Potential beneficial and adverse effects to be addressed in the EPA application to introduce the Darwin's barberry rust fungus, *Puccinia berberidis-darwinii* as a biocontrol agent for Darwin's barberry

Angela Bownes, Manaaki Whenua – Landcare Research, bownesa@landcareresearch.co.nz, 321 9605

The potential risks, costs, and benefits of the introduction of biocontrol agents to New Zealand for invasive weeds have been identified through formal brainstorming and through consultation with the public and professionals. There is a suite of possible risks, costs and benefits that are common to most biocontrol agents proposed for release, and other effects that may be specific to each biocontrol agent. These are outlined below for the proposed introduction of *Puccinia berberidis-darwinii* as a biocontrol agent for Darwin's barberry.

The effects of the introduction of exotic biocontrol agents can result from:

(1) the introduction of a new organism to the New Zealand environment; and

(2) a reduction in the target pest through successful biocontrol.

Those effects considered to be significant (in terms of the magnitude of the effect and the frequency of or likelihood of the effect) are highlighted in bold and discussed more extensively in the application.

Potential impacts on Māori values will be addressed in a separate consultation process and will be done accordingly for the Darwin's barberry rust fungus application.

Please contact Angela Bownes if you have any comments about the approach used in the application, or to report additional potential effects.

POTENTIAL BENEFICIAL EFFECTS	
Potential Beneficial Effects on the Environment	
Source	*Comment*
Maintenance of habitats	
Reduced competition from Darwin's barberry leads to increased survival and diversity of native and other desirable plants in affected habitats.	This is the major expected benefit from the contribution of Darwin's barberry rust to the biological control programme against this weed. Darwin's barberry invades pastureland reducing available grazing for livestock and can displace native plants in bush remnants. The weed can aggressively invade forest margins and light gaps in disturbed or remnant forest. It overtops the margins and understory of patchy remnant forest, destroying low-growing native plants that should grow in such areas, including seedling forest trees. It is a threat to the ecological and biodiversity values of reserved land. Currently Darwin's barberry is regarded as widespread and abundant in areas of Otago, Canterbury and Wellington, as well as locally common in Southland, Marlborough, Manawatū-Whanganui, Waikato and Bay of Plenty. A limited number of sites has been recorded in Tasman-Nelson, Taranaki, Hawke's Bay and the West Coast. The rust will affect existing Darwin's barberry plants, reducing plant growth, plant biomass, and seed formation. Successful biological control will reduce adverse effects wherever the weed occurs, acting far beyond the reach of existing management efforts. Successful control will reduce the future development of adverse effects of the weed as it spreads.
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.
Reduced invasion protects rare and endangered flora and fauna	A likely effect.
Restoration of native vegetation increases the diversity of associated species.	Over the long-term increase in biodiversity is likely

Reduced growth rate and biomass of Darwin's barberry reduces competition with native seedlings for light and nutrients.	Expected outcome and significant benefit.
Reduced damage to native and other non-target plant species from spraying.	Darwin's barberry is a difficult target for chemical and mechanical control as it is commonly found amongst regenerating native species. Cutting down the weed and spraying with herbicides also damages non-target plant species. Successful biological control will reduce the need for chemical and mechanical control. Currently, Darwin's barberry is included in the Regional Pest Management Strategies of ten councils, therefor a reduction in necessary control operations will be a significant benefit.
Ecosystem processes	
Benefits to parasitoids, predator, and disease relationships in trophic webs	Increased plant diversity as Darwin's barberry monocultures break up will increase the diversity and complexity of trophic webs. Effects will vary locally, spatially, and temporally.
Restoration of soil biology.	Reduction of Darwin's barberry plant biomass and monoculture will reduce the persistent barberry litter, thereby restoring soil biology.
Reduced contamination of air, soil, and water from reduced Darwin's barberry spraying.	Successful biocontrol of barberry will reduce the need for chemical control.
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	
Improved look and feel of native bush for visitors.	Successful control limits the development or reduces the occurrence of unsightly monocultures of Darwin's barberry.
Inherent genetic diversity in New Zealand	
Loss of endangered species is slowed.	Reducing current Darwin's barberry stands would allow regeneration of threatened native species.
Improvements in biodiversity associated with successful control increase the inherent genetic diversity of native secondary low forest and scrub land.	Reducing current Darwin's barberry stands would allow regeneration of native species and improving biodiversity. For example, near Dunedin, barberry is common in and adjacent to stands of

