Environmental Protection Authority
Te Mana Rauhī Taiao

Staff Assessment Report

APP202887: An application to release the arundo wasp (*Tetramesa romana*) and the arundo scale insect (*Rhizaspidiotus donacis*), two biological control agents for the weed giant reed (*Arundo donax*).

November 2016

Purpose	To introduce a gall forming wasp (*Tetramesa romana*) and a scale insect (*Rhizaspidiotus donacis*) to control giant reed (*Arundo donax*)
Application number	APP202887
Application type	Notified, Full Release
Applicant	Northland Regional Council
Date formally received	12 September 2016

Executive Summary and Recommendation

In September 2016, Northland Regional Council made an application to the Environmental Protection Authority (EPA) seeking to introduce the arundo wasp (*Tetramesa romana*) and arundo scale insect (*Rhizaspidiotus donacis*) as biological control agents for the weed giant reed (*Arundo donax*) which is distantly related to native New Zealand grass species.

We assessed the benefits (positive effects) and risks and costs (adverse effects) of introducing the two biocontrol agents to New Zealand and found that the benefits relating to environmental outcomes to be significant and the adverse effects negligible.

We consider it likely that biological control of giant reed will improve biodiversity values and conservation of protected natural habitats. We also consider it likely that biocontrol of giant reed will reduce flooding events and limit extraction of water where native vegetation compete for resources in semi-dry to dry regions. We note that this proactive biocontrol programme could reduce the weed's future effects minimising its distribution into sensitive environments.

We consider it very unlikely for arundo wasp and arundo scale insect to pose risks to native or valued plants in New Zealand. There are no native species in the *Arundo* genus, to which the two insects are host specific, shown in containment and field tests. There are also no other valued species within this genus in New Zealand.

We also evaluated the possible indirect effects of the two agents, including apparent competition, and found it unlikely for arundo wasp and arundo scale insect to have adverse impacts on ecosystems.

The EPA staff assessment report also discusses the effects of the two insects on the relationship of Māori to their environment, and measures the agents against the minimum standards in the Hazardous Substances and New Organisms Act (HSNO Act). We conclude that the arundo wasp and arundo scale insect meet the minimum standards.

Our assessment found the benefits of releasing the arundo wasp and arundo scale insect outweigh any identified risks and costs and recommend that the application be approved.

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1. Purpose of this document

1.1. On 12 September 2016, Northland Regional Council applied to the Environmental Protection Authority (EPA) to introduce the arundo wasp (*Tetramesa romana*) and the arundo scale insect (*Rhizaspidiotus donacis*), to control the weed giant reed (*Arundo donax*) in New Zealand.

1.2. This document has been prepared by EPA staff to advise the Decision-making Committee on our risk assessment for the release of the arundo wasp and arundo scale insect. The document discusses the information provided in the application, information readily available in scientific literature, and information submitted to the EPA during the public notification process.

2. Application process

2.1. Northland Regional Council lodged an application with the EPA on 12 September 2016 seeking approval to release the arundo wasp and the arundo scale insect under section 34 of the Hazardous Substances and New Organisms (HSNO) Act (the Act).

2.2. The application was publicly notified, and open for submissions for 30 working days on 21 September 2016 as required by section 53(1)(b) of the Act. The submission period ended on 3 November 2016.

3. Submissions

3.1. We received eight submissions on this application. The submissions are summarised in Appendix 1. Seven submitters supported the application and one submitter opposed the application.

3.2. We received submissions from Cecelia Martin who opposes the application, Clinton Care, Dr John Liddle (New Zealand Plant Producers Incorporated), Davor Bejakovich (Greater Wellington Regional Council), Holly Cox (Auckland Council), Gerry Te Kapa Coates (Ngāi Tahu HSNO Komiti), David Havell (Department of Conservation) and Philippa Rawlinson (Federated Farmers) who all support the application. None of the submitters explicitly requested to be heard at a public hearing. However, Gerry Coates notes that Ngāi Tahu HSNO Komiti may wish to appear to speak to their submission if a hearing is requested by other submitters. Similarly, David Havell from DOC does not request a hearing to be held, but will be present in support of the application if a hearing is convened. Since no submitter requested that a hearing be held to speak to their submission a hearing will not take place for this application.

4. Submissions from DOC and MPI

4.1. As required by the Act and the Hazardous Substances and New Organisms (Methodology) Order 1998, the Ministry for Primary Industries (MPI) and the Department of Conservation (DOC) were notified of the application and provided with the opportunity to comment.

4.2. MPI did not make any comments on the application.

4.3. DOC supports the application. Their full submission is included in Appendix 2.

5. Giant reed as the target weed

The biology and ecology of *Arundo donax*

5.1. Giant reed is a tall (2 to 10 m) and robust bamboo or reed-like perennial grass. It is native to the Mediterranean and Caspian Basins, Arabian Peninsula and east to the Indian subcontinent (Goolsby, Moran et al. 2016). It is thought to have been introduced internationally during colonisation as an ornamental, for bank stabilisation and as a source of fibre. It can now be found growing throughout the Americas, Southern Africa, South-East Asia, and Oceania including the Pacific Islands.

5.2. Giant reed has a strong root structure, which grows extensively via fleshy carbohydrate-rich rootstocks or rhizomes that penetrate deep into the soil and produce many stems that grow as hollow cane-like stems above ground. This generates large colonies of giant reed plants that directly impact the environment it invades. Giant reed's stems are hard and brittle, with a smooth glossy surface that turns pale yellow (CABI 2015).

