ability	No viable seed produced in New Zealand.
Dispersal methods	Spreads by branched runners, if a leaf is broken off a new plant will grow. Spread most commonly through accidental or purposeful human intervention.
Resistance to control	No known suitable herbicide, can be controlled with weed mat for aquatic plants.
Benefits	None

Land use/habitats occupied in Hawke's Bay

Land use type	Current infestation	Potential infestation
Dairy	-	-
Sheep and beef	-	-
Forestry	-	-
Horticulture	-	-
Aquaculture	-	-
Urban	-	-
Native terrestrial	-	-
Coastal land	-	-
Freshwater	-	High
Estuarine	-	-
Marine	-	-

High = Most infested/preferred land use(s), Low = Less infested/preferred land use(s), - = Unsuitable land use

Qualltative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-		
Sheep and beef	-	-		
Forestry	-	-		
Horticulture	-	-		
Aquaculture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	M	Dense mats deoxygenate water.	1, 2
Species diversity	-	M	Spreads quickly, forms dense mats of floating leaves, out-competes native aquatic plants. Deoxygenates water killing flora and fauna.	1, 2
Threatened species	-	L	See Species diversity.	1, 2
Social/Cultural				
Human health	-	-		
Recreation	-	M	Dense mats restrict access to waterways for fishing, swimming, kayaking etc.	1, 2
Māori culture	-	M	See Recreation.	

L = low, M = moderate, H = high
source 1: Anon. (2007b), 2: Clayton & Tanner (1985)

Estimated quantitative impacts

Quantitative annual impacts per hectare are calculated as the current or anticipated proportional impact on land value across the region. All amounts are in net present value (NPV, $).

Calculation: **Economic value per land use/habitat type** × **Impact level**

Impact level
Low = 1–4% reduction in annual economic value per hectare
Moderate = 5–9% reduction in annual economic value per hectare
High = 10–50% reduction in annual economic value per hectare

Reduction in annual economic value ($) per hectare

LAND USE/HABITAT TYPE	CURRENT IMPACT PER HA	POTENTIAL IMPACT PER HA
Production		
Dairy	0	0
Sheep and beef	0	0
Forestry	0	0
Horticulture	0	0
Aquaculture	0	0
Environment/Social/Cultural		
Urban	0	0
Native terrestrial	0	0
Coastal	0	0
Freshwater	0	953.50–2,457.90
Estuarine	0	0
Marine	0	0

Cost-benefit analysis results

Proposed management programme: **Exclusion**

Area of Programme: **whole region ha**

Proposed annual expenditure by Council: **$500**

Assumptions

ASSUMPTIONS	VALUES	ASSUMPTIONS	VALUES
Current area infested	0 ha	Time to reach maximum extent†	100 yrs
Current impacts★	$0/ha	Potential extent in the region°	2,090 ha
Current benefits	$0/ha	Discount rate	4%

★ Current annual impact of the pest averaged across all land uses currently occupied.

° The potential extent the pest is predicted to achieve in the absence of regional management.

† The time a pest is predicted to take between first going wild in the region and reaching its maximum extent.

10 year assessment

The cost-benefit analysis indicates that the benefits of the proposed management programme over the next 10 years will be of net benefit to the region.

SCENARIO	PEST IMPACTS★	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNERS COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$27,046,633	$0		$0	$0	$0	
	min: 9,071,857						
	max: 116,920,511						
Exclusion	$0	$0	$27,046,633	$4,218	$0	$0	$27,042,415
	min: 0		min: 9,071,857				min: 9,067,639
	max: 0		max: 116,920,511				max: 116,916,293

★ Includes economic, environmental and social costs.

° The estimated economic benefit provided by the pest.

† Administration and implementation costs incurred by the Council through the programme.

‡ Costs of control imposed on landowners through the programme, over and above the costs already being paid by landowners, as estimated by the Council. They are applied for the 10 years of the Plan.

50 year assessment

The longer-term cost-benefit analysis indicates that the monetised benefits over the next 50 years of the proposed management programme will be of net benefit to the region. Additional non-monetised benefits associated with the protection of biodiversity values are also anticipated.

SCENARIO	PEST IMPACTS★	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNERS COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$15,228,442,221	$0		$0	$0	$0	
	min: 5,107,698,831						
	max: 65,832,159,175						
Exclusion	$0	$0	$15,228,442,221	$11,171	$0	$0	$15,228,431,050
	min: 0		min: 5,107,698,831				min: 5,107,687,660
	max: 0		max: 65,832,159,175				max: 65,832,148,004

CBA statement and risks to success

Marshwort is present in other North Island regions and poses a risk of being introduced to Hawke's Bay. Biodiversity values would be impacted if marshwort was discovered and no regional intervention was undertaken. An exclusion programme is the only appropriate option available.

The principal means of delivering this programme is through education and active surveillance. Because these pests are declared under the Plan, occupiers are obliged to inform Council of the presence of them, and they are banned from sale and distribution.

The benefits of regional intervention, focused on excluding marshwort from the region, outweigh the cost of the programme.

Risks of the programme being unsuccessful in achieving objectives

RISK	LEVEL OF RISK	EXPLANATION
Technical risk	Low	
Operational risk	Low	
Legal risk	Low	
Socio-political risk	Low	
Other risks	Low	

Who should pay?

Beneficiaries and exacerbators

GROUP	BENEFICIARY	EXACERBATOR	CHANGE BEHAVIOUR	ASSESS COSTS & BENEFITS
Land occupiers (Crown and private)	Major	Major	Yes	Yes
Dairy/sheep and beef sector	Major		No	Yes
Regional community	Major		No	Yes

Who should pay for the proposed management approach?

There are shared benefits, with both land occupiers and the regional community being beneficiaries of the proposed programme. The cost of the Exclusion programmes is minimal, with the general community benefiting more than individual land occupiers. It is proposed that exclusion programmes will be funded through the general rate.

NOOGOORA BUR
Xanthium strumarium

EXCLUSION

Relevant biology

ATTRIBUTE	DESCRIPTION
Form	Erect, annual herb less than 1m high. Stems have purple blotches, covered in short, upward pointing hairs. Roughly textured, dark green leaves have minute bristles, hairs and prominent veins. Inconspicuous flowers (Jan–Mar) clustered at ends of branches. Hard, brown, woody burs with numerous spikes and hooks each contain two seeds.
Habitat	Pasture, open areas, roadsides. Prefers warm conditions on disturbed and fertile soil.
Regional distribution	Not currently present in Hawke's Bay.
Competitive ability	Highly competitive with an extensive root system and rapid growth rate. Can form dense patches in pastures and crops and exclude all other ground species.
Reproductive ability	Brown burs each contain two seeds.
Dispersal methods	Seed dispersed by clinging to wool, fur, clothing and machinery. Also in agricultural seeds and gravel. Air pockets on spines of burs aids dispersal by water.
Resistance to control	Mechanical control is effective but plants must be treated before any burs are formed to ensure seeding is prevented. Otherwise control must continue for at least 6 years.
Benefits	None

Land use/habitats occupied in Hawke's Bay

LAND USE TYPE	CURRENT INFESTATION	POTENTIAL INFESTATION
Dairy	-	Low
Sheep and beef	-	Low
Forestry	-	-
Horticulture	-	High
Aquaculture	-	-
Urban	-	Low
Native terrestrial	-	-
Coastal land	-	Low
Freshwater	-	-
Estuarine	-	-
Marine	-	-

High = Most infested/preferred land use(s), Low = Less infested/preferred land use(s), - = Unsuitable land use

Qualitative impact assessment

CATEGORY	CURRENT	POTENTIAL	COMMENT	SOURCE
Production				
Dairy	-	M	Foliage on young plants and seeds are toxic to cattle. Competes with pasture species.	
Sheep and beef	-	M	Foliage on young plants and seeds are toxic to stock, particularly cattle. Competes with pasture species. Burs contaminate wool.	
Forestry	-	-		1, 2, 3, 4
Horticulture	-	H	Competes with crops and can carry fungal diseases capable of infecting other plants.	
Aquaculture	-	-		
Other	-	-	Foliage on young plants and seeds are toxic to pigs.	
International trade	-	M	Can contaminate wool and crops.	1, 2, 3, 4
Environment				
Soil resources	-	L	Excludes other ground-cover plants and may leave areas of soil exposed to erosion after it dies back in autumn.	
Water quality	-	-		
Species diversity	-	-		
Threatened species	-	-		
Social/Cultural				
Human health	-	M	Prickly, poisonous, can cause allergic skin reaction. Pollen may cause hay fever.	2, 3, 5, 6
Recreation	-	L	Has prickly spines, could restrict access in coastal areas.	2, 5
Māori culture	-	L	Could obstruct access to cultural sites in coastal areas (e.g. waahi tapu, urupa).	

L = low, M = moderate, H = high

source 1: AQIS (2009), 2: Anon. (2009b), 3: Anon. (2005), 4: ARC (2009), 5: Fischer et al. (1988), 6: Anon. (2009e)

Estimated quantitative impacts

Quantitative annual impacts per hectare are calculated as the current or anticipated proportional impact on land value across the region. All amounts are in net present value (NPV, $).

Calculation: **Economic value per land use/habitat type** × **Impact level**

Impact level
Low = 1–4% reduction in annual economic value per hectare
Moderate = 5–9% reduction in annual economic value per hectare
High = 10–50% reduction in annual economic value per hectare

Reduction in annual economic value ($) per hectare

LAND USE/HABITAT TYPE	CURRENT IMPACT PER HA	POTENTIAL IMPACT PER HA
Production		
Dairy	0	273.15–600.93
Sheep and beef	0	36.95–81.27
Forestry	0	0
Horticulture	0	1,051.10–9,880.00
Aquaculture	0	0
Environment/Social/Cultural		
Urban	0	26.64–126.11
Native terrestrial	0	0
Coastal	0	12.47–61.00
Freshwater	0	0
Estuarine	0	0
Marine	0	0

Cost-benefit analysis results

Proposed management programme: **Exclusion**
Area of Programme: **whole region ha**
Proposed annual expenditure by Council: **$500**

Assumptions

ASSUMPTIONS	VALUES	ASSUMPTIONS	VALUES
Current area infested	0 ha	Time to reach maximum extent†	50 yrs
Current impacts★	$0/ha	Potential extent in the region°	25,215 ha
Current benefits	$0/ha	Discount rate	4%

★ Current annual impact of the pest averaged across all land uses currently occupied.

° The potential extent the pest is predicted to achieve in the absence of regional management.

† The time a pest is predicted to take between first going wild in the region and reaching its maximum extent.

10 year assessment

The cost-benefit analysis indicates that the benefits of the proposed management programme over the next 10 years will be of net benefit to the region.

SCENARIO	PEST IMPACTS★	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNERS COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$6,025,871,456	$0		$0	$0	$0	
	min: 831,875,732						
	max: 27,383,118,985						
Exclusion	$0	$0	$6,025,871,456	$4,218	$0	$0	$6,025,867,238
	min: 0		min: 831,875,732				min: 831,871,514
	max: 0		max: 27,383,118,985				max: 27,383,114,767

★ Includes economic, environmental and social costs.

° The estimated economic benefit provided by the pest.

† Administration and implementation costs incurred by the Council through the programme.

‡ Costs of control imposed on landowners through the programme, over and above the costs already being paid by landowners, as estimated by the Council. They are applied for the 10 years of the Plan.

50 year assessment

The longer-term cost-benefit analysis indicates that the monetised benefits over the next 50 years of the proposed management programme will be of net benefit to the region. Additional non-monetised benefits associated with the protection of biodiversity values are also anticipated.

SCENARIO	PEST IMPACTS★	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNERS COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$4.133329e+12	$0		$0	$0	$0	
	min: 570,597,918,290						
	max: 1.878296e+13						
Exclusion	$0	$0	$4.133329e+12	$11,171	$0	$0	$4.133329e+12
	min: 0		min: 570,597,918,290				min: 570,597,907,119
	max: 0		max: 1.878296e+13				max: 1.878296e+13

CBA statement and risks to success

Under no regional intervention there would be unacceptable loss of production values if this pest established in the region. Some residual effects would also occur on horticultural and biodiversity values. There would also be political risks to Council of doing nothing as the effects of this plant are widely known among arable farmers. Noogoora bur is present in other North Island regions and poses a risk of being introduced to Hawke's Bay.

The principal means of delivering this programme is through education and active surveillance. Because these pests are declared under the Plan, occupiers are obliged to inform Council of the presence of them, and they are banned from sale and distribution.

The benefits of regional intervention, focused on excluding noogoora bur from the region, outweigh the cost of the programme.

Risks of the programme being unsuccessful in achieving objectives

RISK	LEVEL OF RISK	EXPLANATION
Technical risk	Low	
Operational risk	Low	
Legal risk	Low	
Socio-political risk	Low	
Other risks	Low	

Who should pay?

Beneficiaries and exacerbators

GROUP	BENEFICIARY	EXACERBATOR	CHANGE BEHAVIOUR	ASSESS COSTS & BENEFITS
Land occupiers (Crown and private)	Major	Major	Yes	Yes
Arable farmers	Major		No	Yes
Regional community	Major		No	Yes

Who should pay for the proposed management approach?

There are shared benefits, with both land occupiers and the regional community being beneficiaries of the proposed programme. The cost of the Exclusion programmes is minimal, with the general community benefiting more than individual land occupiers. It is proposed that exclusion programmes will be funded through the general rate.

SENEGAL TEA
Gymnocoronis spilanthoides

EXCLUSION

Relevant biology

ATTRIBUTE	DESCRIPTION
Form	Mat forming perennial aquatic herb with scrambling, floating stems, which produce roots at nodes. Stems erect when flowering to 1.5 m tall.
Habitat	Wet marshy soils often spreading out from water margins to form a floating mat.
Regional distribution	Not currently present in Hawke's Bay.
Competitive ability	Dominates shorter herbaceous vegetation and floating mats shade out submerged species.
Reproductive ability	Few seeds are produced in New Zealand, however seeds are highly fertile.
Dispersal methods	Spreads by stem fragmentation, humans and machinery. Seeds dispersed by water movement.
Resistance to control	Mechanical control unsuccessful as it spreads fragments of the plant. Can be controlled with herbicides.
Benefits	None

Land use/habitats occupied in Hawke's Bay

LAND USE TYPE	CURRENT INFESTATION	POTENTIAL INFESTATION
Dairy	-	-
Sheep and beef	-	-
Forestry	-	-
Horticulture	-	-
Aquaculture	-	-
Urban	-	-
Native terrestrial	-	-
Coastal land	-	-
Freshwater	-	High
Estuarine	-	-
Marine	-	-

High = Most infested/preferred land use(s), Low = Less infested/preferred land use(s), - = Unsuitable land use

Qualitative impact assessment

CATEGORY	CURRENT	POTENTIAL	COMMENT	SOURCE
Production				
Dairy	-	-		
Sheep and beef	-	-		
Forestry	-	-		1
Horticulture	-	-		
Aquaculture	-	-		
Other	-	L	Blocks up water channels, which could affect irrigation.	
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	M	Blocks up waterways and drainage channels, can exacerbate flooding.	1, 2, 3
Species diversity	-	H	Dominates shorter vegetation, and floating mats shade out submerged species.	1, 2, 3
Threatened species	-	H	Could threaten some indigenous wetland species.	1, 2, 3
Social/Cultural				
Human health	-	-		
Recreation	-	M	Dense mats restrict access to waterways for fishing, swimming, kayaking etc.	1, 3
Māori culture	-	M	See Recreation.	

L = low, M = moderate, H = high

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

Estimated quantitative impacts

Quantitative annual impacts per hectare are calculated as the current or anticipated proportional impact on land value across the region. All amounts are in net present value (NPV, $).

Calculation: **Economic value per land use/habitat type** × **Impact level**

Impact level
Low = 1–4% reduction in annual economic value per hectare
Moderate = 5–9% reduction in annual economic value per hectare
High = 10–50% reduction in annual economic value per hectare

Reduction in annual economic value ($) per hectare

LAND USE/HABITAT TYPE	CURRENT IMPACT PER HA	POTENTIAL IMPACT PER HA
Production		
Dairy	0	0
Sheep and beef	0	0
Forestry	0	0
Horticulture	0	0
Aquaculture	0	0
Environment/Social/Cultural		
Urban	0	0
Native terrestrial	0	0
Coastal	0	0
Freshwater	0	1,907.00–13,655.00
Estuarine	0	0
Marine	0	0

Cost-benefit analysis results

Proposed management programme: **Exclusion**

Area of Programme: **whole region ha**

Proposed annual expenditure by Council: **$500**

Assumptions

Assumptions	Values	Assumptions	Values
Current area infested	0 ha	Time to reach maximum extent†	100 yrs
Current impacts★	$0/ha	Potential extent in the region°	2,090 ha
Current benefits	$0/ha	Discount rate	4%

★ Current annual impact of the pest averaged across all land uses currently occupied.

° The potential extent the pest is predicted to achieve in the absence of regional management.

† The time a pest is predicted to take between first going wild in the region and reaching its maximum extent.

10 year assessment

The cost-benefit analysis indicates that the benefits of the proposed management programme over the next 10 years will be of net benefit to the region.

SCENARIO	PEST IMPACTS★	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNERS COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$123,376,490	$0		$0	$0	$0	
	min: 18,143,065						
	max: 649,543,616						
Exclusion	$0	$0	$123,376,490	$4,218	$0	$0	$123,372,272
	min: 0		min: 18,143,065				min: 18,138,847
	max: 0		max: 649,543,616				max: 649,539,398

★ Includes economic, environmental and social costs.

° The estimated economic benefit provided by the pest.

† Administration and implementation costs incurred by the Council through the programme.

‡ Costs of control imposed on landowners through the programme, over and above the costs already being paid by landowners, as estimated by the Council. They are applied for the 10 years of the Plan.

50 year assessment

The longer-term cost-benefit analysis indicates that the monetised benefits over the next 50 years of the proposed management programme will be of net benefit to the region. Additional non-monetised benefits associated with the protection of biodiversity values are also anticipated.

Scenario	Pest impacts*	Pest values°	Benefit	Council costs†	Landowner compliance costs‡	Agency compliance costs‡	Net benefit
No intervention	$69,468,472,158	$0		$0	$0	$0	
	min: 10,215,384,233						
	max: 365,733,911,783						
Exclusion	$0	$0	$69,468,472,158	$11,171	$0	$0	$69,468,460,987
	min: 0		min: 10,215,384,233				min: 10,215,373,062
	max: 0		max: 365,733,911,783				max: 365,733,900,612

CBA statement and risks to success

If Senegal tea were to become established it could seriously affect waterways and wetlands in Hawke's Bay, including aquatic flora and fauna species. The 10 year and 50 year assessment supports this potential impact. Senegal tea is present in other North Island regions and poses a risk of being introduced to Hawke's Bay, primarily through dirty machinery.

There are public good benefits in preventing Senegal tea from becoming established and avoiding the possibility of more significant costs for the region in the future.

The principal means of delivering this programme is through education and active surveillance. Because these pests are declared under the Plan, occupiers are obliged to inform Council of the presence of them, and they are banned from sale and distribution.

The benefits of regional intervention, focused on excluding Senegal tea from the region, outweigh the cost of the programme.

Risks of the programme being unsuccessful in achieving objectives

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

Who should pay?

Beneficiaries and exacerbators

GROUP	BENEFICIARY	EXACERBATOR	CHANGE BEHAVIOUR	ASSESS COSTS & BENEFITS
Land occupiers (Crown and private)	Minor	Major	Yes	No
Regional community	Major		No	Yes

Who should pay for the proposed management approach?

There are shared benefits, with both land occupiers and the regional community being beneficiaries of the proposed programme. The cost of the Exclusion programmes is minimal, with the general community benefiting more than individual land occupiers. It is proposed that exclusion programmes will be funded through the general rate.

SPARTINA
Spartina anglica, S. alterniflora

EXCLUSION

Relevant biology

ATTRIBUTE	DESCRIPTION
Form	Perennial, erect, clump-forming grass to 1 m with rhizomes and fibrous roots. Stems 4–9 mm diameter with many brownish leaf sheaths. Alternate leaves (5–45 x 4–15 mm) are deeply wide-ribbed on upper surface and have ligules (1–3 mm long). Seed heads are occasionally seen, and seed is occasionally produced at some sites.
Habitat	Mainly in saline wetlands, especially in estuaries where it forms dense mats in inter-tidal zones. Prefers deep, soft mud with a sandy loam texture. Can establish in the tidal ends of streams and rivers.
Regional distribution	Not currently present in Hawke's Bay.
Competitive ability	Once established forms dense stands, which may spread at a rate of 2% per annum. Tolerates all weathers and temperatures, fire, grazing, and other damage.
Reproductive ability	*S. anglica* reproduces by seed. *S. alterniflora* rarely flowers in New Zealand. *S.* x *townsendii* is a sterile hybrid.
Dispersal methods	Seed and vegetative fragments carried by water. Livestock, propellors, and nets dislodge rhizome fragments, which then spread by tidal and current movement. Can survive at sea long-term and travel long distances with the currents. Planted deliberately to aid foreshore protection and stabilise marshes.
Resistance to control	Can be controlled reasonably well with herbicide.
Benefits	Prevents erosion at estuary margins due to its ability to trap sediment. Can also assist reclamation of tidal flats.

Land use/habitats occupied in Hawke's Bay

LAND USE TYPE	CURRENT INFESTATION	POTENTIAL INFESTATION
Dairy	-	-
Sheep and beef	-	-
Forestry	-	-
Horticulture	-	-
Aquaculture	-	-
Urban	-	-
Native terrestrial	-	-
Coastal land	-	-
Freshwater	-	-
Estuarine	-	High
Marine	-	-

High = Most infested/preferred land use(s), Low = Less infested/preferred land use(s), - = Unsuitable land use

Qualitative impact assessment

CATEGORY	CURRENT	POTENTIAL	COMMENT	SOURCE
Production				
Dairy	-	-		
Sheep and beef	-	-		
Forestry	-	-		
Horticulture	-	-		
Aquaculture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-			
Water quality	-	H	Can reduce large estuaries and shallow harbours to thin drains surrounded by rough pasture.	1, 2
Species diversity	-	H	Traps sediment, raising level above high tide mark, destroys intertidal zone and habitat. Adventive grasses succeed spartina, creating dry meadows, and leading to immense biodiversity loss.	1, 2, 3
Threatened species	-	M	See Species diversity.	
Social/Cultural				
Human health	-	-		
Recreation	-	M	Dense stands obstruct access to estuaries and waterways.	
Māori culture	-	H	Smothers shellfish beds, prevents kaimoana harvesting.	

L = low, M = moderate, H = high
source 1: Anon. (2009d), 2: Anon. (2009a), 3: Craw (2000)

Estimated quantitative impacts

Quantitative annual impacts per hectare are calculated as the current or anticipated proportional impact on land value across the region. All amounts are in net present value (NPV, $).

Calculation: **Economic value per land use/habitat type** × **Impact level**

Impact level
Low = 1–4% reduction in annual economic value per hectare
Moderate = 5–9% reduction in annual economic value per hectare
High = 10–50% reduction in annual economic value per hectare

Reduction in annual economic value ($) per hectare

LAND USE/HABITAT TYPE	CURRENT IMPACT PER HA	POTENTIAL IMPACT PER HA
Production		
Dairy	0	0
Sheep and beef	0	0
Forestry	0	0
Horticulture	0	0
Aquaculture	0	0
Environment/Social/Cultural		
Urban	0	0
Native terrestrial	0	0
Coastal	0	0
Freshwater	0	0
Estuarine	0	602.40–3,681.00
Marine	0	0

Cost-benefit analysis results

Proposed management programme: **Exclusion**

Area of Programme: **whole region ha**

Proposed annual expenditure by Council: **$500**

Assumptions

ASSUMPTIONS	VALUES	ASSUMPTIONS	VALUES
Current area infested	0 ha	Time to reach maximum extent†	75 yrs
Current impacts★	$0/ha	Potential extent in the region°	225 ha
Current benefits	$0/ha	Discount rate	4%

★ Current annual impact of the pest averaged across all land uses currently occupied.

° The potential extent the pest is predicted to achieve in the absence of regional management.

† The time a pest is predicted to take between first going wild in the region and reaching its maximum extent.

10 year assessment

The cost-benefit analysis indicates that the benefits of the proposed management programme over the next 10 years will be of net benefit to the region.

SCENARIO	PEST IMPACTS★	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNERS COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$7,062,104	$0		$0	$0	$0	
	min: 1,191,888						
	max: 36,413,182						
Exclusion	$0	$0	$7,062,104	$4,218	$0	$0	$7,057,886
	min: 0		min: 1,191,888				min: 1,187,670
	max: 0		max: 36,413,182				max: 36,408,964

★ Includes economic, environmental and social costs.

° The estimated economic benefit provided by the pest.

† Administration and implementation costs incurred by the Council through the programme.

‡ Costs of control imposed on landowners through the programme, over and above the costs already being paid by landowners, as estimated by the Council. They are applied for the 10 years of the Plan.

50 year assessment

The longer-term cost-benefit analysis indicates that the monetised benefits over the next 50 years of the proposed management programme will be of net benefit to the region. Additional non-monetised benefits associated with the protection of biodiversity values are also anticipated.

SCENARIO	PEST IMPACTS*	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNERS COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$6,831,681,534	$0		$0	$0	$0	
	min: 1,152,937,101						
	max: 35,225,403,701						
Exclusion	$0	$0	$6,831,681,534	$11,171	$0	$0	$6,831,670,363
	min: 0		min: 1,152,937,101				min: 1,152,925,930
	max: 0		max: 35,225,403,701				max: 35,225,392,530

CBA statement and risks to success

Spartina can trap sediment raising ground levels above the high tide mark and stranding former intertidal habitat for birds and fish. Estuaries and shallow harbours can be reduced to thin drains surrounded by rough weedy pasture with significant loss of biodiversity. Spartina is found in other North Isand regions including Gisborne.

The principal means of delivering this programme is through education and active surveillance. Because these pests are declared under the Plan, occupiers are obliged to inform Council of the presence of them, and they are banned from sale and distribution.

The benefits of regional intervention, focused on excluding spartina from the region, outweigh the cost of the programme.

Risks of the programme being unsuccessful in achieving objectives

RISK	LEVEL OF RISK	EXPLANATION
Technical risk	Low	
Operational risk	Low	
Legal risk	Low	
Socio-political risk	Low	
Other risks	Low	

Who should pay?

Beneficiaries and exacerbators

GROUP	BENEFICIARY	EXACERBATOR	CHANGE BEHAVIOUR	ASSESS COSTS & BENEFITS
Regional community	Major		No	Yes

Who should pay for the proposed management approach?

There are shared benefits, with both land occupiers and the regional community being beneficiaries of the proposed programme. The cost of the Exclusion programmes is minimal, with the general community benefiting more than individual land occupiers. It is proposed that exclusion programmes will be funded through the general rate.

YELLOW BRISTLE GRASS
Setaria pumila

EXCLUSION

Relevant biology

ATTRIBUTE	DESCRIPTION
Form	Tufted, multi-tillered upright annual grass that grows 25–45 cm high.The seed head is a cylindrical 'spike' 2.5–10 cm long, characterised by 7–10 bristles emerging from below each floret.
Habitat	Bare ground along roadsides and in pasture (e.g. pugging, wheel tracks), including areas that have recently been sprayed. Partially drought tolerant, but requires moist conditions to germinate. Grows best where rainfall exceeds 500 mm/year or in areas with high soil moisture (e.g. ephemeral drains).
Regional distribution	Not currently present in Hawke's Bay.
Competitive ability	Highly competitive with perennial ryegrass and white clover. Capable of covering 20–40% of ground within 5 years of invading pasture. Severe drought, which opens up pastures, can increase the competitiveness of this species. A decline in the use of residual herbicides for controlling weeds on roadsides may increase populations.
Reproductive ability	Establishes in early summer and can produce seeds within 4 weeks. Plants can produce 50–100 seed heads, each containing 60–200 seeds. Most seeds survive only a few years under field conditions, although some may survive buried for 10 years. Seed can survive in the rumen of cattle and effluent ponds, and remain viable in silage stacks for up to 3 months.
Dispersal methods	Via water and soil movement, stock, infested hay and silage, agricultural machinery, mowers, road works machinery and other vehicles. The barbed seeds are carried in fur, feathers or clothing.
Resistance to control	Difficult to control. Summer cropping, undersowing, oversowing, grazing, and non-selective herbicide are ineffective. Fenoxaprop-Pethyl may work in pastures without damage to sown grasses or clovers (research is underway to determine livestock withholding period). At least 2 consecutive years of control needed to deplete soil seed bank. Complete renewal of pasture over 2 consecutive summers is best option, with plants such as chicory or turnips.
Benefits	Palatable to livestock during the vegetative stage, but it has poor nutritive values and stock avoid it after seed heads emerge (mid Jan–May).

Land use/habitats occupied in Hawke's Bay

LAND USE TYPE	CURRENT INFESTATION	POTENTIAL INFESTATION
Dairy	-	High
Sheep and beef	-	High
Forestry	-	-

Horticulture	-	-
Aquaculture	-	-
Urban	-	-
Native terrestrial	-	Low
Coastal land	-	-
Freshwater	-	-
Estuarine	-	-
Marine	-	-

High = Most infested/preferred land use(s), Low = Less infested/preferred land use(s), - = Unsuitable land use

Qualitative impact assessment

CATEGORY	CURRENT	POTENTIAL	COMMENT	SOURCE
Production				
Dairy	-	M	Can reduce annual feed production by up to 20%, resulting in increased on-farm costs from supplementary feed and/or pasture renovation. Seed heads can cause lesions and ulcers to mouths of grazing cattle.	
Sheep and beef	-	M	See Dairy. May be grazed by sheep during vegetative stage, but has poor nutritive value and stock avoid it after seed heads emerge.	
Forestry	-	-		1, 2, 3, 4, 5
Horticulture	-	-		
Aquaculture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	-	-	Mainly invades pasture and open or disturbed ground.	2, 3, 6
Threatened species	-	-		2, 3, 6
Social/Cultural				
Human health	L	L	Seeds can adhere to clothing and possibly cause irritation.	2, 3
Recreation	-	-		
Māori culture	-	-		

L = low, M = moderate, H = high

source 1: Taranaki Regional Council (2013d), 2: James et al. (2009), 3: Tozer et al. (2012), 4: AgResearch (2013), 5: James (2011), 6: James & Rahman (2009)

Estimated quantitative impacts

Quantitative annual impacts per hectare are calculated as the current or anticipated proportional impact on land value across the region. All amounts are in net present value (NPV, $).

Calculation: **Economic value per land use/habitat type** × **Impact level**

Impact level
Low = 1–4% reduction in annual economic value per hectare
Moderate = 5–9% reduction in annual economic value per hectare
High = 10–50% reduction in annual economic value per hectare

Reduction in annual economic value ($) per hectare

LAND USE/HABITAT TYPE	CURRENT IMPACT PER HA	POTENTIAL IMPACT PER HA
Production		
Dairy	0	273.15–600.93
Sheep and beef	0	36.95–81.27
Forestry	0	0
Horticulture	0	0
Aquaculture	0	0
Environment/Social/Cultural		
Urban	0	0
Native terrestrial	0	0
Coastal	0	0
Freshwater	0	0
Estuarine	0	0
Marine	0	0

Cost-benefit analysis results

Proposed management programme: **Exclusion**
Area of Programme: **whole region ha**
Proposed annual expenditure by Council: **$500**

Assumptions

ASSUMPTIONS	VALUES	ASSUMPTIONS	VALUES
Current area infested	0 ha	Time to reach maximum extent†	50 yrs
Current impacts★	$0/ha	Potential extent in the region°	135,278 ha
Current benefits	$0/ha	Discount rate	4%

★ Current annual impact of the pest averaged across all land uses currently occupied.

° The potential extent the pest is predicted to achieve in the absence of regional management.

† The time a pest is predicted to take between first going wild in the region and reaching its maximum extent.

10 year assessment

The cost-benefit analysis indicates that the benefits of the proposed management programme over the next 10 years will be of net benefit to the region.

SCENARIO	PEST IMPACTS★	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNERS COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$5,144,325,019	$0		$0	$0	$0	
	min: 1,749,289,529						
	max: 21,896,703,603						
Exclusion	$0	$0	$5,144,325,019	$4,218	$0	$0	$5,144,320,801
	min: 0		min: 1,749,289,529				min: 1,749,285,311
	max: 0		max: 21,896,703,603				max: 21,896,699,385

★ Includes economic, environmental and social costs.

° The estimated economic benefit provided by the pest.

† Administration and implementation costs incurred by the Council through the programme.

‡ Costs of control imposed on landowners through the programme, over and above the costs already being paid by landowners, as estimated by the Council. They are applied for the 10 years of the Plan.

50 year assessment

The longer-term cost-benefit analysis indicates that the monetised benefits over the next 50 years of the proposed management programme will be of net benefit to the region. Additional non-monetised benefits associated with the protection of biodiversity values are also anticipated.

SCENARIO	PEST IMPACTS★	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNERS COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$3.52856e+12	$0		$0	$0	$0	
	min: 1.199832e+12						
	max: 1.501938e+13						
Exclusion	$0	$0	$3.52856e+12	$11,171	$0	$0	$3.52856e+12
	min: 0		min: 1.199832e+12				min: 1.199832e+12
	max: 0		max: 1.501938e+13				max: 1.501938e+13

CBA statement and risks to success

Yellow bristle grass can invade pastures across Hawke's Bay. It hardens off in autumn resulting in lower pasture quality. The 10 year and 50 year assessment give highlight to its potential regional impact.

The principal means of delivering this programme is through education and active surveillance. Because these pests are declared under the Plan, occupiers are obliged to inform Council of the presence of them, and they are banned from sale and distribution.

The benefits of regional intervention, focused on excluding yellow bristle grass from the region, outweigh the cost of the programme.

Risks of the programme being unsuccessful in achieving objectives

RISK	LEVEL OF RISK	EXPLANATION
Technical risk	Low to medium	
Operational risk	Low	
Legal risk	Low to medium	
Socio-political risk	Low	
Other risks	Low	

Who should pay?

Beneficiaries and exacerbators

GROUP	BENEFICIARY	EXACERBATOR	CHANGE BEHAVIOUR	ASSESS COSTS & BENEFITS
Land occupiers (Crown and private)	Major	Major	Yes	Yes
Dairy/sheep and beef sector	Major		No	Yes
Regional community	Major		No	Yes

Who should pay for the proposed management approach?

There are shared benefits, with both land occupiers and the regional community being beneficiaries of the proposed programme. The cost of the Exclusion programmes is minimal, with the general community benefiting more than individual land occupiers. It is proposed that exclusion programmes will be funded through the general rate.

ERADICATION PESTS

ROOK
Corvus frugilegus

ERADICATION

Relevant biology

ATTRIBUTE	DESCRIPTION
Form	Large, totally black birds with violet-blue glossy sheen. 20-30 cm long.
Habitat	Rookeries are usually built in pines, eucalyptus or oak trees; poplars and walnut trees are also utilised for nesting.
Regional distribution	Found throughout the region, with the greatest numbers in the southern half of the region. Regional population was estimated at 3000 birds (with 278 active nests) in 2014.
Competitive ability	Can cause extensive damage to maize, peas, squash, green feed and cereal crops.
Reproductive ability	2-5 eggs per female laid each year, fledgings are able to fly in 30 days. Population can increase rapidly.
Resistance to control	Controlled by poisoning and trapping. Indiscriminate poisoning can result in the splitting of rookeries and spread of rook populations. Can become very 'shy' to shooting.
Benefits	May help control grass grub in pasture.

Land use/habitats occupied in Hawke's Bay

LAND USE TYPE	CURRENT INFESTATION	POTENTIAL INFESTATION
Dairy	Low	High
Sheep and beef	Low	High
Forestry	-	Low
Horticulture	Low	High
Aquaculture	-	-
Urban	Low	Low
Native terrestrial	-	-
Coastal land	Low	Low
Freshwater	-	-
Estuarine	-	-
Marine	-	-

High = Most infested/preferred land use(s), Low = Less infested/preferred land use(s), - = Unsuitable land use

Qualitative impact assessment

CATEGORY	CURRENT	POTENTIAL	COMMENT	SOURCE
Production				
Dairy	L	L	Causes damage to pasture by uprooting the ground in search of grass grubs. Also damages forage crops.	
Sheep and beef	L	L	Causes damage to pasture by uprooting the ground in search of grass grubs. Damages forage crops and paddocks being resown for sheep and beef.	
Forestry	-	-		1, 2
Horticulture	L	M	Causes extensive damage to cereal crops, maize, peas, squash.	
Aquaculture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	L	M	Tears up soil when hunting for grass grubs near the ground surface in winter.	3
Water quality	-	-		
Species diversity	-	-		
Threatened species	-	-		
Social/Cultural				
Human health	L	L	Noise disturbance by loud, harsh call.	4
Recreation	-	-		
Māori culture	-	-		

L = low, M = moderate, H = high

source 1: Heather & Robertson (1996), 2: Zahradnik & Cihar (1990), 3: Environment Bay of Plenty (2004b), 4: Environment Bay of Plenty (2004a)

Estimated quantitative impacts

Quantitative annual impacts per hectare are calculated as the current or anticipated proportional impact on land value across the region. All amounts are in net present value (NPV, $).

Calculation: **Economic value per land use/habitat type** × **Impact level**

Impact level
Low = 1–4% reduction in annual economic value per hectare
Moderate = 5–9% reduction in annual economic value per hectare
High = 10–50% reduction in annual economic value per hectare

Reduction in annual economic value ($) per hectare

LAND USE/HABITAT TYPE	CURRENT IMPACT PER HA	POTENTIAL IMPACT PER HA
Production		
Dairy	54.63–267.08	54.63–267.08
Sheep and beef	7.39–36.12	7.39–36.12
Forestry	0	0
Horticulture	105.11–790.40	525.55–1,778.40
Aquaculture	0	0
Environment/Social/Cultural		
Urban	5.33–56.05	5.33–56.05
Native terrestrial	0	0
Coastal	12.47–61.00	62.35–137.25
Freshwater	0	0
Estuarine	0	0
Marine	0	0

Cost-benefit analysis results

Proposed management programme: **Eradication**
Area of Programme: **whole region ha**
Proposed annual expenditure by Council: **$125,436**

Assumptions

ASSUMPTIONS	VALUES	ASSUMPTIONS	VALUES
Current area infested	48,952.55 ha	Time to reach maximum extent†	50 yrs
Current impacts★	$37.15/ha	Potential extent in the region°	138,046 ha
	$11.33–62.96/ha		48,952.55–227,139.9 ha
Current benefits	$0/ha	Discount rate	4%

★ Current annual impact of the pest averaged across all land uses currently occupied.

° The potential extent the pest is predicted to achieve in the absence of regional management.

† The time a pest is predicted to take between first going wild in the region and reaching its maximum extent.

10 year assessment

The cost-benefit analysis indicates that the benefits of the proposed management programme over the next 10 years will be of net benefit to the region.

SCENARIO	PEST IMPACTS★	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNERS COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$37,072,244	$0		$0	$0	$0	
	min: 5,055,423						
	max: 113,361,696						
Eradication	$12,330,023	$0	$24,742,221	$1,058,094	$0	$0	$23,684,127
	min: 3,089,978		min: 1,965,445				min: 907,351
	max: 24,631,519		max: 88,730,177				max: 87,672,083

★ Includes economic, environmental and social costs.

° The estimated economic benefit provided by the pest.

† Administration and implementation costs incurred by the Council through the programme.

‡ Costs of control imposed on landowners through the programme, over and above the costs already being paid by landowners, as estimated by the Council. They are applied for the 10 years of the Plan.

50 year assessment

The longer-term cost-benefit analysis indicates that the monetised benefits over the next 50 years of the proposed management programme will be of net benefit to the region. Additional non-monetised benefits associated with the protection of biodiversity values are also anticipated.

SCENARIO	PEST IMPACTS★	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNERS COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$244,155,972	$0		$0	$0	$0	
	min: 12,474,839						
	max: 1,285,232,567						
Eradication	$14,640,462	$0	$229,515,510	$1,779,139	$0	$0	$227,736,371
	min: 3,237,867		min: 9,236,972				min: 7,457,833
	max: 44,068,140		max: 1,241,164,427				max: 1,239,385,288

CBA statement and risks to success

Rooks can negatively impact pastoral and arable crops. The cost to eradicate rooks is likely to be significantly less than the losses that would be incurred if they were left to re-expand their range. Based on the low level of risk, and the 'high' level of support from the farming communities, it is proposed that rooks are eradicated from Hawke's Bay within the next 30 years. The benefits of regional intervention, focused on eradicating rooks from the region, outweigh the cost of the programme.

All regions in the North Island that have rooks have active rook management programmes. The aim is to eradicate rooks from New Zealand.

Risks of the programme being unsuccessful in achieving objectives

RISK	LEVEL OF RISK	EXPLANATION
Technical risk	Low	
Operational risk	Low	
Legal risk	Low	
Socio-political risk	Low	
Other risks	Low	

Who should pay?

Beneficiaries and exacerbators

GROUP	BENEFICIARY	EXACERBATOR	CHANGE BEHAVIOUR	ASSESS COSTS & BENEFITS
Land occupiers (Crown and private)	Major		No	Yes
Any person not declaring presence of a rookery on their land.		Major	Yes	Yes
Regional community	Major		No	Yes

Who should pay for the proposed management approach?

Both land occupiers and the regional community are beneficiaries. The agricultural sector will benefit proportionally more than the regional community, therefore a 70% targeted rate, 30% general rate is proposed.

AFRICAN FEATHER GRASS
Cenchurus macrourus

ERADICATION

Relevant biology

ATTRIBUTE	DESCRIPTION
Form	Robust rhizomatous perennial grass up to 2 m tall with overhanging flower spikes which resemble pampas. Yellow-reddish-purple flowers form a narrow cylindrical stem 10–30 cm long x 2 cm diameter, with barbed bristles sticking out from the spike.
Habitat	Prefers damp situations such as swamps or stream and lake margins, but grows in a range of habitats and soil types, including sand.
Regional distribution	Scattered on farmland in the Maraekakaho and Ngaruroro River berm areas.
Competitive ability	Forms dense clumps that exclude other vegetation.
Reproductive ability	Seed viability is high but seedling establishment is poor.
Dispersal methods	Seeds are dispersed by wind, water, animals (in wool or fur), and machinery. Also spreads from creeping rhizomes and may spread through cultivation with contaminated machinery.
Resistance to control	Readily controlled by appropriate herbicides.
Benefits	None

Land use/habitats occupied in Hawke's Bay

LAND USE TYPE	CURRENT INFESTATION	POTENTIAL INFESTATION
Dairy	-	High
Sheep and beef	Low	High
Forestry	-	Low
Horticulture	-	Low
Aquaculture	-	-
Urban	-	Low
Native terrestrial	-	Low
Coastal land	-	High
Freshwater	-	-
Estuarine	-	-
Marine	-	-

High = Most infested/preferred land use(s), Low = Less infested/preferred land use(s), - = Unsuitable land use

Qualitative impact assessment

CATEGORY	CURRENT	POTENTIAL	COMMENT	SOURCE
Production				
Dairy	-	L	Unpalatable to livestock. Fire hazard.	
Sheep and beef	L	M	See Dairy.	
Forestry	-	-		1, 2, 3
Horticulture	-	-		
Aquaculture	-	-		
Other	-	-		
International trade	-	M	Can contaminate wool. Crop contaminant, prohibited seed (nil tolerance) in imports into Australia.	1, 4
Environment				
Soil resources	-	L	Causes accretion of sand and changes in habitat, leading to erosion or flooding.	1
Water quality	-	L	See Soil Resources.	1
Species diversity	-	M	Forms dense clumps and out-competes native pioneer species in many vulnerable habitats. Also invades established plant communities. Can harbour rats, mice and possums.	1, 2
Threatened species	-	M	Causes accretion of sand and change in habitat, leading to loss of dunelakes and wetlands, which may support threatened species.	1, 2
Social/Cultural				
Human health	-	-		
Recreation	-	M	Obstructs access to lakes, beaches.	1
Māori culture	-	M	Obstructs access to cultural sites (e.g. waahi tapu, urupa).	

L = low, M = moderate, H = high

source 1: Craw (2000), 2: Environment Bay of Plenty (2005a), 3: Environment Bay of Plenty (2004a), 4: AQIS (2009)

Estimated quantitative impacts

Quantitative annual impacts per hectare are calculated as the current or anticipated proportional impact on land value across the region. All amounts are in net present value (NPV, $).

