

Identification and assessment of risks, costs and benefits

The potential risks, costs and benefits of the proposed introduction to New Zealand of *Anthonomus kuscheli* and *Berberidicola exaratus* and the possible reduction in the abundance and vigour of Darwin's barberry were identified by literature review, by public consultation and by formal brainstorming involving personnel from Environment Southland and the Department of Conservation. The significant effects identified are highlighted in this table and addressed in section 6 of the application. Other effects are discussed in the table.

Beneficial effects on the environment

Source of potential benefit	Comments
Maintenance of habitats	
Reduced dominance of Darwin's barberry increases diversity of flowers available to invertebrates.	A likely effect. The significance of this benefit is unknown.
Sustainability of flora and fauna	
Less seed production reduces the rate of invasion and consolidation of Darwin's barberry, and limits reinvasion of cleared sites	Expected outcome, see Section 6.1.1
Reduced invasion protects rare and endangered flora and fauna	Expected outcome, see Section 6.1.1
Restoration of native vegetation increases the diversity of associated species .	Increase in biodiversity may well ensue, but is long-term outcome. Agents will not affect existing Darwin's barberry plants, see Section 6.
Reduced growth rate and biomass of Darwin's barberry reduces competition with native seedlings for light and nutrients .	A significant benefit, but is long-term outcome. Agents will not affect existing Darwin's barberry plants, see Section 6.
Adult weevils augment prey available to otherwise vulnerable generalist predators.	No significant effect expected because weevil numbers will only rise in the immediate vicinity of Darwin's barberry, and because weevil populations will be a small proportion of prey available overall .
Immature weevils augment prey available to parasitoids.	Larval and pupal weevils occur within plant parts, and are unlikely to be easily available to predatory invertebrates.
Ecosystem processes	
Interactions with resident parasitoids and predators	It is uncertain whether the influence on trophic webs

changes the make-up of trophic webs.	would be beneficial or adverse, but not either influence not significant because agents are host specific, and effects would be limited to the vicinity of barberry plants, see above.
Reduction of barberry monoculture reduces the biomass of persistent barberry litter, restoring soil biology.	No significant effect. The agents primarily feed on flowers or seeds. Although adult weevils feed slightly on Darwin's barberry leaves, the impact of this on the turnover or vigour of extant, long-lived plants is expected to be minimal.
Successful control of barberry results in reduced herbicide application, and less pollution of air soil and water.	Ditto. These insects affect barberry recruitment only. Any such effects would only become evident once extant plants are dead.
Reduced metabolism of affected plants raises water table.	Ditto. Whether a beneficial or adverse effect would be site dependent.
Increased carbon turnover compared to native vegetation.	Ditto.
Decreased dominance of <i>Berberis</i> species in native and domestic settings increases ecological services.	Possible benefit, but undefined.
Reduction in the invasive potential of Darwin's barberry allows the development of larger trees that are more effective carbon sinks.	Real effect, but only evident in the long term.
Intrinsic value of ecosystems	
Improvement in the look and feel of native bush for visitors.	The proposed agents are seed-feeders. Although adult weevils feed slightly on Darwin's barberry leaves, the impact of this on the turnover or vigour of extant, long-lived plants is expected to be minimal. Any benefit will be long-term.
Inherent genetic diversity in New Zealand	

Beneficial effects on human health and safety

Source of potential benefit	Comments
Reduction in flowering reduces allergenic effects of	It is expected that <i>Anthonomus</i> attack will reduce the abundance of flowers. This would reduce any

Darwin's barberry pollen.	allergenic effects but web search reveals no records of Darwin's barberry causing significant allergies.
Reducing the rate of invasion reduces human anxiety about weedy nature of Darwin's barberry.	This is likely to be a real effect but in few individuals.

Beneficial effects on the relationship of Māori and their culture and traditions with the environment

See section 5 of the application.

Beneficial effects on society and communities

Source of potential benefit	Comments
Control agents stop other <i>Berberis</i> species from becoming weeds in New Zealand	See Section 6.3.1
Reduced need to manage barberry leads to better allocation of community and volunteer resources for weed management.	Ditto. The expected reduction in the rate of invasion will lead to less investment in the removal of seedling plants in new invasion sites, see Section 6.4.1.
Reduction in Darwin's Barberry improves access for recreational pursuits including hunting.	The proposed agents are seed-feeders. Although adult weevils feed slightly on Darwin's barberry leaves, the impact of this feeding on the vigour or survival of existing, long-lived plants is expected to be minimal. Any benefit will only be long-term.
Reduced herbicide use lowers adverse human health effects of herbicide application and other weed management techniques.	Pesticide use within label guidelines should not incur significant risk to operators. Darwin's barberry is not yet widespread in most of New Zealand. Current issue is small and benefits likely to be low.
Reduced Darwin's barberry results in less skin irritation when moving in infestations.	Ditto.
Reduced need to manage barberry leads improved morale in DOC and RC staff.	Successful biological control would be well received, but extant plants will still require management.