5.3. Giant reed is now recognised by authoritative biological invasion resources internationally as a serious global threat to ecosystems. The Global Invasive Species Database, which is managed by the Invasive Species Specialist Group of the International Union for Conservation of Nature, has identified giant reed to be amongst the 100 worst invasive species (GISD 2016). The Centre of Agriculture and Biosciences International (CABI) is an international not-for-profit organisation working to solve problems in agriculture and the environment. CABI comprehensively profiles giant reed in its Compendium of Invasive Species (CABI 2015).

Table 1: Complete taxonomic description of giant reed

Taxonomic Unit	Classification
Phylum/Division	Streptophyta
Class	Lilopsida
Order	Poales
Family	Poaceae
Subfamily	Arundinoideae
Tribe	Arundineae
Genus	*Arundo*
Species	*donax*
Common name	giant reed

5.4. Giant reed prefers growing on or near water but can grow in a variety of conditions, from soils with a water table at or near the surface to moist well-drained soils. It prefers coarse sands, gravelly soils, heavy clays and river sediments, freshwater to semi-saline soils on brackish estuaries, and along the banks of rivers and streams (GISD 2015). The plant takes advantage of wet soil conditions and disperses effectively through its rhizome network into moist environments (Quinn and Holt 2008).

5.5. Giant reed reproduces by way of its rhizome network, which roots and sprouts readily. The plant forms large continuous clonal root masses covering several acres underground which can grow multiple vertical shoots expanding its range (GISD 2015, Quinn and Holt 2008). It is also known to disperse downstream via rhizomes that become dislodged during flood events.

5.6. Giant reed has aggressively invaded riparian habitats in California and Texas (Quinn and Holt 2008, Goolsby, Moran et al. 2016). It is known to establish in field conditions that provide bare ground and sufficient soil moisture. Giant reed is classified as a ruderal species, as it is one of the first species to colonise disturbed land, for example, disturbed water/soil margins following flooding. Giant reed can grow 10 cm per day, which allows the plant to monopolise space and nutrients on exposed flood banks to the detriment of other ruderal plant species following climate events (Quinn and Holt 2008).

5.7. Giant reed's ability to disperse effectively via rhizomes, its broad physiological tolerance to different conditions and ability to dominate entire habitats such as watersheds are attributes that confer the greatest potential to invade new habitats and adapt successfully to changing conditions (Dudley 2000). A meta-analysis of 466 European plant species that were introduced in North America revealed that the time a species has been present in the wild (outside of cultivation), in its introduced range, is a strong driver of invasion success. Additionally, the propagule pressures of a plant in its introduced range (i.e. the number of individuals of a species released into a new area and its growth rates), ecological versatility and tolerance to different conditions are large-scale drivers that support invasive behaviour across different conditions in new regions (Pyšek, Manceur et al. 2015).

5.8. Giant reed has been naturalised in New Zealand since 1936 according to the New Zealand Plant Conservation Network[1], in addition to the plant showing versatility in the types of environments it can grow and tolerance to a variety of conditions in its native range. These factors support the invasive tendencies of giant reed in New Zealand. Many plants that naturalised in the 1920s to 1950s are now being recognised to be highly invasive in specific regions of New Zealand, including pampas grass, field horsetail, old man's beard and privet.

5.9. Landcare Research scientists surveyed the invertebrates that are associated with giant reed at five locations across the range where giant reed is abundant in New Zealand (Winks 2016). There was a limited range and number of native or introduced invertebrates living on or using giant reed for food and shelter. They included slugs and snails, sap-feeding passionvine hoppers and herbivorous species of beetles that did not attribute any significant damage to the plant. Most predatory species were low in numbers, except for spiders and Argentine ants which were recorded in higher numbers across the study locations. No parasitoids were collected during the survey. The results from the

[1] The New Zealand Plant Conservation Network was established in 2003 with the main focus to provide information to protect and restore New Zealand's indigenous plant life and their natural habitats: http://www.nzpcn.org.nz/

survey indicate that there are no specialist or ecologically significant species that would be associated solely with giant reed in our environment. Since there was minimal damage to plants at the study locations we consider that there are also no natural enemies of giant reed already present in New Zealand. Therefore, there are no invertebrates that will be impacted by reductions in giant reed populations. Most of the invertebrate species found on giant reed do not depend on the plant for food or shelter and thus, we conclude that giant reed is not playing an important ecological role in New Zealand.

Impact of giant reed on the environment

5.10. A large-scale assessment of the global impacts invasive plants have on resident species, communities and ecosystems was undertaken in 2012 by scientists from across Europe and New Zealand (Pyšek, Jarošík et al. 2012). This assessment was performed on 167 invasive species across all populated continents. The proportion of significant impacts that invasive plant species had was highest on the outcome factors associated with plant populations, followed by impacts on soil characteristics, and animal populations. The outcome factors that were most significantly impacted by the cases studied were survival of resident organisms, activity of animals, and productivity of communities of organisms. The remaining outcomes included impacts on species abundance, species diversity and capacity to produce offspring (fecundity) by resident organisms, which were likely to be significantly impacted if the invasive species is an annual grass. If the invasive plant is not an annual grass it is most likely to have significant impacts on the surrounding environment if the plant is taller than 4.8 m. Giant reed is a grass, albeit a perennial grass species, and can grow to between 2 and 10 m tall. Giant reed therefore, fits the profile of an invasive plant that would have significant impacts on resident species, communities and ecosystems in introduced ranges.

5.11. It is important to note that the article by Pyšek and colleagues commented on the nature of the impacts that invasive plants might have in their introduced habitats. The impacts could be interpreted as ‘positive’ or ‘negative’ depending on proper assessment of the outcomes of the impacts. Alien species may become important components in their introduced ecosystems by providing ecological services and, therefore, may play positive roles.