Calculation: **Economic value per land use/habitat type** × **Impact level**

Impact level

Low = 1–4% reduction in annual economic value per hectare

Moderate = 5–9% reduction in annual economic value per hectare

High = 10–50% reduction in annual economic value per hectare

Reduction in annual economic value ($) per hectare

LAND USE/HABITAT TYPE	CURRENT IMPACT PER HA	POTENTIAL IMPACT PER HA
Production		
Dairy	0	54.63–267.08
Sheep and beef	7.39–36.12	36.95–81.27
Forestry	0	0
Horticulture	0	0
Aquaculture	0	0
Environment/Social/Cultural		
Urban	0	0
Native terrestrial	0	27.80–61.20
Coastal	0	62.35–137.25
Freshwater	0	0
Estuarine	0	0
Marine	0	0

Cost-benefit analysis results

Proposed management programme: **Eradication**
Area of Programme: **whole region ha**
Proposed annual expenditure by Council: **$12,000**

Assumptions

ASSUMPTIONS	VALUES	ASSUMPTIONS	VALUES
Current area infested	1 ha	Time to reach maximum extent†	75 yrs
Current impacts★	$21.75/ha	Potential extent in the region°	141,397 ha
	$7.39–36.12/ha		48,024.79–234,769.7 ha
Current benefits	$0/ha	Discount rate	4%

★ Current annual impact of the pest averaged across all land uses currently occupied.

° The potential extent the pest is predicted to achieve in the absence of regional management.

† The time a pest is predicted to take between first going wild in the region and reaching its maximum extent.

10 year assessment

The cost-benefit analysis indicates that the benefits of the proposed management programme over the next 10 years will be of net benefit to the region.

SCENARIO	PEST IMPACTS★	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNERS COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$116,836	$0		$0	$0	$0	
	min: 35,222						
	max: 515,752						
Eradication	$148	$0	$116,688	$101,224	$0	$0	$15,464
	min: 41		min: 35,181				min: -66,043
	max: 289		max: 515,463				max: 414,239

★ Includes economic, environmental and social costs.

° The estimated economic benefit provided by the pest.

† Administration and implementation costs incurred by the Council through the programme.

‡ Costs of control imposed on landowners through the programme, over and above the costs already being paid by landowners, as estimated by the Council. They are applied for the 10 years of the Plan.

50 year assessment

The longer-term cost-benefit analysis indicates that the monetised benefits over the next 50 years of the proposed management programme will be of net benefit to the region. Additional non-monetised benefits associated with the protection of biodiversity values are also anticipated.

SCENARIO	PEST IMPACTS★	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNERS COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$92,916,299	$0		$0	$0	$0	
	min: 29,956,090						
	max: 400,697,909						
Eradication	$175	$0	$92,916,124	$175,841	$0	$0	$92,740,283
	min: 43		min: 29,956,047				min: 29,780,206
	max: 516		max: 400,697,393				max: 400,521,552

CBA statement and risks to success

African Feather grass can adversely impact primary production and environmental values, including wetlands, waterbodies and coastal areas. Given the total area infested in Hawke's Bay is only approximately one hectare, eradication is very feasible. The cost to eradicate African feather grass is cost beneficial both over a 10 year and 50 year period.

African feather grass produces large amount of seeds which are easily dispersed by wind and can be carried on clothing, animal hair or wool. This poses a risk to the success of the programme. If new areas are detected, these areas may require stock to be excluded to prevent seed transfer.

The benefits of regional intervention, focused on eradicating African feather grass from the region, outweigh the cost of the programme.

Risks of the programme being unsuccessful in achieving objectives

RISK	LEVEL OF RISK	EXPLANATION
Technical risk	Low to medium	
Operational risk	Low	
Legal risk	Low to medium	
Socio-political risk	Low	
Other risks	Low	

Who should pay?

Beneficiaries and exacerbators

GROUP	BENEFICIARY	EXACERBATOR	CHANGE BEHAVIOUR	ASSESS COSTS & BENEFITS
Land occupiers (Crown and private)	Major	Major	Yes	Yes
Dairy/sheep and beef sector	Major		No	Yes
Regional community	Major		No	Yes

Who should pay for the proposed management approach?

Although both land occupiers and the regional community are beneficiaries, the agricultural sector will benefit proportionally more than the regional community, therefore a 70% targeted rate, 30% general rate is proposed.

CATHEDRAL BELLS
Cobaea scandens

ERADICATION

Relevant biology

ATTRIBUTE	DESCRIPTION
Form	Vigorous perennial climber growing to canopy height. Climbs by hooked tendrils. Bell-shaped purple flowers followed by oval pods.
Habitat	Garden escape that can smother trees, shrubs and riverside cliffs.
Regional distribution	Approx 10 small sites across the region.
Competitive ability	Highly competitive - fast growing, smothering supporting plants.
Reproductive ability	Seeds prolifically and seed can germinate throughout most of the year.
Dispersal methods	Wind or water borne seed.
Resistance to control	Easily controlled by spraying with herbicide.
Benefits	None

Land use/habitats occupied in Hawke's Bay

LAND USE TYPE	CURRENT INFESTATION	POTENTIAL INFESTATION
Dairy	-	-
Sheep and beef	Low	-
Forestry	-	High
Horticulture	-	-
Aquaculture	-	-
Urban	Low	Low
Native terrestrial	Low	High
Coastal land	-	-
Freshwater	-	-
Estuarine	-	-
Marine	-	-

High = Most infested/preferred land use(s), Low = Less infested/preferred land use(s), - = Unsuitable land use

Qualitative impact assessment

CATEGORY	CURRENT	POTENTIAL	COMMENT	SOURCE
Production				
Dairy	-	-		
Sheep and beef	-	-		
Forestry	-	M	Smothers trees in plantation forests.	1
Horticulture	-	-		
Aquaculture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	L	Could cause canopy collapse leading to erosion.	
Water quality	-	-		
Species diversity	L	H	Smothers all plants up to medium-high canopy and can bring down canopy trees, altering forest structure. Dense layers shade out ground vegetation and prevent recruitment.	1, 2
Threatened species	-	M	See Species diversity.	1, 2
Social/Cultural				
Human health	-	-		
Recreation	-	L	Dense walls of vines obstruct access to forest.	1
Māori culture	-	L	See Recreation.	

L = low, M = moderate, H = high
source 1: Anon. (2007a), 2: Craw (2000)

Estimated quantitative impacts

Quantitative annual impacts per hectare are calculated as the current or anticipated proportional impact on land value across the region. All amounts are in net present value (NPV, $).

Calculation: **Economic value per land use/habitat type** × **Impact level**

Impact level
Low = 1–4% reduction in annual economic value per hectare
Moderate = 5–9% reduction in annual economic value per hectare
High = 10–50% reduction in annual economic value per hectare

Reduction in annual economic value ($) per hectare

LAND USE/HABITAT TYPE	CURRENT IMPACT PER HA	POTENTIAL IMPACT PER HA
Production		
Dairy	0	0
Sheep and beef	0	0
Forestry	0	87.35–192.15
Horticulture	0	0
Aquaculture	0	0
Environment/Social/Cultural		
Urban	0	0
Native terrestrial	5.56–27.20	55.60–340.00
Coastal	0	0
Freshwater	0	0
Estuarine	0	0
Marine	0	0

Cost-benefit analysis results

Proposed management programme: **Eradication**

Area of Programme: **whole region ha**

Proposed annual expenditure by Council: **$13,600**

Assumptions

ASSUMPTIONS	VALUES	ASSUMPTIONS	VALUES
Current area infested	1 ha	Time to reach maximum extent†	50 yrs
Current impacts★	$4.28/ha	Potential extent in the region°	74,162 ha
	$1.45–7.12/ha		24,758.38–123,564.7 ha
Current benefits	$0/ha	Discount rate	4%

★ Current annual impact of the pest averaged across all land uses currently occupied.

° The potential extent the pest is predicted to achieve in the absence of regional management.

† The time a pest is predicted to take between first going wild in the region and reaching its maximum extent.

10 year assessment

The cost-benefit analysis indicates that the benefits of the proposed management programme over the next 10 years may be of net benefit to the region.

SCENARIO	PEST IMPACTS★	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNERS COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$67,873	$0		$0	$0	$0	
	min: 15,682						
	max: 328,337						
Eradication	$28	$0	$67,845	$114,721	$0	$0	$-46,876
	min: 8		min: 15,674				min: -99,047
	max: 57		max: 328,280				max: 213,559

★ Includes economic, environmental and social costs.

° The estimated economic benefit provided by the pest.

† Administration and implementation costs incurred by the Council through the programme.

‡ Costs of control imposed on landowners through the programme, over and above the costs already being paid by landowners, as estimated by the Council. They are applied for the 10 years of the Plan.

50 year assessment

The longer-term cost-benefit analysis indicates that the monetised benefits over the next 50 years of the proposed management programme will be of net benefit to the region. Additional non-monetised benefits associated with the protection of biodiversity values are also anticipated.

SCENARIO	PEST IMPACTS*	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNERS COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$44,021,478	$0		$0	$0	$0	
	min: 10,239,753						
	max: 212,620,084						
Eradication	$33	$0	$44,021,445	$192,250	$0	$0	$43,829,195
	min: 8		min: 10,239,745				min: 10,047,495
	max: 102		max: 212,619,982				max: 212,427,732

CBA statement and risks to success

Cathedral bells can grow over trees and shrubs, forming a dense canopy that out-competes desirable plants by smothering them. The total area infested in Hawke's Bay is believed to be small and eradication is believed to be feasible. Although the cost to eradicate is not cost beneficial over a 10 year period, it is significantly cost beneficial over a 50 year period. This is due to the slow establishment of cathedral bells. If Council was to do nothing over the next ten years, the impacts are likely to be minor. However, as cathedral bell establish over a longer period, the impacts increase. Eradicating now will save significant future pest impact costs.

The benefits of regional intervention, focused on eradicating cathedral bell from the region, outweigh the cost of the programme.

Risks of the programme being unsuccessful in achieving objectives

RISK	LEVEL OF RISK	EXPLANATION
Technical risk	Low	
Operational risk	Low	
Legal risk	Low	
Socio-political risk	Low	
Other risks	Low	

Who should pay?

Beneficiaries and exacerbators

GROUP	BENEFICIARY	EXACERBATOR	CHANGE BEHAVIOUR	ASSESS COSTS & BENEFITS
Land occupiers (Crown and private)	Major	Major	Yes	Yes
Forestry industry	Major		No	Yes
Regional community	Major		No	Yes

Who should pay for the proposed management approach?

Although forestry are a beneficiary, the primary impact of cathedral bell is on biodiversity values. For this reason is proposed that this programme is funded through the general rate.

GOATS RUE
Galega officinalis

ERADICATION

Relevant biology

Attribute	Description
Form	Fast-growing perennial, colony-forming woody herb that grows to 1.2 m tall (sometimes to 2 m tall). Nitrogen-fixer. Plants are spindly when young, but usually grow into dense clumps with tall stems, which die back in autumn. Lilac or pink pea-like flowers grow in bunches on spikes of 30 cm or more. Seeds in pods.
Habitat	Can establish in many habitats, especially irrigated pastures, irrigation canels, swamplands, river beds, railway lines and roadsides. Prefers full sun but will tolerate light shade.
Regional distribution	Roadsides and railway lines at Eskdale, Omakere and Tikokino.
Competitive ability	Very robust, fast-growing and vigorous. Can tolerate severe frosts. Considered unpalatable to stock, as they avoid it.
Reproductive ability	Plants can produce up to 15,000 seed pods per plant. The seed bank at infested sites can potentially be huge (14,000–75,000 seeds/m2), and very persistent, with little reduction in viability for up to 26 years.
Dispersal methods	Seeds mainly fall near the parent plant, but can be dispersed by water and by animals if ingested, or as a contaminent of hay or gravel.
Resistance to control	A broad range of herbicides are effective e.g. Escort, Grazon and Tordon. Small infestations can be removed by digging, with frequent removal of root-sprouts and seedlings. Fire not effective as it stimulates roots to sprout. Stock cannot be used for control, as the species is toxic under some conditions.
Benefits	Claimed to have many medicinal benefits, including increasing milk production in goats and cows. Valued as a forage crop, bee plant, green manure and a garden (ornamental) plant.

Land use/habitats occupied in Hawke's Bay

LAND USE TYPE	CURRENT INFESTATION	POTENTIAL INFESTATION
Dairy	-	High
Sheep and beef	Low	High
Forestry	-	Low
Horticulture	-	Low
Aquaculture	-	-
Urban	-	Low
Native terrestrial	-	-
Coastal land	-	Low
Freshwater	-	-
Estuarine	-	-
Marine	-	-

High = Most infested/preferred land use(s), Low = Less infested/preferred land use(s), - = Unsuitable land use

Qualitative impact assessment

CATEGORY	CURRENT	POTENTIAL	COMMENT	SOURCE
Production				
Dairy	-	M	Poisonous to livestock; can cause death. Can contaminate hay and poison animals that feed on it.	
Sheep and beef	L	M	Poisonous to sheep, but when eaten regularly in small doses resistance can build up.	
Forestry	-	-		1, 2, 3
Horticulture	-	-		
Aquaculture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	-	M	Has potential to invade wetlands and river margins in New Zealand where its vigorous growth could displace other species. In the US it forms dense stands in wetlands, displacing native species and reducing food and nesting habitat for wildlife.	2, 3
Threatened species	-	L	See Species diversity.	2, 3
Social/Cultural				
Human health	-	L	Can be fatal to humans if ingested due to a poisonous alkaloid.	2
Recreation	-	-		
Māori culture	-	-		

L = low, M = moderate, H = high

source 1: Keeler et al. (1986), 2: Di Tomaso et al. (2013), 3: Hawke's Bay Regional Council (2004a)

Estimated quantitative impacts

Quantitative annual impacts per hectare are calculated as the current or anticipated proportional impact on land value across the region. All amounts are in net present value (NPV, $).

Calculation: **Economic value per land use/habitat type** × **Impact level**

Impact level
Low = 1–4% reduction in annual economic value per hectare
Moderate = 5–9% reduction in annual economic value per hectare
High = 10–50% reduction in annual economic value per hectare

Reduction in annual economic value ($) per hectare

LAND USE/HABITAT TYPE	CURRENT IMPACTS PER HA	POTENTIAL IMPACT PER HA
Production		
Dairy	0	273.15–600.93
Sheep and beef	7.39–36.12	36.95–81.27
Forestry	0	0
Horticulture	0	0
Aquaculture	0	0
Environment/Social/Cultural		
Urban	0	5.33–56.05
Native terrestrial	0	0
Coastal	0	62.35–137.25
Freshwater	0	0
Estuarine	0	0
Marine	0	0

Cost-benefit analysis results

Proposed management programme: **Eradication**
Area of Programme: **whole region ha**
Proposed annual expenditure by Council: **$1,500**

Assumptions

ASSUMPTIONS	VALUES	ASSUMPTIONS	VALUES
Current area infested	0.0011 ha	Time to reach maximum extent†	50 yrs
Current impacts★	$21.75/ha	Potential extent in the region°	133,739 ha
	$7.39–36.12/ha		44,975.9–222,503 ha
Current benefits	$0/ha	Discount rate	4%

★ Current annual impact of the pest averaged across all land uses currently occupied.

° The potential extent the pest is predicted to achieve in the absence of regional management.

† The time a pest is predicted to take between first going wild in the region and reaching its maximum extent.

10 year assessment

The cost-benefit analysis indicates that the benefits of the proposed management programme over the next 10 years will be of net benefit to the region.

SCENARIO	PEST IMPACTS★	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNERS COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$618,763	$0		$0	$0	$0	
	min: 207,136						
	max: 2,655,148						
Eradication	$0	$0	$618,763	$12,653	$0	$0	$606,110
	min: 0		min: 207,136				min: 194,483
	max: 0		max: 2,655,148				max: 2,642,495

★ Includes economic, environmental and social costs.

° The estimated economic benefit provided by the pest.

† Administration and implementation costs incurred by the Council through the programme.

‡ Costs of control imposed on landowners through the programme, over and above the costs already being paid by landowners, as estimated by the Council. They are applied for the 10 years of the Plan.

50 year assessment

The longer-term cost-benefit analysis indicates that the monetised benefits over the next 50 years of the proposed management programme will be of net benefit to the region. Additional non-monetised benefits associated with the protection of biodiversity values are also anticipated.

SCENARIO	PEST IMPACTS★	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNERS COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$401,114,942	$0		$0	$0	$0	
	min: 137,320,956						
	max: 1,706,145,784						
Eradication	$0	$0	$401,114,942	$29,494	$0	$0	$401,085,448
	min: 0		min: 137,320,956				min: 137,291,462
	max: 1		max: 1,706,145,783				max: 1,706,116,289

CBA statement and risks to success

Goats rue is fast growing and is capable of invading many habitats. It outcompetes other vegetation, particularly pasture and crops, having a negative impact on primary production and biodiversity values.
The total known area infested in Hawke's Bay is very small and eradication is believed to be very feasible. Te proposed programme is cost beneficial over both a 10 year and 50 year period.

The benefits of regional intervention, focused on eradicating goats rue from the region, outweigh the cost of the programme.

Risks of the programme being unsuccessful in achieving objectives

RISK	LEVEL OF RISK	EXPLANATION
Technical risk	Low	
Operational risk	Low	
Legal risk	Low	
Socio-political risk	Low	
Other risks	Low	

Who should pay?

Beneficiaries and exacerbators

GROUP	BENEFICIARY	EXACERBATOR	CHANGE BEHAVIOUR	ASSESS COSTS & BENEFITS
Land occupiers (Crown and private)	Major	Major	Yes	Yes
Dairy/sheep and beef sector	Major		No	Yes
Regional community	Major		No	Yes

Who should pay for the proposed management approach?

Goats rue is primarily a agricultural weed, with the agricultural sector being the primary beneficiary. A 70% targeted rate, 30% general rate is proposed.

PHRAGMITES
Phragmites australis

ERADICATION

Relevant biology

ATTRIBUTE	DESCRIPTION
Form	Erect, rhizomatous, perennial grass, 2–4 m high. Rhizomes can grow to 2 m deep, with 40% of the plant underground. Hollow stems. Long, smooth flat leaf blades up to 60 cm long. Leaf margins are rough and leaf sheaths overlap. Ligule has a fringe of long hairs. Brownish or purplish feathery-shaped flowerheads, 20–50 cm long. Dies back in winter.
Habitat	Margins of water bodies, irrigation channels, drainage ditches and poorly drained areas. Can also grow away from water.
Regional distribution	Limited distribution. A few sites in some streams and drains in and around Napier City urban area.
Competitive ability	Vigorous and fast-growing. Can tolerate slightly saline conditions.
Reproductive ability	Produces flowers but does not set seed in New Zealand.
Dispersal methods	Spreads by broken rhizome fragments via water or machinery.
Resistance to control	Very difficult to control. Once established is difficult to eradicate.
Benefits	None

Land use/habitats occupied in Hawke's Bay

LAND USE TYPE	CURRENT INFESTATION	POTENTIAL INFESTATION
Dairy	-	Low
Sheep and beef	-	Low
Forestry	-	Low
Horticulture	-	Low
Aquaculture	-	-
Urban	Low	High
Native terrestrial	-	Low
Coastal land	-	High
Freshwater	Low	Low
Estuarine	Low	High
Marine	-	-

High = Most infested/preferred land use(s), Low = Less infested/preferred land use(s), - = Unsuitable land use

Qualitative impact assessment

CATEGORY	CURRENT	POTENTIAL	COMMENT	SOURCE
Production				
Dairy	-	L	Can invade low-lying pasture.	
Sheep and beef	-	L		
Forestry	-	-		1
Horticulture	-	-		
Aquaculture	-	-		
Other	-	L	Can penetrate compacted road material and grow through cracks in concrete floors.	
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	L	M	Can block drainage systems, causing flooding. Rhizomes can penetrate stop-banks, causing them to slump.	1
Species diversity	L	M	Forms dense stands and crowds out other plants. Could reduce numbers of insects and birds in wetland habitats and waterway margins.	1, 2
Threatened species	-	M	See Species diversity.	1, 2
Social/Cultural				
Human health	-	-		
Recreation	L	M	Can block access to waterways, restricting fishing and boating activities.	1
Māori culture	L	M	See Recreation.	

L = low, M = moderate, H = high
source 1: Biosecurity New Zealand (2009), 2: Environment Canterbury (2007b)

Estimated quantitative impacts

Quantitative annual impacts per hectare are calculated as the current or anticipated proportional impact on land value across the region. All amounts are in net present value (NPV, $).

Calculation: **Economic value per land use/habitat type** × **Impact level**

Impact level
Low = 1–4% reduction in annual economic value per hectare
Moderate = 5–9% reduction in annual economic value per hectare
High = 10–50% reduction in annual economic value per hectare

Reduction in annual economic value ($) per hectare

LAND USE/HABITAT TYPE	CURRENT IMPACT PER HA	POTENTIAL IMPACT PER HA
Production		
Dairy	0	54.63–267.08
Sheep and beef	0	7.39–36.12
Forestry	0	0
Horticulture	0	0
Aquaculture	0	0
Environment/Social/Cultural		
Urban	0	0
Native terrestrial	0	27.80–61.20
Coastal	0	62.35–137.25
Freshwater	190.70–1,092.40	953.50–2,457.90
Estuarine	60.24–294.48	301.20–662.58
Marine	0	0

Cost-benefit analysis results

Proposed management programme: **Eradication**
Area of Programme: **whole region ha**
Proposed annual expenditure by Council: **$0**

Assumptions

ASSUMPTIONS	VALUES	ASSUMPTIONS	VALUES
Current area infested	0.029 ha	Time to reach maximum extent†	75 yrs
Current impacts★	$241.28/ha	Potential extent in the region°	38,312 ha
	$72.01–410.54/ha		15,068.36–61,555.55 ha
Current benefits	$0/ha	Discount rate	4%

★ Current annual impact of the pest averaged across all land uses currently occupied.

° The potential extent the pest is predicted to achieve in the absence of regional management.

† The time a pest is predicted to take between first going wild in the region and reaching its maximum extent.

10 year assessment

The cost-benefit analysis indicates that the benefits of the proposed management programme over the next 10 years may be of net benefit to the region.

SCENARIO	PEST IMPACTS★	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNERS COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$77,052	$0		$0	$0	$0	
	min: 15,088						
	max: 330,166						
Eradication	$46	$0	$77,006	$84,353	$0	$84,353	$-91,700
	min: 11		min: 15,077				min: -153,629
	max: 95		max: 330,071				max: 161,365

★ Includes economic, environmental and social costs.

° The estimated economic benefit provided by the pest.

† Administration and implementation costs incurred by the Council through the programme.

‡ Costs of control imposed on landowners through the programme, over and above the costs already being paid by landowners, as estimated by the Council. They are applied for the 10 years of the Plan.

50 year assessment

The longer-term cost-benefit analysis indicates that the monetised benefits over the next 50 years of the proposed management programme will be of net benefit to the region. Additional non-monetised benefits associated with the protection of biodiversity values are also anticipated.

SCENARIO	PEST IMPACTS★	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNERS COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$6,886,187	$0		$0	$0	$0	
	min: 2,027,618						
	max: 26,733,847						
Eradication	$54	$0	$6,886,133	$143,076	$0	$84,353	$6,658,704
	min: 11		min: 2,027,607				min: 1,800,178
	max: 170		max: 26,733,677				max: 26,506,248

CBA statement and risks to success

Phragmites is considered one of, if not the worst potential aquatic weed in New Zealand. It is an allelopathic species, where it inhibits the growth of other species. It restricts waterways and outcompetes native species. Phragmites is listed as an unwanted organism under the Biosecurity Act 1993, is a Notifiable Organism (Biosecurity (Notifiable Organisms) Order 2010) and is listed in the National Pest Plant Accord 2012. It is also one of eleven pest species that are part of the National Interest Pests Response (NIPR). Management of this pest plant is led by the Ministry for Primary Industries and they cover all costs.

Risks of the programme being unsuccessful in achieving objectives

RISK	LEVEL OF RISK	EXPLANATION
Technical risk	Low	
Operational risk	Low	
Legal risk	Low	
Socio-political risk	Low	
Other risks	Low	

Who should pay?

Beneficiaries and exacerbators

GROUP	BENEFICIARY	EXACERBATOR	CHANGE BEHAVIOUR	ASSESS COSTS & BENEFITS	CONTROL COST EFFECTIVELY
Land occupiers (Crown and private)	Major	Major	Yes	Yes	Yes
Dairy/sheep and beef sector	Major		No	Yes	Yes
Regional community	Major		No	Yes	Yes

Who should pay for the proposed management approach?

All costs for this programme will be covered by the Ministry for Primary Industries (lead agency for this programme).

PURPLE LOOSESTRIFE
Lythrum salicaria

ERADICATION

Relevant biology

Attribute	Description
Form	Erect, hairy, summer-green, hardy perennial herb, with numerous stems usually 1–2 m tall. Fibrous roots forming dense mats. Stems branched, 4–8 sided, pink at base. Leaves lanceolate to elliptic, 20–100 mm long, 5–27 mm wide, usually in pairs. Flower spike terminal, densely hairy, 200-250 mm long, flowers rose to purple-magenta, with 5-6 petals. Seed capsules, blackish, 3-5 mm long. Flowers December to February.
Habitat	Damp places along stream banks, ditches, swamps, lakesides, and waste areas. Can grow in shallow water. Once established it can spread into adjacent dry sites. Tolerates hot and cold air temperatures, and low-to-high nutrient water.
Regional distribution	One site at Te Pohue.
Competitive ability	Can form dense, impenetratable swards that smother other vegetation.
Reproductive ability	Seeds are produced in large numbers and retain their viability for a long time. Can easily spread from rooted pieces. Seedbanks in areas with established purple loosestrife populations can excede 400,000 seeds per m2. Seeds germinate quickly in 3–4 days and have high germination rates.
Dispersal methods	Spread by water, contaminated machinery, and livestock.
Resistance to control	Spray with glyphosate. Water levels can be altered by raising water level to drown plants or lowering the water levels to dry out soil. Water levels less than 30 cm deep does not kill purple loosestrife seedlings. Plantings can shade out loosestrife.
Benefits	None

Land use/habitats occupied in Hawke's Bay

LAND USE TYPE	CURRENT INFESTATION	POTENTIAL INFESTATION

Dairy	-	Low
Sheep and beef	Low	Low
Forestry	-	-
Horticulture	-	-
Aquaculture	-	-
Urban	-	Low
Native terrestrial	-	High
Coastal land	-	-
Freshwater	-	High
Estuarine	-	-
Marine	-	-

High = Most infested/preferred land use(s), Low = Less infested/preferred land use(s), - = Unsuitable land use

Qualitative impact assessment

CATEGORY	CURRENT	POTENTIAL	COMMENT	SOURCE
Production				
Dairy	-	L	Can form dense stands in wetland areas.	
Sheep and beef	-	L	Can form dense stands in wetland areas.	
Forestry	-	-		1, 2
Horticulture	-	L	Can form dense stands in wetland areas.	
Aquaculture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	L	Alters decomposition rates and nutrient cycling.	2
Water quality	-	M	Causes blockages and flooding in water channels, reducing the quality of the water.	1, 2
Species diversity	-	H	Dense stands compete with indigenous species and prevent recruitment. Alters decomposition rates and nutrient cycling, leads to reductions in wetland plant diversity, and reduces habitat suitability for specialised wetland bird species.	2
Threatened species	-	H	Significant threat to indigenous biodiversity of a range of wetland habitats such as stream banks, swamps and lakesides, all of which which support specialist indigenous species. Excludes other species and destroys wetland and marginal habitat and food sources for many fish and bird species.	1, 2
Social/Cultural				
Human health	-	-		
Recreation	-	M	Forms dense and impenetratable stands that obstruct access.	1
Māori culture	-	L	Can impede or restrict access to cultural sites.	

L = low, M = moderate, H = high

source 1: Craw (2000), 2: Blossey et al. (2001)

Estimated quantitative impacts

Quantitative annual impacts per hectare are calculated as the current or anticipated proportional impact on land value across the region. All amounts are in net present value (NPV, $).

Calculation: **Economic value per land use/habitat type** × **Impact level**

Impact level
Low = 1–4% reduction in annual economic value per hectare
Moderate = 5–9% reduction in annual economic value per hectare
High = 10–50% reduction in annual economic value per hectare

Reduction in annual economic value ($) per hectare

LAND USE/HABITAT TYPE	CURRENT IMPACT PER HA	POTENTIAL IMPACT PER HA
Production		
Dairy	0	54.63–267.08
Sheep and beef	0	7.39–36.12
Forestry	0	0
Horticulture	0	105.11–790.40
Aquaculture	0	0
Environment/Social/Cultural		
Urban	0	0
Native terrestrial	0	55.60–340.00
Coastal	0	0
Freshwater	0	1,907.00–13,655.00
Estuarine	0	0
Marine	0	0

Cost-benefit analysis results

Proposed management programme: **Eradication**
Area of Programme: **whole region ha**
Proposed annual expenditure by Council: **$790**

Assumptions

ASSUMPTIONS	VALUES	ASSUMPTIONS	VALUES
Current area infested	0.001 ha	Time to reach maximum extent†	75 yrs
Current impacts★	$0.1/ha	Potential extent in the region°	68,837 ha
Current benefits	$0/ha	Discount rate	4%

★ Current annual impact of the pest averaged across all land uses currently occupied.

° The potential extent the pest is predicted to achieve in the absence of regional management.

† The time a pest is predicted to take between first going wild in the region and reaching its maximum extent.

10 year assessment

The cost-benefit analysis indicates that the benefits of the proposed management programme over the next 10 years will be of net benefit to the region.

SCENARIO	PEST IMPACTS★	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNERS COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$56,490,564	$0		$0	$0	$0	
	min: 8,915,126						
	max: 277,314,982						
Eradication	$0	$0	$56,490,564	$6,664	$0	$0	$56,483,900
	min: 0		min: 8,915,126				min: 8,908,462
	max: 0		max: 277,314,982				max: 277,308,318

★ Includes economic, environmental and social costs.

° The estimated economic benefit provided by the pest.

† Administration and implementation costs incurred by the Council through the programme.

‡ Costs of control imposed on landowners through the programme, over and above the costs already being paid by landowners, as estimated by the Council. They are applied for the 10 years of the Plan.

50 year assessment

The longer-term cost-benefit analysis indicates that the monetised benefits over the next 50 years of the proposed management programme will be of net benefit to the region. Additional non-monetised benefits associated with the protection of biodiversity values are also anticipated.

SCENARIO	PEST IMPACTS★	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNERS COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$54,643,895,283	$0		$0	$0	$0	
	min: 8,621,599,975						
	max: 268,259,305,822						
Eradication	$0	$0	$54,643,895,283	$15,535	$0	$0	$54,643,879,748
	min: 0		min: 8,621,599,975				min: 8,621,584,440
	max: 0		max: 268,259,305,822				max: 268,259,290,287

CBA statement and risks to success

Purple loosestrife is a highly aggressive invader of damp ground, wetlands and shallow water, smothering other vegetation. If Council was to adopt a no intervention approach, biodiversity values of wetlands in particular could be impacted. There is only one known location in the region and eradication is believed to be very feasible. The proposed programme is cost beneficial over both a 10 year and 50 year period.

The benefits of regional intervention, focused on eradicating purple loosestrife from the region, outweigh the cost of the programme.

Risks of the programme being unsuccessful in achieving objectives

RISK	LEVEL OF RISK	EXPLANATION
Technical risk	Low	
Operational risk	Low	
Legal risk	Low	
Socio-political risk	Low	
Other risks	Low	

Who should pay?

Beneficiaries and exacerbators

GROUP	BENEFICIARY	EXACERBATOR	CHANGE BEHAVIOUR	ASSESS COSTS & BENEFITS
Land occupiers (Crown and private)	Major	Major	Yes	Yes
Dairy/sheep and beef sector	Minor		No	Yes
Regional community	Major		No	Yes

Who should pay for the proposed management approach?

Although the agriculture sector are a beneficiary, the primary impact of purple loosestrife is on biodiversity values. For this reason is proposed that this programme is funded through the general rate.

SPINY EMEX
Emex australis

ERADICATION

Relevant biology

ATTRIBUTE	DESCRIPTION
Form	Hairless semi-prostrate annual herb with a stout taproot. Leaves are dull green and a similar shape to dock; forming a rosette in early growth then branching later. Flowers are inconspicuous at the base of leaf stems, and develop into hard fruit (burs) that ripen from green to brown. Burs are woody and c.7 mm long. Each bur has three sharp spikes, and when they are shed they lie with one spike pointing upwards.
Habitat	Sandy or loamy soils in coastal areas. Pasture, crops, lawns and waste places. Can tolerate temperate to subtropical climates.
Regional distribution	Very limited distribution. Only present on two properties: at Whakaki and between Napier and Bayview.
Competitive ability	Relatively weak competitor (being out-competed by grasses and legumes), but it can dominate in habitats where environmental conditions such as drought or unseasonal rains modify pasture composition.
Reproductive ability	Produces long-lived viable seed. Overseas, seeds can remain viable for up to 8 years.
Dispersal methods	Burs are well-equipped for dispersal, as one spike always points upward attaching to shoes, tyres, animal feet etc. Also dispersed in fodder crops like hay. Burs can float on water and spread along water courses.
Resistance to control	Can be grubbed out or controlled with glyphosate. Hormone herbicides can be used at the rosette stage only e.g. MCPA or 2,4-D.
Benefits	None

Land use/habitats occupied in Hawke's Bay

LAND USE TYPE	CURRENT INFESTATION	POTENTIAL INFESTATION
Dairy	-	High
Sheep and beef	Low	High
Forestry	-	-
Horticulture	-	Low
Aquaculture	-	-
Urban	-	High
Native terrestrial	-	-
Coastal land	-	High
Freshwater	-	-
Estuarine	-	-
Marine	-	-

High = Most infested/preferred land use(s), Low = Less infested/preferred land use(s), - = Unsuitable land use

Qualitative impact assessment

CATEGORY	CURRENT	POTENTIAL	COMMENT	SOURCE
Production				
Dairy	-	M	Competes with pasture, particularly for nitrogen. Burs can cause lameness or infection in animals.	
Sheep and beef	L	M	Contains high levels of oxalates and has caused sheep deaths in Western Australia through oxalic acid poisoning. Can attach to sheep and reduce wool quality.	
Forestry	-	-		1, 2, 3
Horticulture	-	L	Competes with crops, reducing yields.	
Aquaculture	-	-		
Other	-	-		
International trade	-	L	Can reduce wool quality.	2
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	-	-	Mainly a problem in agricultural land.	2
Threatened species	-	-		
Social/Cultural				
Human health	L	L	Sharp burs can spike into feet and cause discomfort in humans.	1, 2
Recreation	-	L	See Human Health.	1, 2
Māori culture	-	-		

L = low, M = moderate, H = high

source 1: Environment Bay of Plenty (2013), 2: Hawke's Bay Regional Council (1995b), 3: CABI (2013)

Estimated quantitative impacts

Quantitative annual impacts per hectare are calculated as the current or anticipated proportional impact on land value across the region. All amounts are in net present value (NPV, $).

Calculation: **Economic value per land use/habitat type** × **Impact level**

Impact level

Low = 1–4% reduction in annual economic value per hectare

Moderate = 5–9% reduction in annual economic value per hectare

High = 10–50% reduction in annual economic value per hectare

Reduction in annual economic value ($) per hectare

LAND USE/HABITAT TYPE	CURRENT IMPACT PER HA	POTENTIAL IMPACT PER HA
Production		
Dairy	0	273.15–600.93
Sheep and beef	7.39–36.12	36.95–81.27
Forestry	0	0
Horticulture	0	105.11–790.40
Aquaculture	0	0
Environment/Social/Cultural		
Urban	0	5.33–56.05
Native terrestrial	0	0
Coastal	0	12.47–61.00
Freshwater	0	0
Estuarine	0	0
Marine	0	0

Cost-benefit analysis results

Proposed management programme: **Eradication**
Area of Programme: **whole region ha**
Proposed annual expenditure by Council: **$4,600**

Assumptions

ASSUMPTIONS	VALUES	ASSUMPTIONS	VALUES
Current area infested	0.006 ha	Time to reach maximum extent†	50 yrs
Current impacts★	$21.75/ha	Potential extent in the region°	131,972 ha
	$7.39–36.12/ha		44,027.36–219,916 ha
Current benefits	$0/ha	Discount rate	4%

★ Current annual impact of the pest averaged across all land uses currently occupied.

° The potential extent the pest is predicted to achieve in the absence of regional management.

† The time a pest is predicted to take between first going wild in the region and reaching its maximum extent.

10 year assessment

The cost-benefit analysis indicates that the benefits of the proposed management programme over the next 10 years will be of net benefit to the region.

SCENARIO	PEST IMPACTS★	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNERS COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$758,056	$0		$0	$0	$0	
	min: 269,802						
	max: 3,196,877						
Eradication	$1	$0	$758,055	$38,803	$0	$0	$719,252
	min: 0		min: 269,802				min: 230,999
	max: 2		max: 3,196,875				max: 3,158,072

★ Includes economic, environmental and social costs.

° The estimated economic benefit provided by the pest.

† Administration and implementation costs incurred by the Council through the programme.

‡ Costs of control imposed on landowners through the programme, over and above the costs already being paid by landowners, as estimated by the Council. They are applied for the 10 years of the Plan.

50 year assessment

The longer-term cost-benefit analysis indicates that the monetised benefits over the next 50 years of the proposed management programme will be of net benefit to the region. Additional non-monetised benefits associated with the protection of biodiversity values are also anticipated.

SCENARIO	PEST IMPACTS★	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNERS COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$497,116,043	$0		$0	$0	$0	
	min: 180,406,563						
	max: 2,079,075,063						
Eradication	$2	$0	$497,116,041	$102,771	$0	$0	$497,013,270
	min: 1		min: 180,406,562				min: 180,303,791
	max: 3		max: 2,079,075,060				max: 2,078,972,289

CBA statement and risks to success

Spiny emex is an agricultural weed that can adversely impact production values, through invading pasture and seeds causing hoof lameness to stock. Given the total known area infested in Hawke's Bay is less than one hectare, eradication is feasible. The cost to eradicate spiny emex is cost beneficial both over a 10 year and 50 year period.

The benefits of regional intervention, focused on eradicating spiny emex from the region, outweigh the cost of the programme.

Risks of the programme being unsuccessful in achieving objectives

RISK	LEVEL OF RISK	EXPLANATION
Technical risk	Low	
Operational risk	Low	
Legal risk	Low	
Socio-political risk	Low	
Other risks	Low	

Who should pay?

Beneficiaries and exacerbators

GROUP	BENEFICIARY	EXACERBATOR	CHANGE BEHAVIOUR	ASSESS COSTS & BENEFITS
Land occupiers (Crown and private)	Major	Major	Yes	Yes
Dairy/sheep and beef sector	Major		No	Yes
Regional community	Major		No	Yes

Who should pay for the proposed management approach?

Spiny emex is primarily a agricultural weed, with the agricultural sector being the primary beneficiary. A 70% targeted rate, 30% general rate is proposed.

White-edged nightshade
Solanum marginatum

ERADICATION

Relevant biology

ATTRIBUTE	DESCRIPTION
Form	Much branched perennial shrub to small tree to 5 m tall. Prickles 1.5 cm only on stems and leaves. White felted twigs, white marginal zones on upper surface of mature leaves.
Habitat	Mainly in scrub, poor rough country, roadsides, wastelands and bush margins in warm, sunny situations.
Regional distribution	Very limited distribution. Only present on one property at Eskdale.
Competitive ability	Forms dense impenetrable thickets. Can invade poor open pasture and other open areas.
Reproductive ability	Produces moderate amounts of seeds. Flowers within 5–7 months of germination.
Dispersal methods	Seeds spread by soil movement and livestock.
Resistance to control	Regrows strongly after mechanical damage. Susceptible to picloram.
Benefits	None

Land use/habitats occupied in Hawke's Bay

LAND USE TYPE	CURRENT INFESTATION	POTENTIAL INFESTATION
Dairy	-	High
Sheep and beef	Low	High
Forestry	-	Low
Horticulture	Low	Low
Aquaculture	-	-
Urban	-	Low
Native terrestrial	-	-
Coastal land	-	High
Freshwater	-	-
Estuarine	-	-
Marine	-	-

High = Most infested/preferred land use(s), Low = Less infested/preferred land use(s), - = Unsuitable land use

Qualitative impact assessment

CATEGORY	CURRENT	POTENTIAL	COMMENT	SOURCE
PRODUCTION				

Dairy	-	M	Shades out and displaces pasture species. Toxic to stock. Spines can injure stock, and restrict their movement.	
Sheep and beef	L	H	Can attach to sheep wool. See Dairy.	
Forestry	-	-		1, 2, 3, 4
Horticulture	L	L	Competes with crops, reducing yields.	
Aquaculture	-	-		
Other	-	-		
International trade	-	-		
ENVIRONMENT				
Soil resources	-	-		
Water quality	-	-		
Species diversity	-	M	Forms dense stands and can displace native ground cover and shrub species.	1, 3, 4
Threatened species	-	-		
SOCIAL/CULTURAL				
Human health	-	L	Poisonous. Sharp spines can cause injury.	4
Recreation	L	M	Dense impenetrable stands are difficult to get through.	4
Māori culture	-	L	See Recreation.	

L = low, M = moderate, H = high
source 1: Anon. (), 2: Environment Bay of Plenty (2004a), 3: Environment Canterbury (2007c), 4: Hawke's Bay Regional Council (2004)

Estimated quantitative impacts

Reduction in annual economic value ($) per hectare

LAND USE/HABITAT TYPE	CURRENT IMPACT PER HA	POTENTIAL IMPACT PER HA
PRODUCTION		
Dairy	0	273.15–600.93
Sheep and beef	7.39–36.12	73.90–451.50
Forestry	0	0
Horticulture	105.11–790.40	105.11–790.40
Aquaculture	0	0
ENVIRONMENT/SOCIAL/CULTURAL		
Urban	0	5.33–56.05
Native terrestrial	0	0
Coastal	0	62.35–137.25
Freshwater	0	0
Estuarine	0	0
Marine	0	0

Cost-benefit analysis results

Proposed management programme: **Eradication**
Area of Programme: **whole region**
Proposed annual expenditure by Council: **$740**

Assumptions

ASSUMPTIONS	VALUES	ASSUMPTIONS	VALUES
Current area infested	0.0001 ha	Time to reach maximum extent†	125 yrs
Current impacts★	$32.9/ha	Potential extent in the region°	133,917 ha
	$9.95–55.86/ha		45,032.87–222,802 ha
Current benefits	$0/ha	Discount rate	4%

★ Current annual impact of the pest averaged across all land uses currently occupied.

° The potential extent the pest is predicted to achieve in the absence of regional management.

† The time a pest is predicted to take between first going wild in the region and reaching its maximum extent.

10 year assessment

The cost-benefit analysis indicates that the benefits of the proposed management programme over the next 10 years will be of net benefit to the region.

SCENARIO	PEST IMPACTS★	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNER COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$234,835	$0		$0	$0	$0	
	min: 38,481						
	max: 1,206,301						
Eradication	$0	$0	$234,835	$6,242	$0	$0	$228,593
	min: 0		min: 38,481				min: 32,239
	max: 0		max: 1,206,301				max: 1,200,059

★ Includes economic, environmental and social costs.

° The estimated economic benefit provided by the pest.

† Administration and implementation costs incurred by the Council through the programme.

‡ Costs of control imposed on landowners through the programme, over and above the costs already being paid by landowners, as estimated by the Council. They are applied for the 10 years of the Plan.

50 year assessment

The longer-term cost-benefit analysis indicates that the monetised benefits over the next 50 years of the proposed management programme will be of net benefit to the region. Additional non-monetised benefits associated with the protection of biodiversity values are also anticipated.

SCENARIO	PEST IMPACTS*	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNER COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$55,565,008	$0		$0	$0	$0	
	min: 9,021,236						
	max: 285,842,289						
Eradication	$0	$0	$55,565,008	$14,732	$0	$0	$55,550,276
	min: 0		min: 9,021,236				min: 9,006,504
	max: 0		max: 285,842,289				max: 285,827,557

CBA statement and risks to success

White edged nightshade is an agricultural weed that can adversely impact production values, through forming dense impenetrable thickets and invading poor open pasture and other open areas. The berries are poisonous to stock and humans. Leaf margins are pale but its most distinguishing features are spines on both sides of the leaves and thorns on the stems. Its seed is spread by attaching to sheep fleeces, through birds eating its berries, and by machinery. The plant grows in poor rough scrub-covered country, on roadsides and wastelands and bush margins. It was first discovered in the region in 1984 on one property at Eskdale. It remains restricted to 120ha.

Given the restricted nature of the infestion in Hawke's Bay, eradication is feasible. The cost to eradicate white edged nightshade is cost beneficial both over a 10 year and 50 year period.