	Benefits accrue to few people.
Reduction in the visibility of Darwin's barberry leads to improvement in the look and feel of native bush for visitors.	The proposed agents are seed-feeders. Although adult weevils feed slightly on Darwin's barberry leaves, the impact of this feeding on the turnover or vigour of existing, long-lived plants is expected to be minimal. Any benefit will be long-term.
Less visual pollution.	No change in the look of infestations is expected in the short term.

Beneficial effects on the market economy

Source of potential benefit	Comments
Limitation of future invasion of pastoral land	See Section 6.4.1
More natural environment for tourism.	The proposed agents are seed-feeders. The impact of this feeding on the vigour or survival of existing, long-lived plants is expected to be minimal.
Increased revenue to nurseries for replacement of affected garden plants.	The agents are not expected to reduce the survival of garden <i>Berberis</i> . However, <i>Anthonomus</i> could reduce the showiness of any susceptible species.

Adverse effects on the environment

Source of potential adverse effect	Comments
Maintenance of habitats	
Weevils compete with native insects	None of the herbivore niches are well occupied in New Zealand. Significant competition between resident and novel barberry insects is highly unlikely, see Section 6.1.2.
Fewer flowers means less food for nectar feeders, reptiles and other animals.	Ditto.
Darwin's barberry is replaced by a worse weed.	Existing populations of Darwin's barberry will not be reduced by these agents. Such changes in vegetation structure will only occur in the long term. No such replacement has been seen as a result of DB removal

	by conventional control (L. Huggins, DOC pers. comm.)
Reduction in barberry biomass changes the nature of the litter and adversely affects the diversity and abundance of litter fauna.	Seed-feeding weevils will not significantly alter the nature of the litter under Darwin's barberry. Any effects will only occur in the long term
Sustainability of flora and fauna	
Introduced weevils displace native species.	Significant competition between resident and novel barberry insects is highly unlikely see Section 6.1.2
Ecosystem processes	
Increased carbon turnover compared to native vegetation	The proposed agents are seed-feeders. The impact of these weevils on the vigour, turnover or survival of existing, long-lived plants is expected to be minimal
Reduced metabolism of affected plants raises water table	Ditto
Adverse changes in soil quality	Ditto
Rapid biocontrol leads to erosion, followed by reduced water quality from sediments.	Introduction of seed-feeders will not influence erosion rates.
Intrinsic value of ecosystems	
No significant effects have been identified.	See maintenance of habitats.
Inherent genetic diversity	
Potential for hybridisation with native insects.	No congeners of either control agent exist in New Zealand. No hybridisation is possible
Displacement of native weevils on barberry	Significant competition between resident and novel barberry insects is highly unlikely (Smith et al. 2004).
Plant and animal health	
Weevils vector plant diseases.	Weevils are not acknowledged as significant vectors of plant diseases.

Weevils vector insect diseases.

Larvae occur within plant parts, isolating them from native insects. Adult weevils unlikely to be significantly more capable.

Adverse effects on human health and safety

Source of potential adverse effect	Comments
Introduced species increase incidence of allergic responses to weevils.	No reason to believe that these weevils would cause more allergies than resident weevils.

Adverse effects on the relationship of Māori and their culture and traditions with the environment

See separate section and the application.

Adverse effects on society and communities

Source of potential adverse effect	Comments
Reduced job opportunities for Darwin's barberry control and less dollars to community.	Darwin's barberry is abundant in few places and supports few jobs currently
Reduction in use of garden barberry species.	No reduction in utility expected, see Section 6.3.2
Fewer seeds available for use in curries.	The small supply required for this purpose unlikely to be jeopardised by these introductions.
Control reduces the aesthetic values of Darwin's barberry.	No significant risk. Plant is not strongly valued by the public.

Adverse effects on the market economy

Source of potential adverse effect	Comments
Increased expenditure by DOC, Regional Councils and occupiers on barberry treatment to mitigate the effects of Darwin's barberry.	No such effects expected, see Section 6..2
Cost of managing non-target effects in future	No such effects expected, see Section 6..2

Reduced flowering leads to smaller pollen resource for beekeepers in spring, and reduced pollination services and honey production.	Darwin's barberry is not abundant in most of New Zealand must form a small proportion of the national spring flower resource, see Section 6.4.2
Increased cost to public for replacement of affected garden plants.	Survival of ornamental Berberis will not be significantly affected, see Section 6.3.2
Successful control leads to educational benefits on merits of weed management.	These agents do not attack extant plants and would have limited value in demonstrating the practice of biological control.
Reduction in the abundance of Darwin's barberry increases tourism values.	Few would value the aesthetic of Darwin's barberry. This plant is not abundant in many areas.
Successful biological control reduces revenue for contractors and suppliers.	Not a significant effect. Revenues directly related to barberry management are not a key revenue source for many or any contractors or suppliers.
The costs of introduction and establishment exceed the monetary benefit.	This is an early intervention to preclude the development of future costs.