5.12. Giant reed’s weed risk was previously assessed by the Department of Agriculture and Fisheries, Queensland Government, and the Institute of Pacific Islands Forestry, US Department of Agriculture, to be of high risk, noting its proneness to becoming highly invasive in riparian habitats (Csurhes 2016, Institue of Pacific Islands Forestry 2013).

5.13. Giant reed poses significant problems to native riparian habitats in North America. Its effects have been documented in a number of studies. Giant reed is known to grow 2 to 5 times faster than native plants, and can invade new areas rapidly and form pure stands. Once established, giant reed can quickly outcompete native vegetation, reduce habitat for wildlife and change ecological processes (GISD 2016).

5.14. In a 2003 study of the effects of giant reed on riparian arthropod abundance and diversity in California, the total number of organisms, total biomass and taxonomic richness of aerial invertebrates associated with native vegetation was approximately twice that associated with giant reed vegetation (Herrera and Dudley 2003). The researchers found that giant reed invasion changes the structure of vegetation in riparian zones which may jeopardise habitat value for birds and other wildlife whose diets were largely composed of insects found in native vegetation.

5.15. Giant reed is known to have contributed to the loss of the endemic Rio Salado darter fish in Mexico because of its ability to inhabit shallow water systems; displacement and reduction of the habitat of the endangered bird species, the Least Bell's Vireo, in California; and displacement of the endangered endemic plant *Echium callithyrsum* found only in the Canary Islands (GISD 2016).

5.16. David Havell from DOC notes in his submission that he has observed giant reed patches covering over 1000 m^2, with one site that DOC administers covering approx. 6000 m^2 (Appendix 2). Mr Havell further notes that giant reed patches cause deep shading due to a combination of the dense core of primary shoots and outer mass of secondary finer shoots forming a closed canopy. He found no evidence of native plant establishment within patches of giant reed examined in Swanson, Puhoi, Henderson and Henderson Valley in the Auckland region.

5.17. Giant reed consumes large quantities of water, as much as approximately 2000 litre per m^2, which is three times the water uptake of typical native plants in Texas (Seawright, Rister et al. 2009). Giant reed is a serious concern in arid and semi-arid regions, such as dune systems, where it outcompetes native vegetation for access to water, lowering water tables (CABI 2015).

5.18. After reviewing available information, we conclude that giant reed has negative outcomes in habitats where it has been introduced, including here in New Zealand,.

Distribution in New Zealand

5.19. The Department of Conservation manages giant reed in at least 10 sites, which are mostly small patches in Northland, Auckland, Great Barrier Island, the Coromandel and along the West Coast. David Havell from DOC notes that most of these giant reed patches occur near roads and rivers, along lakes and in forest areas.

5.20. Northland Regional Council undertook a roadside survey of giant reed populations throughout the region in 2011 and 2012 (Thompson 2012). A total of 306 individual infestations were recorded in Northland totalling an area of approximately 16 ha. Individual infestations ranged from 1.45 to 14872 m^2 (1.49 ha). From the data collected several hotspots of giant reed stands were identified in the Hokianga, Bay of Islands, and the far north near Waiharara where infestations are particularly problematic. Sixty-one infestations within 100 m of protected natural areas and 45 infestations on stream banks were recorded in this survey. Giant reed may have wider distributions in remote Northland areas since this survey was conducted on stands visible from state highway and arterial roads only.

5.21. The infestations near or on riparian habitats are of particular concern to Northland Regional Council since internationally, giant reed has been shown to pose a significant threat to riparian habitats along coastal rivers in southern California, along the Rio Grande in west and southwest Texas and the Rio Grande Basin in northern Mexico (Goolsby and Moran 2009). Giant reed was introduced to the USA in the early phases of Spanish colonisation and quickly became invasive in sensitive habitats. It has shown to be a threat to native plants and animals by forming large stands that pose a wildfire threat. The concern is that it will cause similar issues in protected natural areas and waterways here in New Zealand, if stands that are not adequately controlled by conventional means, continue to grow unchecked.

5.22. Elsewhere, giant reed stands are also recorded by regional and district land territorial managers, including:

- Taranaki, stands size estimated to total 35 m^2
- Auckland region, stands estimated to be between 10 to 6000 m^2 are growing in the Waitakere Ranges and along threatened wetlands ecosystems, including the Massey area in West Auckland
- Horizons district (Horowhenua-Manawatu-Wanganui-Ruapehu) where there are at least 29 sites of giant reed stands known
- Bay of Plenty district, stands are generally less than 100 m^2 found at isolated sites in the western Bay of Plenty
- Hawke's Bay, there are estimated to be at least 200 sites less than 20 m^2 in size individually
- Haast region on the West Coast, where 20 plants are scattered on river banks.

Current strategies to control giant reed

5.23. Giant reed can be controlled using herbicides. Glyphosate, a broad-spectrum herbicide, is commonly used and has proven to be effective against giant reed as it is a systemic herbicide and, when used at appropriate times, translocates to roots killing entire plants (USDA 2009). Fluazipop, a phenoxy herbicide, applied after flowering either as a cut stump treatment or foliar spray has also been found to control giant reed (GISD 2016).

5.24. Doug Foster, Land Manager, Northland Regional Council, noted in the application that it is difficult to obtain good coverage of giant reed, therefore, high application rates of glyphosate are required to provide effective control. He further noted that spraying giant reed stands located next to streams is undesirable.