The benefits of regional intervention, focused on eradicating white edged nightshade from the region, outweigh the cost of the programme.

Risks of the programme being unsuccessful in achieving objectives

RISK	LEVEL OF RISK	EXPLANATION
Technical risk	Low	
Operational risk	Low	
Legal risk	Low	
Socio-political risk	Low	
Other risks	Low	

Who should pay?

Beneficiaries and exacerbators

GROUP	BENEFICIARY	EXACERBATOR	CHANGE BEHAVIOUR	ASSESS COSTS & BENEFITS
Land occupiers (Crown and private)	Major	Major	Yes	Yes
Dairy/sheep and beef sector	Major		No	Yes
Regional community	Major		No	Yes

Who should pay for the proposed management approach?

White edged nightshade is primarily a agricultural weed, with the agricultural sector being the primary beneficiary. A 70% targeted rate, 30% general rate is proposed.

YELLOW WATER LILY
Nuphar lutea

ERADICATION

Relevant biology

ATTRIBUTE	DESCRIPTION
Form	Plants have both floating and submerged leaves. Floating leaves are oval, up to 30 cm long by 40 cm wide, with a deep indent at one end. Leaves are tough, leathery and dark green. Stout, tuber-like rhizomes up to 10 cm in diameter grow on the bottom to a depth of 3 m. Stalked, solitary buttercup-like 4–6 cm diameter flowers rise well above the leaves. Flowers have a strongly alcoholic aroma, hence the common name 'brandy bottle'. Fruit are 2–3 cm long, green, and flask-shaped.
Habitat	Slow-running, shallow (up to 2 m deep) nutrient-rich streams, lakes, reservoirs, ponds and canals.
Regional distribution	Very limited distribution. Only found at two sites in Hawke's Bay: Horseshoe Lake at Patangata and a nearby farm dam.
Competitive ability	Fast growing, can outcompete all other aquatic plants. Has massive rhizomes that hold nutrient stores.
Reproductive ability	Fruit contain hundreds of long-lived viable seeds.
Dispersal methods	Spread by rhizome fragments and by seed. Can be spread by drain clearing machinery.
Resistance to control	Very difficult to eradicate once established. The most successful method is 3% glyphosate with a penetrant. Aerial spraying is the best method to avoid disturbing the water surface, as leaves lie on or just above the water surface, however it can be sprayed from a boat or the water edge with care. Need to spray in mid to late December during flowering.
Benefits	None

Land use/habitats occupied in Hawke's Bay

LAND USE TYPE	CURRENT INFESTATION	POTENTIAL INFESTATION
Dairy	-	-
Sheep and beef	-	-
Forestry	-	-
Horticulture	-	-
Aquaculture	-	-
Urban	-	-
Native terrestrial	-	-
Coastal land	-	-
Freshwater	Low	High
Estuarine	-	-
Marine	-	-

High = Most infested/preferred land use(s), Low = Less infested/preferred land use(s), - = Unsuitable land use

Qualitative impact assessment

CATEGORY	CURRENT	POTENTIAL	COMMENT	SOURCE
Production				
Dairy	-	-		
Sheep and beef	-	-		
Forestry	-	-		1, 2
Horticulture	-	-		
Aquaculture	-	-		
Other	-	L	Rhizomes may clog up hydro power intakes.	
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	L	M	Blocks up streams and drainage systems, reducing water flow leading to increased siltation and flooding. Reduces oxygen levels in water.	1, 2
Species diversity	L	H	Dense mats of leaves completely cover the water surface and block all light from below; causing die-off of submerged native water plants, excessive water loss from ponds, and oxygen deprivation.	1, 2
Threatened species	-	L	See Species diversity.	1, 2
Social/Cultural				
Human health	-	-		
Recreation	L	M	Completely blocks lakes and waterways, restricting recreational uses such as swimming, fishing, and boating.	2
Māori culture	L	M	See Recreation.	

L = low, M = moderate, H = high

source 1: Environment Canterbury (2013), 2: Hawke's Bay Regional Council (2004b)

Estimated quantitative impacts

Quantitative annual impacts per hectare are calculated as the current or anticipated proportional impact on land value across the region. All amounts are in net present value (NPV, $).

Calculation: **Economic value per land use/habitat type** × **Impact level**

Impact level
Low = 1–4% reduction in annual economic value per hectare
Moderate = 5–9% reduction in annual economic value per hectare
High = 10–50% reduction in annual economic value per hectare

Reduction in annual economic value ($) per hectare

LAND USE/HABITAT TYPE	CURRENT IMPACT PER HA	POTENTIAL IMPACT PER HA
Production		
Dairy	0	0
Sheep and beef	0	0
Forestry	0	0
Horticulture	0	0
Aquaculture	0	0
Environment/Social/Cultural		
Urban	0	0
Native terrestrial	0	0
Coastal	0	0
Freshwater	190.70–1,092.40	1,907.00–13,655.00
Estuarine	0	0
Marine	0	0

Cost-benefit analysis results

Proposed management programme: **Eradication**
Area of Programme: **whole region ha**
Proposed annual expenditure by Council: **$444**

Assumptions

ASSUMPTIONS	VALUES	ASSUMPTIONS	VALUES
Current area infested	0.0001 ha	Time to reach maximum extent†	75 yrs
Current impacts★	$641.55/ha	Potential extent in the region°	2,090 ha
	$190.7–1,092.4/ha		696.73–3,483.62 ha
Current benefits	$0/ha	Discount rate	4%

★ Current annual impact of the pest averaged across all land uses currently occupied.

° The potential extent the pest is predicted to achieve in the absence of regional management.

† The time a pest is predicted to take between first going wild in the region and reaching its maximum extent.

10 year assessment

The cost-benefit analysis indicates that the benefits of the proposed management programme over the next 10 years will be of net benefit to the region.

SCENARIO	PEST IMPACTS★	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNERS COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$32,947	$0		$0	$0	$0	
	min: 5,129						
	max: 172,037						
Eradication	$0	$0	$32,947	$3,745	$0	$0	$29,202
	min: 0		min: 5,129				min: 1,384
	max: 1		max: 172,036				max: 168,291

★ Includes economic, environmental and social costs.

° The estimated economic benefit provided by the pest.

† Administration and implementation costs incurred by the Council through the programme.

‡ Costs of control imposed on landowners through the programme, over and above the costs already being paid by landowners, as estimated by the Council. They are applied for the 10 years of the Plan.

50 year assessment

The longer-term cost-benefit analysis indicates that the monetised benefits over the next 50 years of the proposed management programme will be of net benefit to the region. Additional non-monetised benefits associated with the protection of biodiversity values are also anticipated.

SCENARIO	PEST IMPACTS★	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNERS COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$23,245,523	$0		$0	$0	$0	
	min: 3,423,152						
	max: 122,357,378						
Eradication	$0	$0	$23,245,523	$8,839	$0	$0	$23,236,684
	min: 0		min: 3,423,152				min: 3,414,313
	max: 2		max: 122,357,376				max: 122,348,537

CBA statement and risks to success

Yellow water can invade permanent water of lakes and slow-flowing streams over mud and silt, outcompeting all other aquatic plants. Eradication is highly feasible due to it being present at only two isolated spots in the region. The cost to eradicate yellow water lily is cost beneficial both over a 10 year and 50 year period.

The benefits of regional intervention, focused on eradicating yellow water lily from the region, outweigh the cost of the programme.

Risks of the programme being unsuccessful in achieving objectives

RISK	LEVEL OF RISK	EXPLANATION
Technical risk	Low	
Operational risk	Low	
Legal risk	Low	
Socio-political risk	Low	
Other risks	Low	

Who should pay?

Beneficiaries and exacerbators

GROUP	BENEFICIARY	EXACERBATOR	CHANGE BEHAVIOUR	ASSESS COSTS & BENEFITS
Land occupiers (Crown and private)	Minor	Major	Yes	Yes
Regional community	Major		No	Yes

Who should pay for the proposed management approach?

The primary impact of yellow water lily is on biodiversity values. For this reason it is proposed that this programme is funded through the general rate.

PROGRESSIVE CONTAINMENT

JAPANESE HONEYSUCKLE
Lonicera japonica

PROGRESSIVE CONTAINMENT

Relevant biology

ATTRIBUTE	DESCRIPTION
Form	Evergreen woody vine (semi-evergreen in cold climates). Stems are purplish, long, tough and hairy, and twine in a clockwise direction. Leaves are oval, stalkless or on short stalks and in opposite pairs. Flowers are sweetly-scented, tubular and coloured white, ageing to yellow. Flowers September-May. Berries are glossy, black and egg shaped, 5–7 mm in diameter. Seeds are c.2mm in diameter.
Habitat	Roadsides, riverbanks, hedges, shelterbelts, disturbed forest and forest edges. As it is palatable to stock it is generally only found in retired areas, usually around the margins.
Regional distribution	Region-wide but major infestations occur from the Devils Elbow to northern Wairoa.
Competitive ability	Tolerates moderate shade, frost, salt, damage, wet or dry, most soils, and high to low temperature. Has a moderate-fast growth rate.
Reproductive ability	Produces viable fleshy fruit, but is a relatively poor seeder.
Dispersal methods	Mainly dispersed by birds, possibly possums. Also spread by roading machinery, dumped vegetation, soil and fill.
Resistance to control	Small plants can be dug out. Plants can be hard to kill. Cut stumps re-sprout and need herbicide treatment (e.g. with Escort). Poor seeder, so sites usually remain clear after treatment, as long as all living material has been removed. Stock browsing can control its growth.
Benefits	Nectar for birds and insects.

Land use/habitats occupied in Hawke's Bay

LAND USE TYPE	CURRENT INFESTATION	POTENTIAL INFESTATION
Dairy	Low	Low
Sheep and beef	Low	Low
Forestry	Low	High
Horticulture	Low	Low
Aquaculture	-	-
Urban	Low	High
Native terrestrial	Low	High
Coastal land	Low	Low
Freshwater	-	-
Estuarine	-	-
Marine	-	-

High = Most infested/preferred land use(s), Low = Less infested/preferred land use(s), - = Unsuitable land use

Qualitative impact assessment

CATEGORY	CURRENT	POTENTIAL	COMMENT	SOURCE
Production				
Dairy	-	-		
Sheep and beef	-	-		
Forestry	-	-		
Horticulture	-	-		
Aquaculture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	M	M	Forms dense, long-lived masses that climb over and smoth most plants from ground to medium canopy height. Damage is most severe in young or regenerating bush. Can cause canopy collapse and succession to grasses or ground vines. Provides support for faster-growing vines (e.g. morning glory, mothplant).	1, 2
Threatened species	L	M	Could smother rare native vines and shrubs that occupy forest edge habitats (e.g. Pittosporum obcordatum, Brachygottis sciadophila).	2
Social/Cultural				
Human health	-	-		
Recreation	-	-		
Māori culture	-	-		

L = low, M = moderate, H = high
source 1: Craw (2000), 2: Department of Conservation (2001)

Estimated quantitative impacts

Quantitative annual impacts per hectare are calculated as the current or anticipated proportional impact on land value across the region. All amounts are in net present value (NPV, $).

Calculation: **Economic value per land use/habitat type** × **Impact level**

Impact level
Low = 1–4% reduction in annual economic value per hectare
Moderate = 5–9% reduction in annual economic value per hectare
High = 10–50% reduction in annual economic value per hectare

Reduction in annual economic value ($) per hectare

LAND USE/HABITAT TYPE	CURRENT IMPACT PER HA	POTENTIAL IMPACT PER HA
Production		
Dairy	0	0
Sheep and beef	0	0
Forestry	0	0
Horticulture	0	0
Aquaculture	0	0
Environment/Social/Cultural		
Urban	0	0
Native terrestrial	27.80–61.20	27.80–61.20
Coastal	62.35–137.25	62.35–137.25
Freshwater	0	0
Estuarine	0	0
Marine	0	0

Cost-benefit analysis results

Proposed management programme: **Site-led**

Area of Programme: **995 ha**

Proposed annual expenditure by Council: **$5,000**

Assumptions

ASSUMPTIONS	VALUES	ASSUMPTIONS	Values
Current area infested	1 ha	Time to reach maximum extent †	100 yrs
Current impacts ★	$17.32/ha	Potential extent in the region °	43 ha
	$10.82–23.82/ha		14.84–71.35 ha
Current benefits	$0/ha	Discount rate	4%

★ Current annual impact of the pest averaged across all land uses currently occupied.

° The potential extent the pest is predicted to achieve in the absence of regional management.

† The time a pest is predicted to take between first going wild in the region and reaching its maximum extent.

10 year assessment

The cost-benefit analysis indicates that the benefits of the proposed management programme over the next 10 years will not be of net benefit to the region with the assumptions made.

SCENARIO	PEST IMPACTS ★	PEST VALUES °	BENEFIT	COUNCIL COSTS †	LANDOWNERS COMPLIANCE COSTS ‡	AGENCY COMPLIANCE COSTS ‡	NET BENEFIT
No intervention	$282	$0		$0	$0	$0	
	min: 167						
	max: 428						
Site-led	$33	$0	$249	$19,980	$16,871	$12,653	$-49,255
	min: 16		min: 151		min: 16,871		min: -49,353
	max: 66		max: 362		max: 16,871		max: -49,142

★ Includes economic, environmental and social costs.

° The estimated economic benefit provided by the pest.

† Administration and implementation costs incurred by the Council through the programme.

‡ Costs of control imposed on landowners through the programme, over and above the costs already being paid by landowners, as estimated by the Council. They are applied for the 10 years of the Plan.

50 year assessment

The longer-term cost-benefit analysis indicates that the monetised benefits of the proposed management programme over the next 50 years will still not be of net benefit to the region with the assumptions made.

SCENARIO	PEST IMPACTS*	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNERS COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$3,549	$0		$0	$0	$0	
	min: 1,583						
	max: 9,958						
Site-led	$33	$0	$3,516	$26,574	$16,871	$12,653	$-52,582
	min: 16		min: 1,567		min: 16,871		min: -54,531
	max: 66		max: 9,892		max: 16,871		max: -46,206

CBA statement and risks to success

Japanese honeysuckle forms dense, long-lived masses that climb over and smother most plants from ground to medium canopy height. Damage is most severe in young or regenerating bush. Can cause canopy collapse and succession to grasses or ground vines, in particular rare native vines and shrubs that occupy forest edge habitats (e.g. *Pittosporum obcordatum, Brachygottis sciadophila*).

This programme only applies to the Japanese honeysuckle containment area, which encompasses Lake Tūtira and Tūtira Regional Park. The regional park has an important function as a sustainable land use demonstration area which has had thousands of trees planted by school students, community groups, organisations, and HBRC staff volunteers. Lake Tūtira is also one of the six Annual Plan 2017-18 Six Hotspots sites. Although the cost benefit analysis has come out negative, this containment area has been in place for 11 years and has been successful in protecting the investment undertaken by the community. Given the low cost and success of the programme, this programme will remain in place.

Risks of the programme being unsuccessful in achieving objectives

RISK	LEVEL OF RISK	EXPLANATION
Technical risk	Low	
Operational risk	Low	
Legal risk	Low	
Socio-political risk	Low	
Other risks	Low	

Who should pay?

Beneficiaries and exacerbators

GROUP	BENEFICIARY	EXACERBATOR	CHANGE BEHAVIOUR	ASSESS COSTS & BENEFITS	CONTROL COST EFFECTIVELY
Land occupiers (Crown and private)	Major	Major	Yes	Yes	Yes
Dairy/sheep and beef sector	Major		No	Yes	Yes
Regional community	Major		No	Yes	Yes

Who should pay for the proposed management approach?

Japanese honeysuckle is an environmental pest. This progamme only applies to the Japanese honeysuckle containment area, which encompasses Lake Tūtira and Tūtira Regional Park. It is therefore proposed this programme is funded through the general rate.

OLD MAN'S BEARD
Clematis vitalba

PROGRESSIVE CONTAINMENT

Relevant biology

ATTRIBUTE	DESCRIPTION
Form	Deciduous woody vine which grows along the ground or over trees and shrubs. Prolific white flowers.
Habitat	Scrub, wasteland, among willows, forest remnants, hedgerows, roadsides, river banks, in gardens, disturbed native bush, shelterbelts. Prefers well-drained soils.
Regional distribution	Widespread south of State Highway 5, more limited infestations occur north of State Highway 5.
Competitive ability	Rapid growth rate. Can completely shade out canopy species, preferring well-drained alluvial soil. Light-demanding in seedling stage.
Reproductive ability	Produces >10,000 seeds per sq m, which remain viable on the vine over winter. Seed has an awn that enables it to bury into the soil for germination. Germination rate >80%.
Dispersal methods	Usually spread by wind over short distances, or water over long distances. Can also be spread in road gravel.
Resistance to control	Difficult to 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 reducing plant vigour and killing seedlings.
Benefits	None

Land use/habitats occupied in Hawke's Bay

LAND USE TYPE	CURRENT INFESTATION	POTENTIAL INFESTATION
Dairy	-	Low
Sheep and beef	-	Low
Forestry	Low	High
Horticulture	Low	Low
Aquaculture	-	-
Urban	Low	Low
Native terrestrial	Low	High
Coastal land	-	Low
Freshwater	-	-
Estuarine	-	-
Marine	-	-

High = Most infested/preferred land use(s), Low = Less infested/preferred land use(s), - = Unsuitable land use

Qualitative impact assessment

CATEGORY	CURRENT	POTENTIAL	COMMENT	SOURCE
Production				

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

L = low, M = moderate, H = high

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

Estimated quantitative impacts

Quantitative annual impacts per hectare are calculated as the current or anticipated proportional impact on land value across the region. All amounts are in net present value (NPV, $).

Calculation: **Economic value per land use/habitat type** × **Impact level**

Impact level

Low = 1–4% reduction in annual economic value per hectare

Moderate = 5–9% reduction in annual economic value per hectare

High = 10–50% reduction in annual economic value per hectare

Reduction in annual economic value ($) per hectare

LAND USE/HABITAT TYPE	CURRENT IMPACT PER HA	POTENTIAL IMPACT PER HA
Production		
Dairy	0	0
Sheep and beef	0	0
Forestry	17.47–85.40	87.35–192.15
Horticulture	0	105.11–790.40
Aquaculture	0	0
Environment/Social/Cultural		
Urban	0	0
Native terrestrial	27.80–61.20	55.60–340.00
Coastal	0	124.70–762.50
Freshwater	0	0
Estuarine	0	0
Marine	0	0

Cost-benefit analysis results

Proposed management programme: **Site-led**
Area of Programme: **717,848.2 ha**
Proposed annual expenditure by Council: **$50,000**

Assumptions

ASSUMPTIONS	VALUES	ASSUMPTIONS	VALUES
Current area infested	50 ha	Time to reach maximum extent†	125 yrs
Current impacts★	$47.93/ha	Potential extent in the region°	45,924 ha
	$22.61–73.24/ha		15,780.22–76,068.09 ha
Current benefits	$0/ha	Discount rate	4%

★ Current annual impact of the pest averaged across all land uses currently occupied.

° The potential extent the pest is predicted to achieve in the absence of regional management.

† The time a pest is predicted to take between first going wild in the region and reaching its maximum extent.

10 year assessment

The cost-benefit analysis indicates that the benefits of the proposed management programme over the next 10 years will not be of net benefit to the region with the assumptions made.

SCENARIO	PEST IMPACTS★	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNERS COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$45,868	$0		$0	$0	$0	
	min: 20,426						
	max: 76,407						
Site-led	$3,504	$0	$42,364	$104,551	$168,707	$84,353	$-315,247
	min: 1,653		min: 18,773		min: 168,707		min: -338,838
	max: 5,355		max: 71,052		max: 168,707		max: -286,559

★ Includes economic, environmental and social costs.

° The estimated economic benefit provided by the pest.

† Administration and implementation costs incurred by the Council through the programme.

‡ Costs of control imposed on landowners through the programme, over and above the costs already being paid by landowners, as estimated by the Council. They are applied for the 10 years of the Plan.

50 year assessment

The longer-term cost-benefit analysis indicates that the monetised benefits over the next 50 years of the proposed management programme will be of net benefit to the region. Additional non-monetised benefits associated with the protection of biodiversity values are also anticipated.

SCENARIO	PEST IMPACTS★	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNERS COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$2,235,712	$0		$0	$0	$0	
	min: 761,436						
	max: 5,813,234						
Site-led	$3,504	$0	$2,232,208	$110,706	$168,707	$84,353	$1,868,442
	min: 1,653		min: 759,783		min: 168,707		min: 396,017
	max: 5,355		max: 5,807,879		max: 168,707		max: 5,444,113

CBA statement and risks to success

Old man's beard is an invasive climber which can form dense, heavy, permanent masses that can smother and kills all plants to highest canopy (especially on forest edges and along riparian margins). Old man's beard is widespread south of State Highway 5 in Hawke's Bay. The Council do not believe that the benefits of control in this area would outweigh the costs imposed on land occupiers in continuing to require them to control old man's beard.

North of State Highway 5 in Hawke's Bay, old man's beard is not so widespread and Council believe that this is still worthwhile to require land occupiers to continue to control it. There are a large number of native bush fragments throughout this landscape that would be significantly negatively impacted by Old man's beard if left unmanaged.

The old man's beard control line is defined as being the line defined by State Highway 5 from the region's western boundary to its junction with State Highway 2, then along State Highway 2 from its junction with State Highway 5 to the Esk River, then down the Esk River from the State Highway 2 bridge to the sea as shown in Figure 7.

The CBA for Old man's beard suggests that this form of regional intervention will have monetarised benefits over a 50 year timeframe.

Risks of the programme being unsuccessful in achieving objectives

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

Who should pay?

Beneficiaries and exacerbators

GROUP	BENEFICIARY	EXACERBATOR	CHANGE BEHAVIOUR	ASSESS COSTS & BENEFITS	CONTROL COST EFFECTIVELY
Land occupiers (Crown and private)	Minor	Major	Yes	Yes	Yes
Forestry sector	Minor		Yes	Yes	Yes
Anyone intentionally dumping or disposing of the plant		Major	Yes	Yes	Yes
Regional community	Major		No	Yes	Yes

Who should pay for the proposed management approach?

Old man's beard is a major threat to biodiversity values in the Hawke's Bay region. To maximise the effectiveness of individual control across the region and to minimise the externality impacts of the plant the Council has proposed an advisory, inspectorial, and compliance regime. The benefits of this programme are a public good rather than a private good. It is proposed this programme is funded through the general rate.

APPLE OF SODOM

Solanum linnaeanum

PROGRESSIVE CONTAINMENT

Relevant biology

ATTRIBUTE	DESCRIPTION
Form	Strongly spiny, woody, perennial shrub up to 1 m tall. Green and white berries ripen to yellow.
Habitat	Frost-free coastal areas, poor pasture and scrub margins.
Regional distribution	Occurs from Napier to Tangoio, and is bounded inland by a line from Waipunga Road to Seafield Road. Bayview/Eskdale area.
Competitive ability	Can out-compete some species in coastal areas, but does not usually form pure stands.
Reproductive ability	Produces viable seed.
Dispersal methods	Seeds dispersed by birds.
Resistance to control	Can be controlled with picloram.
Benefits	None

Land use/habitats occupied in Hawke's Bay

LAND USE TYPE	CURRENT INFESTATION	POTENTIAL INFESTATION
Dairy	-	High
Sheep and beef	Low	High
Forestry	Low	Low
Horticulture	-	Low
Aquaculture	-	-
Urban	-	Low
Native terrestrial	Low	Low
Coastal land	-	Low
Freshwater	-	-
Estuarine	-	-
Marine	-	-

High = Most infested/preferred land use(s), Low = Less infested/preferred land use(s), - = Unsuitable land use

Qualitative impact assessment

CATEGORY	CURRENT	POTENTIAL	COMMENT	SOURCE
Production				
Dairy	-	M	Forms dense thickets, which reduce pasture growth. Leaves and unripe fruit are toxic to stock.	
Sheep and beef	L	M	See Dairy.	
Forestry	-	-		1, 2, 3
Horticulture	-	-		
Aquaculture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	L	L	Forms dense thickets in coastal areas, excluding low-growing native species.	1
Threatened species	-	L	See Species diversity.	1
Social/Cultural				
Human health	-	M	Leaves and unripe fruit are poisonous to humans.	1, 2
Recreation	-	M	Spiny shrub restricts access to beaches.	1, 2
Māori culture	-	M	Obstructs access to cultural sites (e.g. waahi tapu, urupa).	

L = low, M = moderate, H = high
source 1: Craw (2000), 2: Roy et al. (2004), 3: Environment Bay of Plenty (2004a)

Estimated quantitative impacts

Quantitative annual impacts per hectare are calculated as the current or anticipated proportional impact on land value across the region. All amounts are in net present value (NPV, $).

Calculation: **Economic value per land use/habitat type** × **Impact level**

Impact level
Low = 1–4% reduction in annual economic value per hectare
Moderate = 5–9% reduction in annual economic value per hectare
High = 10–50% reduction in annual economic value per hectare

Reduction in annual economic value ($) per hectare

LAND USE/HABITAT TYPE	CURRENT IMPACT PER HA	POTENTIAL IMPACT PER HA
Production		
Dairy	0	273.15–600.93
Sheep and beef	7.39–36.12	36.95–81.27
Forestry	0	0
Horticulture	0	0
Aquaculture	0	0
Environment/Social/Cultural		
Urban	0	26.64–126.11
Native terrestrial	5.56–27.20	5.56–27.20
Coastal	0	62.35–137.25
Freshwater	0	0
Estuarine	0	0
Marine	0	0

Cost-benefit analysis results

Proposed management programme: **Progressive Containment**
Area of Programme: **whole region ha**
Proposed annual expenditure by Council: **$12,000**

Assumptions

ASSUMPTIONS	VALUES	ASSUMPTIONS	VALUES
Current area infested	0.05 ha	Time to reach maximum extent†	150 yrs
Current impacts★	$17.36/ha	Potential extent in the region°	141,219 ha
	$5.89–28.82/ha		47,967.83–234,470.6 ha
Current benefits	$0/ha	Discount rate	4%

★ Current annual impact of the pest averaged across all land uses currently occupied.

° The potential extent the pest is predicted to achieve in the absence of regional management.

† The time a pest is predicted to take between first going wild in the region and reaching its maximum extent.

10 year assessment

The cost-benefit analysis indicates that the benefits of the proposed management programme over the next 10 years may be of net benefit to the region.

SCENARIO	PEST IMPACTS★	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNERS COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$35,700	$0		$0	$0	$0	
	min: 10,579						
	max: 158,486						
Progressive Containment	$2	$0	$35,698	$49,961	$33,741	$8,435	$-56,439
	min: 0		min: 10,579		min: 33,741		min: -81,558
	max: 7		max: 158,479		max: 33,741		max: 66,342

★ Includes economic, environmental and social costs.

° The estimated economic benefit provided by the pest.

† Administration and implementation costs incurred by the Council through the programme.

‡ Costs of control imposed on landowners through the programme, over and above the costs already being paid by landowners, as estimated by the Council. They are applied for the 10 years of the Plan.

50 year assessment

The longer-term cost-benefit analysis indicates that the monetised benefits over the next 50 years of the proposed management programme will be of net benefit to the region. Additional non-monetised benefits associated with the protection of biodiversity values are also anticipated.

SCENARIO	PEST IMPACTS*	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNERS COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$3,714,842	$0		$0	$0	$0	
	min: 1,216,547						
	max: 15,926,706						
Progressive Containment	$2	$0	$3,714,840	$56,977	$33,741	$8,435	$3,615,687
	min: 0		min: 1,216,547		min: 33,741		min: 1,117,394
	max: 7		max: 15,926,699		max: 33,741		max: 15,827,546

CBA statement and risks to success

Apple of Sodom is regarded as an invasive species in Australia, Hawaii, Fiji, New Caledonia, and other Pacific Islands. It produces large number of seeds. Its spines discourage herbivores from grazing on it, giving it a competitive advantage over more palatable species. It forms dense thickets in coastal areas, excluding low-growing native species. Seed dispersal by birds adds to the threat characteristics. The known distribution in Hawke's Bay is centred on the Bay View area, stretching from Napier to Tangoio. It is bounded inland by a line from Waipunga Road across to Seafield Road.
The CBA for Apple of Sodom suggests that this form of regional intervention will have monetarised benefits over a 50 year timeframe.

Risks of the programme being unsuccessful in achieving objectives

RISK	LEVEL OF RISK	EXPLANATION
Technical risk	Low	
Operational risk	Low	
Legal risk	Low	
Socio-political risk	Low	
Other risks	Low	

Who should pay?

Beneficiaries and exacerbators

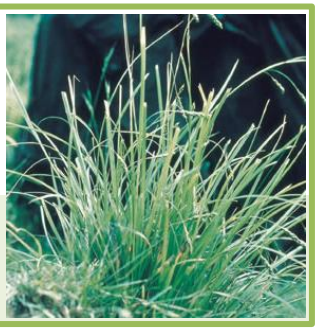
GROUP	BENEFICIARY	EXACERBATOR	CHANGE BEHAVIOUR	ASSESS COSTS & BENEFITS	CONTROL COST EFFECTIVELY
Land occupiers (Crown and private)	Major	Major	Yes	Yes	Yes
Dairy/sheep and beef sector	Major		No	Yes	Yes
Regional community	Major		No	Yes	Yes

Who should pay for the proposed management approach?

Apple of Sodom is a threat to primary production and biodiversity values in the Hawke's Bay region. To maximise the effectiveness of individual control across the region and to minimise the externality impacts of the plant the Council has proposed an advisory, inspectorial, and compliance regime. The primary beneficiaries of this programme are land occupiers. It is proposed this programme is funded through a 70% targeted rate, 30% general rate.

AUSTRALIAN SEDGE
Carex longebrachiata

PROGRESSIVE CONTAINMENT



Relevant biology

ATTRIBUTE	DESCRIPTION
Form	Strong, harsh, dense tussocks 30–90 cm high. New leaves grow from inside leaf sheath, are about 5 mm wide and Y-shaped in cross-section, appearing yellowish towards tips. Edges are sharp. Seed head is a drooping panicle with green to pale brown seeds hanging at ends of long, thin, cotton-like filaments.
Habitat	Pasture, disturbed scrub, regenerating forest and short tussockland. Prefers seasonally dry habitats.
Regional distribution	Kotemaori, Rapunga and Mangopoike in the Wairoa District.
Competitive ability	Forms dense, long-lived clumps that exclude other grass species. Tough roots cannot be pulled by livestock. Tolerates fire, hot to moderately cold, wet, drought, wind, salt, poor soils, damage, and semi-shade. Has difficulty invading well-managed pastures.
Reproductive ability	Produces many long-lived seeds in open areas.
Dispersal methods	Seeds can disperse long distances by wind, water, livestock, and farm machinery.
Resistance to control	Control with glyphosate, then replant with other species. Grazing not effective control, only spreads seed. Need to exclude stock. Re-seeds prolifically. Re-sprouts from crown.
Benefits	None

Land use/habitats occupied in Hawke's Bay

LAND USE TYPE	CURRENT INFESTATION	POTENTIAL INFESTATION
Dairy	-	High
Sheep and beef	Low	High
Forestry	-	Low
Horticulture	-	-
Aquaculture	-	-
Urban	-	-
Native terrestrial	-	Low
Coastal land	-	-
Freshwater	-	-
Estuarine	-	-
Marine	-	-

High = Most infested/preferred land use(s), Low = Less infested/preferred land use(s), - = Unsuitable land use

Qualitative impact assessment

CATEGORY	CURRENT	POTENTIAL	COMMENT	SOURCE
Production				
Dairy	-	L	Can form dense swards, which crowd out pasture grasses. Unpalatable to stock. Persists under canopy.	
Sheep and beef	L	M	See Dairy.	
Forestry	-	-		1
Horticulture	-	-		
Aquaculture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	-	M	Suppresses native plants and seedlings along scrub and forest margins, and remains an obstruction under regenerating canopy. Crowds out low-growing native species in tussock grasslands. Fire hazard. Harbours rats and mice.	1, 2
Threatened species	-	L	See Species diversity.	1
Social/Cultural				
Human health	-	-		
Recreation	-	L	Can be difficult to walk through.	1
Māori culture	-	-		

L = low, M = moderate, H = high

source 1: Waikato Regional Council (2011), 2: Taranaki Regional Council (2012)

Estimated quantitative impacts

Quantitative annual impacts per hectare are calculated as the current or anticipated proportional impact on land value across the region. All amounts are in net present value (NPV, $).

Calculation: **Economic value per land use/habitat type** × **Impact level**

Impact level

Low = 1–4% reduction in annual economic value per hectare

Moderate = 5–9% reduction in annual economic value per hectare

High = 10–50% reduction in annual economic value per hectare

Reduction in annual economic value ($) per hectare

LAND USE/HABITAT TYPE	CURRENT IMPACT PER HA	POTENTIAL IMPACT PER HA
Production		
Dairy	0	54.63–267.08
Sheep and beef	7.39–36.12	36.95–81.27
Forestry	0	0
Horticulture	0	0
Aquaculture	0	0
Environment/Social/Cultural		
Urban	0	0
Native terrestrial	0	27.80–61.20
Coastal	0	0
Freshwater	0	0
Estuarine	0	0
Marine	0	0

Cost-benefit analysis results

Proposed management programme: **Progressive Containment**

Area of Programme: **whole region ha**

Proposed annual expenditure by Council: **$21,000**

Assumptions

ASSUMPTIONS	VALUES	ASSUMPTIONS	VALUES
Current area infested	2 ha	Time to reach maximum extent†	75 yrs
Current impacts★	$21.75/ha	Potential extent in the region°	140,064 ha
	$7.39–36.12/ha		47,505.58–232,621.6 ha
Current benefits	$0/ha	Discount rate	4%

★ Current annual impact of the pest averaged across all land uses currently occupied.

° The potential extent the pest is predicted to achieve in the absence of regional management.

† The time a pest is predicted to take between first going wild in the region and reaching its maximum extent.

10 year assessment

The cost-benefit analysis indicates that the benefits of the proposed management programme over the next 10 years may be of net benefit to the region.

SCENARIO	PEST IMPACTS★	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNERS COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$122,901	$0		$0	$0	$0	
	min: 37,235						
	max: 542,271						
Progressive Containment	$64	$0	$122,837	$47,666	$84,353	$0	$-9,182
	min: 22		min: 37,213		min: 84,353		min: -94,806
	max: 170		max: 542,101		max: 84,353		max: 410,082

★ Includes economic, environmental and social costs.

° The estimated economic benefit provided by the pest.

† Administration and implementation costs incurred by the Council through the programme.

‡ Costs of control imposed on landowners through the programme, over and above the costs already being paid by landowners, as estimated by the Council. They are applied for the 10 years of the Plan.

50 year assessment

The longer-term cost-benefit analysis indicates that the monetised benefits over the next 50 years of the proposed management programme will be of net benefit to the region. Additional non-monetised benefits associated with the protection of biodiversity values are also anticipated.

SCENARIO	PEST IMPACTS★	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNERS COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$98,973,655	$0		$0	$0	$0	
	min: 31,940,698						
	max: 427,215,366						
Progressive Containment	$64	$0	$98,973,591	$53,821	$84,353	$0	$98,835,417
	min: 22		min: 31,940,676		min: 84,353		min: 31,802,502
	max: 170		max: 427,215,196		max: 84,353		max: 427,077,022

CBA statement and risks to success

Australian sedge suppresses native plants and seedlings along scrub and forest margins, and remains an obstruction under regenerating canopy. It crowds out low-growing native species in tussock grasslands. Australian sedge prefers land which is seasonally dry and is well suited to the climate and soils of Hawke's Bay. It invades disturbed scrub, regenerating forest and short tussock grasslands, but does not compete successfully with vigorous, well managed pastures. Australian sedge is a prolific seeder, but the seeds are relatively heavy and most fall close to the parent plant. Animals may spread seeds. The leaves are generally not palatable to stock. Once established it can be difficult to control. Infestations in Hawke's Bay occur throughout the Wairoa District.

The benefits of regional intervention, focused on sustainably controlling Australian Sedge as part of a Progressive Containment programme, outweigh the cost of the programme.

Risks of the programme being unsuccessful in achieving objectives

RISK	LEVEL OF RISK	EXPLANATION
Technical risk	Low	
Operational risk	Low	
Legal risk	Low	
Socio-political risk	Low	
Other risks	Low	

Who should pay?

Beneficiaries and exacerbators

GROUP	BENEFICIARY	EXACERBATOR	CHANGE BEHAVIOUR	ASSESS COSTS & BENEFITS	CONTROL COST EFFECTIVELY
Land occupiers (Crown and private)	Major	Major	Yes	Yes	Yes
Dairy/sheep and beef sector	Major		No	Yes	Yes
Regional community	Major		No	Yes	Yes

Who should pay for the proposed management approach?

Australian sedge is a threat to primary production and biodiversity values in the Hawke's Bay region. To maximise the effectiveness of individual control across the region and to minimise the externality impacts of the plant the Council has proposed an advisory, inspectorial, and compliance regime. The primary beneficiaries of this programme are land occupiers. It is proposed this programme is funded through a 70% targeted rate, 30% general rate.

COTTON THISTLE
Onopordum acanthium

PROGRESSIVE CONTAINMENT

Relevant biology

Attribute	Description
Form	Large, pricky biennial plant that can grow to 3 m tall and 1.5 m wide under some conditions. Leaves have a grey velvety appearance. Flowers are dark pink, lavender or purple, globe-shaped and 2.5-6 cm in diameter.
Habitat	Ruderal places, dry pasture, disturbed fields (including those subject to heavy grazing), shingle flats, roadsides, agricultural areas, grasslands, riparian zones, scrub/shrublands, and waterways; especially sites with fertile soils. Prefers dry summers.
Regional distribution	Maraekakaho area, and between Napier, Bayview and Omaranui.
Competitive ability	Large stands are impenetrable, and can displace forage used by stock. Plants are drought resistant and can spread rapidly, as seeds are primarily dispersed by wind. Temperature and moisture, rather than soil nutrient concentrations, determine its ecological performance.
Reproductive ability	One plant produces 70-100 flowering heads containing 100-140 seeds per head. Seed production varies with environmental conditions. Seeds can remain viable for up to 20 years.
Dispersal methods	Primarily spread by wind, however its plumed seeds can also be dispersed by attachment to clothing and animal fur. Seeds may also be transported by water and in hay and machinery.
Resistance to control	Herbicides can by effective (e.g. glyphosphate and Escort) but it is resistant to many commonly used hormone sprays (only in NZ). Healthy, dense pasture in autumn can lessen germination. When mowing is conducted too late, viable seed may still develop following cutting. Because plants can mature at different times, a single mowing is unlikely to provide satisfactory control.
Benefits	Has reportedly been used to treat cancers and ulcers and to diminish discharges of mucous membranes. The receptacle was eaten in earlier times like an artichoke. The cottony hairs on the stem have been occasionally collected to stuff pillows. Oil from seeds has been used in Europe for burning and cooking.

Land use/habitats occupied in Hawke's Bay

LAND USE TYPE	CURRENT INFESTATION	POTENTIAL INFESTATION

Dairy	-	High
Sheep and beef	Low	High
Forestry	-	Low
Horticulture	-	Low
Aquaculture	-	-
Urban	-	-
Native terrestrial	-	-
Coastal land	-	Low
Freshwater	-	-
Estuarine	-	-
Marine	-	-

High = Most infested/preferred land use(s), Low = Less infested/preferred land use(s), - = Unsuitable land use

Qualitative impact assessment

CATEGORY	CURRENT	POTENTIAL	COMEMENT	SOURCE
Production				
Dairy	-	L	Dense stands can restrict stock access to waterways and forage and displace pasture grasses.	
Sheep and beef	M	H	Seed heads can become entangled in wool and fibre, devaluing fleeces and injuring those handling stock and fleece.	
Forestry	-	-		1, 2
Horticulture	-	H	Can contaminate cereal crops.	
Aquaculture	-	-		
Other	-	-		
International trade	-	Nil		
Environment				
Soil resources	-	-		
Water quality	-	-	NIL	
Species diversity	-	-		1
Threatened species	-	-		
Social/Cultural				
Human health	-	-		
Recreation	-	L	Can form large stands on camping grounds, lessening amenity values.	2, 3
Māori culture	-	-		

L = low, M = moderate, H = high

source 1: Invasive Species Specialist Group (2005), 2: Marlborough District Council (2014), 3: Anon. (2013)

Estimated quantitative impacts

Quantitative annual impacts per hectare are calculated as the current or anticipated proportional impact on land value across the region. All amounts are in net present value (NPV, $).

Calculation: **Economic value per land use/habitat type** × **Impact level**

Impact level
Low = 1–4% reduction in annual economic value per hectare
Moderate = 5–9% reduction in annual economic value per hectare
High = 10–50% reduction in annual economic value per hectare

Reduction in annual economic value ($) per hectare

LAND USE/HABITAT TYPE	CURRENT IMPACT PER HA	POTENTIAL IMPACT PER HA
Production		

Dairy	0	54.63–267.08
Sheep and beef	36.95–81.27	73.90–451.50
Forestry	0	0
Horticulture	0	1,051.10–9,880.00
Aquaculture	0	0
Environment/Social/Cultural		
Urban	0	0
Native terrestrial	0	0
Coastal	0	12.47–61.00
Freshwater	0	0
Estuarine	0	0
Marine	0	0

Cost-benefit analysis results

Proposed management programme: **Progressive Containment**

Area of Programme: **whole region ha**

Proposed annual expenditure by Council: **$3,000**

Assumptions

ASSUMPTIONS	VALUES	ASSUMPTIONS	VALUES
Current area infested	0.028 ha	Time to reach maximum extent†	50 yrs
Current impacts★	$59.11/ha	Potential extent in the region°	133,171 ha
	$36.95–81.27/ha		44,748.7–221,594.1 ha
Current benefits	$0/ha	Discount rate	4%

★ Current annual impact of the pest averaged across all land uses currently occupied.

° The potential extent the pest is predicted to achieve in the absence of regional management.

† The time a pest is predicted to take between first going wild in the region and reaching its maximum extent.

10 year assessment

The cost-benefit analysis indicates that the benefits of the proposed management programme over the next 10 years will be of net benefit to the region.

SCENARIO	PEST IMPACTS★	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNERS COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$2,533,837	$0		$0	$0	$0	
	min: 401,686						
	max: 13,092,178						
Progressive Containment	$5	$0	$2,533,832	$17,695	$8,435	$0	$2,507,702
	min: 2		min: 401,684		min: 8,435		min: 375,554
	max: 20		max: 13,092,158		max: 8,435		max: 13,066,028

★ Includes economic, environmental and social costs.

° The estimated economic benefit provided by the pest.

† Administration and implementation costs incurred by the Council through the programme.

‡ Costs of control imposed on landowners through the programme, over and above the costs already being paid by landowners, as estimated by the Council. They are applied for the 10 years of the Plan.

50 year assessment

The longer-term cost-benefit analysis indicates that the monetised benefits over the next 50 years of the proposed management programme will be of net benefit to the region. Additional non-monetised benefits associated with the protection of biodiversity values are also anticipated.

SCENARIO	PEST IMPACTS*	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNERS COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$1,675,003,565	$0		$0	$0	$0	
	min: 251,846,897						
	max: 8,722,430,058						
Progressive Containment	$5	$0	$1,675,003,560	$25,117	$8,435	$0	$1,674,970,008
	min: 2		min: 251,846,895		min: 8,435		min: 251,813,343
	max: 49		max: 8,722,430,009		max: 8,435		max: 8,722,396,457

CBA statement and risks to success

Cotton thistles form large stands that are impenetrable to stock. Plants are drought resistant and can spread rapidly, as seeds are primarily dispersed by wind. Seeds can also be dispersed by attachment to clothing, animal fur, water and in hay and machinery. Seed heads can become entangled in wool and fibre, devaluing fleeces and injuring those handling stock and fleece. The plants contaminate cereal crops in the nearby vicinity. Its distribution in the Hawke's Bay region is presently limited to the Maraekakaho area, and between Napier, Bay View and Omaranui.
The benefits of regional intervention, focused on sustainably controlling cotton thistle as part of a Progressive Containment programme, outweigh the cost of the programme.

Risks of the programme being unsuccessful in achieving objectives

RISK	LEVEL OF RISK	EXPLANATION
Technical risk	Low	
Operational risk	Low	
Legal risk	Low	
Socio-political risk	Low	
Other risks	Low	

Who should pay?

Beneficiaries and exacerbators

GROUP	BENEFICIARY	EXACERBATOR	CHANGE BEHAVIOUR	ASSESS COSTS & BENEFITS	CONTROL COST EFFECTIVELY
Land occupiers (Crown and private)	Major	Major	Yes	Yes	Yes
Dairy/sheep and beef sector	Major		No	Yes	Yes
Regional community	Major		No	Yes	Yes

Who should pay for the proposed management approach?