	predominantly native secondary low forest and scrub (Allen and Wilson 1992)).
Potential beneficial effects on Human Health and Safety	
Source of potential benefit	*Comment*
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.
Reduced frequency of control operations lowers the incidence of occupational health issues for gardeners and conservation workers.	Pesticide use within label guidelines should not incur significant risk to operators. A reduction in necessary control operations will be a significant benefit.
Reduced Darwin's barberry results in less skin irritation when moving in infestations (during control operations and recreationally).	A significant benefit as a reduction in infestation density as well as in necessary control operations will reduce incidence of skin irritation.
Potential beneficial effect on Society and Communities	
Source of potential benefit	*Comment*
Successful biological control reduces costs of Darwin's barberry management to regional and territorial authorities	A significant benefit. The expected reduction in biomass in current infestations and reduction in rate of spread will lead to less investment in management efforts at current sites as well as the removal of seedling plants in new invasion sites.
Reduced need to manage Darwin's barberry leads to better allocation of community and volunteer resources for weed management.	A significant benefit.
Reduced need to manage Darwin's barberry leads improved morale in DOC and RC staff, as well as weed busting community groups.	Successful biological control would be well received. Benefits accrue to few people.
Improved access for recreational pursuits including hunting.	The expected reduction in plant biomass and breaking up of dense stands of barberry will allow easier access.
Improved look and feel of native bush for visitors.	Successful control reduces the occurrence of unsightly monocultures and limits the establishment of new infestations of Darwin's barberry.
Reduced public concern about the unsightliness of dense infestations of Darwin's barberry.	Reduction in unsightly monocultures expected.
Potential beneficial effects on the Market Economy	
Source of potential benefit	*Comment*

Reduced or more efficient investment by stakeholders to mitigate effects of Darwin's barberry	The rust is expected to reduce biomass and fruit production, thereby reducing the investment needed for control and compliance.
Restoration of productive values of infested pastoral land	The rust is expected to reduce Darwin's barberry plant health and fruit formation in existing infestations.
Limitation of future invasion of pastoral land	The rust is expected to reduce biomass and fruit formation, which will assist in limiting spread and future invasion of pastoral land.
More natural environment for tourism	Reduction in monocultures of barberry and restoration of native species.
Management of control agents creates business opportunities for Manaaki Whenua – Landcare Research.	A real effect, but a small contribution to Manaaki Whenua – Landcare Research revenue.
POTENTIAL ADVERSE EFFECTS	
Potential Adverse Effects on the Environment	
Source of potential adverse effects	*Comment*
Maintenance of habitats	
Fewer flowers mean less food for nectar feeders, reptiles, and other animals	Darwin's barberry flowers and fruit have not been identified as a crucial resource to any native fauna species.
Successful control of Darwin's barberry reduces the food supply of fruit and seed-feeding native birds	Not recorded as a critical item in the current diet of any native bird species, therefor not a significant risk to native birds (discussed in detail in 2012 two weevil application under 6.2)
Reduced habitat quality for some native fauna.	Not significant. Replacement vegetation will also support invertebrate fauna. No fauna of special significance found on Darwin's barberry in NZ (Smith, Winks et al. 2004).
Darwin's barberry is replaced by another (worse) weed	Potentially, though Darwin's barberry is shade tolerant whereas many other weeds are not. This scenario will therefore be site dependent and vary spatially and temporally.
Sustainability of flora and fauna	
Darwin's barberry rust competes with native fungal species	None of the fungal species naturally occurring on Darwin's barberry in NZ were found to be specific to this host (Smith, Winks et al. 2004, Waipara, Smith et al. 2005). Therefore, significant competition between resident rusts and the Darwin's barberry rust is highly unlikely.
Darwin's barberry rust competes with native herbivore species	None of the herbivore niches on Darwin's barberry are well occupied in NZ (Smith, Winks et al. 2004). Significant competition between resident