5.25. Hand-pulling can be effective at removing smaller infestations however, care must be taken that the root system and any rhizomes present should be dug up and removed as well, otherwise the plant will grow back. Burning is not recommended as this has demonstrated to support the successful re-invasion of giant reed (GISD 2016).

5.26. David Havell from DOC notes in his submission to the EPA that amitrol (3-Amino-1,2,4-triazole) and haloxyfop (a methyl ester) can also be used to control giant reed. Mr Havell further notes both herbicides and physical removal can take over ten years as patches of giant reed often contain deep rooted rhizomes and patches can be widely scattered throughout a site. Moreover, these herbicides are ecotoxic to varying degrees to aquatic organisms.

6. Organisms proposed for release

6.1. Northland Regional Council seek to release the arundo galling wasp (*Tetramesa romana*) and arundo scale insect (*Rhizaspidiotus donacis)* to control giant reed in New Zealand.

The native range and biology of the arundo wasp

6.2. The arundo galling wasp is approximately seven millimetres long and widely distributed around the Mediterranean from Turkey to Spain and Morocco (Moran and Goolsby 2009, USDA 2009). Table 2 shows the taxonomic classification of the species.

6.3. Female wasps produce eggs parthenogenetically, which is reproduction without fertilisation as eggs develop into juvenile wasps without being fertilised by sperm. There is a sex ratio bias in emerging immature wasps towards females, which is known as thelytoky, due to the activity of a group of bacteria called *Wolbachia*. These bacteria live inside the cells of female wasps (Floate, Kyei-Poku et al. 2006). Any male arundo wasps that develop to maturity are sterile.

6.4. Femail arundo wasps deposit their eggs inside giant reed shoot tips by probing shoots using its ovipositor. This causes the shoots to start swelling as gall tissue builds up inside the shoot cavity. Galls are abnormal plant growths caused by irritation or stimulation of plant cells due to egg-laying or feeding by insects. Growing wasp larvae feed on gall tissue. There are four larvae instar phases with development completed by the 27th day after oviposition. Adult wasps emerged after approximately 33 days from galls in laboratory studies, however, generation times varied from 26 to 50 days in the lab study. Adult wasps live an average of approximately four days (Moran and Goolsby 2009, USDA 2009).

6.5. A single reproductive wasp can produce 20 to 30 offspring parthenogenetically during its life.

6.6. Short generation times, asexual reproductive capacity and high reproductive output support the wasp's candidacy as a biocontrol agent for giant reed. Moreover, observations in the United States where the arundo wasp has successfully established in regions where variable temperature regimes exist, indicate adaptability in the life cycle of *T. romana* (Moran and Goolsby 2009).

Table 2: Taxonomic description of Tetramesa romana

Taxonomic Unit	Classification
Class	Insecta
Order	Hymenoptera
Family	Eurytomidae
Subfamily	Eurytominae
Genus	*Tetramesa*
Species	*romana*
Common names	arundo galling wasp

The impacts of arundo wasp on giant reed

6.7. Arundo wasps were exposed to giant reed plants and other related plant species in a containment facility in Texas before seeking an approval for release from the United States Department of Agriculture in 2009 (Goolsby, Spencer et al. 2009). Galling of giant reed stems decreased the length of stems by up to 92% in a 12-week study. Insect-induced galls are metabolic sinks, therefore, they compromise the vigour of plant growth. Damage by the wasp caused galls in meristem plant tissue, found at the growing tips of shoots, which resulted in increased branching. Increased branching reduces the height of stems and provides additional oviposition and feeding sites for the wasp and the arundo scale insect, increasing the impacts of the agents on the plant (see 6.15).

6.8. The arundo wasp was approved for release in 2009 in the USA. Releases of 1.2 million wasps occurred from 2009 and by 2012, *T. romana* was established along the length of the Rio Grande River in southern Texas (Goolsby, Moran et al. 2016). Giant reed plant attributes were recorded at ten pre-identified study sites in Texas two years before an approval for release was obtained and again, five years after releases. Above ground, giant reed biomass decreased on average by 22% across the ten sites over five years. Researchers found an increase in dead shoot density and concomitant decline in the percentage of live shoots per study site suggesting that the wasp is reducing recruitment of live main shoots. This is expected to make giant reed stands easier to penetrate physically and visually. Visibility within stands improves light penetration of giant reed canopies. Better light entry into giant reed stands is critical for regeneration of native flora.

The native range and biology of the arundo scale insect

6.9. Armoured scale insects damage plants by puncturing plant tissue with piercing mouthparts, called stylets, sucking nutrients that reduce and deform plant growth (Moran and Goolsby 2010).

6.10. The arundo scale insect is limited to mild Mediterranean climates but was approved for release in the USA in 2010 as a biocontrol agent for giant reed. The first releases occurred in 2011 in southern Texas (Cortes, Kirk et al. 2011).

Table 3: Taxonomic description of Rhizaspidiotus donacis

Taxonomic Unit	Classification
Class	Insecta
Order	Hemiptera
Family	Diaspididae
Tribe	Aspidiotini
Genus	*Rhizaspidiotus*
Species	*donacis*
Common names	arundo armoured scale insect

6.11. Juvenile *R. donacis* crawlers emerge from the body of female arundo scale insects to disperse to new plant tissues. The crawlers settle on leaf collars, stem nodes or rhizomes to probe the tissue with their mouthparts and start feeding. The crawlers moult to a second instar called a white cap. Second instars are immobile and continue to grow. The late second instar female scale is inseminated by mobile winged male insects. The female scale moults to the adult instar and continues to feed and develop before producing a new batch of live juvenile crawlers (USDA 2010). Male crawlers moult to the second instar. At the end of the second instar, they emerge as winged adults at the right time to mate with late instar females.