Cotton thistle is a threat to primary production. To maximise the effectiveness of individual control across the region and to minimise the externality impacts of the plant the Council has proposed an advisory, inspectorial, and compliance regime. The primary beneficiaries of this programme are land occupiers. It is proposed this programme is funded through a 70% targeted rate, 30% general rate.

DARWIN'S BARBERRY
Berberis darwinii

PROGRESSIVE CONTAINMENT

Relevant biology

Attribute	Description
Form	Evergreen shrub up to 4 m tall with holly-like leaves and purple berries.
Habitat	Shade-tolerant, can survive in a variety of habitats, including native forest, shrubland.
Regional distribution	Two areas: Gwavas and Puketitiri
Competitive ability	Can form impenetrable stands. May invade forest as it is shade tolerant.
Reproductive ability	Produces viable seed.
Dispersal methods	Has been planted as a hedge plant in some areas; birds also disperse the seed.
Resistance to control	Can be controlled with appropriate herbicides.
Benefits	None

Land use/habitats occupied in Hawke's Bay

LAND USE TYPE	CURRENT INFESTATION	POTENTIAL INFESTATION
Dairy	-	Low
Sheep and beef	Low	High
Forestry	Low	High
Horticulture	-	-
Aquaculture	-	-
Urban	-	Low
Native terrestrial	Low	High
Coastal land	-	-
Freshwater	-	-
Estuarine	-	-
Marine	-	-

High = Most infested/preferred land use(s), Low = Less infested/preferred land use(s), - = Unsuitable land use

Qualitative impact assessment

CATEGORY	CURRENT	POTENTIAL	COMMENT	SOURCE
Production				
Dairy	-	L	Excludes grass and clover, reducing pasture availability. Not palatable to stock.	
Sheep and beef	L	M	See Dairy.	
Forestry	L	M	Nuisance in plantation forestry.	1
Horticulture	-	-		
Aquaculture	-	-		
Other	-	-		

International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	L	M	Can form impenetrable thickets and compete with native plants in shrubland and regenerating forest. Once established, adult plants are very shade-tolerant and can persist under forest, however seed production is reduced and seedling survival is 10% or less. Will eventually be overtopped by native forest species.	1, 2, 3, 4, 5
Threatened species	-	L	Could be a threat to native species in shrubland and grassland habitats.	1, 2, 5
Social/Cultural				
Human health	-	-		
Recreation	-	L	Prickly spines restrict access.	2
Māori culture	-	L	Could obstruct access to cultural sites (e.g. wāhi tapu, urupa).	

L = low, M = moderate, H = high

source 1: Craw (2000), 2: Environment Canterbury (2006), 3: McAlpine (2005), 4: McAlpine & Jesson (2008), 5: McAlpine & Wotton (2012)

Estimated quantitative impacts

Quantitative annual impacts per hectare are calculated as the current or anticipated proportional impact on land value across the region. All amounts are in net present value (NPV, $).

Calculation: **Economic value per land use/habitat type** × **Impact level**

Impact level

Low = 1–4% reduction in annual economic value per hectare

Moderate = 5–9% reduction in annual economic value per hectare

High = 10–50% reduction in annual economic value per hectare

Reduction in annual economic value ($) per hectare

LAND USE/HABITAT TYPE	CURRENT IMPACT PER HA	POTENTIAL IMPACT PER HA
Production		
Dairy	0	54.63–267.08
Sheep and beef	7.39–36.12	36.95–81.27
Forestry	17.47–85.40	87.35–192.15
Horticulture	0	0
Aquaculture	0	0
Environment/Social/Cultural		
Urban	0	0
Native terrestrial	5.56–27.20	27.80–61.20
Coastal	0	0
Freshwater	0	0
Estuarine	0	0
Marine	0	0

Cost-benefit analysis results

Proposed management programme: **Progressive Containment**
Area of Programme: **whole region ha**
Proposed annual expenditure by Council: **$40,000**

Assumptions

ASSUMPTIONS	VALUES	ASSUMPTIONS	VALUES
Current area infested	2 ha	Time to reach maximum extent†	50 yrs
Current impacts★	$24.86/ha	Potential extent in the region°	198,188 ha
	$8.44–41.27/ha		66,150.86–330,225.4 ha
Current benefits	$0/ha	Discount rate	4%

★ Current annual impact of the pest averaged across all land uses currently occupied.

° The potential extent the pest is predicted to achieve in the absence of regional management.

† The time a pest is predicted to take between first going wild in the region and reaching its maximum extent.

10 year assessment

The cost-benefit analysis indicates that the benefits of the proposed management programme over the next 10 years may be of net benefit to the region.

SCENARIO	PEST IMPACTS★	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNERS COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$234,473	$0		$0	$0	$0	
	min: 77,628						
	max: 1,017,315						
Progressive Containment	$95	$0	$234,378	$120,993	$126,530	$25,306	$-38,451
	min: 25		min: 77,603		min: 126,530		min: -195,226
	max: 393		max: 1,016,922		max: 126,530		max: 744,093

★ Includes economic, environmental and social costs.

° The estimated economic benefit provided by the pest.

† Administration and implementation costs incurred by the Council through the programme.

‡ Costs of control imposed on landowners through the programme, over and above the costs already being paid by landowners, as estimated by the Council. They are applied for the 10 years of the Plan.

50 year assessment

The longer-term cost-benefit analysis indicates that the monetised benefits over the next 50 years of the proposed management programme will be of net benefit to the region. Additional non-monetised benefits associated with the protection of biodiversity values are also anticipated.

SCENARIO	PEST IMPACTS★	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNERS COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$121,554,601	$0		$0	$0	$0	
	min: 45,236,539						
	max: 502,534,575						
Progressive Containment	$95	$0	$121,554,506	$127,587	$126,530	$25,306	$121,275,083
	min: 25		min: 45,236,514		min: 126,530		min: 44,957,091
	max: 393		max: 502,534,182		max: 126,530		max: 502,254,759

CBA statement and risks to success

Darwin's barberry is capable of threatening the purity of indigenous forest by invading intact and undisturbed stands, forming impenetrable thickets. Older plants can flower and produce seeds in the shade and so perpetrate the production of fresh seed. However, the amount of seed is significantly reduced. Regardless, the potential invasion of new habitat is much greater than this suppression. This long-lived hardy plant tolerates moderate to cold temperatures, damp to dry conditions, high wind, salt, shade, damage and a range of soils. It is not browsed by stock. Birds and possibly possums eat the berries and subsequently spread the seeds. Berries are also occasionally spread by soil and water movement. Darwin's barberry is known to infest Gwavas & Puketitiri in the Hawke's Bay region.

The CBA for Darwin's barberry suggests that this form of regional intervention will have monetarised benefits over a 50 year timeframe.

Risks of the programme being unsuccessful in achieving objectives

RISK	LEVEL OF RISK	EXPLANATION
Technical risk	Low	
Operational risk	Low	
Legal risk	Low	
Socio-political risk	Low	
Other risks	Low	

Who should pay?

Beneficiaries and exacerbators

GROUP	BENEFICIARY	EXACERBATOR	CHANGE BEHAVIOUR	ASSESS COSTS & BENEFITS	CONTROL COST EFFECTIVELY
Land occupiers (Crown and private)	Major	Major	Yes	Yes	Yes
Dairy/sheep and beef sector	Major		No	Yes	Yes
Regional community	Major		No	Yes	Yes

Who should pay for the proposed management approach?

Darwin's barberry is a major threat to biodiversity values in the Hawke's Bay region. To maximise the effectiveness of individual control across the region and to minimise the externality impacts of the plant the Council has proposed an advisory, inspectorial, and compliance regime. The benefits of this programme are a public good rather than a private good. It is proposed this programme is funded through the general rate.

LODGEPOLE PINE
Pinus contorta

PROGRESSIVE CONTAINMENT

Relevant biology

Attribute	Description
Form	Small- to medium-sized pine tree; up to 25 m high in lowland areas. Two yellowish-green pine needles per fascicle (bundle), each c.5 cm long, with bluntly pointed tips. Bark reddish-brown, grey on the surface, fissured into small, squarish pieces. Male cones are orange-yellow and arise in clusters around young shoots; female cones arise in separate clusters, usually as a whorl of six reddish-coloured, small flowers. These grow into egg-shaped, green-coloured cones with many brown, sharp spines. Mature female cones are 3–6 cm long, persistent, and usually point backwards or downwards.
Habitat	Grows on a wide range of sites, esp. subalpine areas and low fertility sites e.g. tussockland, herbfield, fernland, disturbed and open forest, shrubland, bare land, mineralised places, screes, and volcanic habitats.
Regional distribution	Kaweka Ranges and upland Rangitaiki areas, and along the western margins of the region.
Competitive ability	An aggressive coloniser, particularly when planted at higher altitudes. Once established, it can replace most other species. Tolerant of hot to very cold, wind, salt, damp to dry, good to poor or mineralised soils. Shade intolerant. Seedlings do not compete well with introduced grasses.
Reproductive ability	Prolific seeder and early maturing - can produce cones after 6 years. Fallen trees can release seed.
Dispersal methods	Seed spread mainly by wind (up to at least 8 km). Planted as a forestry species in the past.
Resistance to control	Can be controlled by hand or herbicides. Regrowth can occur from inadequately slashed plants (i.e. if lower branches with green needles are left). Fire increases seedling numbers.
Benefits	Used for shelterbelts in areas with harsh climates, and erosion control.

Land use/habitats occupied in Hawke's Bay

LAND USE TYPE	CURRENT INFESTATION	POTENTIAL INFESTATION
Dairy	-	-
Sheep and beef	Low	Low
Forestry	Low	High
Horticulture	-	-
Aquaculture	-	-
Urban	-	-
Native terrestrial	Low	High
Coastal land	-	Low
Freshwater	-	-
Estuarine	-	-
Marine	-	-

High = Most infested/preferred land use(s), Low = Less infested/preferred land use(s), - = Unsuitable land use

Qualitative impact assessment

CATEGORY	CURRENT	POTENTIAL	COMMENT	SOURCE
Production				
Dairy	-	L	Can shade out and displace pasture species, particularly in higher altitude areas.	
Sheep and beef	M	H	See Dairy.	
Forestry	L	M	Could compete with more desirable plantation species.	1, 2
Horticulture	-	-		
Aquaculture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	L	L	Can alter nutrient profiles and mycorrhizal communities of soils.	1, 3
Water quality	-	L	Leaf litter affects water quality, can destroy freshwater habitats. Plantations remove ground water in summer, fail to retain it in winter, causing drought and flooding.	1, 3
Species diversity	M	H	Becomes permanent canopy species and forms dense, often pure stands, esp. on poor soils. Modifies habitat and extends forest above native treeline. Leaf litter inhibits growth of understory species.	1, 2, 3, 4
Threatened species	L	M	Major threat to rare plant species in subalpine/alpine grasslands and other non-forested habitats.	1, 3, 4
Social/Cultural				
Human health	-	-	There is no substantiated evidence for lodgepole pine pollen causing allergies.	5
Recreation	L	M	Forms dense stands which restrict access for trampers and hunters.	1
Māori culture	-	-		

L = low, M = moderate, H = high

source 1: Ledgard (2001), 2: EBOP (2005), 3: Craw (2000), 4: Ministry of Agriculture and Forestry (2008), 5: Anon. (2009c)

Estimated quantitative impacts

Quantitative annual impacts per hectare are calculated as the current or anticipated proportional impact on land value across the region. All amounts are in net present value (NPV, $).

Calculation: **Economic value per land use/habitat type** × **Impact level**

Impact level
Low = 1–4% reduction in annual economic value per hectare
Moderate = 5–9% reduction in annual economic value per hectare
High = 10–50% reduction in annual economic value per hectare

Reduction in annual economic value ($) per hectare

LAND USE/HABITAT TYPE	CURRENT IMPACT PER HA	POTENTIAL IMPACT PER HA
Production		
Dairy	0	54.63–267.08
Sheep and beef	36.95–81.27	73.90–451.50
Forestry	17.47–85.40	87.35–192.15
Horticulture	0	0
Aquaculture	0	0
Environment/Social/Cultural		
Urban	0	0
Native terrestrial	27.80–61.20	55.60–340.00
Coastal	0	124.70–762.50
Freshwater	0	0
Estuarine	0	0
Marine	0	0

Cost-benefit analysis results

Proposed management programme: **Progressive Containment**
Area of Programme: **whole region ha**
Proposed annual expenditure by Council: **$55,000**

Assumptions

ASSUMPTIONS	VALUES	ASSUMPTIONS	VALUES
Current area infested	1,000 ha	Time to reach maximum extent†	125 yrs
Current impacts★	$54.66/ha	Potential extent in the region°	94,175 ha
	$32.02–77.3/ha		32,763.57–155,585.5 ha
Current benefits	$0/ha	Discount rate	4%

★ Current annual impact of the pest averaged across all land uses currently occupied.

° The potential extent the pest is predicted to achieve in the absence of regional management.

† The time a pest is predicted to take between first going wild in the region and reaching its maximum extent.

10 year assessment

The cost-benefit analysis indicates that the benefits of the proposed management programme over the next 10 years will be of net benefit to the region.

SCENARIO	PEST IMPACTS★	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNERS COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$933,029	$0		$0	$0	$0	
	min: 487,083						
	max: 1,486,870						
Progressive Containment	$128,539	$0	$804,490	$155,664	$210,883	$421,767	$16,176
	min: 46,826		min: 440,257		min: 210,883		min: -348,057
	max: 278,467		max: 1,208,403		max: 210,883		max: 420,089

★ Includes economic, environmental and social costs.

° The estimated economic benefit provided by the pest.

† Administration and implementation costs incurred by the Council through the programme.

‡ Costs of control imposed on landowners through the programme, over and above the costs already being paid by landowners, as estimated by the Council. They are applied for the 10 years of the Plan.

50 year assessment

The longer-term cost-benefit analysis indicates that the monetised benefits over the next 50 years of the proposed management programme will be of net benefit to the region. Additional non-monetised benefits associated with the protection of biodiversity values are also anticipated.

SCENARIO	PEST IMPACTS★	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNERS COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$18,596,715	$0		$0	$0	$0	
	min: 6,261,389						
	max: 52,646,936						
Progressive Containment	$128,539	$0	$18,468,176	$162,680	$210,883	$421,767	$17,672,846
	min: 46,826		min: 6,214,563		min: 210,883		min: 5,419,233
	max: 278,467		max: 52,368,469		max: 210,883		max: 51,573,139

CBA statement and risks to success

Pinus contorta's aggressive colonizing characteristics aid its ability to displace low-level plant communities, especially native grasslands, and create forests. This impacts significantly on biodiversity and landscape values as well as potentially decreasing hydrological yields. Economic well-being is also threatened by the loss of grazing and increased fire hazard.

It is usually found in alpine and sub-alpine areas hence its presence in the Kaweka Ranges, the upland Rangitaiki areas and along the western margins of the region. Owing to its hardiness, it is used as a shelter belt species in the southern Rangitaiki area. Pinus contorta is not a recognised commercial timber species.

The benefits of regional intervention, focused on sustainably controlling *Pinus contorta* as part of a Progressive Containment programme, outweigh the cost of the programme.

Risks of the programme being unsuccessful in achieving objectives

RISK	LEVEL OF RISK	EXPLANATION
Technical risk	Low	

Operational risk	Low
Legal risk	Low
Socio-political risk	Low
Other risks	Low

Who should pay?

Beneficiaries and exacerbators

GROUP	BENEFICIARY	EXACERBATOR	CHANGE BEHAVIOUR	ASSESS & COSTS BENEFITS	CONTROL COST EFFECTIVELY
Land occupiers (Crown and private)	Major	Major	Yes	Yes	Yes
Dairy/sheep and beef sector	Major		No	Yes	Yes
Regional community	Major		No	Yes	Yes

Who should pay for the proposed management approach?

Pinus contorta is primarily a threat to biodiversity values in the Hawke's Bay region. To maximise the effectiveness of individual control across the region and to minimise the externality impacts of the plant the Council has proposed an advisory, inspectorial, and compliance regime. The benefits of this programme are a public good rather than a private good. It is proposed this programme is funded through the general rate.

NASSELLA TUSSOCK
Nassella trichotoma

PROGRESSIVE CONTAINMENT

Relevant biology

Attribute	Description
Form	Perennial tussock-forming grass growing to a height of 50 cm, with numerous drooping fine, rough leaves overtopped by slender open seed heads.
Habitat	Open sites such as sunny dry pasture, stream margins, roadsides and wasteland. Tolerates a wide range of climates.
Regional distribution	Limited distribution. Found in two areas: Tangoio and a site in the lower Tukituki.
Competitive ability	Can form a complete cover in pasture situations.
Reproductive ability	Can produce up to 100,000 seeds per plant. Seed can remain dormant in the soil for over 15 years.
Dispersal methods	Primarily by wind but also stock, machinery, water, hay and as a seed impurity.
Resistance to control	Difficult to control due to large, long-lived seed bank.
Benefits	None

Land use/habitats occupied in Hawke's Bay

LAND USE TYPE	CURRENT INFESTATION	POTENTIAL INFESTATION
Dairy	-	High
Sheep and beef	Low	High
Forestry	Low	High

Horticulture	-	Low
Aquaculture	-	-
Urban	-	Low
Native terrestrial	Low	High
Coastal land	-	High
Freshwater	-	-
Estuarine	-	-
Marine	-	-

High = Most infested/preferred land use(s), Low = Less infested/preferred land use(s), - = Unsuitable land use

Qualitative impact assessment

CATEGORY	CURRENT	POTENTIAL	COMMENT	SOURCE
Production				
Dairy	-	L	Competes with pasture and reduces food availability for stock. Cannot be digested by livestock (forms indigestible balls in the stomach).	
Sheep and beef	M	H	Competes with pasture and reduces food availability for stock. Cannot be digested by livestock (forms indigestible balls in the stomach). Seeds spoil the fleece.	
Forestry	-	-		1, 2
Horticulture	-	-		
Aquaculture	-	-		
Other	-	-		
International trade	-	L	Crop contaminant, prohibited seed (nil tolerance) in imports into Australia.	3
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	L	H	Forms pure stands in low-growing plant communities, esp. in harsh sites, excludes other species.	1, 2
Threatened species	-	H	See Species diversity.	1, 2
Social/Cultural				
Human health	-	-		
Recreation	-	-		
Māori culture	-	-		

L = low, M = moderate, H = high

source 1: Craw (2000), 2: Anon. (2004), 3: AQIS (2009)

Estimated quantitative impacts

Quantitative annual impacts per hectare are calculated as the current or anticipated proportional impact on land value across the region. All amounts are in net present value (NPV, $).

Calculation: **Economic value per land use/habitat type** × **Impact level**

Impact level
Low = 1–4% reduction in annual economic value per hectare
Moderate = 5–9% reduction in annual economic value per hectare
High = 10–50% reduction in annual economic value per hectare

Reduction in annual economic value ($) per hectare

LAND USE/HABITAT TYPE	CURRENT IMPACT PER HA	POTENTIAL IMPACT PER HA
Production		

Dairy	0	54.63–267.08
Sheep and beef	36.95–81.27	73.90–451.50
Forestry	0	0
Horticulture	0	0
Aquaculture	0	0
Environment/Social/Cultural		
Urban	0	0
Native terrestrial	5.56–27.20	55.60–340.00
Coastal	0	124.70–762.50
Freshwater	0	0
Estuarine	0	0
Marine	0	0

Cost-benefit analysis results

Proposed management programme: **Progressive Containment**

Area of Programme: **whole region ha**

Proposed annual expenditure by Council: **$17,000**

Assumptions

ASSUMPTIONS	VALUES	ASSUMPTIONS	VALUES
Current area infested	50 ha	Time to reach maximum extent†	75 yrs
Current impacts★	$40.75/ha	Potential extent in the region°	202,725 ha
	$24.4–57.09/ha		67,649.73–337,800.7 ha
Current benefits	$0/ha	Discount rate	4%

★ Current annual impact of the pest averaged across all land uses currently occupied.

° The potential extent the pest is predicted to achieve in the absence of regional management.

† The time a pest is predicted to take between first going wild in the region and reaching its maximum extent.

10 year assessment

The cost-benefit analysis indicates that the benefits of the proposed management programme over the next 10 years will be of net benefit to the region.

SCENARIO	PEST IMPACTS★	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNERS COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$215,751	$0		$0	$0	$0	
	min: 61,233						
	max: 1,050,209						
Progressive Containment	$3,897	$0	$211,854	$54,613	$0	$0	$157,241
	min: 1,784		min: 59,449				min: 4,836
	max: 7,934		max: 1,042,275				max: 987,662

★ Includes economic, environmental and social costs.

° The estimated economic benefit provided by the pest.

† Administration and implementation costs incurred by the Council through the programme.

‡ Costs of control imposed on landowners through the programme, over and above the costs already being paid by landowners, as estimated by the Council. They are applied for the 10 years of the Plan.

50 year assessment

The longer-term cost-benefit analysis indicates that the monetised benefits over the next 50 years of the proposed management programme will be of net benefit to the region. Additional non-monetised benefits associated with the protection of biodiversity values are also anticipated.

SCENARIO	PEST IMPACTS*	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNERS COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$153,554,395	$0		$0	$0	$0	
	min: 27,548,160						
	max: 789,873,877						
Progressive Containment	$3,897	$0	$153,550,498	$61,207	$0	$0	$153,489,291
	min: 1,784		min: 27,546,376				min: 27,485,169
	max: 7,934		max: 789,865,943				max: 789,804,736

CBA statement and risks to success

Nassella tussock is capable of completely depleting a grassland sward, both native and exotic. It is indigestible if eaten by livestock and seeds spoil the fleece of sheep. It is tolerant to drought, fire and grazing. It can form pure stands in low-growing plant communities such as pasture, preventing other species from establishing.

Nassella tussock will grow almost anywhere, but is most commonly found on dry, low fertility land, sunny slopes, dry spurs and knobs, and stony riverbeds. The seed straw is readily carried by strong wind and can travel many kilometres. It is also distributed by water, stock and machinery, or on the bark of milled trees. Regular inspection of areas cleared of nassella tussock is therefore necessary to prevent re-establishment.

Intensive control measures over 30 years have prevented the spread of nassella tussock, with the two known sites in the region being Tangoio and the lower Tukituki area. Plant numbers at these sites are now low. Any failure to remove all nassella tussock plants before seeding perpetuates the problem as the amount of seed produced by a mature plant, and the mechanism of wind dispersal of the seed contribute to a high potential for spreading. By preventing seeding, and given the present limited distribution of nassella tussock in the Hawke's Bay region, an opportunity exists to progressively reduce plant incidence.

Nassella tussock is a well-known and high-profile pastoral pest in many other parts of the country. There would be substantial political and farming concerns if this tussock species was not managed. Further, maintaining the gains of previous management efforts would be wasted if regional intervention was not instigated.
The benefits of regional intervention, focused on sustainably controlling nassella tussock as part of a Progressive Containment programme, outweigh the cost of the programme.

Risks of the programme being unsuccessful in achieving objectives

RISK	LEVEL OF RISK	EXPLANATION
Technical risk	Low	
Operational risk	Low	
Legal risk	Low	
Socio-political risk	Low	
Other risks	Low	

Who should pay?

Beneficiaries and exacerbators

GROUP	BENEFICIARY	EXACERBATOR	CHANGE BEHAVIOUR	ASSESS COSTS & BENEFITS	CONTROL COST EFFECTIVELY

Land occupiers (Crown and private)	Major	Major	Yes	Yes	Yes
Dairy/sheep and beef sector	Major		No	Yes	Yes
Regional community	Major		No	Yes	Yes

Who should pay for the proposed management approach?

Nassella tussock is a major threat to primary production. To maximise the effectiveness of individual control across the region and to minimise the externality impacts of the plant the Council has proposed an advisory, inspectorial, and compliance regime. The primary beneficiaries of this programme are land occupiers. It is proposed this programme is funded through a 70% targeted rate, 30% general rate.

SAFFRON THISTLE
Carthamus lanatus

PROGRESSIVE CONTAINMENT

Relevant biology

ATTRIBUTE	DESCRIPTION
Form	Annual, spiny, glandular, woolly plant, which often looks like it is covered in spiderwebs due to its fine tangled fibers. Has a pale stem up to 1 m tall. Rigid, pointed, very spiny leaves. Flowers are bright yellow. One plant can produce many spiny stems which mat together to form a small thicket.
Habitat	Disturbed, open sites in grasslands, pastures, and agricultural lands, especially grain fields. Prefers seasonally dry, heavily-grazed pastures, particularly areas with 400-600 mm annual rainfall. Inhabits many soil types.
Regional distribution	Problem in dry areas. Crownthorpe, Bayview, Putorino, Sherenden, Wairere, Havlock North, Maraekakaho, Waipawa, Porangahau, Kahuranaki, Paki Paki.
Competitive ability	Regarded as a pasture weed because it competes with desired plants such as pasture or crops and eventually displaces them.
Reproductive ability	Seed production is abundant. Seed germination is most likely in areas with little vegetation or pasture cover e.g. when an area has been overgrazed. Seed germination requires specific temperature cues and water; most seeds germinate in autumn. Many seeds remain dormant (will not germinate, even in ideal conditions), and seed banks decrease by approximately 70–74% per year if no seed is added. Seeds can remain viable for 10 years.
Dispersal methods	The large seeds are mainly dispersed by water, vehicles, livestock, and contaminated forage. Seeds may remain in flower heads for long periods, allowing their spread all season-long. Plants can also snap off at the base and be wind-blown, spreading seeds. Seeds can lay dormant in soil for some time.
Resistance to control	Can be controlled using various herbicides (e.g. Tordon Brushkiller), or at the rosette stage with MCPA or 2,4-D. Mowing/grubbing before seed-set can help in low-rainfall areas but plants should be removed and incinerated. Good pasture cover in autumn will reduce germination; ideally grazing pressure should be reduced over summer to increase the cover of summer-growing perennial grasses. Biocontrol may be an option when an agent that will not attack safflower is found.
Benefits	None

Land use/habitats occupied in Hawke's Bay

LAND USE TYPE	CURRENT INFESTATION	POTENTIAL INFESTATION
Dairy	-	High
Sheep and beef	Low	High
Forestry	-	Low
Horticulture	-	High
Aquaculture	-	-
Urban	-	-
Native terrestrial	-	-
Coastal land	-	Low
Freshwater	-	-
Estuarine	-	-
Marine	-	-

High = Most infested/preferred land use(s), Low = Less infested/preferred land use(s), - = Unsuitable land use

Qualitative impact assessment

CATEGORY	CURRENT	POTENTIAL	COMMENT	SOURCE
Production				
Dairy	-	L	Form dense stands that exclude stock. Can cause eye and mouth damage to stock.	
Sheep and beef	L	M	Devalues sheep/alpaca fleece, and can injure shearers.	
Forestry	-	-		1, 2, 3
Horticulture	-	M	Crop contaminant; cereal grain contaminated with saffron thistle seed has reduced value.	
Aquaculture	-	-		
Other	-	-		
International trade	L	M	Prohibited seed of nil tolerance in Australia.	4
Environment				
Soil resources	L	L	Control with use of residual herbicides has led US farmers to drop organic status to control this weed. Some residual herbicides effect the growth of legumes.	5
Water quality	-	-		
Species diversity	-	L	Primarily a pasture/agricultural weed of low fertility, dry soils. Possible impact on native grasslands that are heavily grazed/fire damaged if a source population is nearby.	2
Threatened species	-	-		
Social/Cultural				
Human health	L	M	Spicky seed heads can injure sheep/alpaca shearers, and those handling these stock.	2, 3
Recreation	-	M	Forms dense stands which restrict access.	1
Māori culture	-	-		

L = low, M = moderate, H = high

source 1: Cowan (2010), 2: Western Australian Agriculture Authority (2012), 3: Hawke's Bay Regional Council (1995a), 4: AQIS (2009), 5: Kyser (2012)

Estimated quantitative impacts

Quantitative annual impacts per hectare are calculated as the current or anticipated proportional impact on land value across the region. All amounts are in net present value (NPV, $).

Calculation: **Economic value per land use/habitat type** × **Impact level**

Impact level

Low = 1–4% reduction in annual economic value per hectare

Moderate = 5–9% reduction in annual economic value per hectare

High = 10–50% reduction in annual economic value per hectare

Reduction in annual economic value ($) per hectare

LAND USE/HABITAT TYPE	CURRENT IMPACT PER HA	POTENTIAL IMPACT PER HA
Production		
Dairy	0	54.63–267.08
Sheep and beef	7.39–36.12	36.95–81.27
Forestry	0	0
Horticulture	0	525.55–1,778.40
Aquaculture	0	0
Environment/Social/Cultural		
Urban	0	0
Native terrestrial	0	0
Coastal	0	62.35–137.25
Freshwater	0	0
Estuarine	0	0
Marine	0	0

Cost-benefit analysis results

Proposed management programme: **Progressive Containment**
Area of Programme: **whole region ha**
Proposed annual expenditure by Council: **$80,000**

Assumptions

ASSUMPTIONS	VALUES	ASSUMPTIONS	VALUES
Current area infested	226 ha	Time to reach maximum extent†	50 yrs
Current impacts★	$21.75/ha	Potential extent in the region°	135,932 ha
	$7.39–36.12/ha		45,631.94–226,231.1 ha
Current benefits	$0/ha	Discount rate	4%

★ Current annual impact of the pest averaged across all land uses currently occupied.

° The potential extent the pest is predicted to achieve in the absence of regional management.

† The time a pest is predicted to take between first going wild in the region and reaching its maximum extent.

10 year assessment

The cost-benefit analysis indicates that the benefits of the proposed management programme over the next 10 years will be of net benefit to the region.

SCENARIO	PEST IMPACTS★	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNERS COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$2,198,941	$0		$0	$0	$0	
	min: 927,417						
	max: 4,505,150						
Progressive Containment	$9,404	$0	$2,189,537	$149,854	$126,530	$0	$1,913,153
	min: 2,442		min: 924,975		min: 126,530		min: 648,591
	max: 38,866		max: 4,466,284		max: 126,530		max: 4,189,900

★ Includes economic, environmental and social costs.

° The estimated economic benefit provided by the pest.

† Administration and implementation costs incurred by the Council through the programme.

‡ Costs of control imposed on landowners through the programme, over and above the costs already being paid by landowners, as estimated by the Council. They are applied for the 10 years of the Plan.

50 year assessment

The longer-term cost-benefit analysis indicates that the monetised benefits over the next 50 years of the proposed management programme will be of net benefit to the region. Additional non-monetised benefits associated with the protection of biodiversity values are also anticipated.

SCENARIO	PEST IMPACTS★	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNERS COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$476,507,791	$0		$0	$0	$0	
	min: 148,443,555						
	max: 1,989,156,128						
Progressive Containment	$9,404	$0	$476,498,387	$156,448	$126,530	$0	$476,215,409
	min: 2,442		min: 148,441,113		min: 126,530		min: 148,158,135
	max: 38,866		max: 1,989,117,262		max: 126,530		max: 1,988,834,284

CBA statement and risks to success

Saffron thistle occurs predominantly in disturbed, open sites in grasslands, pastures, and agricultural lands, especially grain fields. Its multiple woody stems grow to about 1 m high which mat together to form small impenetrable thickets, preventing grazing access for animals. It Prefers seasonally dry, heavily-grazed pastures, particularly areas with 400-600 mm annual rainfall. Seed dispersal is mainly by stock wool or hair, machinery, and water.

Saffron thistle occurs as small infestations scattered throughout Hawke's Bay, including Crownthorpe, Bay View, Putorino, Sherenden, Wairere, Havelock North, Maraekakaho, Waipawa, Porangahau, Kahuranaki, and Paki Paki.

The benefits of regional intervention, focused on sustainably controlling saffron thistle as part of a Progressive Containment programme, outweigh the cost of the programme.

Risks of the programme being unsuccessful in achieving objectives

RISK	LEVEL OF RISK	EXPLANATION
Technical risk	Low	
Operational risk	Low	
Legal risk	Low	
Socio-political risk	Low	
Other risks	Low	

Who should pay?

Beneficiaries and exacerbators

GROUP	BENEFICIARY	EXACERBATOR	CHANGE BEHAVIOUR	ASSESS COSTS & BENEFITS	CONTROL COST EFFECTIVELY
Land occupiers (Crown and private)	Major	Major	Yes	Yes	Yes
Dairy/sheep and beef sector	Major		No	Yes	Yes
Regional community	Major		No	Yes	Yes

Who should pay for the proposed management approach?

Saffron thistle is a major threat to primary production. To maximise the effectiveness of individual control across the region and to minimise the externality impacts of the plant the Council has proposed an advisory, inspectorial, and compliance regime. The primary beneficiaries of this programme are land occupiers. It is proposed this programme is funded through a 70% targeted rate, 30% general rate.

VELVETLEAF

Abutilon theophrasti

PROGRESSIVE CONTAINMENT

Relevant biology

ATTRIBUTE	DESCRIPTION
Form	Erect annual, 1–2.5 m tall, densely hairy, woody at base. Leaves up to 15 cm long, heart-shaped, velvety, soft, margin toothed, tip pointed. Flowers axillary, 30 mm diameter appear spring to autumn. Petals 7–133 mm long, buttery-yellow. Seed capsules about 25 mm across, forming a cup-like ring of 13 woody and hairy segments; segments intact at maturity, each with 1–3 seeds released through a slit on the top of the capsule.
Habitat	Occurs mainly in crop production areas and pasture. In the USA it also occurs in waste areas, roadsides, vacant lots, fence rows, and gardens; but to date it has not been recorded from these areas in NZ.
Regional distribution	Two properties at Puki Puki and Tutira.
Competitive ability	Can potentially affect many arable crops by competing for nutrients, space, and water. It is known to produce allelopathic chemicals that can inhibit germination and growth in many crop plants.
Reproductive ability	A single plant can produce up to 17,000 seeds. Seeds remain viable for long periods (over 50 years),and large numbers of seed can accumulate in the soil seed bank.
Dispersal methods	Spread by contaminated crop seeds, farm machinery and livestock.
Resistance to control	Hand pulling is effective control when only few plants are present. Good control can be achieved in crops with a combination of pre- and post-herbicide applications. However, control can be difficult as seeds can germinate over a long period. Burying seeds deeper than 150 mm may help prevent them from germinating, but burial will not kill seeds as they can remain dormant for decades.
Benefits	None

Land use/habitats occupied in Hawke's Bay

LAND USE TYPE	CURRENT INFESTATION	POTENTIAL INFESTATION
Dairy	Low	High
Sheep and beef	Low	High
Forestry	-	-
Horticulture	-	High
Aquaculture	-	-
Urban	-	-
Native terrestrial	-	-
Coastal land	-	Low
Freshwater	-	-
Estuarine	-	-
Marine	-	-

High = Most infested/preferred land use(s), Low = Less infested/preferred land use(s), - = Unsuitable land use

Qualitative impact assessment

CATEGORY	CURRENT	POTENTIAL	COMMENT	SOURCE
Production				
Dairy	L	M	As velvetleaf is a new weed incursion, its impacts on pasture, crops and livestock in New Zealand are largely unknown, but they are exected to be signficant based on overseas experience. Moderate infestations that emerge the same time as a crop can reduce production by 25 Sheep and beef	L - See Dairy. Could impact and compete with grasses when establishing pasture.
Forestry	-	-		1
Horticulture	-	H	Velvet leaf is primarily a weed of high fertility, cultivated soils. Moderate infestations that emerge the same time as a crop can reduce production by 25 Aquaculture	-
Other	-	-		
International trade	-	M	As it can grow in crops it has the potential to grow among and contaminate seed crops, and therefore impact on seed exports.	
Environment				
Soil resources	L	M	It can produce allelopathic chemicals that occur in the soil and these supress the germination and growth of other plant species.	1, 2
Water quality	-	-		
Species diversity	-	L	Its threats to indigenous biodiversity are unknown as at this stage it is primarily considered to be a weed of arable land. It is possible it could establish among indigenous vegetation in open and disturbed areas, but it prefers fertile, cultivated soils and so the risk of occurring in and competing with indigenous vegetation is possibly quite low.	1, 3
Threatened species	-	L	See Species diversity.	3
Social/Cultural				
Human health	-	-	Primarily a weed of arable crops and therefore unlikely to impact on human health.	
Recreation	-	-	Primarily a weed of arable crops and therefore unlikely to impact on recreation.	
Māori culture	-	-	Primarily a weed of arable crops and therefore unlikely to impact on maori culture.	

L = low, M = moderate, H = high

source 1: AgPest (2017), 2: Colton & Einhellig (1980), 3: Uva & Neal (1997)

Estimated quantitative impacts

Quantitative annual impacts per hectare are calculated as the current or anticipated proportional impact on land value across the region. All amounts are in net present value (NPV, $).

Calculation: **Economic value per land use/habitat type** × **Impact level**

Impact level

Low = 1–4% reduction in annual economic value per hectare

Moderate = 5–9% reduction in annual economic value per hectare

High = 10–50% reduction in annual economic value per hectare

Reduction in annual economic value ($) per hectare

LAND USE/HABITAT TYPE	CURRENT IMPACT PER HA	POTENTIAL IMPACT PER HA
Production		
Dairy	54.63–267.08	273.15–600.93
Sheep and beef	7.39–36.12	7.39–36.12
Forestry	0	0
Horticulture	0	1,051.10–9,880.00
Aquaculture	0	0
Environment/Social/Cultural		
Urban	0	0
Native terrestrial	0	0
Coastal	0	62.35–137.25
Freshwater	0	0
Estuarine	0	0
Marine	0	0

Cost-benefit analysis results

Proposed management programme: **Progressive Containment**

Area of Programme: **whole region ha**

Proposed annual expenditure by Council: **$3,600**

Assumptions

ASSUMPTIONS	VALUES	ASSUMPTIONS	VALUES
Current area infested	0.001 ha	Time to reach maximum extent†	50 yrs
Current impacts★	$26.68/ha	Potential extent in the region°	131,146 ha
	$9.06–44.3/ha		43,717.62–218,573.9 ha
Current benefits	$0/ha	Discount rate	4%

★ Current annual impact of the pest averaged across all land uses currently occupied.

° The potential extent the pest is predicted to achieve in the absence of regional management.

† The time a pest is predicted to take between first going wild in the region and reaching its maximum extent.

10 year assessment

The cost-benefit analysis indicates that the benefits of the proposed management programme over the next 10 years will be of net benefit to the region.

SCENARIO	PEST IMPACTS★	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNERS COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$1,925,706	$0		$0	$0	$0	
	min: 287,812						
	max: 10,114,642						
Progressive Containment	$0	$0	$1,925,706	$13,535	$0	$0	$1,912,171
	min: 0		min: 287,812				min: 274,276
	max: 0		max: 10,114,642				max: 10,101,107

★ Includes economic, environmental and social costs.

° The estimated economic benefit provided by the pest.

† Administration and implementation costs incurred by the Council through the programme.

‡ Costs of control imposed on landowners through the programme, over and above the costs already being paid by landowners, as estimated by the Council. They are applied for the 10 years of the Plan.

50 year assessment

The longer-term cost-benefit analysis indicates that the monetised benefits over the next 50 years of the proposed management programme will be of net benefit to the region. Additional non-monetised benefits associated with the protection of biodiversity values are also anticipated.

SCENARIO	PEST IMPACTS★	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNERS COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$1,293,063,230	$0		$0	$0	$0	
	min: 191,744,938						
	max: 6,799,295,909						
Progressive Containment	$0	$0	$1,293,063,230	$19,690	$0	$0	$1,293,043,540
	min: 0		min: 191,744,938				min: 191,725,247
	max: 0		max: 6,799,295,909				max: 6,799,276,219

CBA statement and risks to success

Velvetleaf is a serious cropping weed, potentially affecting many arable crops by competing for nutrients, space, and water. It is declared an Unwanted Organism in New Zealand. Its effect on indigenous biodiversity are unlikely but unknown as at this stage. Due to its preference for sites with fertile and cultivated soils, the risk of occurring in and competing with indigenous vegetation is possibly quite low.

It is a relatively new introduction to the region and occupies bare ground along roadsides and in pasture (e.g. pugging, wheel tracks), including areas that have recently been sprayed. Partially drought tolerant, but requires moist conditions to germinate. Grows best where rainfall exceeds 500 mm/year or in areas with high soil moisture (e.g. ephemeral drains). There are only two known sites in the region, being Paki Paki and Tutira.

The benefits of regional intervention, focused on sustainably controlling velvetleaf as part of a Progressive Containment programme, outweigh the cost of the programme.

Risks of the programme being unsuccessful in achieving objectives

RISK	LEVEL OF RISK	EXPLANATION
Technical risk	Low	
Operational risk	Low	
Legal risk	Low	
Socio-political risk	Low	
Other risks	Low	

Who should pay?

Beneficiaries and exacerbators

GROUP	BENEFICIARY	EXACERBATOR	CHANGE BEHAVIOUR	ASSESS COSTS & BENEFITS	CONTROL COST EFFECTIVELY
Land occupiers (Crown and private)	Major	Major	Yes	Yes	Yes
Dairy/sheep and beef sector	Major		No	Yes	Yes
Regional community	Major		No	Yes	Yes

Who should pay for the proposed management approach?

Velvetleaf is a major threat to primary production. To maximise the effectiveness of individual control across the region and to minimise the externality impacts of the plant the Council has proposed an advisory, inspectorial, and compliance regime. The primary beneficiaries of this programme are land occupiers. It is proposed this programme is funded through a 70% targeted rate, 30% general rate.

WOOLLY NIGHTSHADE
Solanum mauritianum

PROGRESSIVE CONTAINMENT

Relevant biology

ATTRIBUTE	DESCRIPTION
Form	Perennial shrub or small tree of up to 4 m high. Leaves are grey green, ovate and densely covered with furry hairs. Violet flowers and a dull yellow berry.
Habitat	Able to establish in a wide variety of climates and soil types. Habitat limitations not well known in New Zealand.
Regional distribution	Mainly an urban problem.
Competitive ability	Can eliminate other species in dense stands. Effects on native bush not well known. Some believe that it will be shaded out over time, while others think it will continue to dominate.
Reproductive ability	Large numbers of seeds produced with 95% viability. 3 year-old plants recorded bearing 10,000 seeds.
Dispersal methods	Most seeds fall close to parent. Some spread by birds.
Resistance to control	Control by herbicides, cut and stump treatment, ring-barking, basal treatment and hand pulling.
Benefits	None

Land use/habitats occupied in Hawke's Bay

LAND USE TYPE	CURRENT INFESTATION	POTENTIAL INFESTATION
Dairy	-	Low
Sheep and beef	Low	Low
Forestry	Low	High
Horticulture	-	Low
Aquaculture	-	-
Urban	Low	Low
Native terrestrial	Low	High
Coastal land	-	Low
Freshwater	-	-
Estuarine	-	-
Marine	-	-

High = Most infested/preferred land use(s), Low = Less infested/preferred land use(s), - = Unsuitable land use

Qualitative impact assessment

CATEGORY	CURRENT	POTENTIAL	COMMENT	SOURCE
Production				
Dairy	-	L	Thought to be toxic to stock.	
Sheep and beef	L	M	Can form dense stands on rough pasture. Displaces pasture grasses and clover, thus reducing food availability for stock. Thought to be toxic to stock.	
Forestry	L	M	Could compete with young trees in plantation forests.	1, 2
Horticulture	-	L	Can form dense stands and invade open, disturbed or poorly managed areas.	
Aquaculture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	L	H	Forms dense, often pure stands, outcompeting most other species. Inhibits and slows regeneration of native plant species.	2
Threatened species	L	M	See Species diversity.	2
Social/Cultural				
Human health	L	M	Can cause skin irritation and respiratory problems in some people.	2
Recreation	L	M	Forms dense stands which obstruct access.	2
Māori culture	L	M	See Human Health and Recreation.	

L = low, M = moderate, H = high

source 1: Environment Bay of Plenty (2004a), 2: Environment Bay of Plenty (2005b)

Estimated quantitative impacts

Quantitative annual impacts per hectare are calculated as the current or anticipated proportional impact on land value across the region. All amounts are in net present value (NPV, $).