	herbivores and Darwin's barberry rust is therefore highly unlikely.
Swift evolutionary change in insect leads to unexpected non-target damage to valued plants and/or alterations to food webs	Not a significant risk. There is little evidence of adaptive host range expansion to non-target species in weed biocontrol agents.
Ecosystem processes	
Food web interactions are adversely affected by the introduction of new prey species	Adverse effects are conceivable but not expected. Increased plant diversity as Darwin's barberry monocultures break up will increase the diversity and complexity of trophic webs, but effects will vary locally, spatially, and temporally.
Native ecosystems and trophic webs are adversely affected by the introduction of Darwin's barberry rust fungus	Known mycoparasites of rusts are present in New Zealand. It is not known whether Darwin's barberry rust will be susceptible to resident mycoparasites, or whether the outcomes of hyperparasitism would be adverse or beneficial. Given that rust species are common in New Zealand there would only be a small increase from the result of the introduction. The impact on mycoparasite populations would be negligible and therefore we did not consider this a significant risk to native rust species.
Rapid biocontrol leads to erosion, followed by reduced water quality from sediments	Biotrophic rusts debilitate hosts, reducing ability to compete with other vegetation (Morin, Neave et al. 2006). Progressive replacement of Darwin's barberry is predicted, not rapid death of the weed and baring of soil.
Intrinsic value of ecosystems	
No significant negative effects have been identified	See maintenance of habitats
Inherent genetic diversity	
Potential hybridisation with native rust fungi	Not a significant risk as no rust has been found on Darwin's barberry in New Zealand (Waipara, Smith et al. 2005).
Indirect competition causes extinction of native insects	Not a significant risk. No indication that vulnerable or endangered species are associated with Darwin's barberry infestations (Smith, Winks et al. 2004) and any measurable indirect competition would be restricted to the immediate vicinity of the host plant.
Potential adverse effect on Human Health	
Source of potential adverse effect	*Comment*

The rust generates an allergic response	A literature review revealed no reports on fungal biocontrol agents causing allergic reactions. It is possible that long term exposure to high concentrations of spores in confined spaces can potentially induce allergic responses (such as in the case of stored grain rusts). In the case of Darwin's barberry rust, this is deemed very low risk as there are no reports that indicate an allergic response is possible.
Rust need spraying with adverse effects to humans.	Not a significant risk. No predicted large-scale attack on non-target plants.
Potential adverse effect on the Market Economy	
Source of potential adverse effect	*Comment*
Successful biological control reduces revenue for contractors and suppliers.	Not a significant effect. Revenues directly related to Darwin's barberry management are not a key revenue source for many or any contractors or suppliers.
Reduction in strategic spring resources for bees	The rust is expected to reduce the flowering of Darwin's barberry and therefore this adverse effect is real, especially in areas of dense infestations. Currently Darwin's barberry is regarded as widespread and abundant in areas of Otago, Canterbury and Wellington, as well as locally common in Southland, Marlborough, Manawatū-Whanganui, Waikato and Bay of Plenty.
Increased cost of replacing garden ornamentals (other Barberry species)	No significant risk. Rust is specific to Darwin's barberry– no risk to ornamental Barberry species
Potential adverse effect on Society and Communities	
Source of potential adverse effect	*Comment*
Fear and distrust of exotic species and their possible non-target effects	Firmly held opinion in a proportion of the New Zealand population.
Control reduces aesthetic values of Darwin's barberry.	No significant risk. Plant is not strongly valued by public.
Reduction in use of garden barberry species	Rust is specific to Darwin's barberry - no risk to garden species
Fewer seeds available for use in curries	The small supply required for this purpose unlikely to be jeopardized by the introduction of biocontrol agents

References:

Allen, R. B. and J. B. Wilson (1992). "Fruit and seed production in Berberis darwinii Hook., a shrub recently naturalised in New Zealand." New Zealand Journal of Botany 30(1): 45-55.

Morin, L., M. J. Neave, K. L. Batchelor and A. M. Reid (2006). "Biological control: a promising tool for managing bridal creeper, Asparagus asparagoides (L.) Druce, in Australia." Plant protection quarterly 21: 69-77.

Smith, L., C. Winks, N. Waipara, A. Gianotti, J. Wilkie and E. McKenzie (2004). Fungi and invertebrates associated with barberry (Berberis spp.) in New Zealand. Auckland, New Zealand, Manaaki Whenua – Landcare Research contract report LC0405/26: 41.

Waipara, N., L. Smith, A. Gianotti, P. Wilkie, C. Winks and E. McKenzie (2005). "A survey of fungal plant pathogens associated with weed infestations of barberry (Berberis spp.) in New Zealand and their biocontrol potential." Australasian Plant Pathology 34: 369-376.