6.12. Females insects collected from the field in Spain and France produced an average of 85 live crawlers. Peak reproduction from field collections occurred between November and March and scales completed up to two generations per year (Moran and Goolsby 2010). The length of time to complete one life cycle of arundo scale is between 6 and 6.5 months.

The impacts of arundo scale on giant reed

6.13. Feeding by arundo scale crawlers causes a witches' broom effect, a symptom of stress caused by the scales, reducing shoot growth, photosynthesis and thinning of giant reed stands. As giant reed plants lose sap to scale herbivory, leaves are likely to wilt or distort. This reduces the fitness of plants, as the insects are sinks for photosynthates that would otherwise be directed toward plant growth and maintenance (Moore, Watts et al. 2010, Cortes, Kirk et al. 2011).

6.14. Field sites, with and without arundo scale insects, in France and Spain were investigated for effects on giant reed stands (Cortes, Kirk et al. 2011). Rhizomes collected from nine sites with scale insect populations had 46% less biomass compared to rhizomes from sites with no scale insects. The researchers concluded that the reduction in rhizome weight by arundo scale feeding is likely to have a significant adverse effect on the regenerative capacity of giant reed.

The relationship between the arundo wasp and arundo scale insect

6.15. The formation of stem galls by arundo wasps causes proliferation of side shoots that are ideal for colonisation by arundo scale insects (Goolsby, Moran et al. 2009). No negative interactions between arundo wasps and arundo scale insects were observed in greenhouse studies on giant reed biocontrol using the two candidate agents (Goolsby, Spencer et al. 2009). The feeding niches of the wasp and scale insect on giant reed are complementary, therefore, the combined efforts of the insects against giant reed are likely to be additive.

7. Risk assessment

Risk assessment assumptions

7.1. Our assessment of the benefits and risks associated with the release of the arundo wasp and arundo scale insect to control giant reed is based on the assumption that both insects successfully establish in the New Zealand environment and develop self-sustaining populations.

7.2. If the two insects do not establish in New Zealand there is no risk. Conversely, if either or both insects establish large populations, the frequency of potential risks, discussed in our assessment below, increases. At the same time, the benefits will also increase with larger populations since both insects will need to reach high numbers to cause optimum damage to giant reed populations in order to be beneficial. Therefore, an assessment made on full establishment makes it easier for us to determine if the benefits truly outweigh the risks, or *vice versa*.

7.3. We further note that the arundo wasp and arundo scale insect may take some time to establish and build self-sustaining populations; therefore, the effects of the insects on giant reed populations will be gradual at first.

8. Assessment of benefits (positive effects)

8.1. The applicant considers that release of arundo wasp and arundo scale insect would have significant beneficial effects on the environment, market economy, and on Māori and their relationship with the environment, their culture and traditions.

8.2. We have assessed all the benefits but only discuss the effects that we considered to have a significant result, therefore, those effects where the magnitude of the effect and likelihood of that effect occurring is improbable or speculative, are not included in our risk assessment.

Our assessment of the potential environmental benefits

8.3. The applicant identified the following benefits of arundo wasp and arundo scale insect to the New Zealand environment:

- improvement in plant and animal biodiversity in areas where giant reed populations exist in large monocultures because of a decrease in competition with native plant species
- reduction in the spread of giant reed within existing distribution ranges
- limit the development of new giant reed stands, therefore, future-proofing our native biodiversity against expansion of giant reed's range in New Zealand
- reduction in the future risk of giant reed-related flood and infrastructure damage
- limit the water extraction in semi-dry and dry areas where large giant reed populations exist.

Biological control of giant reed is likely to improve biodiversity values and conservation of protected natural habitats in areas affected by giant reed infestation

8.4. The known adverse effects of giant reed on the environment is discussed in sections 5.10 to 5.18 of this report.

8.5. Giant reed is recognised as a threat to native vegetation and indigenous biodiversity values by territorial authorities in Northland, Taranaki and Bay of Plenty, and by the Department of Conservation on public conservation land in Northland, Coromandel, Bay of Plenty, Marlborough and the West Coast.

8.6. Sara Brill, Biosecurity Officer at Northland Regional Council, commented in supporting material to the application that giant reed is common on many streams, coastlines and rivers in Northland. Ms Brill also noted that first sightings of giant weed on Lake Ngatu, which is a dune lake in the far north, were found in 2014. Lake Ngatu is a high value lake and will be compromised if giant reed becomes established in the area.

8.7. Giant reed disperses effectively downstream during flooding events when rhizomes and fragments of giant reed become dislodged (Quinn and Holt 2008). Giant reed is ruderal (5.6) thus it is capable of establishing on bare newly exposed flood banks or similar areas. Its ability to outcompete other ruderal species in these environments makes it effective at monopolising new habitats disturbed by flooding.

8.8. We considered the future effects of giant reed infestation scenarios if giant reed is allowed to grow unchecked in our environment, especially near riparian regions and associated protected natural habitats where weed stands are difficult to control using conventional means. We also considered climate change forecasts to predict future distribution scenarios for giant reed. An increase in temperature is predicted to extend the southern range of plant species that are limited by cold temperatures and increase the altitude at which they can survive. Climate change projections indicate a 2ºC rise in atmospheric temperature by 2090. This change will be gradual and estimated to expand the range of cold-limited organisms by approximately 6km per year latitude or 3.3 m per year elevation (Gerard, Barringer et al. 2013). Therefore, giant reed may have the capacity to expand its range south as temperatures become warmer and cause adverse impacts on riparian and other sensitive habitats it invades. The predicted increase in frequency and magnitude of extreme climatic events is significant as they give giant reed greater oppourtunity to expand its range in the future.