Calculation: **Economic value per land use/habitat type** × **Impact level**

Impact level

Low = 1–4% reduction in annual economic value per hectare

Moderate = 5–9% reduction in annual economic value per hectare

High = 10–50% reduction in annual economic value per hectare

Reduction in annual economic value ($) per hectare

LAND USE/HABITAT TYPE	CURRENT IMPACT PER HA	POTENTIAL IMPACT PER HA
Production		
Dairy	0	54.63–267.08
Sheep and beef	7.39–36.12	36.95–81.27
Forestry	17.47–85.40	87.35–192.15
Horticulture	0	105.11–790.40
Aquaculture	0	0
Environment/Social/Cultural		
Urban	5.33–56.05	26.64–126.11
Native terrestrial	5.56–27.20	55.60–340.00
Coastal	0	124.70–762.50
Freshwater	0	0
Estuarine	0	0
Marine	0	0

Cost-benefit analysis results

Proposed management programme: **Progressive Containment**
Area of Programme: **whole region ha**
Proposed annual expenditure by Council: **$30,000**

Assumptions

ASSUMPTIONS	VALUES	ASSUMPTIONS	VALUES
Current area infested	1.25 ha	Time to reach maximum extent†	125 yrs
Current impacts★	$24.96/ha	Potential extent in the region°	96,049 ha
	$8.39–41.53/ha		33,513.29–158,584.4 ha
Current benefits	$0/ha	Discount rate	4%

★ Current annual impact of the pest averaged across all land uses currently occupied.

° The potential extent the pest is predicted to achieve in the absence of regional management.

† The time a pest is predicted to take between first going wild in the region and reaching its maximum extent.

10 year assessment

The cost-benefit analysis indicates that the benefits of the proposed management programme over the next 10 years may be of net benefit to the region.

SCENARIO	PEST IMPACTS★	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNERS COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$20,419	$0		$0	$0	$0	
	min: 4,602						
	max: 95,187						
Progressive Containment	$46	$0	$20,373	$65,320	$16,871	$0	$-61,818
	min: 15		min: 4,587		min: 16,871		min: -77,604
	max: 144		max: 95,043		max: 16,871		max: 12,852

★ Includes economic, environmental and social costs.

° The estimated economic benefit provided by the pest.

† Administration and implementation costs incurred by the Council through the programme.

‡ Costs of control imposed on landowners through the programme, over and above the costs already being paid by landowners, as estimated by the Council. They are applied for the 10 years of the Plan.

50 year assessment

The longer-term cost-benefit analysis indicates that the monetised benefits over the next 50 years of the proposed management programme will be of net benefit to the region. Additional non-monetised benefits associated with the protection of biodiversity values are also anticipated.

SCENARIO	PEST IMPACTS★	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNERS COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$2,598,830	$0		$0	$0	$0	
	min: 642,176						
	max: 11,857,607						
Progressive Containment	$46	$0	$2,598,784	$71,475	$16,871	$0	$2,510,438
	min: 15		min: 642,161		min: 16,871		min: 553,815
	max: 144		max: 11,857,463		max: 16,871		max: 11,769,117

CBA statement and risks to success

Woolly nightshade grows very rapidly and can crowd-out or shade-out native plants to form dense stands. It poisons the soil to inhibit or prevent the establishment of native plant seedlings and slows the regeneration of native forests. It is moderately shade tolerant, tolerant to frost and requires medium to high soil fertility. Dense stands can invade pasture on poor soils, especially in hill country areas and impede livestock movement. All parts of the plant are thought to be toxic to livestock and handling the plants can cause irritation and nausea.

It grows in open locations, forest and plantation margins, scrub and waste land. In Hawke's Bay, woolly nightshade is mainly found in the more temperate urban areas. It is primarily found in urban areas across approximately 8,800ha. The CBA for woolly nightshade suggests that this form of regional intervention will have monetarised benefits over a 50 year timeframe.

Risks of the programme being unsuccessful in achieving objectives

RISK	LEVEL OF RISK	EXPLANATION
Technical risk	Low	
Operational risk	Low	
Legal risk	Low	
Socio-political risk	Low	
Other risks	Low	

Who should pay?

Beneficiaries and exacerbators

GROUP	BENEFICIARY	EXACERBATOR	CHANGE BEHAVIOUR	ASSESS COSTS & BENEFITS	CONTROL COST EFFECTIVELY
Land occupiers (Crown and private)	Major	Major	Yes	Yes	Yes
Dairy/sheep and beef sector	Major		No	Yes	Yes
Regional community	Major		No	Yes	Yes

Who should pay for the proposed management approach?

Woolly nightshade is a threat to primary production and biodiversity values in the Hawke's Bay region. To maximise the effectiveness of individual control across the region and to minimise the externality impacts of the plant the

Council has proposed an advisory, inspectorial, and compliance regime. The benefits of this programme are a public good rather than a private good, particularly given that the main infestation is within the urban environment. It is proposed this programme is funded through the general rate.

SUSTAINED CONTROL PESTS

FERAL CAT
Felis catus

PREDATOR CONTROL AREAS

Relevant biology

ATTRIBUTE	DESCRIPTION
Form	Resemble domestic cats in both size and colouration. Females average about 75% of the weight of males.
Habitat	Inhabits a wide range of urban, rural and forest habitats. Found from sea level to alpine habitats.
Regional distribution	Throughout the region.
Competitive ability	Diet is wide-ranging and includes small mammals, fish, birds and invertebrates.
Reproductive ability	2-3 litters per year with an average of 4 young in each.
Resistance to control	Controlled by poisons, trapping and shooting. No natural predators.
Benefits	Controls rodents and to some degree mustelids (young stoats and weasels).

Land use/habitats occupied in Hawke's Bay

LAND USE TYPE	CURRENT INFESTATION	POTENTIAL INFESTATION
Dairy	High	High
Sheep and beef	High	High
Forestry	High	High
Horticulture	Low	Low
Aquaculture	-	-
Urban	Low	-
Native terrestrial	High	High
Coastal land	Low	Low
Freshwater	-	-
Estuarine	-	-
Marine	-	-

High = Most infested/preferred land use(s), Low = Less infested/preferred land use(s), - = Unsuitable land use

Qualitative impact assessment

CATEGORY	CURRENT	POTENTIAL	COMMENT	SOURCE
Production				
Dairy	L	L	Can transmit bovine Tb which can be transferred to cattle. In an area with Tb-infected cattle, a study found 1 in 50 cats had gross lesions typical of Tb.	
Sheep and beef	L	L	Carry many parasites and both feral and farm cats can transmit Toxoplasma gondii to sheep, causing toxoplasmosis. Sheep become infected from eating contaminated pasture, concentrate feeds and hay. Once ingested, the toxoplasma spreads to the sheep's muscles and brain, and also into the placenta.	
Forestry	-	-		1, 2, 3, 4
Horticulture	-	-		
Aquaculture	-	-		
Other	-	-		
International trade	-	L	Tuberculosis vector - presence of bovine Tb in cattle has a major impact on exports.	
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	M	H	Eats native birds, lizards and invertebrates.	1, 2, 3, 4
Threatened species	M	H	Predator of eggs and chicks of threatened native birds and lizards (e.g. brown teal, NZ dotterel).	1, 2
Social/Cultural				
Human health	L	L	Can bite and scratch. Can transmit Toxoplasma gondii and cause toxoplasmosis to humans.	1
Recreation	-	-		1
Māori culture	-	-		

L = low, M = moderate, H = high

source 1: King (2005), 2: Auckland Regional Council (2004), 3: Environment Bay of Plenty (2003), 4: Taranaki Regional Council (2013a)

Estimated quantitative impacts

Quantitative annual impacts per hectare are calculated as the current or anticipated proportional impact on land value across the region. All amounts are in net present value (NPV, $).

Calculation: **Economic value per land use/habitat type** × **Impact level**

Impact level
Low = 1–4% reduction in annual economic value per hectare
Moderate = 5–9% reduction in annual economic value per hectare
High = 10–50% reduction in annual economic value per hectare

Reduction in annual economic value ($) per hectare

LAND USE/HABITAT TYPE	CURRENT IMPACT PER HA	POTENTIAL IMPACT PER HA
Production		
Dairy	54.63–267.08	54.63–267.08
Sheep and beef	7.39–36.12	7.39–36.12
Forestry	0	0
Horticulture	0	0
Aquaculture	0	0
Environment/Social/Cultural		
Urban	5.33–56.05	0
Native terrestrial	27.80–61.20	55.60–340.00
Coastal	62.35–137.25	124.70–762.50
Freshwater	0	0
Estuarine	0	0
Marine	0	0

Cost-benefit analysis results

Proposed management programme: **Sustained Control**
Area of Programme: **whole region ha**
Proposed annual expenditure by Council: **$200,000**

Assumptions

ASSUMPTIONS	VALUES	ASSUMPTIONS	VALUES
Current area infested	1,321,293 ha	Time to reach maximum extent†	50 yrs
Current impacts★	$26.79/ha	Potential extent in the region°	1,321,293 ha
	$11.9–41.69/ha		1,321,293–1,321,293 ha
Current benefits	$0/ha	Discount rate	4%

★ Current annual impact of the pest averaged across all land uses currently occupied.

° The potential extent the pest is predicted to achieve in the absence of regional management.

† The time a pest is predicted to take between first going wild in the region and reaching its maximum extent.

10 year assessment

The cost-benefit analysis indicates that the benefits of the proposed management programme over the next 10 years will be of net benefit to the region.

SCENARIO	PEST IMPACTS★	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNERS COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$322,562,194	$0		$0	$0	$0	
	min: 143,200,004						
	max: 501,924,385						
Sustained Control	$51,770,501	$0	$270,791,693	$300,705	$2,934,796	$0	$267,556,192
	min: 22,983,276		min: 120,216,728		min: 1,956,530		min: 116,002,962
	max: 80,557,725		max: 421,366,660		max: 3,913,061		max: 419,109,425

★ Includes economic, environmental and social costs.

° The estimated economic benefit provided by the pest.

† Administration and implementation costs incurred by the Council through the programme.

‡ Costs of control imposed on landowners through the programme, over and above the costs already being paid by landowners, as estimated by the Council. They are applied for the 10 years of the Plan.

50 year assessment

The longer-term cost-benefit analysis indicates that the monetised benefits over the next 50 years of the proposed management programme will be of net benefit to the region. Additional non-monetised benefits associated with the protection of biodiversity values are also anticipated.

SCENARIO	PEST IMPACTS★	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNERS COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$795,959,363	$0		$0	$0	$0	
	min: 353,362,501						
	max: 1,238,556,225						
Sustained Control	$51,770,501	$0	$744,188,862	$306,860	$2,934,796	$0	$740,947,206
	min: 22,983,276		min: 330,379,225		min: 1,956,530		min: 326,159,304
	max: 80,557,725		max: 1,157,998,500		max: 3,913,061		max: 1,155,735,110

CBA statement and risks to success

Cats are generalist predators and can have large home ranges. It is estimated that feral, stray and pet cats kill up to 100 million birds in New Zealand each year. They are a major predator of kiwi chicks and also eat eggs, lizards, invertebrates and frogs. Cats can transmit bovine Tb and carry many parasites including Toxoplasma gondii.
This programme provides the opportunity for communities to decide whether they would like to control feral cats and their impacts through a predator control programme. It is dependent on funding from central government or philanthropic providers to pay for the initial set up of maintenance infrastructure.
The benefits of regional intervention, focused on sustainably controlling feral cats as part of a predator control programme, outweigh the cost of the programme.

Risks of the programme being unsuccessful in achieving objectives

RISK	LEVEL OF RISK	EXPLANATION
Technical risk	Low	
Operational risk	Low	
Legal risk	Low	
Socio-political risk	Low	
Other risks	Low	

Who should pay?

Beneficiaries and exacerbators

GROUP	BENEFICIARY	EXACERBATOR	CHANGE BEHAVIOUR	ASSESS COSTS & BENEFITS
Land occupiers (Crown and private)	Major	Major	Yes	Yes
Dairy/sheep and beef sector	Major		No	Yes
Regional community	Major	Minor	Yes	Yes

Who should pay for the proposed management approach?

There are both biodiversity benefits and primary production benefits from managing feral cat densities. Although the general community will benefit from the biodiversity gains, the primary beneficiary of feral cat control will be the agricultural sector. This is due to the programme being delivered in rural areas and the benefit from reducing the spread of parasites such as Toxoplasma gondii.

This cost benefit analysis for feral cats is one components of the predator control programme. The second component is mustelid control. It is proposed the overall predator control programme if funded through a 60% targeted rate, 40% general rate funding ratio. This funding is for initial control and setup of maintenance infrastructure. The ongoing maintenance costs will be met by land occupiers.

MUSTELID

Mustela furo, M. erminea, M. nivalis

PREDATOR CONTROL AREAS

Relevant biology

ATTRIBUTE	DESCRIPTION
Form	See individual descriptions for ferret, stoat, and weasel
Habitat	See individual descriptions for ferret, stoat, and weasel
Regional distribution	Throughout the region.
Competitive ability	See individual descriptions for ferret, stoat, and weasel
Reproductive ability	See individual descriptions for ferret, stoat, and weasel
Resistance to control	See individual descriptions for ferret, stoat, and weasel
Benefits	See individual descriptions for ferret, stoat, and weasel

Land use/habitats occupied in Hawke's Bay

LAND USE TYPE	CURRENT INFESTATION	POTENTIAL INFESTATION
Dairy	High	High
Sheep and beef	High	High
Forestry	High	High
Horticulture	Low	Low
Aquaculture	-	-
Urban	Low	Low
Native terrestrial	High	High
Coastal land	Low	High
Freshwater	-	-
Estuarine	-	-
Marine	-	-

High = Most infested/preferred land use(s), Low = Less infested/preferred land use(s), - = Unsuitable land use

Qualitative impact assessment

CATEGORY	CURRENT	POTENTIAL	COMMENT	SOURCE
Production				
Dairy	M	M		
Sheep and beef	L	M		
Forestry	-	-		
Horticulture	-	-		
Aquaculture	-	-		
Other	-	-		
International trade	-	L		
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	M	H		
Threatened species	M	H		
Social/Cultural				
Human health	L	L		
Recreation	-	-		
Māori culture	L	H		

L = low, M = moderate, H = high

source 1:

Estimated quantitative impacts

Quantitative annual impacts per hectare are calculated as the current or anticipated proportional impact on land value across the region. All amounts are in net present value (NPV, $).

Calculation: **Economic value per land use/habitat type** × **Impact level**

Impact level

Low = 1–4% reduction in annual economic value per hectare

Moderate = 5–9% reduction in annual economic value per hectare

High = 10–50% reduction in annual economic value per hectare

Reduction in annual economic value ($) per hectare

LAND USE/HABITAT TYPE	CURRENT IMPACT PER HA	POTENTIAL IMPACT PER HA
Production		
Dairy	273.15–600.93	273.15–600.93
Sheep and beef	7.39–36.12	36.95–81.27
Forestry	0	0
Horticulture	0	0
Aquaculture	0	0
Environment/Social/Cultural		
Urban	5.33–56.05	5.33–56.05
Native terrestrial	27.80–61.20	55.60–340.00
Coastal	62.35–137.25	124.70–762.50
Freshwater	0	0
Estuarine	0	0
Marine	0	0

Cost-benefit analysis results

Proposed management programme: **Sustained Control**
Area of Programme: **whole region ha**
Proposed annual expenditure by Council: **200,000**

Assumptions

ASSUMPTIONS	VALUES	ASSUMPTIONS	VALUES
Current area infested	1,251,752 ha	Time to reach maximum extent†	50 yrs
Current impacts★	$32.96/ha	Potential extent in the region°	1,251,752 ha
	$16.77–49.16/ha		1,251,752–1,251,752 ha
Current benefits	$0/ha	Discount rate	4%

★ Current annual impact of the pest averaged across all land uses currently occupied.

° The potential extent the pest is predicted to achieve in the absence of regional management.

† The time a pest is predicted to take between first going wild in the region and reaching its maximum extent.

10 year assessment

The cost-benefit analysis indicates that the benefits of the proposed management programme over the next 10 years will be of net benefit to the region.

SCENARIO	PEST IMPACTS★	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNERS COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$375,941,684	$0		$0	$0	$0	
	min: 191,283,758						
	max: 560,599,609						
Sustained Control	$60,337,787	$0	$315,603,897	$300,705	$2,780,333	$0	$312,522,859
	min: 30,700,609		min: 160,583,149		min: 1,853,555		min: 156,575,334
	max: 89,974,966		max: 470,624,643		max: 3,707,110		max: 468,470,383

★ Includes economic, environmental and social costs.

° The estimated economic benefit provided by the pest.

† Administration and implementation costs incurred by the Council through the programme.

‡ Costs of control imposed on landowners through the programme, over and above the costs already being paid by landowners, as estimated by the Council. They are applied for the 10 years of the Plan.

50 year assessment

The longer-term cost-benefit analysis indicates that the monetised benefits over the next 50 years of the proposed management programme will be of net benefit to the region. Additional non-monetised benefits associated with the protection of biodiversity values are also anticipated.

SCENARIO	PEST IMPACTS★	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNERS COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$927,679,401	$0		$0	$0	$0	
	min: 472,014,703						
	max: 1,383,344,098						
Sustained Control	$60,337,787	$0	$867,341,614	$306,860	$2,780,333	$0	$864,254,421
	min: 30,700,609		min: 441,314,094		min: 1,853,555		min: 437,300,124
	max: 89,974,966		max: 1,293,369,132		max: 3,707,110		max: 1,291,208,717

CBA statement and risks to success

Mustelids can be devastating to native bird life and other fauna, through predating native birds, lizards, frogs and large native invertebrates. Mustelids can also transmit bovine Tb.
New technologies are constantly being worked on in an effort to develop cost effective tools for region-wide management of mustelids. This programme provides the opportunity for communities to decide whether they would like to control mustelids and their impacts through a predator control programme. It is dependent on funding from central government or philanthropic providers to pay for the initial set up of maintenance infrastructure.
The benefits of regional intervention, focused on sustainably controlling mustelids as part of a predator control programme, outweigh the cost of the programme

Risks of the programme being unsuccessful in achieving objectives

RISK	LEVEL OF RISK	EXPLANATION
Technical risk	Low	
Operational risk	Low	
Legal risk	Low	
Socio-political risk	Low	
Other risks	Low	

Who should pay?

Beneficiaries and exacerbators

GROUP	BENEFICIARY	EXACERBATOR	CHANGE BEHAVIOUR	ASSESS COSTS & BENEFITS
Land occupiers (Crown and private)	Major	Major	Yes	Yes
Dairy/sheep and beef sector	Minor		No	Yes
Regional community	Major		No	Yes

Who should pay for the proposed management approach?

Although mustelids can transmit bovine Tb, the primary benefit of this programme will be biodiversity gains. Both the agricultural sector and the regional community will be a beneficiary of mustelid control.

This cost benefit analysis for mustelid control is one components of the predator control programme. The second component is feral cat control. It is proposed the overall predator control programme if funded through a 60% targeted rate, 40% general rate funding ratio. This funding is for initial control and setup of maintenance infrastructure. The ongoing maintenance costs will be met by land occupiers.

POSSUM
Trichosurus vulpecula

SUSTAINED CONTROL

Relevant biology

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

Land use/habitats occupied in Hawke's Bay

LAND USE TYPE	CURRENT INFESTATION	POTENTIAL INFESTATION
Dairy	Low	Low
Sheep and beef	Low	Low
Forestry	Low	High
Horticulture	Low	Low
Aquaculture	-	-
Urban	Low	Low
Native terrestrial	Low	High
Coastal land	Low	High
Freshwater	-	-
Estuarine	-	-
Marine	-	-

High = Most infested/preferred land use(s), Low = Less infested/preferred land use(s), - = Unsuitable land use

Qualitative impact assessment

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

L = low, M = moderate, H = high

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

Estimated quantitative impacts

Quantitative annual impacts per hectare are calculated as the current or anticipated proportional impact on land value across the region. All amounts are in net present value (NPV, $).

Calculation: **Economic value per land use/habitat type** × **Impact level**

Impact level
Low = 1–4% reduction in annual economic value per hectare
Moderate = 5–9% reduction in annual economic value per hectare
High = 10–50% reduction in annual economic value per hectare

Reduction in annual economic value ($) per hectare

LAND USE/HABITAT TYPE	CURRENT IMPACT PER HA	POTENTIAL IMPACT PER HA
Production		
Dairy	54.63–267.08	546.30–3,338.50
Sheep and beef	36.95–81.27	73.90–451.50
Forestry	17.47–85.40	87.35–192.15
Horticulture	525.55–1,778.40	1,051.10–9,880.00
Aquaculture	0	0
Environment/Social/Cultural		
Urban	5.33–56.05	26.64–126.11
Native terrestrial	55.60–340.00	55.60–340.00
Coastal	124.70–762.50	124.70–762.50
Freshwater	0	0
Estuarine	0	0
Marine	0	0

Cost-benefit analysis results

Proposed management programme: **Site-led**
Area of Programme: **948,298.9 ha**
Proposed annual expenditure by Council: **$1,215,945**

Assumptions

ASSUMPTIONS	VALUES	ASSUMPTIONS	VALUES
Current area infested	28,448.97 ha	Time to reach maximum extent†	50 yrs
Current impacts★	$88.74/ha	Potential extent in the region°	45,155 ha
	$46.47–131.01/ha		28,448.97–61,860.28 ha
Current benefits	$5/ha	Discount rate	4%

★ Current annual impact of the pest averaged across all land uses currently occupied.

° The potential extent the pest is predicted to achieve in the absence of regional management.

† The time a pest is predicted to take between first going wild in the region and reaching its maximum extent.

10 year assessment

The cost-benefit analysis indicates that the benefits of the proposed management programme over the next 10 years will be of net benefit to the region.

SCENARIO	PEST IMPACTS★	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNERS COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$34,211,684	$1,342,577		$0	$0	$0	
	min: 12,044,705	min: 1,199,882					
	max: 68,188,317	max: 1,597,582					
Site-led	$22,111,130	$1,194,870	$11,952,847	$9,413,366	$274,820	$0	$2,264,661
	min: 11,578,915	min: 1,194,870	min: 63,078		min: 71,692		min: -9,828,236
	max: 32,643,345	max: 1,194,870	max: 35,539,960		max: 477,948		max: 26,054,902

★ Includes economic, environmental and social costs.

° The estimated economic benefit provided by the pest.

† Administration and implementation costs incurred by the Council through the programme.

‡ Costs of control imposed on landowners through the programme, over and above the costs already being paid by landowners, as estimated by the Council. They are applied for the 10 years of the Plan.

50 year assessment

The longer-term cost-benefit analysis indicates that the monetised benefits over the next 50 years of the proposed management programme will be of net benefit to the region. Additional non-monetised benefits associated with the protection of biodiversity values are also anticipated.

SCENARIO	PEST IMPACTS★	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNERS COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$155,648,839	$3,972,260		$0	$0	$0	
	min: 29,721,697	min: 3,177,959					
	max: 416,763,804	max: 5,634,842					
Site-led	$53,741,947	$3,124,530	$101,059,162	$24,931,854	$274,820	$0	$75,852,488
	min: 28,142,995	min: 3,124,530	min: -931,610		min: 71,692		min: -26,341,412
	max: 79,340,900	max: 3,124,530	max: 337,369,475		max: 477,948		max: 312,365,929

CBA statement and risks to success

Possums can have a significant impact on production (dairy, sheep and beef, forestry, and horticulture), environmental and social/cultural values. They are widespread across all forms of habitat in Hawke's Bay.

Hawke's Bay Regional Council has been controlling possums through its Possum Control Area (PCA) programme since 2000. There has been a very high level of support for the PCA programme, and a strong belief by most land occupiers within the programme that it is providing value for money for programme participants. The programme has grown to over 700,000ha and is exceeding its target with an average residual trap catch (RTC) of 2.3% across all PCA programmes. Rules requiring land occupiers to maintain possum numbers at low levels are necessary to support the programme so as to protect production and biodiversity values and address externality impacts on neighbouring properties.

The benefits of regional intervention, focused on sustainably controlling possums as part of a possum control area programme, outweigh the cost of the programme.

RISK	LEVEL OF RISK	EXPLANATION
Technical risk	Low to medium	HBRC has demonstrated this is technically feasable through its Possum Control Area (PCA) programme, initiated in 2000. It is a proven flagship biosecurity programme with a current average RTC rate of 2.3% across all PCAs.
Operational risk	Low	See above
Legal risk	Low to medium	
Socio-political risk	Low	
Other risks	Low	

Who should pay?

Beneficiaries and exacerbators

GROUP	BENEFICIARY	EXACERBATOR	CHANGE BEHAVIOUR	ASSESS & COSTS BENEFITS	CONTROL COST EFFECTIVELY
Land occupiers (Crown and private)	Major	Major	Yes	Yes	Yes
Dairy/sheep and beef sector	Major		No	Yes	Yes
Regional community	Major		No	Yes	Yes

Who should pay for the proposed management approach?

Possum are a major threat to production and conservation values in Hawke's Bay. In farming areas, they spread bovine tuberculosis to beef and dairy cattle, and to farmed deer, damage crops and orchards, kill poplars and willows planted to control hill-country erosion and stabilise riverbanks, and eat pasture. In exotic forest plantations they kill young trees and stunt the growth of older trees by ring-barking them or breaking the uppermost branches.
In native vegetated areas, possums cause severe damage by altering habitats important to native animals and birds. Tree species that are palatable to possums (e.g. rata, kamahi, and pohutukawa) become much reduced or locally extinct, and are replaced by plants that are less palatable such as tree ferns and pepperwood. As well as altering the composition of native forests and competing with native fauna, possums also prey directly on native insects and birds.

It is proposed this programme is funded through a 70% targeted rate, 30% general rate.

RABBIT
Oryctolagus cuniculus

SUSTAINED CONTROL

Relevant biology

ATTRIBUTE	DESCRIPTION
Form	Rabbits are about the size of a small domestic cat, grey-brown in colour with a reddish neck and white under-parts. Both sexes are alike.
Habitat	Generally found in open habitats e.g. pasture, orchards, arable land, parks and gardens.
Regional distribution	Throughout the region.

Competitive ability	Rabbits compete directly with stock for pasture; 8–10 rabbits eat as much as one sheep. In the Bay of Plenty they are responsible for severe browsing damage to palatable dune plants.
Reproductive ability	Can breed throughout the year. In peak years can produce up to 7 litters resulting in 45–50 young per adult doe per year.
Resistance to control	Controlled by poisoning, fumigation, shooting, trapping, exclusion fencing and predation. Become 'shy' to any one method if the same method is used constantly.
Benefits	May help control exotic weeds in coastal dunes.

Land use/habitats occupied in Hawke's Bay

LAND USE TYPE	CURRENT INFESTATION	POTENTIAL INFESTATION
Dairy	Low	High
Sheep and beef	Low	High
Forestry	Low	Low
Horticulture	Low	High
Aquaculture	-	-
Urban	Low	Low
Native terrestrial	Low	Low
Coastal land	Low	High
Freshwater	-	-
Estuarine	-	-
Marine	-	-

High = Most infested/preferred land use(s), Low = Less infested/preferred land use(s), - = Unsuitable land use

Qualitative impact assessment

CATEGORY	CURRENT	POTENTIAL	COMMENT	SOURCE
Production				
Dairy	M	M	Causes major damage to pastures.	
Sheep and beef	M	M	10 rabbits can eat as much as one sheep.	
Forestry	L	L		1, 2
Horticulture	L	L		
Aquaculture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	L	H	Causes major disturbance and erosion of soil through burrowing, and a reduction in vegetation cover through browsing.	2
Water quality	L	L	Erosion of soil can lead to increased sedimentation in waterways.	2
Species diversity	M	H	Eats native low-growing native plants in non-forested habitats such as sand dunes and beaches.	1, 2
Threatened species	L	M	Heavy browsing can prevent reproduction and/or eliminate low-growing threatened plant species e.g. native brooms.	1, 2
Social/Cultural				
Human health	-	-		
Recreation	L	L	Digs holes in golf courses and playing fields.	2
Māori culture	L	M	Can dig up cultural sites, esp. near the coast (e.g. waahi tapu, urupa).	

L = low, M = moderate, H = high

source 1: Auckland Regional Council (2004), 2: King (2005)

Estimated quantitative impacts

Quantitative annual impacts per hectare are calculated as the current or anticipated proportional impact on land value across the region. All amounts are in net present value (NPV, $).

Calculation: **Economic value per land use/habitat type** × **Impact level**

Impact level

Low = 1–4% reduction in annual economic value per hectare

Moderate = 5–9% reduction in annual economic value per hectare

High = 10–50% reduction in annual economic value per hectare

Reduction in annual economic value ($) per hectare

LAND USE/HABITAT TYPE	CURRENT IMPACT PER HA	POTENTIAL IMPACT PER HA
Production		
Dairy	273.15–600.93	273.15–600.93
Sheep and beef	36.95–81.27	36.95–81.27
Forestry	17.47–85.40	17.47–85.40
Horticulture	105.11–790.40	105.11–790.40
Aquaculture	0	0
Environment/Social/Cultural		
Urban	0	0
Native terrestrial	27.80–61.20	55.60–340.00
Coastal	62.35–137.25	124.70–762.50
Freshwater	0	0
Estuarine	0	0
Marine	0	0

Cost-benefit analysis results

Proposed management programme: **Sustained Control**
Area of Programme: **whole region ha**
Proposed annual expenditure by Council: **$59,704**

Assumptions

ASSUMPTIONS	VALUES	ASSUMPTIONS	VALUES
Current area infested	945,767.8 ha	Time to reach maximum extent†	50 yrs
Current impacts★	$68.37/ha	Potential extent in the region°	945,768 ha
	$37.93–98.81/ha		945,767.8–945,767.8 ha
Current benefits	$0/ha	Discount rate	4%

★ Current annual impact of the pest averaged across all land uses currently occupied.

° The potential extent the pest is predicted to achieve in the absence of regional management.

† The time a pest is predicted to take between first going wild in the region and reaching its maximum extent.

10 year assessment

The cost-benefit analysis indicates that the benefits of the proposed management programme over the next 10 years will be of net benefit to the region.

SCENARIO	PEST IMPACTS★	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNERS COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$589,118,848	$0		$0	$0	$0	
	min: 326,837,606						
	max: 851,400,091						
Sustained Control	$566,336,565	$0	$22,782,283	$503,623	$184,295	$0	$22,094,365
	min: 314,198,209		min: 12,639,397		min: 184,295		min: 11,951,479
	max: 818,474,921		max: 32,925,170		max: 184,295		max: 32,237,252

★ Includes economic, environmental and social costs.

° The estimated economic benefit provided by the pest.

† Administration and implementation costs incurred by the Council through the programme.

‡ Costs of control imposed on landowners through the programme, over and above the costs already being paid by landowners, as estimated by the Council. They are applied for the 10 years of the Plan.

50 year assessment

The longer-term cost-benefit analysis indicates that the monetised benefits over the next 50 years of the proposed management programme will be of net benefit to the region. Additional non-monetised benefits associated with the protection of biodiversity values are also anticipated.

SCENARIO	PEST IMPACTS★	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNERS COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$1,453,718,606	$0		$0	$0	$0	
	min: 806,509,434						
	max: 2,100,927,778						
Sustained Control	$1,376,502,693	$0	$77,215,913	$1,333,875	$184,295	$0	$75,697,743
	min: 763,670,771		min: 42,838,663		min: 184,295		min: 41,320,493
	max: 1,989,334,615		max: 111,593,163		max: 184,295		max: 110,074,993

CBA statement and risks to success

Rabbits eat a variety of plant matter, competing directly with stock for grazing, damaing seedlings of trees and crops as well as native species. A sustained control programme outcome (to reduce the impacts and spread to other properties) is the preferred option and represents the most pragmatic and affordable management approach.

The benefits of regional intervention, focused on sustainably controlling rabbits throughout the region, outweigh the cost of the programme.

Risks of the programme being unsuccessful in achieving objectives

RISK	LEVEL OF RISK	EXPLANATION
Technical risk	Low	
Operational risk	Low	
Legal risk	Low	
Socio-political risk	Low	
Other risks	Low	

Who should pay?

Beneficiaries and exacerbators

GROUP	BENEFICIARY	EXACERBATOR	CHANGE BEHAVIOUR	ASSESS COSTS & BENEFITS
Land occupiers (Crown and private)	Major	Major	Yes	Yes
Dairy/sheep and beef sector	Major		No	Yes
Regional community	Major		No	Yes

Who should pay for the proposed management approach?

Although there minor biodiversity benefits from managing rabbit densities, the primary beneficiary of rabbit control is the agricultural sector. It is proposed that this programme is funded through a 70% targeted rate and 30% general rate.

CHILEAN NEEDLE GRASS
Nassella neesiana

SUSTAINED CONTROL

Relevant biology

ATTRIBUTE	DESCRIPTION
Form	Erect, tufted, perennial grass that grows to 1.2 m tall. Leaves are up to 5 mm wide, bright green and harsh. Flowers have a purple tinge and ripen into hard, sharp seeds with long twisting tails. Seeds are up to 10 mm long, with a hard, sharply-pointed head and a long (c.70 mm long) hair-like awn (tail). Difficult to identify (esp. when not flowering).
Habitat	Prefers disturbed grasslands and grassy woodlands with moderate rainfall. Can occur in agricultural areas, natural forests, grasslands, scrub, waterways, and riparian areas.
Regional distribution	Summer dry areas of Hawke's Bay - west of Napier and at Maraekakaho, Poukawa, Waipawa, Wakarara, Omakere and Porangahau.
Competitive ability	Forms dense stands, excluding other species, and decreasing pasture productivity. Pastures experiencing drought are most susceptible to invasion. It can establish on the hardest bare sites on disturbed ground. Is long-lived and very hardy.
Reproductive ability	Both sexual and asexual seed production. Can produce up to 22,000 seeds/plant/year via sexual reproduction (depending on moisture availability). Asexual seeds are hidden in the nodes and bases of flowering stems; these enable the plant to reproduce even with grazing, slashing and fire. Can flower all year around. Seed bank can persist for up to 12 years.
Dispersal methods	Mostly spread by stock, machinery, hay, and humans rather than wind because seeds are heavy and tend to fall close to the plant. The point of the seed is very sharp and hairy and attaches easily onto animals, vehicles and clothing.
Resistance to control	Once established, is very difficult to control as seeds are viable for many years. Individual plants should be grubbed out and destroyed by burning. Larger patches can be sprayed with glyphosate, but seedlings will readily invade bare soil and must be sprayed before they produce seed. A combination of chemical, mechanical, rehabilitation, competition, grazing management and biological control are required to eradicate it.
Benefits	Can provide winter-only food for stock, but this is balanced by the reduction in pasture-palatability at other times of year.

Land use/habitats occupied in Hawke's Bay

LAND USE TYPE	CURRENT INFESTATION	POTENTIAL INFESTATION
Dairy	Low	High
Sheep and beef	Low	High
Forestry	Low	Low
Horticulture	Low	Low
Aquaculture	-	-
Urban	Low	High
Native terrestrial	Low	Low
Coastal land	-	High
Freshwater	-	-
Estuarine	-	-
Marine	-	-

High = Most infested/preferred land use(s), Low = Less infested/preferred land use(s), - = Unsuitable land use

Qualitative impact assessment

CATEGORY	CURRENT	POTENTIAL	COMMENT	SOURCE
Production				
Dairy	L	L	Agricultural productivity can be severely reduced by the replacement of palatable vegetation, injury to stock, reduction of produce quality and increased management costs.	
Sheep and beef	L	H	Seeds can cause pelt damage, and painful wounds both externally and internally when they move through skin into muscles. Carcasses are downgraded, blindness can occur and seeds can get into ears. Farm dogs can be similarly affected. Some sheep graziers in eastern Australia have been forced to switch to beef production.	
Forestry	-	-		1, 2, 3, 4
Horticulture	-	L	Potential crop contaminant.	
Aquaculture	-	-		
Other	-	-		
International trade	-	L	A weed of National Significance in Australia. Grain, alpacas and sheep are occasionally exported to Australia.	3, 5
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	L	H	Highly invasive in native grasslands, where it can replace native plants, and alter invertebrate community composition.	3, 5
Threatened species	L	M	Potential distribution overlaps with some threatened grassland plant species.	3
Social/Cultural				
Human health	-	L	Can cause skin irritations.	3
Recreation	L	M	Seeds get caught in clothes and socks making it unpleasant for humans and dogs to walk through.	2
Māori culture	-	-		

L = low, M = moderate, H = high

source 1: Hawke's Bay Regional Council (2002), 2: Environment Canterbury (2008), 3: Laconis (2004), 4: Young & Evans (1969), 5: Invasive Species Specialist Group (2005)

Estimated quantitative impacts

Quantitative annual impacts per hectare are calculated as the current or anticipated proportional impact on land value across the region. All amounts are in net present value (NPV, $).

Calculation: **Economic value per land use/habitat type** × **Impact level**

Impact level
Low = 1–4% reduction in annual economic value per hectare
Moderate = 5–9% reduction in annual economic value per hectare
High = 10–50% reduction in annual economic value per hectare

Reduction in annual economic value ($) per hectare

LAND USE/HABITAT TYPE	CURRENT IMPACT PER HA	POTENTIAL IMPACT PER HA
Production		
Dairy	54.63–267.08	54.63–267.08
Sheep and beef	7.39–36.12	73.90–451.50
Forestry	0	0
Horticulture	0	105.11–790.40
Aquaculture	0	0
Environment/Social/Cultural		
Urban	0	5.33–56.05
Native terrestrial	5.56–27.20	55.60–340.00
Coastal	0	124.70–762.50
Freshwater	0	0
Estuarine	0	0
Marine	0	0

Cost-benefit analysis results

Proposed management programme: **Sustained Control**
Area of Programme: **whole region ha**
Proposed annual expenditure by Council: **$160,000**

Assumptions

ASSUMPTIONS	VALUES	ASSUMPTIONS	VALUES
Current area infested	665 ha	Time to reach maximum extent†	75 yrs
Current impacts★	$19.92/ha	Potential extent in the region°	144,237 ha
	$6.76–33.07/ha		48,933.59–239,540.9 ha
Current benefits	$0/ha	Discount rate	4%

★ Current annual impact of the pest averaged across all land uses currently occupied.

° The potential extent the pest is predicted to achieve in the absence of regional management.

† The time a pest is predicted to take between first going wild in the region and reaching its maximum extent.

10 year assessment

The cost-benefit analysis indicates that the benefits of the proposed management programme over the next 10 years will be of net benefit to the region.

SCENARIO	PEST IMPACTS★	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNERS COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$3,041,431	$0		$0	$0	$0	
	min: 696,987						
	max: 6,796,569						
Sustained Control	$103,169	$0	$2,938,262	$759,180	$421,767	$0	$1,757,315
	min: 16,205		min: 680,782		min: 421,767		min: -500,165
	max: 282,289		max: 6,514,280		max: 421,767		max: 5,333,333

★ Includes economic, environmental and social costs.

° The estimated economic benefit provided by the pest.

† Administration and implementation costs incurred by the Council through the programme.

‡ Costs of control imposed on landowners through the programme, over and above the costs already being paid by landowners, as estimated by the Council. They are applied for the 10 years of the Plan.

50 year assessment

The longer-term cost-benefit analysis indicates that the monetised benefits over the next 50 years of the proposed management programme will be of net benefit to the region. Additional non-monetised benefits associated with the protection of biodiversity values are also anticipated.

SCENARIO	PEST IMPACTS★	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNERS COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$452,588,175	$0		$0	$0	$0	
	min: 70,375,697						
	max: 2,181,272,273						
Sustained Control	$170,161	$0	$452,418,014	$1,872,898	$421,767	$0	$450,123,349
	min: 16,205		min: 70,359,492		min: 421,767		min: 68,064,827
	max: 1,285,338		max: 2,179,986,935		max: 421,767		max: 2,177,692,270

CBA statement and risks to success

Chilean needle grass can reduce agricultural productivity by replacing palatable vegetation, reducing produce quality and increasing management costs. Seeds can cause pelt damage, and painful wounds both externally and internally when they move through skin into muscles. Carcasses are downgraded, blindness can occur and seeds can get into ears. It is likely to invade native grasslands, where it can replace native plants, and alter invertebrate community composition.

Chilean needle grass is very hard to identify and can go undetected on a property for many years. The seeds are easily transported on stock, clothing and machinery. This makes managing Chilean needle grass very difficult. On average eight new properties are found annually within the region. There are almost no viable and effective control tools for large infestations. This poses a risk to the success of the programme.
The objective of preventing the spread of Chilean needle grass is going to be difficult to achieve but it would be irresponsible for Council to select the option of no regional intervention.

The benefits of regional intervention, focused on sustainably controlling Chilean needle grass throughout the region, outweigh the cost of the programme.

Risks of the programme being unsuccessful in achieving objectives

RISK	LEVEL OF RISK	EXPLANATION
Technical risk	Medium	
Operational risk	Low	
Legal risk	Medium	
Socio-political risk	Low	
Other risks	Low	

Who should pay?

Beneficiaries and exacerbators

GROUP	BENEFICIARY	EXACERBATOR	CHANGE BEHAVIOUR	ASSESS COSTS & BENEFITS
Land occupiers (Crown and private)	Major	Major	Yes	Yes
Dairy/sheep and beef sector	Major	Major	Yes	Yes
Regional community	Major		No	Yes

Who should pay for the proposed management approach?

Although there are minor biodiversity benefits from managing Chilean needle grass, the primary beneficiary is the agricultural sector. It is proposed that this programme is funded through a 70% targeted rate and 30% general rate.

PRIVET

Ligustrum lucidum, L. sinense

URBAN AREA

Relevant biology

ATTRIBUTE	DESCRIPTION
Form	Tree privet is a medium-sized evergreen tree growing up to 10 m tall. Chinese privet is an evergreen or semi-deciduous shrub or small tree up to 5 m tall.
Habitat	Widely grown as hedging plants. Occur in lowland and coastal forest, mostly remnants and shrub land. Urban areas, disturbed sites, roadside banks, waste areas.
Regional distribution	Urban problem.
Competitive ability	Tree privet is shade-tolerant and competitive on a wide range of soils. Chinese privet is also shade-tolerant (probably also shade-requiring). Fire intolerant.
Reproductive ability	Both species produce 100,000–10,000,000 seeds per bush or tree.
Dispersal methods	Seed dispersed by birds.
Resistance to control	Adequately controlled by cutting and painting with metsulfuron, but this can possibly damage surrounding vegetation.
Benefits	None

Land use/habitats occupied in Hawke's Bay

LAND USE TYPE	CURRNET INFESTATION	POTENTIAL INFESTATION
Dairy	-	Low
Sheep and beef	Low	Low
Forestry	Low	Low
Horticulture	Low	Low
Aquaculture	-	-
Urban	Low	High
Native terrestrial	Low	High
Coastal land	-	Low
Freshwater	-	-
Estuarine	-	-
Marine	-	-

High = Most infested/preferred land use(s), Low = Less infested/preferred land use(s), - = Unsuitable land use

Qualitative impact assessment

CATEGORY	CURRENT	POTENTIAL	COMMENT	SOURCE
Production				
Dairy	-	L	Can form dense stands and reduce pasture cover.	
Sheep and beef	L	L	Can form dense stands and reduce pasture cover.	
Forestry	L	L	Potential to invade plantation forests, and compete with young trees.	1
Horticulture	L	L	Can form dense stands and invade open, disturbed or poorly managed areas.	
Aquaculture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	L	M	Dense stands prevent recruitment. Displaces vulnerable shrub species. Poisonous berries may possibly impact on native fauna, esp. insects.	2
Threatened species	L	L	See Species diversity.	2
Social/Cultural				
Human health	L	M	Berries and leaves are poisonous. There is no convincing evidence that pollen affects asthma and hay fever although many people believe this.	
Recreation	L	M	Forms dense stands which obstruct access.	2
Māori culture	L	M	See Human Health and Recreation.	

L = low, M = moderate, H = high

source 1: Environment Bay of Plenty (2004a), 2: Craw (2000)

Estimated quantitative impacts

Quantitative annual impacts per hectare are calculated as the current or anticipated proportional impact on land value across the region. All amounts are in net present value (NPV, $).

Calculation: **Economic value per land use/habitat type** × **Impact level**

Impact level

Low = 1–4% reduction in annual economic value per hectare

Moderate = 5–9% reduction in annual economic value per hectare

High = 10–50% reduction in annual economic value per hectare

Reduction in annual economic value ($) per hectare

LAND USE/HABITAT TYPE	CURRENT IMPACT PER HA	POTENTIAL IMPACT PER HA
Production		
Dairy	0	54.63–267.08
Sheep and beef	7.39–36.12	7.39–36.12
Forestry	17.47–85.40	17.47–85.40
Horticulture	105.11–790.40	105.11–790.40
Aquaculture	0	0
Environment/Social/Cultural		
Urban	5.33–56.05	26.64–126.11
Native terrestrial	5.56–27.20	27.80–61.20
Coastal	0	62.35–137.25
Freshwater	0	0
Estuarine	0	0
Marine	0	0

Cost-benefit analysis results

Proposed management programme: **Sustained control**
Area of Programme: **22,720 ha**
Proposed annual expenditure by Council: **$180,000**

Assumptions

ASSUMPTIONS	VALUES	ASSUMPTIONS	VALUES
Current area infested	30 ha	Time to reach maximum extent†	125 yrs
Current impacts★	$30.69/ha	Potential extent in the region°	3,408 ha
	$5.33–56.05/ha		1,136–5,680 ha
Current benefits	$0/ha	Discount rate	4%

★ Current annual impact of the pest averaged across all land uses currently occupied.