8.9. We consider that the risks giant reed poses to native species are likely to occur. Giant reed's effects are damaging and will continue to be damaging to our native ecosystems and associated organisms (Downey and Paterson 2016) if the weed is not managed using sustainable methods of control and continues to spread unchecked.

Biocontrol of giant reed is likely to reduce the future incidence of flooding events

8.10. Dense populations of giant reed can clog riversides and stream channels by forming interconnecting root mats that can form thick frameworks to trap debris behind bridges, culverts and other structures impeding their function (GISD 2016). Giant reed is known to force waters out of channels and onto banks, bridges and other structures when flooding occurs in areas heavily populated by the plant (CABI 2015).

8.11. The applicant notes that giant reed grows along the banks of the Utakura River which flows into the Hokianga Harbour, in addition to growing along the Mangonuiowae stream, a tributary of the Whangape Harbour north of Hokianga, and the Whangae and Kawakawa Rivers which flow into the Bay of Islands in Northland. Giant reed is also found along the Hokianga Harbour and on the Puhoi River where it flows into the Mahurangi Harbour. The applicant considers that continuing invasion of these habitats by giant reed will modify water flows and siltation rates of harbours and their tributaries, modifying the vegetation landscape in these areas.

8.12. Joseph Camuso, River and Natural Hazards Manager (Northland Regional Council), commented that giant reed can severely restrict flow and cross-sectional areas, especially in smaller streams. Giant reed vegetation can also dislodge from river banks causing debris damming downstream.

8.13. We note giant reed may also have adverse effects on stormwater infrastructure, which may have costly economic implications for territorial authorities to remedy damage or remove obstruction caused by excessive giant reed growth. These costs are separately considered in paragraphs 8.20 to 8.26.

Biocontrol of giant reed could lead to reductions in water uptake by giant reed stands

8.14. The applicant noted that without intervention some riparian habitats in water-challenged eastern New Zealand may become infested with giant reed. Giant reed stands can utilise large quantities of water and this effect is aggravated in semi-arid and arid riparian regions, including sensitive dune systems, compromising native organisms and the ecosystems that support them (5.17).

Biocontrol of giant reed biomass is unlikely to lead to significant reductions in herbicide use

8.15. The extent and use of mechanical and chemical methods to control giant reed varies across New Zealand. Northland Regional Council remove small stands using chain saws to cut back giant reed stems and to allow access to dig out the root systems. Regrowth is sprayed or painted with glyphosate. Doug Foster, Land Management Manager, noted in his submission on the application that this method is impractical, and chemical control is difficult as good coverage of glyphosate is needed to provide adequate control. Therefore, conventional methods, including the use of chemicals, are not widely used especially where giant reed stands are large or in close proximity to water bodies.

8.16. The range of giant reed is expected to increase if the plant is left unchecked in our environment. This may mean that territorial authorities would need to increase their use of herbicides, which could pose threats to organisms exposed to herbicide residues in the environment.

8.17. We consider it **unlikely** that biological control of giant reed by the arundo wasp and arundo scale insect will lead to significant reductions in herbicide use locally, where giant reed grows in sensitive habitats, or nationally, as giant reed does not exist throughout the country. Nonetheless, we note that successful biocontrol may prevent the increased use of herbicides that would otherwise occur if giant reed expands its range.

Conclusion to the potential environmental benefits of biological control of giant reed

8.18. We considered the potential environmental benefits that may occur following the release of the arundo wasp and arundo scale insect in New Zealand and found that it is **likely** that biological control of giant reed will improve biodiversity values and conservation of protected natural habitats, reduce the future incidence of flooding events, and limit the extraction of water where native vegetation competes for resources. We consider the magnitude of the benefits will be **minor** with localised and contained benefits to ecosystems, however, we note that future beneficial effects will be **moderate** where giant reed is successfully suppressed by the biocontrol agents minimising the weed's impact in new habitats.

8.19. We consider the environmental benefits to be **significant**.

Our assessment of the potential economic benefits

8.20. The applicant noted that successful biocontrol of giant reed may benefit the market economy by:

- restoring production losses in crop, forestry or pastoral production where giant reed stands invade these areas
- limiting the risk of future infestations in production land
- reducing the cost of control for land occupiers, regional councils, DOC, infrastructure companies and others.

8.21. We note that no information is available on the impact giant reed has on production values in New Zealand. Internationally, there is also limited information on the economic impact of giant reed in productive landscapes available.

8.22. Giant reed infestation in and around man-made infrastructure and urban environments can lead to incurring costs required to unblock obstructed waterways, and structural damage and hazards when trapped behind bridges and other structures (CABI 2015). Holly Cox (Auckland Council) noted to the applicant that the Stormwater division of Auckland Council control giant reed in drains where it impedes flows.

Costs to control giant reed

8.23. The costs to control giant reed currently vary across different parts of New Zealand. This depends on abundance, classification of giant reed under biosecurity provisions in regional pest management strategies, and available funding.

8.24. An overview of the costs that authorities are paying towards controlling giant reed in their constituencies is submitted as part of the application and made available by Landcare Research.

Our assessment of the economic benefits of the arundo wasp and arundo scale insect to control giant reed

8.25. We consider that there is **likely** to be economic benefits from the release of the two agents in reduced costs to control giant reed. The magnitude of the benefits is considered to be **minor** since the economic impacts of giant reed is still limited in New Zealand, however, we note that if giant reed is left to disperse and grow in our environment in the absence of biological control the costs associated with, and adverse economic effects of, giant reed may become more pronounced.

8.26. We consider beneficial effects on New Zealand's market economy from the release of the two agents to be **low** but their future effects in minimising the costs associated with conventional control may be greater.

9. Assessment of the risks and costs

9.1. The applicant considered that the arundo wasp and arundo scale insect may have potential adverse effects on the environment, market economy, and society and communities.

9.2. We have assessed all the risks but only discuss the effects that we considered to have a significant result. Effects where the magnitude of the effect and likelihood of that effect occurring is improbable or speculative are not included in our risk assessment.

Our assessment of the potential risks and costs to the environment

9.3. The applicant noted that arundo wasp and arundo scale insect would have adverse effects on the environment if feeding:

- reduces populations of native plants (direct effects)
- interferes significantly with trophic webs (indirect effects).

Potential adverse effects on native New Zealand plant species

9.4. Candidate weed biocontrol agents are routinely tested in containment to determine the effects they might have on native or exotic beneficial species once they are released into a new environment.

9.5. Both candidate agents were tested in containment facilities in the United States to ascertain whether they might have any effects on plants other than the target giant reed once they are released into the environment.

Host range testing on arundo wasp and arundo scale insect in the USA

9.6. To test non-target plant suitability to a herbivore, researchers consider the phylogenetic relationship that the target plant has with other plants in its introduced range (Wapshere 1974, Pemberton 2000). Plant species most closely related to the target are expected to be most susceptible to attack. Giant reed is in the Poaceae family, which is known as the grass family (Table 1). The grass family contains economically and ecologically important species. *Arundo donax* falls within the PACMAD clade[2] of subfamilies of Poacaea. In containment testing in Texas, representative species of these subfamilies were included in the host range testing, except for the Micrairoideae which is not represented in North America (Goolsby, Moran et al. 2009, Goolsby and Moran 2009). Representatives of more distantly related subfamilies were also tested in addition to habitat-associated species with which the biocontrol agents may come in contact in areas where giant reed is particularly problematic in North America, e.g. southern Texas. The researchers included a number of economically valuable grasses, including *Zea mays* (maize), *Sorghum bicolor* (sorghum) and *Triticum aestivum* (wheat). Grass species of economic value are in different subfamilies from giant reed, if one disregards the potential of giant reed as feedstock for biofuel production (see 9.33 to 9.37 for potential adverse economic impacts).

9.7. No-choice oviposition and probing behaviour tests were performed. No-choice tests are particularly useful to describe the fundamental host range of a candidate biocontrol agent, since an insect will either attempt to use a non-target plant to feed or oviposit on or die when it is not given a choice when performing those behaviours.

9.8. Observations of host specificity of adventive populations of arundo wasp in Texas were also recorded in the field.

9.9. Host range studies on arundo scale insects in the field in Spain were also performed to determine whether artefacts introduced by containment conditions might have been responsible for minor non-target attack in the laboratory.

Host testing results: arundo wasp

9.10. Arundo wasp was found to be highly host specific. The fundamental host range is limited to the genus *Arundo*. Complete development of arundo wasp was restricted to giant reed and *A. formosana,* which is an uncommon exotic ornamental found in one location in the USA. Giant reed supported significantly more offspring that developed to adult wasps compared to *A. formosana* in the tests. Results showed that arundo wasp occasionally probed 13 non-*Arundo* species of the 34 tested non-target species in containment testing, but no gall formation or development of immature insects occurred. The researchers postulated that probing actions by arundo wasp on non-target plants might be due to chemicals that are similar to the chemicals that giant reed releases, however, tissue in non-targets plants may not be suitable for successful larval development. A further constraint to development of arundo wasp on non-*Arundo* species might be due to the formation of gall tissue. Gall forming insects inject stimulants into plant tissue when they oviposit to lay their eggs. This activity is likely to be restricted to a single species or genus (Goolsby and Moran 2009). The mechanism of gall induction suggests a match between the genetics of the gall-causing insect and the susceptibility to

[2] The PACMAD clade is one of two major lineages or clades of true grasses (Poaceae) encompassing six subfamilies: Panicoideae, Arundinoideae, Chloridoideae, Micrairoideae, Aristidoideae, and Danthonioideae.

gall formation in the plant (Craig, Itami et al. 1993). This suggests that there is a strict relationship between the insect and suitability of the plant for oviposition, gall formation, and immature insect development to adult wasp.

9.11. Adventive arundo wasps were recorded from giant reed populations only in the field in Texas. There was no evidence of gall formation or insect exit holes on other plants that grew in proximity to giant reed stands.

Host testing results: arundo scale insect

9.12. Field studies in the scale insect's native range in Spain and France found *R. donacis* to be specific to giant reed plants (Goolsby, Moran et al. 2009).

9.13. Arundo scale juvenile insects successfully developed to adults on giant reed and the closely related exotic ornamental *A. formosana* in containment testing. Very minor development of scale insect immatures was observed on two non-*Arundo* plants. *Spartina alterniflora* and *Leptochloa* species belong to a different subfamily than giant reed. Survival and development of arundo scale was less than 1% on the two non-targets, compared to a 43% development success rate to adult stage on giant reed. Further testing at higher arundo crawler rates showed that scale insect mortality rates on *Spartina* and *Leptochloa* species, prior to development to adult stage, were greater than 99%.