° The potential extent the pest is predicted to achieve in the absence of regional management.

† The time a pest is predicted to take between first going wild in the region and reaching its maximum extent.

10 year assessment

The cost-benefit analysis indicates that the benefits of the proposed management programme over the next 10 years will not be of net benefit to the region with the assumptions made.

SCENARIO	PEST IMPACTS★	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNERS COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$14,392	$0		$0	$0	$0	
	min: 2,703						
	max: 27,808						
Sustained control	$8,097	$0	$6,295	$1,096,593	$0	$0	$-1,090,298
	min: 1,406		min: 1,297				min: -1,095,296
	max: 14,788		max: 13,020				max: -1,083,573

★ Includes economic, environmental and social costs.

° The estimated economic benefit provided by the pest.

† Administration and implementation costs incurred by the Council through the programme.

‡ Costs of control imposed on landowners through the programme, over and above the costs already being paid by landowners, as estimated by the Council. They are applied for the 10 years of the Plan.

50 year assessment

The longer-term cost-benefit analysis indicates that the monetised benefits of the proposed management programme over the next 50 years will still not be of net benefit to the region with the assumptions made.

SCENARIO	PEST IMPACTS★	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNERS COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$236,252	$0		$0	$0	$0	
	min: 47,168						
	max: 705,539						
Sustained control	$19,904	$0	$216,348	$2,904,391	$0	$0	$-2,688,043
	min: 3,456		min: 43,712				min: -2,860,679
	max: 36,352		max: 669,187				max: -2,235,204

CBA statement and risks to success

Although privet has negative impacts on biodiversity, the proposed programme focusses on human health in urban areas only. The benefits of intervention, focused on sustainably controlling privet for human health purposes, do not outweigh the cost of the programme. However, given the new restrictions to the programme making it more focussed on actual privet sufferers, this programme has been retained in the Regional Pest Management Plan.

Risks of the programme being unsuccessful in achieving objectives

RISK	LEVEL OF RISK	EXPLANATION
Technical risk	Low	
Operational risk	Low	
Legal risk	Low	
Socio-political risk	Low	
Other risks	Low	

Who should pay?

Beneficiaries and exacerbators

GROUP	BENEFICIARY	EXACERBATOR	CHANGE BEHAVIOUR	ASSESS COSTS & BENEFITS	CONTROL COST EFFECTIVELY
Land occupiers (Crown and private)	Major	Major	Yes	Yes	Yes
Dairy/sheep and beef sector	Major		No	Yes	Yes
Regional community	Major		No	Yes	Yes

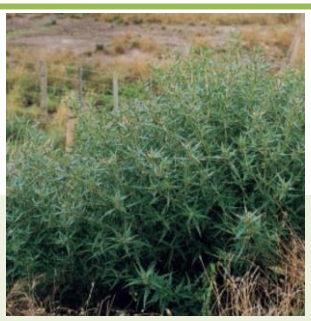
Who should pay for the proposed management approach?

The proposed programme focusses on human health in urban areas therefore it is proposed that it is funded through the general rate.

BATHURST BUR

Xanthium spinosum

BOUNDARY CONTROL



Relevant biology

ATTRIBUTE	DESCRIPTION
Form	Compact annual herb, which can become woody or bush, 30-100cm tall. Stems have groups of three-pronged, stiff, yellow spines at the base of each leaf or branch. Leaves are dark grey to green with prominent white veins and fine silvery hairs underneath. Tiny, greenish-crem flowers develop into hard brown burs, 10-12mm long, covered with many hooked spines. Burs contain two brown or black flattened seeds, each c. 1cm long.
Habitat	Cultivated areas, along rivers, disturbed sites, and coastal areas.
Regional distribution	Widespread throughout the region in pastoral and cropping areas.
Competitive ability	Very hardy and robust invader of pasture and open wasteland.
Reproductive ability	Each bur contains two seeds, one of which germinates the first summer, while the other remains dormant for 2-3 years, occasionally up to 15 years. Seeds germinate from November to January.
Dispersal methods	Burs remain attached to dead plants until they are trampled or transported elsewhere by animals. The burs cling to wool, fur, sacking, clothing and any fibrous material. Seeds are therefore mainly dispersed by animals and people.
Resistance to control	Isolated plants can be hand-pulled or grubbed out, and young plants can be controlled with chemicals (best in late spring). Chemical control is more difficult when plants mature and become woody.
Benefits	None

Land use/habitats occupied in Hawke's Bay

LAND USE TYPE	CURRENT INFESTATION	POTENTIAL INFESTATION
Dairy	High	Low
Sheep and beef	High	High
Forestry	-	-
Horticulture	High	High
Aquaculture	-	-
Urban	-	-
Native terrestrial	Low	High
Coastal land	-	-
Freshwater	-	-
Estuarine	-	-
Marine	-	-

High = Most infested/preferred land use(s), Low = Less infested/preferred land use(s), - = Unsuitable land use

Qualitative impact assessment

CATEGORY	CURRENT	POTENTIAL	COMMENT	SOURCE
Production				
Dairy	L	H	Spiky leaves and burs restrict animal movement, and spines can damage feet and skin of livestock.	
Sheep and beef	M	H	Burs are extremely difficult to remove from wool. Affected wool has significantly reduced value due to increased scouring costs. Can cause shearing combs to jam and break	
Forestry	-	-		1, 2, 3, 4
Horticulture	M	H	Competes with crops in cultivated land. Summer crop species such as maize, sorghum and sunflowers can be contaminated by burs.	
Aquaculture	-	-		
Other	-	L	Seedlings can be toxic to stock when very small. Pigs are affected more than sheep or cattle. Bird seed, poultry feed, horse oats and produce such as tomatoes can also carry burs.	
International trade	L	H	Affected wool has significantly reduced value due to increased scouring costs.	2
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	-	-		3
Threatened species	-	-		
Social/Cultural				
Human health	L	L	The plant is mildly poisonous, and can irritate the skin of shearers or cause contact dermatitis in some people.	4
Recreation	L	L	Spiky leaves and burs restrict access	2,4
Māori culture	-	-		

L = low, M = moderate, H = high
Source: 1: Popay et al. (2010), 2: Hawke's Bay Regional Council (1996), 3: NRC (1998), 4: Auckland Council (2008)

Estimated quantitative impacts

Quantitative annual impacts per hectare are calculated as the current or anticipated proportional impact on land value across the region. All amounts are in net present value (NPV, $).

Calculation: **Economic value per land use/habitat type** × **Impact level**

Impact level
Low = 1–4% reduction in annual economic value per hectare
Moderate = 5–9% reduction in annual economic value per hectare
High = 10–50% reduction in annual economic value per hectare

Reduction in annual economic value ($) per hectare

LAND USE/HABITAT TYPE	CURRENT IMPACT PER HA	POTENTIAL IMPACT PER HA
Production		
Dairy	51.81–207.24	297.54–1308.36
Sheep and beef	0.85–2.42	4.86–42.45
Forestry	0	0
Horticulture	100.97	579.83
Aquaculture	0	0
Non-production		
Environment	0	0
Social/Cultural	0	0

Cost-benefit analysis results

Proposed management programme: **Sustained control**

Area of Programme: **whole region**

Proposed annual expenditure by Council: **$15**

CBA statement and risks to success

Bathurst Bur is invasive and difficult to control. If no action is taken it will spread to more sites, its numbers will increase and its impact will become more severe. Bathurst Bur is a serious agricultural weed that has the potential to spread across the region if no action is taken. Unfortunately Bathurst bur's current regional distribution is beyond the scope of affordable or cost-effective region wide control. However, since most propagules fall within a short distance of parent plants, this spread between neighbouring properties can be slowed by maintaining a width of boundary land clear of this weed. The proposed boundary control width for Bathurst bur is five meters. While such boundary control is not considered likely to alter the region wide extent of the weed, for the small proposed expenditure it is considered cost beneficial from a good neighbour perspective for the regional council to assist land owners in limiting weed spread between adjacent properties.

Tcosts estimated for this programme assume rates of landowner complaints to Council regarding gorse are likely to remain similar to current levels over the lifetime of the plan.

Risks of the programme being unsuccessful in achieving objectives

RISK	LEVEL OF RISK	EXPLANATION
Technical risk	Low	
Operational risk	Low	
Legal risk	Low	
Socio-political risk	Low	
Other risks	Low	

Who should pay?

Beneficiaries and exacerbators

GROUP	BENEFICIARY	EXACERBATOR	CHANGE BEHAVIOUR	ASSESS COSTS & BENEFITS	CONTROL COST EFFECTIVELY
Pastoral farmers	Major	Minor	Yes	Yes	Yes
Crop farmers	Major	Major	Yes	Yes	Yes
Regional community					

Who should pay for the proposed management approach?

Bathurst bur is an agricultural weed. It is proposed this programme is funded through a 70% targeted rate, 30% general rate mix.

BLACKBERRY

Rubus fruticosus agg.

BOUNDARY CONTROL

Relevant biology

ATTRIBUTE	DESCRIPTION
Form	Prickly scrambling, perennial shrub, with spiny prickles surrounding the stem and on the underside of the leaf along the mid-rib. Leaves are oval with jagged edges. Flowers are white to pink in clusters. Fruit are black, fleshy and edible.
Habitat	Lightly grazed pasture, roadsides, wasteland, particularly where rainfall is high.
Regional distribution	Widespread throughout the region, especially north of Napier.
Competitive ability	Can form impenetrable thickets, excluding plants underneath.
Reproductive ability	Seeds freely and regularly. 7000-13,000 seeds/m2 have been recorded in Australia.
Dispersal methods	Fleshy fruit are dispersed by birds.
Resistance to control	Not considered the threat it once was due to advances in mechanical/chemical control.
Benefits	Edible fruit.

Land use/habitats occupied in Hawke's Bay

LAND USE TYPE	CURRENT INFESTATION	POTENTIAL INFESTATION
Dairy	High	High
Sheep and beef	High	High
Forestry	High	High
Horticulture	Low	Low
Aquaculture	-	-
Urban	Low	-
Native terrestrial	High	High
Coastal land	Low	Low
Freshwater	-	-
Estuarine	-	-
Marine	-	-

High = Most infested/preferred land use(s), Low = Less infested/preferred land use(s), - = Unsuitable land use

Qualitative impact assessment

CATEGORY	CURRENT	POTENTIAL	COMMENT	SOURCE
Production				
Dairy	L	L	Stock movement is hindered by dense thickets.	
Sheep and beef	M	M	Can degrade wool and hides.	
Forestry	L	L		1
Horticulture	L	L		
Aquaculture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	M	H	Forms impenetrable thickets, smothers most lowgrowing species, inhibiting recruitment.	1
Threatened species	-	-		
Social/Cultural				
Human health	-	-		
Recreation	M	M	Prickly spines restrict access	
Māori culture	-	L	Restricts access to cultural sites (e.g. waahi tapu, urupa).	

L = low, M = moderate, H = high
Source: 1: Craw (2000),

Estimated quantitative impacts

Quantitative annual impacts per hectare are calculated as the current or anticipated proportional impact on land value across the region. All amounts are in net present value (NPV, $).

Calculation: **Economic value per land use/habitat type** × **Impact level**

Impact level
Low = 1–4% reduction in annual economic value per hectare
Moderate = 5–9% reduction in annual economic value per hectare
High = 10–50% reduction in annual economic value per hectare

Reduction in annual economic value ($) per hectare

LAND USE/HABITAT TYPE	CURRENT IMPACT PER HA	POTENTIAL IMPACT PER HA
Production		
Dairy	36.24–145.79	36.86–148.29
Sheep and beef	0.59–1.7	0.6–1.73
Forestry	2.24	2.28
Horticulture	2.82	2.87
Aquaculture	0	0
Non-production		
Environment	0.02–5.12	0.04–28.95
Social/Cultural	0–0.01	0–0.07

Cost-benefit analysis results

Proposed management programme: **Sustained control**
Area of Programme: **whole region**
Proposed annual expenditure by Council: **$390**

CBA statement and risks to success

Blackberry is a very invasive pasture weed, growing into impenetrable thickets which not only reduce stock carrying capacity, but restrict access to streams and water supplies. Thickets entangle woolly sheep, even causing death, and provide ideal ground cover for pests such as rabbits, hares and possums. In forestry and urban areas, blackberry can be a major fire hazard.
It is a widespread species now beyond the scope of affordable or cost-effective region wide control. As an important high-impact pest of production land, it can be the cause of disputes between land owners when one property is the source of the pest spreading onto adjacent properties. The sprawling nature of blackberry means its spread between neighbouring properties can be slowed by maintaining a width of boundary land clear of this weed. The proposed boundary control width for Blackberry is 10 meters. While such boundary control is not considered likely to alter the region wide extent of the weed, for the small proposed expenditure it is considered cost beneficial from a good neighbour perspective for the regional council to assist land owners in limiting weed spread between adjacent properties.
The costs estimated for this programme assume rates of landowner complaints to Council regarding gorse are likely to remain similar to current levels over the lifetime of the plan.

Risks of the programme being unsuccessful in achieving objectives

RISK	LEVEL OF RISK	EXPLANATION
Technical risk	Low	
Operational risk	Low	
Legal risk	Low	
Socio-political risk	Low	
Other risks	Low	

Who should pay?

Beneficiaries and exacerbators

GROUP	BENEFICIARY	EXACERBATOR	CHANGE BEHAVIOUR	ASSESS & COSTS BENEFITS	CONTROL COST EFFECTIVELY
Land occupiers (Crown and private)					
Pastoral Farmers	Major	Major	Yes	Yes	Yes
Regional community					

Who should pay for the proposed management approach?

Blackberry is an agricultural weed. It is proposed this programme is funded through a 70% targeted rate, 30% general rate mix.

GORSE

Ulex europaeus

BOUNDARY CONTROL

Relevant biology

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

Land use/habitats occupied in Hawke's Bay

LAND USE TYPE	CURRENT INFESTATION	POTENTIAL INFESTATION
Dairy	High	Low
Sheep and beef	High	High
Forestry	High	High
Horticulture	Low	Low
Aquaculture	-	-
Urban	Low	Low
Native terrestrial	Low	High
Coastal land	High	High
Freshwater	-	-
Estuarine	-	-
Marine	-	-

High = Most infested/preferred land use(s), Low = Less infested/preferred land use(s), - = Unsuitable land use

Qualitative impact assessment

CATEGORY	CURRENT	POTENTIAL	COMMENT	SOURCE
Production				
Dairy	L	M	Outcompetes grass and clover, reducing pasture availability.	
Sheep and beef	M	H	Can rapidly invade hill country pastures and outcompete grass and clover, reducing food for grazing stock. Spines pull fleece and lower value of wool.	
Forestry	M	M		1, 2, 3, 4
Horticulture	L	L		
Aquaculture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	L	L	Nitrogen leaching from dense gorse stands can increase nitrate levels in waterways and lakes.	2
Species diversity	L	M	Forms dense stands, out-competes low-growing species. Increases soil nitrogen, may induce succession to forest, to the detriment of specialised plants (e.g. herbs, orchids, low ferns). Native forest succession through gorse is vegetatively different and of lower diversity than succession through kanuka. Succession may be slower in dry sites.	1, 2, 4, 5, 6, 7
Threatened species	L	M	Can invade rare habitat types (e.g. rock outcrops), which support specialist indigenous species. Increases fire risk, which can lead to loss of rare species.	2
Social/Cultural				
Human health	-	-		
Recreation	M	M	Dense shrubs with prickly spines restrict access	8
Māori culture	-	L	Restricts access to cultural sites (e.g. waahi tapu, urupa).	

L = low, M = moderate, H = high

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

Estimated quantitative impacts

Quantitative annual impacts per hectare are calculated as the current or anticipated proportional impact on land value across the region. All amounts are in net present value (NPV, $).

Calculation: **Economic value per land use/habitat type** × **Impact level**

Impact level
Low = 1–4% reduction in annual economic value per hectare
Moderate = 5–9% reduction in annual economic value per hectare
High = 10–50% reduction in annual economic value per hectare

Reduction in annual economic value ($) per hectare

LAND USE/HABITAT TYPE	CURRENT IMPACT PER HA	POTENTIAL IMPACT PER HA
Production		
Dairy	51.64–212.83	66.16–100.32
Sheep and beef	0.84–2.49	2.16–18.08
Forestry	15.94	20.42
Horticulture	4.03	5.16
Aquaculture	0	0
Non-production		
Environment	0–0.53	0.03–9.79
Social/Cultural	0–0.12	0–0.15

Cost-benefit analysis results

Proposed management programme: **Sustained control**

Area of Programme: **whole region**

Proposed annual expenditure by Council: **$117**

CBA statement and risks to success

Gorse can be a significant pastoral weeds, preventing stock access for grazing. It can also be a fire hazard. The benefits estimated for this option assume that spread from adjacent properties is the primary source of invasion, and that managing the source population is more cost-effective than managing the recipient land. This may not be true if adult gorse plants were present on the recipients land, as gorse has an abundant and long lived seed bank (c.30 years), and therefore in many cases reinvasion may be arising from existing seed banks rather than adjacent seed sources. Biosecurity advisors have the ability to take this into account when enforcing the rules of this programme.
Gorse is a widespread species now beyond the scope of affordable or cost-effective region wide control. As an important high-impact pest of production land, it can be the cause of disputes between land owners when one property is the source of the pest spreading onto adjacent properties. Since propagules fall within a short distance of parent plants, this spread between neighbouring properties can be slowed by maintaining a width of boundary land clear of this weed. The proposed boundary control width for gorse is 10 meters While such boundary control is not considered likely to alter the region wide extent of the weed, for the small proposed expenditure it is considered cost beneficial from a good neighbour perspective for the regional council to assist land owners in limiting weed spread between adjacent properties.

The costs estimated for this programme assume rates of landowner complaints to Council regarding gorse are likely to remain similar to current levels over the lifetime of the plan.

Risks of the programme being unsuccessful in achieving objectives

RISK	LEVEL OF RISK	EXPLANATION
Technical risk	Low	
Operational risk	Low	
Legal risk	Low	
Socio-political risk	Medium	Some sections of the community may be concerned at the reduction of the rule boundary distance????
Other risks	Low	

Who should pay?

Beneficiaries and exacerbators

GROUP	BENEFICIARY	EXACERBATOR	CHANGE BEHAVIOUR	ASSESS COSTS & BENEFITS	CONTROL COST EFFECTIVELY
Crown land managers	Minor	Major	No	Yes	Yes
Pastoral Farmers	Major	Major	Yes	Yes	Yes
Forestry	Major	Minor	No	Yes	Yes
Regional community	Major	Major	No	Yes	Yes

Who should pay for the proposed management approach?

Gorse is an agricultural weed. It is proposed this programme is funded through a 70% targeted rate, 30% general rate mix.

NODDING THISTLE
Cardus nutans

BOUNDARY CONTROL

Relevant biology

ATTRIBUTE	DESCRIPTION
Form	Grows to 1.6 m. Leaves are up to 18 cm long by 10 cm wide with spiny margins. Leaves are dissected more than half way to the midrib. Upper leaf surfaces may have rough hairs, a metallic sheen, and appear whitish at the base of the spines. Flower stalks have wings. Flowers are fragrant, bright crimson, c.4 cm across, and droop down, nodding in the wind (Nov– Feb).
Habitat	Pasture, roadsides, and rough open areas. Infrequently found in forest, but can colonise disturbed and open areas.
Regional distribution	Widespread throughout the region.
Competitive ability	Not readily grazed because of its spiny foliage and can form dense patches, achieving almost total ground cover.
Reproductive ability	Usually biennial, germinating in autumn and flowering the second summer. A single plant can produce 40-100 flower heads (normally 40-50), with c.200 seeds per flower, which are 60-80% viable. Most seeds germinate from late summer to early winter, but can germinate in spring–summer with adequate moisture.
Dispersal methods	Seeds are primarily dispersed by wind, but can also be spread in mud, water, fodder and agricultural seed, or on machinery.
Resistance to control	Grubbing plants at least 5 cm below the crown is an effective control method, provided it occurs before seed production. Spraying with herbicide before flowering can be effective, however plants may become more palatable after spraying, so stock need to be excluded until plants are dead. Mowing/topping is less effective, as plants can regrow, and repeated mowing is required. Plants mutilated before flowering may persist as perennials until they can flower. A gallfly has been released as a biocontrol agent.
Benefits	None.

Land use/habitats occupied in Hawke's Bay

LAND USE TYPE	CURRENT INFESTATION	POTENTIAL INFESTATION
Dairy	High	Low
Sheep and beef	High	High
Forestry	Low	Low
Horticulture	Low	Low
Aquaculture	-	-
Urban	-	-
Native terrestrial	-	-
Coastal land	-	-
Freshwater	-	-
Estuarine	-	-
Marine	-	-

High = Most infested/preferred land use(s), Low = Less infested/preferred land use(s), - = Unsuitable land use

Qualitative impact assessment

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

L = low, M = moderate, H = high
Source: 1: Popay (2008), 2: Environment Bay of Plenty (2005c)

Estimated quantitative impacts

Quantitative annual impacts per hectare are calculated as the current or anticipated proportional impact on land value across the region. All amounts are in net present value (NPV, $).

Calculation: **Economic value per land use/habitat type** × **Impact level**

Impact level
Low = 1–4% reduction in annual economic value per hectare
Moderate = 5–9% reduction in annual economic value per hectare
High = 10–50% reduction in annual economic value per hectare

Reduction in annual economic value ($) per hectare

LAND USE/HABITAT TYPE	CURRENT IMPACT PER HA	POTENTIAL IMPACT PER HA
Production		
Dairy	60.58–244.97	254.59–458.27
Sheep and beef	0.99–2.86	4.16–14.87
Forestry	0	0
Horticulture	0	19.85
Aquaculture	0	0
Non-production		
Environment	0	0
Social/Cultural	0	0

Cost-benefit analysis results

Proposed management programme: **Sustained control**
Area of Programme: **whole region**
Proposed annual expenditure by Council: **$117**

CBA statement and risks to success

Nodding thistle is considered to be the most aggressive thistle in New Zealand and can be a serious weed of pasture and horticulture land. If no action is taken it may spread to adjacent properties, with consequent loss of production and increased control costs. However, due to the imacts on agricultural land it is generally dealt with by occupiers as part of usual land management practice.

Nodding thistle is widespread and beyond the scope of affordable or cost-effective region wide control. As an important high-impact pest of production land, it can be the cause of disputes between land owners when one property is the source of the pest spreading onto adjacent properties. Since most propagules fall within a short distance of parent plants, this spread between neighbouring properties can be slowed by maintaining a width of boundary land clear of this weed. The proposed boundary control width for nodding thistle is 20 meters While such boundary control is not considered likely to alter the region wide extent of the weed, for the small proposed expenditure it is considered cost beneficial from a good neighbour perspective for the regional council to assist land owners in limiting weed spread between adjacent properties.

The costs estimated for this programme assume rates of landowner complaints to Council regarding nodding thistle are likely to remain similar to current levels over the lifetime of the plan. There are effective biocontrol agents now available.

Risks of the programme being unsuccessful in achieving objectives

RISK	LEVEL OF RISK	EXPLANATION
Technical risk	Low	
Operational risk	Low	
Legal risk	Low	
Socio-political risk	Low	
Other risks	Low	

Who should pay?

Beneficiaries and exacerbators

GROUP	BENEFICIARY	EXACERBATOR	CHANGE BEHAVIOUR	ASSESS COSTS & BENEFITS	CONTROL COST EFFECTIVELY
Pastoral Farmers	Major	Major	Yes	Yes	Yes
Regional community	Minor	Minor	No	Yes	Yes

Who should pay for the proposed management approach?

Nodding thistle is an agricultural weed. It is proposed this programme is funded through a 70% targeted rate, 30% general rate mix.

RAGWORT
Jacobaea vulgaris

BOUNDARY CONTROL

Relevant biology

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

Land use/habitats occupied in Hawke's Bay

LAND USE TYPE	CURRENT INFESTATION	POTENTIAL INFESTATION
Dairy	High	High
Sheep and beef	High	High
Forestry	Low	Low
Horticulture	-	-
Aquaculture	-	-
Urban	-	-
Native terrestrial	Low	-
Coastal land	-	-
Freshwater	-	-
Estuarine	-	-
Marine	-	-

High = Most infested/preferred land use(s), Low = Less infested/preferred land use(s), - = Unsuitable land use

Qualitative impact assessment

CATEGORY	CURRENT	POTENTIAL	COMMENT	SOURCE
Production				
Dairy	M	M	Forms dense stands in disturbed and grazed areas. Alkaloids present are toxic to cattle, deer, and horses.	
Sheep and beef	M	M	See Dairy.	
Forestry	-	-		1, 2, 3, 4
Horticulture	-	-		
Aquaculture	-	-		
Other	-	-		
International trade	-	L	Prohibited seed of nil tolerance in Australia.	5
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	-	-		
Threatened species	-	-		
Social/Cultural				
Human health	L	L	Can cause skin irritation and allergies when handed extensively.	
Recreation	-	-		
Māori culture	-	-		

L = low, M = moderate, H = high

Source: 1: Craw (2000), 2: Roy et al. (2004), 3: Environment Bay of Plenty (2005d), 4: Environment Canterbury (2007a), 5: AQIS (2009).

Estimated quantitative impacts

Quantitative annual impacts per hectare are calculated as the current or anticipated proportional impact on land value across the region. All amounts are in net present value (NPV, $).

Calculation: **Economic value per land use/habitat type** × **Impact level**

Impact level

Low = 1–4% reduction in annual economic value per hectare

Moderate = 5–9% reduction in annual economic value per hectare

High = 10–50% reduction in annual economic value per hectare

Reduction in annual economic value ($) per hectare

LAND USE/HABITAT TYPE	CURRENT IMPACT PER HA	POTENTIAL IMPACT PER HA
Production		
Dairy	280.08–517.1	326.02–588.01
Sheep and beef	0.91–2.68	1.06–3.05
Forestry	0	0
Horticulture	0	0
Aquaculture	0	0
Non-production		
Environmental	0	0
Social/Cultural	0	0

Cost-benefit analysis results

Proposed management programme: **Sustained control**

Area of Programme: **whole region**

Proposed annual expenditure by Council: **$15**

CBA statement and risks to success

Ragwort is an aggressive, prolific flowering plant that will rapidly colonise exposed areas. It matures quickly and reduces the productivity of the land. There are effective biocontrol agents for ragwort which have significantly reduced the impact of ragwort.

Ragwort is a widespread species beyond the scope of affordable or cost-effective region wide control. Since most propagules fall within a short distance of parent plants, its spread between neighbouring properties can be slowed by maintaining a width of boundary land clear of this weed. The proposed boundary control width for ragwort is 20 meters. While such boundary control is not considered likely to alter the region wide extent of the weed, for the small proposed expenditure it is considered cost beneficial from a good neighbour perspective for the regional council to assist land owners in limiting weed spread between adjacent properties.

The costs estimated for this programme assume rates of landowner complaints to Council regarding ragwort are likely to remain similar to current levels over the lifetime of the plan.

Risks of the programme being unsuccessful in achieving objectives

RISK	LEVEL OF RISK	EXPLANATION
Technical risk	Low	
Operational risk	Low	
Legal risk	Low	
Socio-political risk	Low	
Other risks	Low	

Who should pay?

Beneficiaries and exacerbators

GROUP	BENEFICIARY	EXACERBATOR	CHANGE BEHAVIOUR	ASSESS COSTS & BENEFITS	CONTROL COST EFFECTIVELY
Pastoral Farmers	Major	Major	Yes	Yes	Yes
Regional community	Minor	Minor	No	Yes	Yes

Who should pay for the proposed management approach?

Ragwort is an agricultural weed. It is proposed this programme is funded through a 70% targeted rate, 30% general rate mix.

VARIEGATED THISTLE
Silybum marianum

BOUNDARY CONTROL

Relevant biology

ATTRIBUTE	DESCRIPTION
Form	Annual or biennial thistle growing up to 2 m high. Leaves are very prickly. Stem is hollow without spines. Flowers are large (7 cm in diameter) and red/purple in colour, only one flower per stem.
Habitat	Roadsides, pastures, gardens, wasteland. Grows best on high fertility soils.
Regional distribution	Widespread throughout the region, especially in coastal areas.
Competitive ability	Very aggressive, forming dense impenetrable stands
Reproductive ability	Flowers produce large numbers of seeds which may remain viable for many years.
Dispersal methods	By wind or inclusion in hay bales.
Resistance to control	Spread of germination times increases difficulty of control but is susceptible to several herbicides especially in seedling and rosette stages.
Benefits	Edible (young leaves, peeled young stems, roots, bases of flower heads) and used as medicinal plant (liver complaints).

Land use/habitats occupied in Hawke's Bay

LAND USE TYPE	CURRENT INFESTATION	POTENTIAL INFESTATION
Dairy	High	Low
Sheep and beef	High	High
Forestry	Low	-
Horticulture	Low	-
Aquaculture	-	-
Urban	-	-
Native terrestrial	-	-
Coastal land	-	-
Freshwater	-	-
Estuarine	-	-
Marine	-	-

High = Most infested/preferred land use(s), Low = Less infested/preferred land use(s), - = Unsuitable land use

Qualitative impact assessment

CATEGORY	CURRENT	POTENTIAL	COMMENT	SOURCE
Production				
Dairy	L	M	Forms dense patches, esp. on high fertility soils. Prickles can damage stock and cause nitrate poisoning in cattle and sheep.	
Sheep and beef	L	M	See Dairy.	
Forestry	-	-		1, 2
Horticulture	-	L		
Aquaculture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	-	-		
Threatened species	-	-		
Social/Cultural				
Human health	-	-		
Recreation	-	M	Dense patches of large, spiky plants are nasty to work through	1, 2
Māori culture	-	-		

L = low, M = moderate, H = high
Source: 1: Roy et al. (2004), 2: Environment Bay of Plenty (2005e)

Estimated quantitative impacts

Quantitative annual impacts per hectare are calculated as the current or anticipated proportional impact on land value across the region. All amounts are in net present value (NPV, $).

Calculation: **Economic value per land use/habitat type** × **Impact level**

Impact level
Low = 1–4% reduction in annual economic value per hectare
Moderate = 5–9% reduction in annual economic value per hectare
High = 10–50% reduction in annual economic value per hectare

Reduction in annual economic value ($) per hectare

LAND USE/HABITAT TYPE	CURRENT IMPACT PER HA	POTENTIAL IMPACT PER HA
Production		
Dairy	60.58–244.97	329.33–592.79
Sheep and beef	0.2–1.27	5.38–19.23
Forestry	0	0
Horticulture	0	0
Aquaculture	0	0
Non-production		
Environmental	0	0
Social/Cultural	0	0

Cost-benefit analysis results

Proposed management programme: **Sustained control**
Area of Programme: **whole region**
Proposed annual expenditure by Council: **$234**

CBA statement and risks to success

Variegated thistle is a pastoral weed that prevents stock access for grazing, contaminates wool and increases management costs. Adjacent crops can also be contaminated. It is a widespread species now beyond the scope of affordable or cost-effective region wide control. As an important high-impact pest of production land, it can be the cause of disputes between land owners when one property is the source of the pest spreading onto adjacent properties. Since most propagules fall within a short distance of parent plants, this spread between neighbouring properties can be slowed by maintaining a width of boundary land clear of this weed. The proposed boundary control width for variegated thistle is five meters While such boundary control is not considered likely to alter the region wide extent of the weed, for the small proposed expenditure it is considered cost beneficial from a good neighbour perspective for the regional council to assist land owners in limiting weed spread between adjacent properties.
The costs estimated for this programme assume rates of landowner complaints to Council regarding variegated thistle are likely to remain similar to current levels over the lifetime of the plan.

Risks of the programme being unsuccessful in achieving objectives

RISK	LEVEL OF RISK	EXPLANATION
Technical risk	Low	
Operational risk	Low	
Legal risk	Low	
Socio-political risk	Low	
Other risks	Low	

Who should pay?

Beneficiaries and exacerbators

GROUP	BENEFICIARY	EXACERBATOR	CHANGE BEHAVIOUR	ASSESS COSTS & BENEFITS	CONTROL COST EFFECTIVELY
Pastoral Farmers	Major	Major	Yes	Yes	Yes
Regional community	-	Minor	No	Yes	Yes

Who should pay for the proposed management approach?

Variegated thistle is an agricultural weed. It is proposed this programme is funded through a 70% targeted rate, 30% general rate mix.

Phytosanitary Pest Management Programme

Extent of Infestation

Hawke's Bay currently has around 6,000 planted hectares of pipfruit orchards. The five key pip fruit pests are apple black spot, codling moth, European Canker, fireblight and lightbrown apple moth (leafroller). These pests are widespread across the Hawke's Bay region.

APPLE BLACK SPOT
Venturia inaequalis

PHYTOSANITARY

Description

Apple Black spot is a fungal disease of apples, often referred to as apple scab outside of New Zealand. It is a different fungus to pear black spot, and both are different to black spot on roses. It is found all over the world where ever apples are grown. In New Zealand, black spot is an important problem in all regions.
Rainy and humid conditions early in the growing season provide ideal conditions for apple black spot infection. In general, the higher the temperature and the longer it rains, the more severe the infection period will be. Apple black spot is spread mainly through windblown leaves, carry spores of the fungus.
Infection early in the season may cause misshapen fruit. By harvest, spots are dried, cracked, and brown with a black outer edge. Infection just prior to or during harvest causes small black "pepper spotting" on fruit.
Late season infection may lead to symptoms appearing in cool storage even though there may be no signs of the disease at packing. Even the smallest black spot is unacceptable on an export apple.

CODLING MOTH
Cydia pomonella

PHYTOSANITARY

Description

Codling moth is common throughout New Zealand. It was accidentally introduced to New Zealand early in European settlement and is now found wherever apples are grown and is found extensively throughout the North Island.
Codling Moth is a small speckled, grey moth, hosted by apple, pear and walnut trees. The larvae of Codling moth burrows into fruit leaving a small hole that result in the fruit being rejected for sale. Frass (droppings) indicate the presence of larva.
Codling Moth over-winters as a dormant caterpillar in a cocoon under the bark of the tree or in the soil. In most southern regions throughout New Zealand, Codling moth has one generation per year. In the North Island, Codling moth usually has one and a half to two generations.
The dispersal ability of codling moth has very important implications for management. With high levels of control achieved by insecticides or mating disruption, the resident population of codling moth in most orchards is extremely low. As a result, the immigration of Codling moth adults into orchards is often greater than the resident population, and the removal of outside sources (e.g. neglected apple trees) can make a major contribution to control. 90% of mated females move within 300m of their emergence point and maximum dispersal may be as low as 600m.

EUROPEAN CANKER
Neonectria ditissima

PHYTOSANITARY

Description

European canker occurs in warm humid areas generally with rainfall in excess of 1000mm pa. It is widespread in Waikato and found in Nelson during very wet seasons. European Canker does not often manifest itself in Hawke's Bay due to the relatively dry climate. Rain splash and wind spread the spores and fruiting bodies of European canker. European canker can also be spread through the movement of affected plants or plant parts. Spores can remain dormant for long periods until the right climatic conditions occur, and then the disease can spread quite rapidly. Apples are more affected than pears.

Initial symptoms of European canker are a small sunken area around a bud, leaf scar, or at the base of a small dead shoot or open wound. Concentric rings of canker growth then appear. The sunken area increases in size. The centre of infection becomes flaky. Eventually cankers girdle the stem, and shoots above the canker die.

NZ Apple and Pear has issued a European Canker Management strategy to all growers.

FIREBLIGHT
Erwinia amylovora

PHYTOSANITARY

Description

Fireblight is a bacterial disease. World-wide, Fireblight is found throughout North America and Canada and much of Europe.

Isolated outbreaks of fireblight occur throughout New Zealand. Pink LadyTM, Gala, Royal Gala, Golden Delicious, and all pears are particularly susceptible. Other plants that can be affected by Fireblight are quince and ornamental plants of the Roseaceae family including cotoneaster, hawthorn and pyracantha. Trees are most prone during October when temperatures exceed 16˚C, humidity is high and blossom is present. If unchecked, blossom infection can result in "shepherds crook" of the shoot. Blossoms appear water soaked then turn brown and finally black. Young fruit if infected turn brown, then black, wilt and drop off. Severe infections are rare on mature trees in New Zealand. The main issue is that Fireblight is used as a quarantine barrier by Fireblight-free countries such as Japan and Australia.

LIGHTBROWN APPLE MOTH
Epiphyas postvittana

PHYTOSANITARY

Description

The light brown apple moth (Epiphyas postvittana) is native to Australia and the larvae feed on a wide range of plants including fruit crops, broad-leaved weeds, some vegetables and ornamentals.
Lightbrown apple moth adults are variable in colour and may be confused with other leafroller moths. Typical males have a forewing length of 6-10 mm with a light brown area at the base distinguishable from a much darker, redbrown area at the tip. The latter may be absent, the moth appearing uniformly light brown, as in the females, with only slightly darker oblique markings distinguishing the area at the tip of the wing. Females have a forewing length of 7-13 mm. Colour varies from a uniform light brown, with almost no distinguishing markings.
Larvae [caterpillars] are not easily distinguished from the larvae of other leafrollers. The first larval instar [stage] has a dark brown head; all other instars have a light fawn head and prothoracic plate [plate behind the head]. Overwintering larvae are darker. First instar larvae are approximately 1.6 mm long, and final instar larvae range from 10 to 18 mm in length. The body of a mature larva is medium green with a darker green central stripe and two side stripes.
Pupae are at first green, but become medium brown after rapidly hardening.
The Lightbrown apple moth larvae cause damage to foliage and fruit. Early instars feed on tissue beneath the upper epidermis [surface layer] of leaves, while protected under self-constructed silken webs on the under surface of leaves. Larger larvae migrate from these positions to construct feeding niches between adjacent leaves, between a leaf and a fruit, in the developing bud, or on a single leaf, where the "topical" leaf roll develops. The late stage larvae feed on all leaf tissue except main veins.
Superficial fruit damage is common in apple varieties which form compact fruit clusters. Leaves are webbed to the fruit and feeding injury takes place under the protection of the leaf; or larvae spin up between fruits of a cluster. Internal damage to apple, pear, and citrus fruits is less common, but a young larva may enter the interior of an apple or pear fruit through the calyx or beneath the stem of a citrus fruit. Excreta are usually ejected on to the outside of the fruit; this does not happen with the codling moth. The issue with Lightbrown Apple Moth is the potential increased phytosanitary risk posed to key markets such as the US.

Impact of proposed phytosanitary programme

Hawke's Bay currently has around 6,000 planted hectares of pipfruit orchards (61% of the national production area) and 70% of the national production at 247,000 tonnes. The pipfruit industry is worth around $300 million to the Hawke's Bay economy annually. Most orchards in Hawke's Bay have a combination of pipfruit varieties with individual businesses operating orchards ranging from 2 to more than 30 hectares. Fifteen percent of businesses have orchards more than 30 hectares, while there is still a significant portion operating less than 5 hectares (28%).

Apple production is cyclic in nature. From 2002 to 2012 there was more than a 112% reduction in the area of pipfruit planted in Hawke's Bay as growers removed uneconomic blocks of mainly Braeburn and Royal Gala due to increased production expenses, poor consumer demand and an appreciating exchange rate of the NZ dollar.

Since 2012, the industry has gone through a period of growth with increased productivity, realised high returns for new varieties and expanding export into high value Asian markets. As a result, the planted area in Hawke's Bay has grown by 14%.

With the cyclic nature of crop production it can be expected that the current years of good return may be followed by some downturn years with growers seeking to leave the industry, particularly small to medium sized owner-operators without long-term strategic relationships with exporters and packers.

With people choosing or considering whether to leave the pipfruit production sector during periods of downturn, New Zealand Apples & Pears Incorporated wishes to ensure that the occupiers of all pipfruit production sites, continue to manage and control all the phytosanitary pests on their properties in accordance with industry best practise to ensure that pipfruit production levels remain high, access to international markets is maintained, and that costs for all growers are kept as low as possible.

In addition, biosecurity is critically important to sustained growth and profitability of the NZ apple and pear industry. NZ Apples & Pears biosecurity vision is that the industry, our stakeholders and local communities, are all kept safe and secure from damaging pests and diseases. NZ Apples & Pears have been partners of the Government Industry Agreement (GIA) since 2014. GIA operates as a partnership between primary industry and government to manage pests and diseases that could badly damage New Zealand's primary industries, economy and environment.

With biosecurity pests such as brown marmorated stink bug and Queensland fruit fly having the potential to significantly damage the NZ industry, it is imperative that strategies are in place to ensure unmanaged production sites are inspected and remain vigilant for biosecurity threats.

Therefore to ensure the continued success of the pipfruit industry in Hawke's Bay, this Regional Phytosanitary Pest Management Strategy is proposing methods to ensure that occupiers of unmanaged pipfruit production sites, ensure that they control the phytosanitary pests on their land.

That said, the need to implement this over the next five years is not expected. The industry has been in constant growth since 2012 and is not expected to slow in the foreseeable future. There are one million trees being planted annually with orders for the next three plus years. Suitable land is sought after and any old orchards quickly pulled and replanted. Although there might be an unforeseen downturn within the next 10 years, the current growth will probably even out any costs within this time frame.

Amenity or Nuisance

The control of phytosanitary pests from unmanaged pipfruit production sites will have a positive effect on land occupiers with fruit trees for personal consumption. The effective implementation of this Phytosanitary Pest Management Programme is expected to mitigate the need for increased phytosanitary management in adjacent properties.

Effects on Maori

The phytosanitary pests identified in the Phytosanitary Pest Management Programme are all introduced pests to New Zealand, which have an economic impact on introduced pipfruit species. The controls imposed by this Phytosanitary Pest Management Programme only apply to occupiers of unmanaged pipfruit production sites. Therefore the implementation of this strategy is not likely to impact on the relationship of Maori and their culture and traditions with their ancestral lands, waters, sites, waahi tapu, or taonga.

Effects on overseas marketing and international obligations

The control of phytosanitary pests from unmanaged pipfruit production sites will have a positive effect on production from the pipfruit sector in Hawke's Bay. The effective implementation of this Phytosanitary Pest Management Programme is expected to mitigate the need for increased phytosanitary management in adjacent

properties therefore strengthening the international market acceptability of pipfruit products from Hawke's Bay, and thereby enhancing the economy of the region.

Cost of implementation:

The estimated annual cost of activities related to the proposed Phytosanitary Pest Management Programme have been averaged from 2013-2016 data:

Estimated cost to Hawke's Bay Regional Council $200
Estimated cost to New Zealand Apple and Pear $500
Estimated cost to land occupiers $10,000

IMPACT	EXTENT OF IMPACT	
	POTENTIAL	UNDER PLAN
Horticulture	Major	Minor
Amenity or Nuisance	Minor	Minor

Who should pay?

Beneficiaries and exacerbators

GROUP	BENEFICIARY	EXACERBATOR
Primary Producers	Major	
Horticultural production sites not managing specific phytosanitary pests		Major
Regional community	Major	

CBA statement and risks to success

The horticultural sector is currently experiencing a period of large growth. The need to implement enforcement over the next five years is not expected. The industry has been in constant growth since 2012 and is not expected to slow in the foreseeable future. There are one million trees being planted annually with orders for the next three plus years. Suitable land is sought after and any old orchards quickly pulled and replanted. Although there might be an unforeseen downturn within the next 10 years.
The benefits of Regional intervention, focused on the control of phytosanitary pests from unmanaged pipfruit production sites, will have a positive effect on production from the pipfruit sector in Hawke's Bay. It is considered the benefits outweigh the cost and exceed the benefit of an individual's intervention.

Who should pay for the proposed management approach?

This is a low cost programme that will benefit both the horticvultural sector and the regioanl community. It is proposed this programme is funded through the general rate.

SITE LED PESTS

FERAL CAT
Felis catus

SITE LED

Relevant biology

ATTRIBUTE	DESCRIPTION
Form	Resemble domestic cats in both size and colouration. Females average about 75% of the weight of males.
Habitat	Inhabits a wide range of urban, rural and forest habitats. Found from sea level to alpine habitats.
Regional distribution	Throughout the region.
Competitive ability	Diet is wide-ranging and includes small mammals, fish, birds and invertebrates.
Reproductive ability	2-3 litters per year with an average of 4 young in each.
Resistance to control	Controlled by poisons, trapping and shooting. No natural predators.
Benefits	Controls rodents and to some degree mustelids (young stoats and weasels).

Land use/habitats occupied in Hawke's Bay

LAND USE TYPE	CURRENT INFESTATION	POTENTIAL INFESTATION
Dairy	High	Low
Sheep and beef	High	High
Forestry	High	Low
Horticulture	Low	Low
Aquaculture	-	-
Urban	Low	Low
Native terrestrial	High	High
Coastal land	Low	Low
Freshwater	-	-
Estuarine	-	-
Marine	-	-

High = Most infested/preferred land use(s), Low = Less infested/preferred land use(s), - = Unsuitable land use

Qualitative impact assessment

CATEGORY	CURRENT	POTENTIAL	COMMENT	SOURCE
Production				
Dairy	L	L	Can transmit bovine Tb which can be transferred to cattle. In an area with Tb-infected cattle, a study found 1 in 50 cats had gross lesions typical of Tb.	
Sheep and beef	L	L	Carry many parasites and both feral and farm cats can transmit Toxoplasma gondii to sheep, causing toxoplasmosis. Sheep become infected from eating contaminated pasture, concentrate feeds and hay. Once ingested, the toxoplasma spreads to the sheep's muscles and brain, and also into the placenta.	
Forestry	-	-		1, 2, 3, 4
Horticulture	-	-		
Aquaculture	-	-		
Other	-	-		
International trade	-	L	Tuberculosis vector - presence of bovine Tb in cattle has a major impact on exports.	
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	M	H	Eats native birds, lizards and invertebrates.	1, 2, 3, 4
Threatened species	M	H	Predator of eggs and chicks of threatened native birds and lizards (e.g. brown teal, NZ dotterel).	1, 2
Social/Cultural				
Human health	L	L	Can bite and scratch. Can transmit Toxoplasma gondii and cause toxoplasmosis to humans.	1
Recreation	-	-		1
Māori culture	-	-		

L = low, M = moderate, H = high

source 1: King (2005), 2: Auckland Regional Council (2004), 3: Environment Bay of Plenty (2003), 4: Taranaki Regional Council (2013a)

Estimated quantitative impacts

Quantitative annual impacts per hectare are calculated as the current or anticipated proportional impact on land value across the region. All amounts are in net present value (NPV, $).

Calculation: **Economic value per land use/habitat type** × **Impact level**

Impact level
Low = 1–4% reduction in annual economic value per hectare
Moderate = 5–9% reduction in annual economic value per hectare
High = 10–50% reduction in annual economic value per hectare

Reduction in annual economic value ($) per hectare

LAND USE/HABITAT TYPE	CURRENT IMPACT PER HA	POTENTIAL IMPACT PER HA
Production		
Dairy	54.63–267.08	54.63–267.08
Sheep and beef	7.39–36.12	7.39–36.12
Forestry	0	0
Horticulture	0	0
Aquaculture	0	0
Environment/Social/Cultural		
Urban	5.33–56.05	5.33–56.05
Native terrestrial	27.80–61.20	55.60–340.00
Coastal	62.35–137.25	124.70–762.50
Freshwater	0	0
Estuarine	0	0
Marine	0	0

Cost-benefit analysis results

Proposed management programme: **Site-led**
Area of Programme: **128,256 ha**
Proposed annual expenditure by Council: **$6,822**

Assumptions

ASSUMPTIONS	VALUES	ASSUMPTIONS	VALUES
Current area infested	121,843.2 ha	Time to reach maximum extent†	50 yrs
Current impacts★	$44.5/ha	Potential extent in the region°	121,843 ha
	$27.8–61.2/ha		121,843.2–121,843.2 ha
Current benefits	$0/ha	Discount rate	4%

★ Current annual impact of the pest averaged across all land uses currently occupied.

° The potential extent the pest is predicted to achieve in the absence of regional management.

† The time a pest is predicted to take between first going wild in the region and reaching its maximum extent.

10 year assessment

The cost-benefit analysis indicates that the benefits of the proposed management programme over the next 10 years will be of net benefit to the region.

SCENARIO	PEST IMPACTS★	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNERS COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$49,399,481	$0		$0	$0	$0	
	min: 30,860,799						
	max: 67,938,163						
Site-led	$42,223,947	$0	$7,175,534	$57,546	$0	$0	$7,117,988
	min: 22,965,765		min: 7,895,034				min: 7,837,488
	max: 65,581,848		max: 2,356,315				max: 2,298,769

★ Includes economic, environmental and social costs.

° The estimated economic benefit provided by the pest.

† Administration and implementation costs incurred by the Council through the programme.

‡ Costs of control imposed on landowners through the programme, over and above the costs already being paid by landowners, as estimated by the Council. They are applied for the 10 years of the Plan.

50 year assessment

The longer-term cost-benefit analysis indicates that the monetised benefits over the next 50 years of the proposed management programme will be of net benefit to the region. Additional non-monetised benefits associated with the protection of biodiversity values are also anticipated.

SCENARIO	PEST IMPACTS★	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNERS COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$121,898,909	$0		$0	$0	$0	
	min: 76,152,577						
	max: 167,645,241						
Site-led	$68,686,060	$0	$53,212,849	$142,184	$0	$0	$53,070,665
	min: 27,269,165		min: 48,883,412				min: 48,741,228
	max: 161,209,790		max: 6,435,451				max: 6,293,267

CBA statement and risks to success

Cats are generalist predators and can have large home ranges. It is estimated that feral, stray and pet cats kill up to 100 million birds in New Zealand each year. They are a major predator of kiwi chicks and also eat eggs, lizards, invertebrates and frogs. Cats can transmit bovine Tb and carry many parasites including Toxoplasma gondii.

This programme provides the opportunity for land occupiers to control feral cats and their impacts through a site led pest control programme. Council will provide the technical knowledge and assistance in setting up a pest control programme. It is dependent on land occupiers undertaking the ongoing control.

The benefits of regional intervention, focused on sustainably controlling feral cats as part of a side led pest control programme, outweigh the cost of the programme.

Risks of the programme being unsuccessful in achieving objectives

RISK	LEVEL OF RISK	EXPLANATION
Technical risk	Low	
Operational risk	Low	
Legal risk	Low	
Socio-political risk	Low	
Other risks	Low	

Who should pay?

Beneficiaries and exacerbators

GROUP	BENEFICIARY	EXACERBATOR	CHANGE BEHAVIOUR	ASSESS COSTS & BENEFITS	CONTROL COST EFFECTIVELY
Land occupiers (Crown and private)	Major	Major	Yes	Yes	Yes
Dairy/sheep and beef sector	Major		No	Yes	Yes
Regional community	Major		No	Yes	Yes

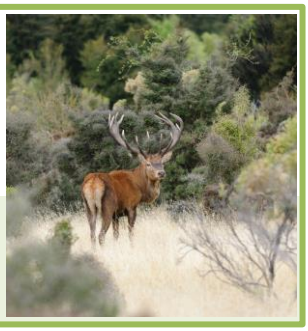
Who should pay for the proposed management approach?

This programme focusses on supporting land occupiers and community groups manage feral cats as part of a pest control programme. Although there are significant biodiversity gains that the wider regional community is a beneficiary, almost all programmes are run on private land in rural areas. It is proposed that this programme is funded through a 70% targeted, 30% general rate.

FERAL DEER

Cervus elaphus, C. nippon, Dama dama

SITE LED



Relevant biology

ATTRIBUTE	DESCRIPTION
Form	Medium- to large-sized ungulates. There are several species in New Zealand. Red deer can reach 180 kg and their coat is reddish-brown. Fallow deer are much smaller and have a chestnut coloured coat. Fallow deer antlers are broad and flattened, measuring up to 70 cm.
Habitat	Deer live in a wide range of habitats, particularly forest.
Regional distribution	Throughout the region, except for urban areas.
Competitive ability	Consume large quantities of native seedlings and saplings, which reduces vegetation biomass and alters habitat for native fauna.
Reproductive ability	Female red deer produce 1–2 offspring per year with a gestation period of 240–262 days. Fawns are weaned and able to join the herd after two months. Fallow deer breed once per year with fawns born in spring.
Resistance to control	Most commonly controlled by shooting, which can be effective at reducing their density. At low densities their behaviour changes, and they become very wary and hard to hunt.
Benefits	A recreational resource for hunters. Wild deer populations have historically been used to source livestock for deer farms. In other parts of New Zealand (e.g. Fiordland) commercial recovery of wild deer for venison still exists.

Land use/habitats occupied in Hawke's Bay

LAND USE TYPE	CURRENT INFESTATION	POTENTIAL INFESTATION
Dairy	Low	Low
Sheep and beef	High	High
Forestry	High	High
Horticulture	Low	Low
Aquaculture	-	-
Urban	-	-
Native terrestrial	High	High
Coastal land	Low	Low
Freshwater	-	-
Estuarine	-	-
Marine	-	-

High = Most infested/preferred land use(s), Low = Less infested/preferred land use(s), - = Unsuitable land use

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	L	L	NZ production losses due to deer grazing on pasture and crops have not been quantified, but are probably low. Hunting pressure usually all but eliminates deer from these habitats.	
Sheep and beef	L	L	See Dairy.	
Forestry	L	L	Can cause severe damage to young trees in plantation forests by browsing young trees and stripping bark from older trees.	1, 2
Horticulture	L	L	See Dairy.	
Aquaculture	-	-		
Other	-	-		
International trade	L	M	There is concern that bovine Tb could establish in feral deer populations and spread to farm animals. Illegal liberations are of particular concern if deer are sourced from regions where Tb occurs.	1, 3, 4
Environment				
Soil resources	L	M	Heavy browsing can impact below-ground processes in native forests by altering the nature of litter inputs into the soil.	5
Water quality	L	L	Some localised small-scale fouling of water sources by wallowing can occur.	3
Species diversity	L	H	Heavy and selective browsing on trees and shrubs can change forest structure and the composition of the understorey. Palatable plant species such as schefflera/pate, broadleaf, three-finger, lancewood, and hen and chicken fern can be all but removed from the ground tier.	2, 3, 4
Threatened species	L	H	Selective browsing can significantly reduce rare palatable subcanopy species. However these species can persist epiphytically. Plants like alpine buttercup, speargrass and tall tussocks can be impacted in subalpine habitats.	3, 4
Social/Cultural				
Human health	L	L	Hunters have alleged that they could get Tb from infected deer when gutting and cutting meat. Deer are generally considered spillover hosts rather than vectors so this is unlikely.	3
Recreation	L	L	Forest damage and loss of palatable native plant species can affect some recreational experiences. However, deer are a recreational resource for hunters.	3
Māori culture	-	L	Significant damage to ecosystems would impact on cultural values. However, deer are also viewed as a hunting resource by Māori.	

L = low, M = moderate, H = high

source 1: Greater Wellington Regional Council (2012), 2: Taranaki Regional Council (2013b), 3: King (2005), 4: Auckland Regional Council (2004), 5: Lagerstroem et al. (2011)

Estimated quantitative impacts

Quantitative annual impacts per hectare are calculated as the current or anticipated proportional impact on land value across the region. All amounts are in net present value (NPV, $).

Calculation: **Economic value per land use/habitat type × Impact level**

Impact level
Low = 1–4% reduction in annual economic value per hectare
Moderate = 5–9% reduction in annual economic value per hectare
High = 10–50% reduction in annual economic value per hectare

Reduction in annual economic value ($) per hectare

Land use/habitat type	Current impact per ha	Potential impact per ha
Production		
Dairy	54.63–267.08	54.63–267.08
Sheep and beef	7.39–36.12	7.39–36.12
Forestry	17.47–85.40	17.47–85.40
Horticulture	105.11–790.40	105.11–790.40
Aquaculture	0	0
Environment/Social/Cultural		
Urban	0	0
Native terrestrial	5.56–27.20	55.60–340.00
Coastal	12.47–61.00	124.70–762.50
Freshwater	0	0
Estuarine	0	0
Marine	0	0

Cost-benefit analysis results

Proposed management programme: **Site-led**
Area of Programme: **128,256 ha**
Proposed annual expenditure by Council: **$1,000**

Assumptions

ASSUMPTIONS	VALUES	ASSUMPTIONS	VALUES
Current area infested	38,476.8 ha	Time to reach maximum extent†	50 yrs
Current impacts★	$16.38/ha	Potential extent in the region°	38,477 ha
	$5.56–27.2/ha		38,476.8–38,476.8 ha
Current benefits	$1/ha	Discount rate	4%

★ Current annual impact of the pest averaged across all land uses currently occupied.

° The potential extent the pest is predicted to achieve in the absence of regional management.

† The time a pest is predicted to take between first going wild in the region and reaching its maximum extent.

10 year assessment

The cost-benefit analysis indicates that the benefits of the proposed management programme over the next 10 years will be of net benefit to the region.

SCENARIO	PEST IMPACTS★	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNERS COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$5,742,142	$324,565		$0	$0	$0	
	min: 1,949,103	min: 324,565					
	max: 9,535,181	max: 324,565					
Site-led	$5,542,986	$324,429	$199,020	$8,435	$0	$0	$190,585
	min: 1,881,502	min: 324,429	min: 67,465				min: 59,030
	max: 9,204,470	max: 324,429	max: 330,575				max: 322,140

★ Includes economic, environmental and social costs.

° The estimated economic benefit provided by the pest.

† Administration and implementation costs incurred by the Council through the programme.

‡ Costs of control imposed on landowners through the programme, over and above the costs already being paid by landowners, as estimated by the Council. They are applied for the 10 years of the Plan.

50 year assessment

The longer-term cost-benefit analysis indicates that the monetised benefits over the next 50 years of the proposed management programme will be of net benefit to the region. Additional non-monetised benefits associated with the protection of biodiversity values are also anticipated.

SCENARIO	PEST IMPACTS★	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNERS COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$14,169,396	$859,628		$0	$0	$0	
	min: 4,809,636	min: 859,628					
	max: 23,529,157	max: 859,628					
Site-led	$13,625,471	$858,183	$542,480	$22,341	$0	$0	$520,139
	min: 4,625,007	min: 858,183	min: 183,184				min: 160,843
	max: 22,625,935	max: 858,183	max: 901,777				max: 879,436

CBA statement and risks to success

Deer can destroy the understorey of native forest by browsing, grazing, bark stripping and trampling, which in turn may increase soil erosion. Feral deer can reduce production by damaging crops and exotic forests. They have also been implicated in the transmission of bovine Tb.

This programme is designed to support land occupiers to control feral deer and their impacts through a site led pest control programme. Assistance may be provided through the use of professional contractors, who have technical knowledge on best practice feral deer control. Feral deer are of particular concern for QEII covenants and ecosystem prioritisation sites. Council may assist or undertake feral deer control at these sites to protect the biodiversity values within these sites.

The benefits of regional intervention, focused on sustainably controlling feral deer as part of a side led pest control programme, outweigh the cost of the programme.

Risks of the programme being unsuccessful in achieving objectives

RISK	LEVEL OF RISK	EXPLANATION
Technical risk	Low	

Operational risk	Low
Legal risk	Low
Socio-political risk	Low
Other risks	Low

Who should pay?

Beneficiaries and exacerbators

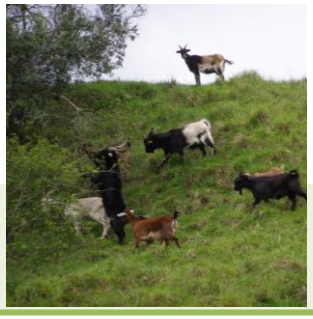
GROUP	BENEFICIARY	EXACERBATOR	CHANGE BEHAVIOUR	ASSESS COSTS & BENEFITS	CONTROL COST EFFECTIVELY
Land occupiers (Crown and private)	Major	Major	Yes	Yes	Yes
Dairy/sheep and beef sector	Major		No	Yes	Yes
Regional community	Major		No	Yes	Yes

Who should pay for the proposed management approach?

This programme focusses on supporting land occupiers and community groups manage feral deer as part of a pest control programme or to protect QEII covenants and ecosystem prioritisation sites. Although there are significant biodiversity gains that the wider regional community is a beneficiary, almost all programmes are on private land in rural areas. It is proposed that this programme is funded through a 70% targeted, 30% general rate.

FERAL GOAT
Capra hircus

SITE LED



Relevant biology

ATTRIBUTE	DESCRIPTION
Form	Feral goats vary in size and colour. Can be white, black, brown or a combination of colours. Both sexes have horns. Adult males stand approximately 70 cm high and weigh 50–60 kg. Females are smaller.
Habitat	Inhabits a wide range of rural and forest habitats. Favours steep, dry, sunny faces.
Regional distribution	Throughout the region, except for urban areas.
Competitive ability	Diet is wide-ranging. Able to exploit a wide variety of habitats.
Reproductive ability	Females begin breeding at 6 months and can breed twice a year. Twins are common. Males can mate from 6 months old but are usually excluded by other males until 3–4 years of age.
Resistance to control	No natural predators in New Zealand. Controlled by shooting and high-quality fencing.
Benefits	Some value as feral meat. Some farmers muster out goats infrequently and sell them off.

Land use/habitats occupied in Hawke's Bay

LAND USE TYPE	CURRENT INFESTATION	POTENTIAL INFESTATION
Dairy	Low	Low
Sheep and beef	High	High
Forestry	High	High
Horticulture	Low	Low
Aquaculture	-	-
Urban	-	-
Native terrestrial	High	High
Coastal land	Low	Low
Freshwater	-	-
Estuarine	-	-
Marine	-	-

High = Most infested/preferred land use(s), Low = Less infested/preferred land use(s), - = Unsuitable land use

Qualitative impact assessment

CATEGORY	CURRENT	POTENTIAL	COMMENT	SOURCE
Production				
Dairy	-	L	Competes with stock for pasture and reduces pasture productivity. May spread livestock diseases.	
Sheep and beef	L	M	Removal of vegetation through browsing and trampling can cause soil erosion, particularly in the eastern hill country.	
Forestry	L	M	Can cause severe damage to young trees in plantation forests by trampling seedlings, browsing young trees and stripping bark from older trees.	1, 2, 3, 4
Horticulture	L	L	Can cause damage to fruit trees and crops.	
Aquaculture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	L	M	Removal of vegetation through browsing and trampling can cause erosion.	4
Water quality	L	M	Erosion of soil can lead to increased sedimentation in waterways.	2
Species diversity	M	H	Eats a wide variety of plant species and can eliminate preferred (palatable) species, leading to changes in plant species composition, and preventing forest regeneration and succession.	3, 4, 5, 6
Threatened species	L	H	Eats a wide variety of plant species and can eliminate preferred (palatable) species, leading to changes in plant species composition, and preventing forest regeneration and succession.	5, 6
Social/Cultural				
Human health	-	-		
Recreation	L	L	Damages and eliminates palatable native plant species and alters structure of native forest, which can affect recreational experiences. Viewed as a recreational resource by some hunters.	2, 4
Māori culture	L	M	Destroys native forests and eats culturally important plants (e.g. koromiko).	

L = low, M = moderate, H = high

source 1: King (2005), 2: Severinsen (2003), 3: Auckland Regional Council (2004), 4: Invasive Species Specialist Group (2010a), 5: Husheer (2006), 6: Clements (2004)

Estimated quantitative impacts

Quantitative annual impacts per hectare are calculated as the current or anticipated proportional impact on land value across the region. All amounts are in net present value (NPV, $).

Calculation: **Economic value per land use/habitat type** × **Impact level**

Impact level

Low = 1–4% reduction in annual economic value per hectare

Moderate = 5–9% reduction in annual economic value per hectare

High = 10–50% reduction in annual economic value per hectare

Reduction in annual economic value ($) per hectare

Land use/habitat type	Current impact per ha	Potential impact per ha

Production		
Dairy	0	54.63–267.08
Sheep and beef	7.39–36.12	36.95–81.27
Forestry	17.47–85.40	87.35–192.15
Horticulture	105.11–790.40	105.11–790.40
Aquaculture	0	0
Environment/Social/Cultural		
Urban	0	0
Native terrestrial	27.80–61.20	55.60–340.00
Coastal	62.35–137.25	124.70–762.50
Freshwater	0	0
Estuarine	0	0
Marine	0	0

Cost-benefit analysis results

Proposed management programme: **Site-led (inclusion of a good neighbour rule)**

Area of Programme: **128,256 ha**

Proposed annual expenditure by Council: **$36,000**

Assumptions

Assumptions	Values	Assumptions	Values
Current area infested	38,476.8 ha	Time to reach maximum extent†	50 yrs
Current impacts★	$44.5/ha	Potential extent in the region°	38,477 ha
	$27.8–61.2/ha		38,476.8–38,476.8 ha
Current benefits	$0.5/ha	Discount rate	4%

★ Current annual impact of the pest averaged across all land uses currently occupied.

° The potential extent the pest is predicted to achieve in the absence of regional management.

† The time a pest is predicted to take between first going wild in the region and reaching its maximum extent

10 year assessment

The cost-benefit analysis indicates that the benefits of the proposed management programme over the next 10 years will be of net benefit to the region.

SCENARIO	PEST IMPACTS★	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNERS COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$15,599,836	$162,282		$0	$0	$0	
	min: 9,745,516	min: 162,282					
	max: 21,454,157	max: 162,282					
Site-led	$13,333,878	$145,301	$2,248,977	$303,672	$0	$0	$1,945,305
	min: 7,252,347	min: 128,387	min: 2,493,101				min: 2,189,429
	max: 20,710,057	max: 162,214	max: 710,205				max: 406,533

★ Includes economic, environmental and social costs.

° The estimated economic benefit provided by the pest.

† Administration and implementation costs incurred by the Council through the programme.

‡ Costs of control imposed on landowners through the programme, over and above the costs already being paid by landowners, as estimated by the Council. They are applied for the 10 years of the Plan.

50 year assessment

The longer-term cost-benefit analysis indicates that the monetised benefits over the next 50 years of the proposed management programme will be of net benefit to the region. Additional non-monetised benefits associated with the protection of biodiversity values are also anticipated.

Scenario	Pest impacts*	Pest values°	Benefit	Council costs†	Landowner compliance costs‡	Agency compliance costs‡	Net benefit
No intervention	$38,494,392	$429,814		$0	$0	$0	
	min: 24,048,182	min: 429,814					
	max: 52,940,602	max: 429,814					
Site-led	$21,690,335	$252,691	$16,626,934	$742,798	$0	$0	$15,884,136
	min: 8,611,315	min: 160,305	min: 15,436,145				min: 14,693,347
	max: 50,908,355	max: 429,092	max: 1,762,738				max: 1,019,940

CBA statement and risks to success

Goats destroy the under storey of vegetation and, when combined with possum damage to the upper canopy, severe deterioration of native forest occurs. Pest plant invasion can occur under these circumstances. Goats also damage vegetation planted on land retired for soil conservation purposes and newly planted or young trees in exotic forests. Goats are one of the most destructive animals found in forests. They have the ability to live in a healthy state where other animals would die out. Feral goats can breed rapidly and can occupy a wide range of habitats.

This programme is designed to support land occupiers to control feral goats and their impacts through a site led pest control programme. Assistance may be provided through the use of professional contractors, who have technical knowledge on best practice feral goat control. Feral goats are of particular concern for QEII covenants and ecosystem prioritisation sites. Council may assist or undertake feral deer control at these sites to protect the biodiversity values within these sites.

Good neighbour rule

A good neighbour rule has been applied to this programme, whereby an occupier adjacent to an area of ecological importance or native plantings may be required to destroy all feral goats on the land that they occupy within 500 meters of the adjoining property boundary where the occupier of the adjoining property is managing feral goats across their property. The reason for this rule is to manage the spread of feral goats causing unreasonable costs to the adjacent occupier where active feral goat management is being undertaken by that occupier. Feral goats ability to breed rapidly and colonise new areas. If the adjacent land occupiers want to keep feral goats as a means of weed control and a secondary source of income, they will need to contain the feral goats within their property through effective fences. Council will only administer the rule upon receiving a written complaint from the adjacent land occupier.

The benefits of regional intervention, focused on sustainably controlling feral deer as part of a side led pest control programme, outweigh the cost of the programme.

Risks of the programme being unsuccessful in achieving objectives

RISK	LEVEL OF RISK	EXPLANATION
Technical risk	Low	
Operational risk	Low	
Legal risk	Low	
Socio-political risk	Low	
Other risks	Low	

Who should pay?

Beneficiaries and exacerbators

GROUP	BENEFICIARY	EXACERBATOR	CHANGE BEHAVIOUR	ASSESS COSTS & BENEFITS	CONTROL COST EFFECTIVELY
Land occupiers (Crown and private)	Major	Major	Yes	Yes	Yes
Dairy/sheep and beef sector	Major		No	Yes	Yes
Regional community	Major		No	Yes	Yes

Who should pay for the proposed management approach?

This programme focusses on supporting land occupiers and community groups manage feral goats as part of a pest control programme, protecting QEII covenants and ecosystem prioritisation sites from feral goat damage, and preventing feral goats from causing unreasonable costs to adjacent occupiers through damage to ecological values or native plantings. Although there are significant biodiversity gains that the wider regional community is a beneficiary, almost all programmes are on private land in rural areas. It is proposed that this programme is funded through a 70% targeted, 30% general rate.

FERAL PIG
Sus scrofa

SITE LED

Relevant biology

ATTRIBUTE	DESCRIPTION
Form	Adults can measure 90–200 cm, and weigh 50–90 kg. Their colour varies from dark grey to brown or black. Adult males develop tusks that protrude from their mouth.
Habitat	Found in a wide range of habitats, however they mostly prefer to live on farmland and rough hill country that includes thick and extensive scrub cover.
Regional distribution	Throughout the region, except for urban areas.
Competitive ability	Vegetation forms 70% of pig diet. Pig rooting can reduce the diversity of seedlings and saplings and cause a dramatic reduction in leaf cover on the forest floor.
Reproductive ability	Sexually mature at two years of age. They breed once per year with gestation lasting 115 days. Litter size ranges from 4–6 piglets. The piglets are weaned at 3–4 months of age.
Resistance to control	Pigs are controlled using shooting. Dogs are widely used to locate pigs in rough terrain. In thick scrubby areas pigs can often find refuge from hunters.
Benefits	A recreational resource for hunters.

Land use/habitats occupied in Hawke's Bay

LAND USE TYPE	CURRENT INFESTATION	POTENTIAL INFESTATION
Dairy	Low	Low
Sheep and beef	High	High
Forestry	High	High
Horticulture	-	Low
Aquaculture	-	-
Urban	-	-
Native terrestrial	High	High
Coastal land	High	High
Freshwater	-	-
Estuarine	-	-
Marine	-	-

High = Most infested/preferred land use(s), Low = Less infested/preferred land use(s), - = Unsuitable land use

Qualitative impact assessment

CATEGORY	CURRENT	POTENTIAL	COMMENT	SOURCE
Production				
Dairy	L	L	Vector of bovine Tb and can also spread other diseases by spreading infectious microbes through the forest.	
Sheep and beef	L	M	Vector of bovine Tb and can also spread other diseases by spreading infectious microbes through the forest. Can prey on lambs. Can damage pasture by rooting. In North Canterbury one farmer claimed a reduction of 500 stock units due to the presence of pigs. Another had to resow a paddock at a cost of $10,000.	
Forestry	L	M	Can damage young trees through rooting.	1, 2
Horticulture	-	L	Can damage crops through rooting.	
Aquaculture	-	-		
Other	-	L	Can spread trichinosis among domestic pigs.	
International trade	-	M	Tuberculosis vector - presence of bovine Tb in cattle has a major impact on exports.	1, 3, 4, 5
Environment				
Soil resources	-	L	Soil disturbance by feral pigs can increase nitrate levels in soil.	5, 6
Water quality	-	L	It is possible that high densities of feral pigs could result in faecal contamination of water bodies.	5
Species diversity	L	H	Can have major effects on native flora and fauna. Pigs eat the tops of native plants and dig up their roots, resulting in the decline of some species. Also eat many native invertebrates and can consume large quantities of native earthworms.	5, 6, 7
Threatened species	L	H	Pig predation of flightless and ground-dwelling birds (e.g. kiwi) has been suggested but rarely confirmed. They are predators of native land snails, and can reduce remnant populations.	5, 7, 8
Social/Cultural				
Human health	L	M	Can spread the disease trichinosis among domestic pigs and then transfer to humans who consume infected pig meat. It is possible for a hunter to get Tb from an infected pig when gutting and cutting meat from the animal.	1
Recreation	L	L	Viewed as a recreational resource by hunters. Can destroy lawns and vegetable gardens through rooting.	1, 5
Māori culture	L	L	Significant damage to ecosystems would impact on cultural values. However, feral pigs are a valued hunting resource for many Māori.	9

L = low, M = moderate, H = high

source 1: Greater Wellington Regional Council (2012), 2: Parkes (2006), 3: Krull et al. (2013b), 4: Nugent et al. (2003), 5: King (2005), 6: Krull et al. (2013a), 7: Auckland Regional Council (2004), 8: Parkes et al. (2004), 9: Eggleston et al. (2003)

Estimated quantitative impacts

Quantitative annual impacts per hectare are calculated as the current or anticipated proportional impact on land value across the region. All amounts are in net present value (NPV, $).

Calculation: **Economic value per land use/habitat type** × **Impact level**

Impact level
Low = 1–4% reduction in annual economic value per hectare
Moderate = 5–9% reduction in annual economic value per hectare
High = 10–50% reduction in annual economic value per hectare

Reduction in annual economic value ($) per hectare

LAND USE/HABITAT TYPE	CURRENT IMPACT PER HA	POTENTIAL IMPACT PER HA
Production		
Dairy	54.63–267.08	54.63–267.08
Sheep and beef	7.39–36.12	36.95–81.27
Forestry	17.47–85.40	87.35–192.15
Horticulture	0	105.11–790.40
Aquaculture	0	0
Environment/Social/Cultural		
Urban	0	0
Native terrestrial	5.56–27.20	55.60–340.00
Coastal	12.47–61.00	124.70–762.50
Freshwater	0	0
Estuarine	0	0
Marine	0	0

Cost-benefit analysis results

Proposed management programme: **Site-led**
Area of Programme: **128,256 ha**
Proposed annual expenditure by Council: **$1,000**

Assumptions

Assumptions	Values	Assumptions	Values
Current area infested	38,476.8 ha	Time to reach maximum extent†	50 yrs
Current impacts★	$16.38/ha	Potential extent in the region°	38,477 ha
	$5.56–27.2/ha		38,476.8–38,476.8 ha
Current benefits	$1/ha	Discount rate	4%

★ Current annual impact of the pest averaged across all land uses currently occupied.

° The potential extent the pest is predicted to achieve in the absence of regional management.

† The time a pest is predicted to take between first going wild in the region and reaching its maximum extent.

10 year assessment

The cost-benefit analysis indicates that the benefits of the proposed management programme over the next 10 years will be of net benefit to the region.

SCENARIO	PEST IMPACTS★	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNERS COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$5,742,142	$324,565		$0	$0	$0	
	min: 1,949,103	min: 324,565					
	max: 9,535,181	max: 324,565					
Site-led	$5,542,986	$324,429	$199,020	$8,435	$0	$0	$190,585
	min: 1,881,502	min: 324,429	min: 67,465				min: 59,030
	max: 9,204,470	max: 324,429	max: 330,575				max: 322,140

★ Includes economic, environmental and social costs.

° The estimated economic benefit provided by the pest.

† Administration and implementation costs incurred by the Council through the programme.

‡ Costs of control imposed on landowners through the programme, over and above the costs already being paid by landowners, as estimated by the Council. They are applied for the 10 years of the Plan.

50 year assessment

The longer-term cost-benefit analysis indicates that the monetised benefits over the next 50 years of the proposed management programme will be of net benefit to the region. Additional non-monetised benefits associated with the protection of biodiversity values are also anticipated.

SCENARIO	PEST IMPACTS★	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNERS COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$14,169,396	$859,628		$0	$0	$0	
	min: 4,809,636	min: 859,628					
	max: 23,529,157	max: 859,628					
Site-led	$13,625,471	$858,183	$542,480	$22,341	$0	$0	$520,139
	min: 4,625,007	min: 858,183	min: 183,184				min: 160,843
	max: 22,625,935	max: 858,183	max: 901,777				max: 879,436

CBA statement and risks to success

Feral pigs can breed rapidly and damage forests by uprooting trees and saplings and eating native plants and invertebrates. They also eat pasture and crops and are known to be carriers of bovine tuberculosis and leptospirosis. Feral pigs are valued by hunters as a recreational resource.

This programme is designed to support land occupiers to control feral pigs and their impacts through a site led pest control programme. Assistance may be provided through the use of professional contractors, who have technical knowledge on best practice feral pig control. Feral pigs are of particular concern for QEII covenants and ecosystem prioritisation sites. Council may assist or undertake feral pig control at these sites to protect the biodiversity values within these sites.

The benefits of regional intervention, focused on sustainably controlling feral pigs as part of a side led pest control programme, outweigh the cost of the programme.

Risks of the programme being unsuccessful in achieving objectives

RISK	LEVEL OF RISK	EXPLANATION

Technical risk	Low
Operational risk	Low
Legal risk	Low
Socio-political risk	Low
Other risks	Low

Who should pay?

Beneficiaries and exacerbators

GROUP	BENEFICIARY	EXACERBATOR	CHANGE BEHAVIOUR	ASSESS COSTS & BENEFITS	CONTROL COST EFFECTIVELY
Land occupiers (Crown and private)	Major	Major	Yes	Yes	Yes
Dairy/sheep and beef sector	Major		No	Yes	Yes
Regional community	Major		No	Yes	Yes

Who should pay for the proposed management approach?

This programme focusses on supporting land occupiers and community groups manage feral pigs as part of a pest control programme or to protect QEII covenants and ecosystem prioritisation sites. Although there are significant biodiversity gains that the wider regional community is a beneficiary, almost all programmes are on private land in rural areas. It is proposed that this programme is funded through a 70% targeted, 30% general rate.

FERRET
Mustela furo

SITE LED

Relevant biology

ATTRIBUTE	DESCRIPTION
Form	Up to 50 cm long and has a creamy-yellow undercoat, with long guard hairs that are black at the tip, giving a generally dark appearance. The lighter facial region has a dark mask around the eyes and across the nose.
Habitat	Live mainly in pastoral habitats, scrub, forest margins, dunelands and tussock grasslands. Not typically found in large tracts of native forest.
Regional distribution	Throughout the region.
Competitive ability	Diet is wide ranging and includes small mammals, fish, birds and invertebrates.
Reproductive ability	Females produce 1 or 2 litters per year with average 6 young, but high juvenile mortality.
Resistance to control	Highly mobile with large home ranges. Difficult to trap or poison.
Benefits	Some benefit in rabbit control.

Land use/habitats occupied in Hawke's Bay

LAND USE TYPE	CURRENT INFESTATION	POTENTIAL INFESTATION
Dairy	High	High
Sheep and beef	High	High
Forestry	Low	Low
Horticulture	Low	Low
Aquaculture	-	-
Urban	-	-
Native terrestrial	Low	Low
Coastal land	High	High
Freshwater	-	-
Estuarine	-	-
Marine	-	-

High = Most infested/preferred land use(s), Low = Less infested/preferred land use(s), - = Unsuitable land use

Qualitative impact assessment

CATEGORY	CURRENT	POTENTIAL	COMMENT	SOURCE
Production				
Dairy	M	M	Vector for bovine Tb spread. Carry parasites and spread toxoplasmosis, which can cause illness in humans and livestock.	
Sheep and beef	L	M	See Dairy.	
Forestry	-	-		1, 2, 3, 4
Horticulture	-	-		
Aquaculture	-	-		
Other	L	L	Predator of chickens and fowl. Threat to poultry farms, particularly free range farms.	
International trade	-	L	Known vector of Tb - presence of bovine Tb in cattle has a major impact on exports.	5
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	M	M	Mainly preys on rabbits, but also eats hares, possums, birds, eggs, lizards, hedgehogs, frogs, eels and various invertebrates. Diet varies with season and food availability. When rabbit numbers are low, ferrets can change their diet to other species.	1, 2, 3, 4
Threatened species	M	M	Predator of adult kiwi, particularly in fragmented forest or forest margins.	2, 6
Social/Cultural				
Human health	L	L	Can bite and scratch. Potential for Tb transmission to humans.	1
Recreation	-	-		
Māori culture	L	L	Threat to New Zealand's native fauna (taonga species).	

L = low, M = moderate, H = high

source 1: Anon. (2010), 2: Auckland Regional Council (2007), 3: King (2005), 4: Taranaki Regional Council (2013c), 5: TBfree New Zealand (2013), 6: Auckland Regional Council (2004)

Estimated quantitative impacts

Quantitative annual impacts per hectare are calculated as the current or anticipated proportional impact on land value across the region. All amounts are in net present value (NPV, $).

Calculation: **Economic value per land use/habitat type** × **Impact level**

Impact level

Low = 1–4% reduction in annual economic value per hectare

Moderate = 5–9% reduction in annual economic value per hectare

High = 10–50% reduction in annual economic value per hectare

Reduction in annual economic value ($) per hectare

LAND USE/HABITAT TYPE	CURRENT IMPACT PER HA	POTENTIAL IMPACT PER HA
Production		
Dairy	273.15–600.93	273.15–600.93
Sheep and beef	7.39–36.12	36.95–81.27
Forestry	0	0
Horticulture	0	0
Aquaculture	0	0
Environment/Social/Cultural		
Urban	0	0
Native terrestrial	27.80–61.20	27.80–61.20
Coastal	62.35–137.25	62.35–137.25
Freshwater	0	0
Estuarine	0	0
Marine	0	0

Cost-benefit analysis results

Proposed management programme: **Site-led**

Area of Programme: **128,256 ha**

Proposed annual expenditure by Council: **$16,822**

Assumptions

ASSUMPTIONS	VALUES	ASSUMPTIONS	VALUES
Current area infested	115,430.4 ha	Time to reach maximum extent†	50 yrs
Current impacts★	$44.5/ha	Potential extent in the region°	115,430 ha
	$27.8–61.2/ha		115,430.4–115,430.4 ha
Current benefits	$0/ha	Discount rate	4%

★ Current annual impact of the pest averaged across all land uses currently occupied.

° The potential extent the pest is predicted to achieve in the absence of regional management.

† The time a pest is predicted to take between first going wild in the region and reaching its maximum extent.

10 year assessment

The cost-benefit analysis indicates that the benefits of the proposed management programme over the next 10 years will be of net benefit to the region.

SCENARIO	PEST IMPACTS★	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNERS COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$46,799,508	$0		$0	$0	$0	
	min: 29,236,547						
	max: 64,362,470						
Site-led	$40,001,634	$0	$6,797,874	$57,546	$0	$0	$6,740,328
	min: 21,757,041		min: 7,479,506				min: 7,421,960
	max: 62,130,172		max: 2,232,298				max: 2,174,752

★ Includes economic, environmental and social costs.

° The estimated economic benefit provided by the pest.

† Administration and implementation costs incurred by the Council through the programme.

‡ Costs of control imposed on landowners through the programme, over and above the costs already being paid by landowners, as estimated by the Council. They are applied for the 10 years of the Plan.

50 year assessment

The longer-term cost-benefit analysis indicates that the monetised benefits over the next 50 years of the proposed management programme will be of net benefit to the region. Additional non-monetised benefits associated with the protection of biodiversity values are also anticipated.

SCENARIO	PEST IMPACTS★	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNERS COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$115,483,177	$0		$0	$0	$0	
	min: 72,144,546						
	max: 158,821,807						
Site-led	$65,071,004	$0	$50,412,173	$142,184	$0	$0	$50,269,989
	min: 25,833,946		min: 46,310,600				min: 46,168,416
	max: 152,725,064		max: 6,096,743				max: 5,954,559

CBA statement and risks to success

Introduced predators, such as ferrets, pose a significant threat to remaining natural ecosystems and habitats and threatened native species and can have a negative impact on primary production. Ferrets are distributed throughout the Hawke's Bay region.

Mustelids were introduced in New Zealand in the 1880's in an attempt to manage growing rabbit populations. This had minimal impact on rabbit densities but had a significant impact on New Zealand's Biodiversity. Ferrets are also a threat to agriculture, particularly through their role as a vector (carrier) of bovine tuberculosis. Mustelids are a threat to poultry farms.

This programme is designed to support land occupiers to control mustelids and their impacts through a site led pest control programme. Assistance may be provided through technical knowledge on best practice mustelid control and in initial setup of a predator control programme. Mustelids are of particular concern for QEII covenants and ecosystem prioritisation sites. Council may assist or undertake mustelid control at these sites to protect the biodiversity values within these sites.

The benefits of regional intervention, focused on sustainably controlling ferrets as part of a side led pest control programme, outweigh the cost of the programme.

Risks of the programme being unsuccessful in achieving objectives

RISK	LEVEL OF RISK	EXPLANATION
Technical risk	Low	
Operational risk	Low	
Legal risk	Low	
Socio-political risk	Low	
Other risks	Low	

Who should pay?

Beneficiaries and exacerbators

GROUP	BENEFICIARY	EXACERBATOR	CHANGE BEHAVIOUR	ASSESS COSTS & BENEFITS	CONTROL COST EFFECTIVELY
Land occupiers (Crown and private)	Major	Major	Yes	Yes	Yes
Dairy/sheep and beef sector	Major		No	Yes	Yes
Regional community	Major		No	Yes	Yes

Who should pay for the proposed management approach?

This programme focusses on supporting land occupiers and community groups manage ferrets as part of a pest control programme or to protect QEII covenants and ecosystem prioritisation sites. Although there are significant biodiversity gains that the wider regional community is a beneficiary, almost all programmes are on private land in rural areas. It is proposed that this programme is funded through a 70% targeted, 30% general rate.

POSSUM

Trichosurus vulpecula

SITE LED

Please refer to page 82 for the possum cost benefit analysis.

RAT (SHIP AND NORWAY)
Rattus rattus, R. norvegicus

SITE LED

Relevant biology

ATTRIBUTE	DESCRIPTION
Form	Ship rat is a slender rat with large hairless ears, grey-brown on the back with a similarly coloured or creamish-white belly, or black all over. The uniformly-coloured tail is always longer than the head and body length combined. Adults usually weigh 120-160 g but can exceed 200 g. Norway rat has brown fur on its back and pale grey fur on its belly. Adults normally weigh 150-300 g, may reach up to 500 g, and are up to 390 mm long. Have relatively small ears which usually do not cover the eyes when pulled forward. Tail is shorter than head-body length.
Habitat	Inhabit a wide range of urban, rural and forest habitats. Ship rats are more common within forest areas.
Regional distribution	Throughout the region.
Competitive ability	Omnivorous and opportunistic and typically eat 10% of their body weight per day. This makes them a competitor for food with many species and predators of others (i.e. bird eggs and fledglings).
Reproductive ability	Can breed as young as 3-4 months old. Females can produce 15-20 young per year. Mortality can be high.
Resistance to control	Controlled by poisoning and trapping.
Benefits	None

Land use/habitats occupied in Hawke's Bay

LAND USE TYPE	CURRENT INFESTATION	POTENTIAL INFESTATION
Dairy	High	High
Sheep and beef	High	High
Forestry	High	High
Horticulture	High	High
Aquaculture	-	-
Urban	High	High
Native terrestrial	High	High
Coastal land	High	High
Freshwater	-	-
Estuarine	-	-
Marine	-	-

High = Most infested/preferred land use(s), Low = Less infested/preferred land use(s), - = Unsuitable land use

Qualitative impact assessment

CATEGORY	CURRENT	POTENTIAL	COMMENT	SOURCE
Production				
Dairy	L	L	Can consume and contaminate stock feed.	
Sheep and beef	L	L	See Dairy.	
Forestry	-	-		1, 2
Horticulture	L	M	Destroy crops and consumes or contaminates human food supplies (with urine and faeces).	
Aquaculture	-	-		
Other	-	-		
International trade	L	L	See Production.	1, 2
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	H	H	Eat a variety of native flora and fauna, in particular native birds, lizards, and invertebrates. Eat large quantities of native seeds, which reduces regeneration of native plants.	1, 2, 3
Threatened species	H	H	Predators of eggs and chicks of North Is kokako.	3
Social/Cultural				
Human health	M	M	Can transmit a range of diseases and parasites to humans (e.g. bubonic plague). Can also chew through power cables.	1, 2
Recreation	L	L	See Human Health.	3
Māori culture	M	M	Major threat to New Zealand's native fauna (taonga species).	

L = low, M = moderate, H = high

source 1: Invasive Species Specialist Group (2010b), 2: Invasive Species Specialist Group (2010c), 3: King (2005)

Estimated quantitative impacts

Quantitative annual impacts per hectare are calculated as the current or anticipated proportional impact on land value across the region. All amounts are in net present value (NPV, $).

Calculation: **Economic value per land use/habitat type** × **Impact level**

Impact level

Low = 1–4% reduction in annual economic value per hectare

Moderate = 5–9% reduction in annual economic value per hectare

High = 10–50% reduction in annual economic value per hectare

Reduction in annual economic value ($) per hectare

LAND USE/HABITAT TYPE	CURRENT IMPACT PER HA	POTENTIAL IMPACT PER HA
Production		
Dairy	54.63–267.08	54.63–267.08
Sheep and beef	7.39–36.12	7.39–36.12
Forestry	0	0
Horticulture	105.11–790.40	525.55–1,778.40
Aquaculture	0	0
Environment/Social/Cultural		
Urban	26.64–126.11	26.64–126.11
Native terrestrial	55.60–340.00	55.60–340.00
Coastal	124.70–762.50	124.70–762.50
Freshwater	0	0
Estuarine	0	0
Marine	0	0

Cost-benefit analysis results

Proposed management programme: **Site-led**

Area of Programme: **128,256 ha**

Proposed annual expenditure by Council: **$4,000**

Assumptions

ASSUMPTIONS	VALUES	ASSUMPTIONS	VALUES
Current area infested	121,843.2 ha	Time to reach maximum extent†	50 yrs
Current impacts★	$197.8/ha	Potential extent in the region°	121,843 ha
	$55.6–340/ha		121,843.2–121,843.2 ha
Current benefits	$0/ha	Discount rate	4%

★ Current annual impact of the pest averaged across all land uses currently occupied.

° The potential extent the pest is predicted to achieve in the absence of regional management.

† The time a pest is predicted to take between first going wild in the region and reaching its maximum extent.

10 year assessment

The cost-benefit analysis indicates that the benefits of the proposed management programme over the next 10 years will be of net benefit to the region.

SCENARIO	PEST IMPACTS★	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNERS COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$219,577,918	$0		$0	$0	$0	
	min: 61,721,599						
	max: 377,434,237						
Site-led	$211,962,248	$0	$7,615,670	$33,741	$0	$0	$7,581,929
	min: 59,580,895		min: 2,140,704				min: 2,106,963
	max: 364,343,600		max: 13,090,637				max: 13,056,896

★ Includes economic, environmental and social costs.

° The estimated economic benefit provided by the pest.

† Administration and implementation costs incurred by the Council through the programme.

‡ Costs of control imposed on landowners through the programme, over and above the costs already being paid by landowners, as estimated by the Council. They are applied for the 10 years of the Plan.

50 year assessment

The longer-term cost-benefit analysis indicates that the monetised benefits over the next 50 years of the proposed management programme will be of net benefit to the region. Additional non-monetised benefits associated with the protection of biodiversity values are also anticipated.

SCENARIO	PEST IMPACTS*	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNERS COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$541,833,800	$0		$0	$0	$0	
	min: 152,305,153						
	max: 931,362,448						
Site-led	$521,034,254	$0	$20,799,546	$89,366	$0	$0	$20,710,180
	min: 146,458,567		min: 5,846,586				min: 5,757,220
	max: 895,609,942		max: 35,752,506				max: 35,663,140

CBA statement and risks to success

Since their arrival in New Zealand, rats have had significant impacts on native flora and fauna. Omnivorous and opportunistic feeders eating 10% of their body weight per day. This makes them a competitor for food with many species and predators of others. They eat a variety of native flora and fauna, in particular native birds (eggs and fledglings), lizards, and invertebrates. Eat large quantities of native seeds, which reduces regeneration of native plants.

This programme is designed to support land occupiers to control rodents and their impacts through a site led pest control programme. Assistance may be provided through technical knowledge on best practice rodent control and in initial setup of a rodent control programme. Rodents are of particular concern for QEII covenants and ecosystem prioritisation sites. Council may assist or undertake rodent control at these sites to protect the biodiversity values within these sites.

The benefits of regional intervention, focused on sustainably controlling rodents as part of a side led pest control programme, outweigh the cost of the programme.

Risks of the programme being unsuccessful in achieving objectives

RISK	LEVEL OF RISK	EXPLANATION
Technical risk	Low	
Operational risk	Low	
Legal risk	Low	
Socio-political risk	Low	
Other risks	Low	

Who should pay?

Beneficiaries and exacerbators

GROUP	BENEFICIARY	EXACERBATOR	CHANGE BEHAVIOUR	ASSESS COSTS & BENEFITS	CONTROL COST EFFECTIVELY
Land occupiers (Crown and private)	Major	Major	Yes	Yes	Yes
Dairy/sheep and beef sector	Major		No	Yes	Yes
Regional community	Major		No	Yes	Yes

Who should pay for the proposed management approach?

This programme focusses on supporting land occupiers and community groups manage rodents as part of a pest control programme or to protect QEII covenants and ecosystem prioritisation sites. Although there are significant biodiversity gains that the wider regional community is a beneficiary, almost all programmes are on private land in rural areas. It is proposed that this programme is funded through a 70% targeted, 30% general rate.

STOAT
Mustela ermina

SITE LED

Relevant biology

Attribute	Description
Form	Has a long thin body, smooth, pointed head, short round ears, and round black eyes. Smaller than ferrets with males growing up to 40 cm long. Fur is dark brown with creamy white underparts and a bushy black tipped tail.
Habitat	Inhabits a wide range of urban, rural and forest habitats (native and exotic forest). Found from sea level to alpine habitats.
Regional distribution	Throughout the region.
Competitive ability	Diet is wide ranging and includes small mammals, fish, birds and invertebrates.
Reproductive ability	Females produce 1 or 2 litters per year with average 6 young, but high juvenile mortality.
Resistance to control	Highly mobile with large home ranges. Difficult to trap or poison.
Benefits	Some benefit in rabbit and rodent control.

Land use/habitats occupied in Hawke's Bay

LAND USE TYPE	CURRENT INFESTATION	POTENTIAL INFESTATION
Dairy	High	High
Sheep and beef	High	High
Forestry	High	High

Horticulture	Low	Low
Aquaculture	-	-
Urban	Low	Low
Native terrestrial	High	High
Coastal land	Low	High
Freshwater	-	-
Estuarine	-	-
Marine	-	-

High = Most infested/preferred land use(s), Low = Less infested/preferred land use(s), - = Unsuitable land use

Qualitative impact assessment

CATEGORY	CURRENT	POTENTIAL	COMMENT	SOURCE
Production				
Dairy	-	L	Potential vector of bovine Tb.	
Sheep and beef	L	L	See Dairy.	
Forestry	-	-		1, 2, 3
Horticulture	-	-		
Aquaculture	-	-		
Other	L	L	Predator of chickens and fowl. Threat to poultry farms, particularly free range farms.	
International trade	L	L	Potential vector of Tb.	
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	M	H	A generalist predator that most commonly eat birds, mice, rabbits. rats, weta and lizards. Widespread and can occur a long beaches, in forests and pastoral land, and in remote high country.	1, 2
Threatened species	M	H	Predator of adult North Is kokako and their eggs. Significant predator of juvenile kiwi. Predator of most other forest birds and lizards.	1, 2
Social/Cultural				
Human health	-	-		
Recreation	-	-		
Māori culture	L	H	Major threat to New Zealand's native fauna (taonga species).	

L = low, M = moderate, H = high

source 1: Auckland Regional Council (2007), 2: King (2005), 3: Taranaki Regional Council (2013c)

Estimated quantitative impacts

Quantitative annual impacts per hectare are calculated as the current or anticipated proportional impact on land value across the region. All amounts are in net present value (NPV, $).

Calculation: **Economic value per land use/habitat type** × **Impact level**

Impact level
Low = 1–4% reduction in annual economic value per hectare
Moderate = 5–9% reduction in annual economic value per hectare
High = 10–50% reduction in annual economic value per hectare

Reduction in annual economic value ($) per hectare

LAND USE/HABITAT TYPE	CURRENT IMPACT PER HA	POTENTIAL IMPACT PER HA
Production		

Dairy	0	54.63–267.08
Sheep and beef	7.39–36.12	7.39–36.12
Forestry	0	0
Horticulture	0	0
Aquaculture	0	0
Environment/Social/Cultural		
Urban	0	0
Native terrestrial	27.80–61.20	55.60–340.00
Coastal	62.35–137.25	124.70–762.50
Freshwater	0	0
Estuarine	0	0
Marine	0	0

Cost-benefit analysis results

Proposed management programme: **Site-led**

Area of Programme: **128,256 ha**

Proposed annual expenditure by Council: **$16,822**

Assumptions

ASSUMPTIONS	VALUES	ASSUMPTIONS	VALUES
Current area infested	115,430.4 ha	Time to reach maximum extent†	50 yrs
Current impacts★	$44.5/ha	Potential extent in the region°	115,430 ha
	$27.8–61.2/ha		115,430.4–115,430.4 ha
Current benefits	$0/ha	Discount rate	4%

★ Current annual impact of the pest averaged across all land uses currently occupied.

° The potential extent the pest is predicted to achieve in the absence of regional management.

† The time a pest is predicted to take between first going wild in the region and reaching its maximum extent.

10 year assessment

The cost-benefit analysis indicates that the benefits of the proposed management programme over the next 10 years will be of net benefit to the region.

SCENARIO	PEST IMPACTS★	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNERS COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$46,799,508	$0		$0	$0	$0	
	min: 29,236,547						
	max: 64,362,470						
Site-led	$40,001,634	$0	$6,797,874	$57,546	$0	$0	$6,740,328
	min: 21,757,041		min: 7,479,506				min: 7,421,960
	max: 62,130,172		max: 2,232,298				max: 2,174,752

★ Includes economic, environmental and social costs.

° The estimated economic benefit provided by the pest.

† Administration and implementation costs incurred by the Council through the programme.

‡ Costs of control imposed on landowners through the programme, over and above the costs already being paid by landowners, as estimated by the Council. They are applied for the 10 years of the Plan.

50 year assessment

The longer-term cost-benefit analysis indicates that the monetised benefits over the next 50 years of the proposed management programme will be of net benefit to the region. Additional non-monetised benefits associated with the protection of biodiversity values are also anticipated.

SCENARIO	PEST IMPACTS*	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNERS COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$115,483,177	$0		$0	$0	$0	
	min: 72,144,546						
	max: 158,821,807						
Site-led	$65,071,004	$0	$50,412,173	$142,184	$0	$0	$50,269,989
	min: 25,833,946		min: 46,310,600				min: 46,168,416
	max: 152,725,064		max: 6,096,743				max: 5,954,559

CBA statement and risks to success

Stoats are extremely fierce and will kill more prey than they need for food if they have the opportunity. They will also attack prey much larger than themselves. It is estimated that 60% of North Island brown kiwi chicks born each year are killed by stoats. Stoats hunt during the day or at night and can cover large distances. The main prey of stoats are rodents, birds, rabbits, hares, possums and invertebrates (particularly weta). Lizards, freshwater crayfish, carrion, birds, eggs, hedgehogs and fish are also taken. Stoats are distributed throughout the Hawke's Bay region.

Mustelids were introduced in New Zealand in the 1880's in an attempt to manage growing rabbit populations. This had minimal impact on rabbit densities but had a significant impact on New Zealand's Biodiversity. Mustelids are a threat to poultry farms.

This programme is designed to support land occupiers to control mustelids and their impacts through a site led pest control programme. Assistance may be provided through technical knowledge on best practice mustelid control and in initial setup of a predator control programme. Mustelids are of particular concern for QEII covenants and ecosystem prioritisation sites. Council may assist or undertake mustelid control at these sites to protect the biodiversity values within these sites.

The benefits of regional intervention, focused on sustainably controlling stoats as part of a side led pest control programme, outweigh the cost of the programme.

Risks of the programme being unsuccessful in achieving objectives

RISK	LEVEL OF RISK	EXPLANATION
Technical risk	Low	
Operational risk	Low	
Legal risk	Low	
Socio-political risk	Low	
Other risks	Low	

Who should pay?

Beneficiaries and exacerbators

GROUP	BENEFICIARY	EXACERBATOR	CHANGE BEHAVIOUR	ASSESS COSTS & BENEFITS	CONTROL COST EFFECTIVELY
Land occupiers (Crown and private)	Major	Major	Yes	Yes	Yes
Dairy/sheep and beef sector	Major		No	Yes	Yes
Regional community	Major		No	Yes	Yes

Who should pay for the proposed management approach?

This programme focusses on supporting land occupiers and community groups manage stoats as part of a pest control programme or to protect QEII covenants and ecosystem prioritisation sites. Although there are significant biodiversity gains that the wider regional community is a beneficiary, almost all programmes are on private land in rural areas. It is proposed that this programme is funded through a 70% targeted, 30% general rate.

WEASEL
Mustela nivalis

SITE LED

Relevant biology

ATTRIBUTE	DESCRIPTION
Form	The smallest and least common mustelid in New Zealand. About 20 cm long. Fur is brown with white underparts often broken by brown spots. Tail is short, brown and tapering.
Habitat	Prefers more disturbed habitats than other mustelids, such as agricultural land, scrub, and cut-over forest.
Regional distribution	Throughout the region.
Competitive ability	Diet is wide ranging and includes small mammals, fish, birds and invertebrates.
Reproductive ability	Females produce one or two litters per year with average six young, but high juvenile mortality.
Resistance to control	Highly mobile with large home ranges. Difficult to trap or poison.
Benefits	Some benefit in rodent control.

Land use/habitats occupied in Hawke's Bay

LAND USE TYPE	CURRENT INFESTATION	POTENTIAL INFESTATION
Dairy	Low	High
Sheep and beef	Low	High
Forestry	High	High
Horticulture	Low	Low
Aquaculture	-	-
Urban	Low	Low
Native terrestrial	Low	High
Coastal land	Low	High
Freshwater	-	-
Estuarine	-	-
Marine	-	-

High = Most infested/preferred land use(s), Low = Less infested/preferred land use(s), - = Unsuitable land use

Qualitative impact assessment

CATEGORY	CURRENT	POTENTIAL	COMMENT	SOURCE
Production				
Dairy	-	L	Potential vector of bovine Tb.	
Sheep and beef	-	L	See Dairy.	
Forestry	-	-		1, 2, 3
Horticulture	-	-		
Aquaculture	-	-		
Other	-	-		
International trade	L	L	Potential vector of bovine Tb.	
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	L	M	Can eat small native birds, lizards, tree wetas, and other native invertebrates.	1, 2
Threatened species	L	M	Poses a threat to small, ground-dwelling and ground-nesting birds.	1, 2
Social/Cultural				
Human health	-	-		
Recreation	-	-		
Māori culture	L	M	Threat to New Zealand's native fauna (taonga species).	

L = low, M = moderate, H = high

source 1: Auckland Regional Council (2007), 2: King (2005), 3: Taranaki Regional Council (2013c)

Estimated quantitative impacts

Quantitative annual impacts per hectare are calculated as the current or anticipated proportional impact on land value across the region. All amounts are in net present value (NPV, $).

Calculation: **Economic value per land use/habitat type** × **Impact level**

Impact level

Low = 1–4% reduction in annual economic value per hectare

Moderate = 5–9% reduction in annual economic value per hectare

High = 10–50% reduction in annual economic value per hectare

Reduction in annual economic value ($) per hectare

LAND USE/HABITAT TYPE	CURRENT IMPACT PER HA	POTENTIAL IMPACT PER HA
Production		
Dairy	0	54.63–267.08
Sheep and beef	0	7.39–36.12
Forestry	0	0
Horticulture	0	0
Aquaculture	0	0
Environment/Social/Cultural		
Urban	0	0
Native terrestrial	5.56–27.20	27.80–61.20
Coastal	12.47–61.00	62.35–137.25
Freshwater	0	0
Estuarine	0	0
Marine	0	0

Cost-benefit analysis results

Proposed management programme: **Site-led**

Area of Programme: **128,256 ha**

Proposed annual expenditure by Council: **$13,220**

Assumptions

ASSUMPTIONS	VALUES	ASSUMPTIONS	VALUES
Current area infested	115,430.4 ha	Time to reach maximum extent†	50 yrs
Current impacts★	$16.38/ha	Potential extent in the region°	115,430 ha
	$5.56–27.2/ha		115,430.4–115,430.4 ha
Current benefits	$0/ha	Discount rate	4%

★ Current annual impact of the pest averaged across all land uses currently occupied.

° The potential extent the pest is predicted to achieve in the absence of regional management.

† The time a pest is predicted to take between first going wild in the region and reaching its maximum extent.

10 year assessment

The cost-benefit analysis indicates that the benefits of the proposed management programme over the next 10 years will be of net benefit to the region.

SCENARIO	PEST IMPACTS★	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNERS COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$17,226,426	$0		$0	$0	$0	
	min: 5,847,309						
	max: 28,605,542						
Site-led	$14,724,197	$0	$2,502,229	$57,546	$0	$0	$2,444,683
	min: 4,351,408		min: 1,495,901				min: 1,438,355
	max: 27,613,410		max: 992,132				max: 934,586

★ Includes economic, environmental and social costs.

° The estimated economic benefit provided by the pest.

† Administration and implementation costs incurred by the Council through the programme.

‡ Costs of control imposed on landowners through the programme, over and above the costs already being paid by landowners, as estimated by the Council. They are applied for the 10 years of the Plan.

50 year assessment

The longer-term cost-benefit analysis indicates that the monetised benefits over the next 50 years of the proposed management programme will be of net benefit to the region. Additional non-monetised benefits associated with the protection of biodiversity values are also anticipated.

SCENARIO	PEST IMPACTS★	PEST VALUES°	BENEFIT	COUNCIL COSTS†	LANDOWNERS COMPLIANCE COSTS‡	AGENCY COMPLIANCE COSTS‡	NET BENEFIT
No intervention	$42,508,189	$0		$0	$0	$0	
	min: 14,428,909						
	max: 70,587,470						
Site-led	$23,951,979	$0	$18,556,210	$142,184	$0	$0	$18,414,026
	min: 5,166,789		min: 9,262,120				min: 9,119,936
	max: 67,877,806		max: 2,709,664				max: 2,567,480

CBA statement and risks to success

Weasels are not as common in New Zealand as other mustelids, but they also have an impact on native birds and lizards, particularly skinks. They kill most of their prey underground, and are usually found where there are plenty of mice, in gardens and near buildings. Weasels are distributed throughout the Hawke's Bay region.

Mustelids were introduced in New Zealand in the 1880's in an attempt to manage growing rabbit populations. This had minimal impact on rabbit densities but had a significant impact on New Zealand's Biodiversity.

This programme is designed to support land occupiers to control mustelids and their impacts through a site led pest control programme. Assistance may be provided through technical knowledge on best practice mustelid control and in initial setup of a predator control programme. Mustelids are of particular concern for QEII covenants and ecosystem prioritisation sites. Council may assist or undertake mustelid control at these sites to protect the biodiversity values within these sites.

The benefits of regional intervention, focused on sustainably controlling weasels as part of a side led pest control programme, outweigh the cost of the programme.

Risks of the programme being unsuccessful in achieving objectives

RISK	LEVEL OF RISK	EXPLANATION
Technical risk	Low	
Operational risk	Low	
Legal risk	Low	
Socio-political risk	Low	
Other risks	Low	

Who should pay?

Beneficiaries and exacerbators

GROUP	BENEFICIARY	EXACERBATOR	CHANGE BEHAVIOUR	ASSESS COSTS & BENEFITS	CONTROL COST EFFECTIVELY
Land occupiers (Crown and private)	Major	Major	Yes	Yes	Yes
Dairy/sheep and beef sector	Major		No	Yes	Yes
Regional community	Major		No	Yes	Yes

Who should pay for the proposed management approach?

This programme focusses on supporting land occupiers and community groups manage weasels as part of a pest control programme or to protect QEII covenants and ecosystem prioritisation sites. Although there are significant biodiversity gains that the wider regional community is a beneficiary, almost all programmes are on private land in rural areas. It is proposed that this programme is funded through a 70% targeted, 30% general rate.

SUMMARY OF PROGRAMMES

The Biosecurity Act 1993 and the Local Government (Rating) Act 2002 require that funding is sought from:

- people who have an interest in the Plan;
- those who benefit from the Plan; and
- those who contribute to the pest problem.

Funding must be sought in a way that reflects economic efficiency and equity. Those seeking funds should also target those funding the Plan and the costs of collecting funding. The following is a summary of the programmes and proposed funding source.

GENERAL RATE		
Sabella	$	20,750.00
Styela	$	20,750.00
Wallaby	$	500.00
Alligator weed	$	500.00
Marshwort	$	500.00
Noogoora bur	$	500.00
Senegal tea	$	500.00
Spartina	$	500.00
Yellow bristle grass	$	500.00
Cathedral bells	$	13,600.00
Goats rue	$	1,500.00
Phragmites	$	-
White-edged nightshade	$	740.00
Yellow water lily	$	444.00
Darwin's barberry	$	40,000.00
Lodgepole pine	$	55,000.00
Woolly nightshade	$	30,000.00
Japanese honeysuckle	$	5,000.00
Old man's beard	$	50,000.00
Privet	$	190,000.00
Total	$	431,284.00

TARGETED RATE		
Possum	$	1,215,945.00
Rook	$	125,436.00
African feather grass	$	12,000.00
Purple loosestrife	$	790.00
Spiny emex	$	4,600.00
Apple of Sodom	$	12,000.00
Australian sedge	$	21,000.00
Cotton thistle	$	3,000.00
Nassella tussock	$	17,000.00
Saffron thistle	$	80,000.00
Velvetleaf	$	3,600.00
Chilean needle grass	$	160,000.00
Feral cat (WSPC)	$	200,000.00
Mustelid (WSPC)	$	200,000.00
Rabbit	$	59,704.00
Feral cat	$	6,822.00
Feral deer	$	1,000.00
Feral goat	$	36,000.00
Feral pig	$	1,000.00
Ferret	$	16,822.00
Rat (ship and Norway)	$	4,000.00
Stoat	$	16,822.00
Weasel	$	13,220.00
Total	$	2,210,761.00

Anticipated costs of implementing the Plan

The anticipated costs of implementing the proposed RPMP reflect a best estimate of expenditure levels. Funding levels will be further examined and set during subsequent Long Term Plan and Annual Plan processes. While community funding is mainly sourced from rates, alternative funding sources will be sought by the Hawke's Bay Regional Council. Such funds will offset rates or be used as a value-added component in appropriate circumstances.

The proposed funding budget allocation is shown in table 13. Please refer to the Hawke's Bay Proposed Regional Pest Management Plan Cost Benefit Report for a full analysis of each programme.

Table 13. Proposed 2017-2018 funding for Regional Pest Management Plan.

ACTIVITY EXPENDITURE	
Production Pest Management	$1,810,761.00
Environmental & Amenity Pest Management	$431,284.00
Wide scale predator control	$400,000
Total Biosecurity	**$2,642,045**

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APPENDIX 1: Section 71 of the amended Biosecurity Act (2012)

71 Second step: satisfaction on requirements

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

1. that the proposal is not inconsistent with—
   (a) the national policy direction; or
   (b) any other pest management plan on the same organism; or
   (c) any pathway management plan; or
   (d) a regional policy statement or regional plan prepared under the Resource Management Act 1991; or
   (e) any regulations; and

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

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

4. that each subject is capable of causing at some time an adverse effect on 1 or more of the following in the region:
   (a) economic wellbeing:
   (b) the viability of threatened species of organisms:
   (c) the survival and distribution of indigenous plants or animals:
   (d) the sustainability of natural and developed ecosystems, ecological processes, and biological diversity:
   (e) soil resources:
   (f) water quality:
   (g) human health:
   (h) social and cultural wellbeing:
   (i) the enjoyment of the recreational value of the natural environment:
   (j) the relationship between Māori, their culture, and their traditions and their ancestral lands, waters, sites, wāhi tapu, and taonga:
   (k) animal welfare; and

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

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

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

8. that each proposed rule—
   (a) would assist in achieving the plan's objectives; and
   (b) would not trespass unduly on the rights of individuals; and

9. that the proposal is not frivolous or vexatious; and

10. that the proposal is clear enough to be readily understood; and

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

APPENDIX 2: National Policy Direction For Pest Management 2015

6. Directions on analysing benefits and costs

Pest management plan and pathway management plan

1. When determining the appropriate level of analysis of the benefits and costs of the plan for each subject for the purposes of a proposal for a pest management plan or pathway management plan, a proposer must consider:
    (a) the level of uncertainty of the impacts of the subject, or an organism being spread by the subject, and of the effectiveness of measures; and
    (b) the likely significance of the subject, or an organism being spread by the subject, or of the proposed measures, in terms of stakeholder interest and contention, and total costs of the proposed plan; and
    (c) the likely costs of the programme relative to the likely benefits; and
    (d) the level of certainty and the quality of the available data.

2. In the proposal for a pest management plan, or in a pathway management plan, an analysis of the benefits and costs of the plan for each subject must:
    (a) identify, and quantify (if practicable) the impacts of the proposed subject or an organism being spread by the subject; and
    (b) identify two or more options for responding to the subject or an organism being spread by the subject (one option must be either taking no action or taking the actions that would be expected in the absence of a plan); and
    (c) identify, and quantify (if practicable), the benefits of each option; and
    (d) identify, and quantify (if practicable), the costs of each option; and
    (e) state the assumptions (if any) on which the impacts, benefits and costs are based; and
    (f) be at an appropriate level of detail as determined in accordance with sub clause (1); and
    (g) take into account any risks that each option will not achieve its objective; and
    (h) identify any realistic mitigation options for the risks identified in sub clause (2)(g); and
    (i) adjust the benefits and costs for each option as appropriate to take account of subclause (2)(g) and (h); and
    (j) clearly identify which option is preferred.

3. When taking into account any risks that each option will not achieve its objective under subclause (2)(g), a proposer must consider:
    (a) the technical and operational risks of the option; and
    (c) the extent to which the option will be implemented and complied with; and
    (d) the risk that compliance with other legislation will adversely affect implementation of the option; and
    (e) the risk that public or political concerns will adversely affect implementation of the option; and
    (f) any other material risk.

4. When taking into account any risks that each option will not achieve its objective under sub clause (2)(g), a proposer must:
    (a) for analyses where the benefits are fully quantified, either:
        i. estimate the residual risks as a probability of success and calculate the expected benefits of the option by multiplying the benefits by the probability of success; or
        ii. state the residual risks to the programme and calculate what the probability of success would need to be to make the expected benefits equal the costs; and
    (b) for all other analyses (where the benefits are not fully quantified):
        i. state the residual risks to the programme and, where practicable, give an indication of likelihood and impact; and
        ii. specify which of the benefits are most likely to be affected if the risk eventuated.

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

APPENDIX 3: Cost-benefit analysis methods

Cost-benefit analyses: use with caution

Cost-benefit analyses are an economic tool to estimate all relevant costs and benefits in the same currency, usually in current dollars (termed the net present value, or NPV). To make these calculations, all future costs and benefits are "discounted" by the amount a dollar could earn if invested now rather than spent. Past applications of the Harris Model for RPMS reviews have used a standard discounting rate of 8% (although other values can be used in the Model). With an annual compounding interest rate of 8%, $1 invested today will have grown to $46.90 in 50 years' time[5]. For this reason, for it to be economically sensible to spend $10,000 today on pest control to prevent impacts in 50 years' time, those impacts would need to be worth $469,000.

CBA estimates can give the illusion of being precise, robust estimates of future costs and benefits. Models like the Harris Model (described below) require precise data estimates and provide precise cost and benefit estimates calculated down to the dollar (or lower). This hides great uncertainty in our ability to predict the impacts and spread of pests and the costs of their control in the next decades. Because of this, there is an unknown but undoubtedly large amount of uncertainty around all final Harris Model estimates costs and benefits, or any CBA estimates applied to the environment.

The scenarios evaluated in pest animal and plant cost-benefit analyses cannot be regarded as accurate predictions of the future. There is enormous ecological uncertainty surrounding future pest spread and impacts. There is also uncertainty, often large, in our current knowledge of the distribution and impacts of pest populations. Applying a cost-benefit analysis becomes a task of extrapolating into the future from the available data, and using this to make as robust conclusions as can be warranted from the data. It is therefore important that decisions made based wholly or in part on CBA results are revisited with updated data at regular intervals.

Another reason to be cautious in interpreting results from CBA methods when applied to pests is because most pests take many decades, sometimes centuries, to become widespread. While we may wish that our ancestors had acted against weeds like boneseed when they first appeared in the wild over 100-years ago, a CBA done at the time may well have concluded that they would have been better off saving their money rather than helping us out. Spending the equivalent of $10,000 (in current dollars) back in 1870 when boneseed (*Chrysanthemoides monilifera*) was first detected in the wild could well have eradicated it from the country, preventing all of the environmental impacts it is causing now. However, investing the equivalent of $10,000 in 1870 would now be worth $477,887,607 at an 8% annual compounding interest rate. A CBA at the time would therefore have required the impacts of boneseed today to cost us half a billion dollars to warrant them taking action against it. That is a big impact even for a rapidly expanding environmental weed like boneseed. The big problem with using CBA in this way is that we do not now have half a billion dollars that was invested from 1870 to deal with today's boneseed problem. Deciding not to control an incipient pest now therefore transfers a financial burden onto the next generation, who may or may not be as wealthy as us, and who will certainly be dealing with many more pest species than we are now. CBA recommendations should therefore be treated with some caution.

While CBA is undoubtedly a useful tool for making political decisions about pest control, it needs be used alongside other political, social, and environmental considerations. Like with so many environmental issues, there is always the temptation to pass costs on to future generations while we enjoy the benefits of delaying action. Future generations are likely to bear the brunt of a great many such decisions. Regardless of CBA results, decisions about whether or not to act against pests now still boil down to "is it the right thing to do?" and "can we afford it?".

The 'Harris model' for cost-benefit analyses

The 'Harris Model' was developed in 2000 by Simon Harris for the Biosecurity Managers Group, for use in the preparation of Regional Pest Management Strategies (RPMS) (now referred to as Regional Pest Management Plans). The Harris Model is used to carry out cost-benefit analyses (CBA) for pest control under different regional

[5] Note that the reference to the compound interest rate is given for example purposes only it is not used in the cost benefit analysis modelling.

pest management scenarios, including no regional control. It has been used for a number of RPMS reviews in different regions, including the 2003 Bay of Plenty RPMS (Severinsen 2003) and previous Auckland RPMS reviews (Auckland Regional Council 2006). We ran into difficulties implementing the standard Harris model for the 2009 review of the Bay of Plenty RPMS, because the standard of data it requires is typically is difficult to obtain and unavailable to most councils. It requires unrealistically precise values for ecological parameters, ignores the costs of non-production impacts, and provides no estimate of the uncertainty around the final estimates of costs and benefits.

Our modified model attempts to improve on these areas. We are ecologists, not economists, and so have not changed the underlying economic equations in the Harris model. Instead, we have attempted to simplify the Harris Model to deal with greater uncertainty in the available data and made our modifications around these equations. For example, allowing for a range of values rather than a single value is the same as running the Harris model twice with the high and low value of a range. Adding costs of non-production impacts simply requires re-running the Harris Model with the addition of per hectare impacts on things like soil quality and biodiversity (such values are notoriously difficult to assign dollar values but excluding them altogether is at least as unrealistic – we have typically assigned these small, non-zero numbers relative to production impacts to assess their possible importance). When we do this, we are sure to also include the CBA results when only production impacts are included.

Our most fundamental modification is the use of a mathematically different "S-shaped" growth curve to the Harris Model when we predict the expansion of pests. We use a logistic growth curve widely used in ecology for weed modelling. In comparison to the Harris Model growth curve, our logistic growth curve includes a shorter "establishment-phase" (the time before a species begins to rapidly spread), a longer spread phase, and a shorter plateau. Our model has each phase occupying a third of the invasion. Long lag-phases are well documented in invasion biology, especially in the period between the introduction of a species (e.g., for forestry) and its first wild establishment (e.g., Mulvaney 2001), but most of the species listed in the RPMP are expected to be beyond this early phase. Our shorter establishment phase is more likely to reflect the behaviour of an already identified weed. Usefully, the logistic growth curve also simplifies the mathematics allowing for an easier separation to the population growth time and the time period over which the costs are calculated. This is very helpful in that it makes it easy to not run out the model for all the time required for a pest to reach its full extent. It is also flexible enough to add a lag-phase for other pests if it is considered likely. We have also been careful to identify all of our data sources which will add transparency to this process and make it simple to incorporate new information into revised cost and benefit estimates as it becomes available.

Our changes to the Harris model

Our modifications to the Harris Model are described below and summarised in Table A.1.

Table A.1: Our key modifications to the Harris Model.

HARRIS MODEL	OUR REVISED MODEL
Production impacts only	Impacts by land use, including non-production land
Single values	Min, average, max values
Sigmoidal curve	Logistic growth curve
CBA duration = pest growth	CBA duration ≠ pest growth
Max extent and spread rate calculated separately	Estimates min and max values for extent and spread when data is absent
Current impacts only	Impacts per hectare can increase

1. Precise estimates of cost and benefit**.**

The Harris Model requires precise estimates of all parameters in its calculations, such as the total number of hectares a pest is expected to eventually occupy and the exact number of years it will take to reach this extent. Getting precise and ecologically realistic values for these parameters is not practical for even a large subset of the pest species typically included in an RPMS. Predicting pest spread and total potential range is complicated, requires more information than is available for most pests, and is sensitive to changes in human-assisted dispersal processes (and land use and climate change). For example, building a recent spread model in New Zealand for argentine ants, one of the world's best studied insect environmental pests, took Lincoln University

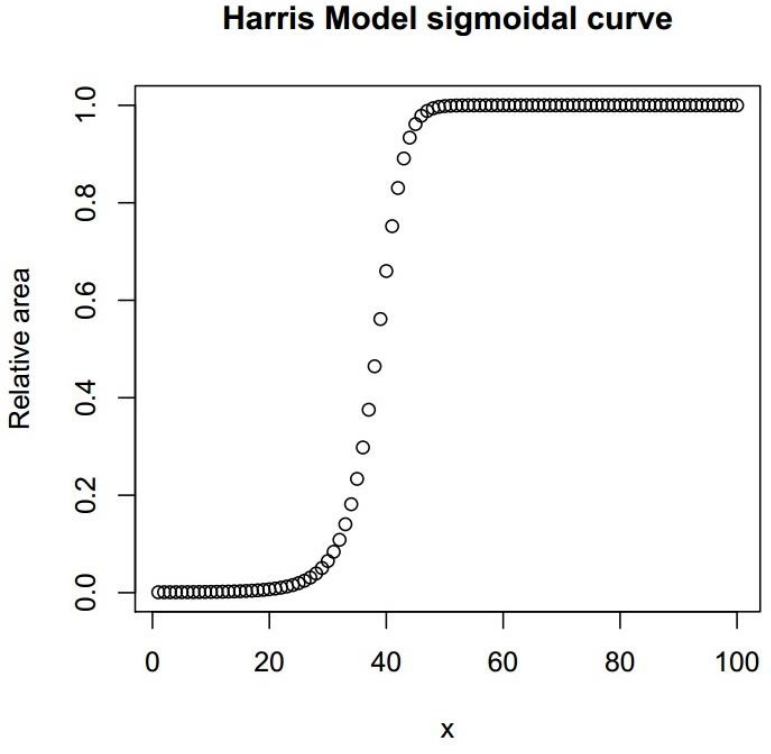
PhD student Joel Pitt three years of work. While the Harris Model does not preclude being run several times with minimum and maximum estimates of different parameters, past applications of the Model have only reported single available best estimates of pests' total extent and rate of spread. Our modified model allows for direct input of coarsely estimated parameters and, when these are used, it outputs maximum and minimum estimates of costs and benefits rather than single values.

2. Duration

Severinsen (2003) applied the Harris Model for a 50-year duration since it required pests to reach their maximum extent. Pests that were expected to spend longer than 50 years to reach their maximum extent were capped at 50 years to deal with discounting of impacts to net present value. It is likely that most incipient pests in the Bay of Plenty will take longer than 50 years to reach their maximum extent (for example, according to Bay of Plenty Regional Council staff rabbits reached the last areas of the Bay of Plenty region only in the past 20 years or so, well over a century after their initial introduction to the region). We have revised the Harris Model to grow pest populations for much longer than 50 years (when appropriate) but still make the CBA calculations for a shorter, more economically reasonable time period (e.g. 10 or 50 years).

3. Population growth model

The Harris Model used a sigmoidal growth curve with a rapid, short growth phase in the middle of a pest's spread (Figure A.1a). We have replaced the pest spread equations of the Harris Model with the logistic growth curve (Figure A.1b), commonly used in ecology to model population growth. This is a mathematically useful, and simple, growth curve that allows us to easily calculate growth and associated discounted impacts over only a portion of the growth curve. We have highlighted this portion in the graphs provided with the CBA outputs i.e. where a pest is expected to be now until its maximum extent.



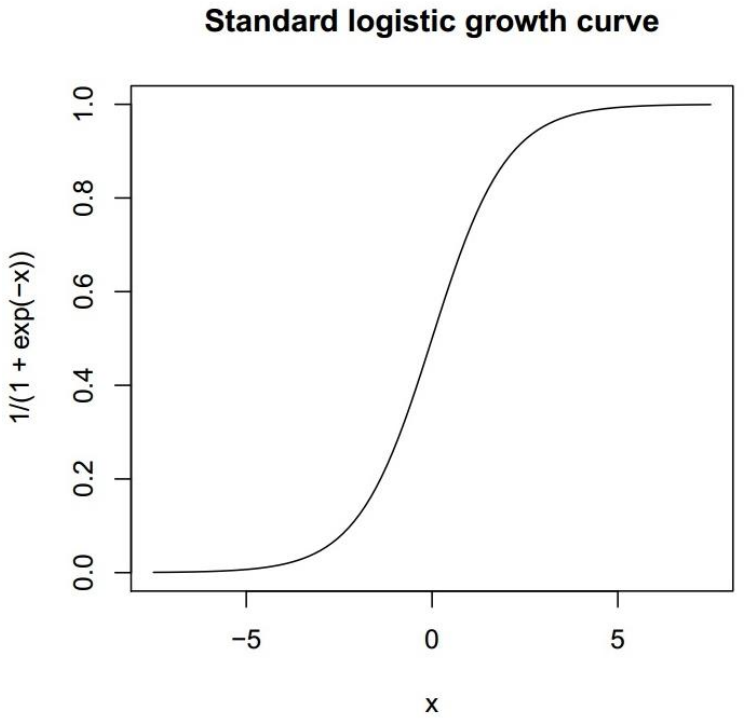


Figure A.1: (a) The sigmoidal growth curve used to model pest spread in the Harris Model. (b) The standard logistic growth curve used to model pest spread in our CBAs.

4. Estimating the potential area infested by each pest

The Harris Model requires a single estimate of the total area a pest is likely to infest in the region, given sufficient time. It is impossible to provide such a value with any useful level of certainty for almost any pest in a particular region. What is possible is to define broad land use types in each region and categorise them as primary (preferred), secondary (less preferred), or unsuitable habitat for each pest. The land use types we used were Dairy, Sheep/Beef/Deer, Horticulture, Forestry, Aquaculture, Native terrestrial, Urban, Coastal land, Estuarine, Freshwater, and Marine (see the Methods section for definitions).

We then make the assumption that if a land use/habitat type is a *primary* habitat for a pest, then it will have the potential to occur in 5-25% of the regional area of that land use type. If a land use/habitat type is a *secondary* habitat for a pest, then we assume that pest will have the potential to occur in 1-4% of the regional area of that land use type. These are the percentages a pest would be capable of reaching at its maximum regional extent in the absence of regional (RPMP) management. This approach was much quicker but also likely no less accurate than the more precise parameter required by the Harris Model.

5. Pest spread

While it is prohibitively expensive and time consuming to accurately estimate a single total
extent and rate of spread for a pest, what we can do with confidence is assign all listed pests into categories of current extent in each land use/habitat type, dispersal ability, and life form. These estimates can then be used to assign species to a range of likely spread rates. Our modified Harris Model uses this more coarse but realistic ecological data to estimate the range of costs and benefits within which the true value likely lies, and allows us to present maximum and minimum cost and benefit estimates around average values.

6. Impacts

The Harris Model bases its estimate of pest impacts on the value of production land, the proportion of this production that is lost due to a pest, and the cost of pest control and the proportion of landowners controlling

the pest. The current total loss of production and total cost of control per year are combined to give a current impact per hectare per year for each pest. Getting accurate, detailed data of this kind for many pests is typically prohibitively difficult. This is especially the case for non-agricultural land, which the Harris Model avoids. We have used a simpler but habitat specific approach to estimating impacts that simply requires each pest to be identified as a low, moderate, or major pest (or not a pest) in each land use/habitat type.

7. Non-production impacts

The Harris Model for simplicity ignores the impacts, however large, on non-production values such as recreation, conservation, and human health. While difficult to quantify economically,
the exclusion of these impacts altogether can lead to clearly unrealistic conclusions. For example, this is the reason why the cost-benefit analysis from the 2003 Bay of Plenty RPMS concluded that there was no regional net benefit in controlling parrot's feather (*Myriophyllum aquaticum*), one of the country's worst aquatic weeds, since it caused no annual loss of production to terrestrial agriculture. To avoid these erroneous conclusions, our revised methods allow for the incorporation of non-production impacts of species. Even if these costs are very small per hectare compared with impacts on agricultural production, they can add up to regionally important impacts for widespread and rapidly expanding pests.

8. Estimating impacts

We have taken a similar approach to impacts as we have taken to estimating the potential area occupied by each pest. It is possible to accurately (and relatively quickly) categorise each pest as a low, moderate, or high impact pest in each of our land use/habitat types. Using past Harris Model CBA estimates and pest literature, we assigned each of these categories to the following ranges of impacts on the per hectare value of each land use/habitat type:

1. **Low impact** on a land use/habitat = 1-4% reduction in the per hectare economic value
2. **Moderate impact** on a land use/habitat = 5-9% reduction in the per hectare economic value
3. **High impact** on a land use/habitat = 10-50% reduction in the per hectare economic value

From these impact estimates per land use/habitat type, we calculated the total annual per hectare impact of a pest in the region by weighting each land use impact by its estimated proportion of the pest's total area. This is illustrated with the following example from the Bay of Plenty (Sullivan and Hutchison 2010).

Apple of Sodom (Solanum linnaeanum)

Current impacts (annual, per hectare)
- Low Dairy (0.01× 1263 to 0.09× 4477)
- Low Native (0.01× 1 to 0.09× 150)

Current land use weighting
- Primary pest in Dairy (68.7%-73.3%)
- Secondary pest in Native (26.7%-31.3%)

Total current annual impact per hectare: 8.67- 83.30

Potential impacts
- Moderate Dairy (0.1× $1263 to 0.49× 4477)
- Low Native (0.01× 1 to 0.09× 150)
- Moderate Urban (human health, recreation values) (0.1× 100 to 0.49× 500)

Potential habitat weighting
- Primary pest in Dairy (68%-72.5%)
- Secondary pest in Native (26%-31%)
- Secondary pest in Urban (0.6%-0.7%)
- Primary pest in Coastal (0.3 %)

Total potential annual impact per hectare: $85.92 - $449.51

The range of our current impacts span the estimate in landowner control costs and lost production from the 2003 Bay of Plenty RPMS CBAs (Severinsen 2003), where the Harris Model was used. In the absence of regional control for many decades, which is likely to result in higher densities over much of its range, it is entirely plausible that the annual costs per hectare for this spiny, toxic weed could be much higher than they are now.

9. Increasing pest impacts

Assessing the full costs of current and potential pest impacts is also a complicated exercise. Predicting pest impacts is an active area of research and there is a great deal that is not well understood, especially about the impacts of pests on natural ecosystems. The Harris Model uses precise estimates of the dollar value of the annual loss of production per pest species. Estimating these parameters with a useful degree of precision is impractical in all but the simplest cases. The Harris Model simply extrapolates the best estimate of current pest impacts per hectare per year into the future, multiplied by the projected increase in pest area with a compounding 8% discount. We found that this simplification led to inaccurate results for some species, particularly low-incidence pests. For example, the notorious pasture pest, nassella tussock, has been so thoroughly controlled that it is not currently found in pastoral land and its current average annual per hectare impacts are low. However, if regional control was relaxed, it is likely that it would reinvade high value land and reach damaging densities, in which case its annual impacts per hectare would become much higher than they are now. The same applies to incipient pests that experience elsewhere shows will become a serious problem if they are not controlled, but which are currently restricted to low-value lands or occur in low densities. To deal with these kinds of cases, we have modified the Harris Model to allow the annual per hectare pest impacts to increase through the pest invasion.

We allowed for estimates of annual pest impacts per hectare to increase through the duration of the CBA (unlike the Harris Model). In year one we use our estimates of the current annual impacts per hectare (see above) then increase this value linearly up to our estimated potential impact at the mid-point of the species spread. For example, if a weed was estimated to take 100 years to reach its maximum extent, we assume that it will reach its potential annual impact per hectare by 50 years. If this weed was estimated to be already 30 years into its spread, we increase the weed's per hectare impacts linearly to reach its potential in 20 more years.