9.14. The researchers followed up the containment testing with field host range surveys and field exposure tests to determine whether arundo scale could use *S. alterniflora* and *Leptochloa* spp. No arundo scale insects were observed on a *Spartina* species. in Spain where the two species have been growing together for significant lengths of time. Field exposure host tests with potted *Leptochloa* plants placed in proximity to giant reed plants that contained arundo scale insects showed that *Leptochloa* plants were not field hosts for the scales.

9.15. The researchers concluded that no native or agronomic grasses would be at risk from arundo scale insects in North America since it is highly specific to plants in the *Arundo* genus.

The implications of containment testing done in the United States to valued species in New Zealand

9.16. New Zealand has a number of indigenous species in the Poaceae family. None of our indigenous grasses belong to the Arundinoideae subfamily, therefore, there are no native species that are closely related to giant reed (Landcare Research 2013).

9.17. Landcare Research researchers performed no-choice host range testing on three New Zealand native species most closely related to species in the Arundinoideae subfamily (Landcare Research 2016). They found no scales on two of the three native plants with a single scale appearing on *Zoysia minima* which the researchers noted was lost during the testing.

Conclusion on the risk that arundo wasp and arundo scale insect pose New Zealand native plants

9.18. We consider that it is **very unlikely** that arundo wasp and arundo scale pose adverse effects to native plant species in New Zealand since host range testing in containment and observations in the native range of the insects have shown that the two agents are specific to plant species in the *Arundo* genus. There are no native New Zealand species in the *Arundo* genus (Landcare Research 2002-2016). In the Arundinoideae subfamily, common reed or *Phragmites australis* is an exotic species and unwanted organism under the Biosecurity Act. *Phragmites karka* is another exotic species that is present in New Zealand, however, its numbers are limited and became naturalised only recently in 2006[3]. We consider that, in the event any adverse effects to native or valued plants occur, the consequences will be **minimal**. Therefore, we consider potential adverse effects to native plants from the release of arundo wasp and arundo scale insect to be **negligible**.

Potential adverse impact on ecosystem interactions and food webs from the introduction of arundo wasp and arundo scale insect

9.19. We considered the potential of the two candidate agents to have adverse indirect effects on ecosystems in the receiving environment in New Zealand. New insect species may affect predator or parasitoid populations, or change New Zealand's inherent genetic diversity where cross-breeding (hybridisation) occurs between the candidate biocontrol agents and native species.

Apparent competition and ecological analogues

9.20. Apparent competition occurs when two species are preyed upon by the same enemy (i.e. a predator or parasitoid). If the population of a prey or host species increases, an increase in predator or parasitoid numbers may occur which, in turn, could exert elevated pressure on populations of other prey/host species. The introduction of the arundo wasp or scale insect could lead to apparent competition if they are preyed upon by predators or parasitoids which could cause abnormal pressures on populations of native wasps or scale insects.

9.21. The applicant noted that interactions between the candidate agents and predator or parasitoid insects would be mitigated by insect fauna diversity on, and in proximity to, giant reed stands in New Zealand. Both agents have been shown to be specific to giant reed plants in their native habitat and in containment testing, therefore, interactions with other insects would be largely limited to giant reed infested environments.

9.22. A survey of insect fauna associated with giant reed stands in New Zealand was performed by Landcare Research in March/April 2016 (Winks 2016). Thirteen predatory species or groups of taxonomically related predatory species were recorded on giant reed plants. Most predatory species were recorded in low numbers (less than five individuals recorded at study sites) except for spiders

[3] New Zealand Plant Conservation Network: http://nzpcn.org.nz/flora_details.aspx?ID=7661

that were present at all sites, with a total of 72 individual spiders recorded at the five study sites, and Argentine ants (60 individuals collected at one site). No parasitoids were collected during this survey.

9.23. We consider the numbers of predators associated with giant reed in New Zealand to be low, and predator diversity to be small. Contemporary ecological thinking considers that large natural enemy diversity leads to higher pressure on herbivorous insects (Frago 2016). Correspondingly, where lower natural enemy diversities are found, such as on giant reed stands in New Zealand, herbivores will experience less pressure. Moreover, herbivores may also suffer less predation in structured habitats, such as in monoculture giant reed infestations, due to lower encounter rates with enemies and the availability of refuges where insects are safe from attack, such as in galls and rhizomes. The frequency and movement of the two candidate biocontrol agents between patches of giant reed stands may increase encounter rates with natural enemies (Kaser and Ode 2016). This may increase the pressure on native insects that encounter larger numbers of natural enemies, due to the effects of apparent competition, further away from giant reed stands.

9.24. The results from the survey of giant reed stands also showed that the two candidate agents are unlikely to have ‘ecological analogues’ associated with the weed in New Zealand (Paynter, Fowler et al. 2010). An agent is likely to be susceptible to parasitoids in its introduced range if there are native insects that belong to the same superfamily as the agent and occupy a similar niche on the target weed. The survey found a single Asian paper wasp on giant reed plants, which is in a different superfamily to the arundo wasp. Arundo scale insect belongs to the scale and mealybug superfamily and one soft scale insect (an olive scale) was found in the survey. No other scales or mealybugs were recorded on giant reed in New Zealand. The absence of ecological analogues on giant reed plants indicates that arundo wasp and arundo scale insect are unlikely to be attacked by parasitoids in New Zealand if they are approved for release. This adds additional support that the two agents are unlikely to be a source of apparent competition in New Zealand.

9.25. There are natural enemies of armoured scale insects present in New Zealand. They include general and host-specific parasitoids, beetles, mites, earwigs, entomopathogenic fungi and lepidopteran larvae (Henderson 2011). The beetle, earwig and fungi have been used as biocontrol agents against exotic scales that are pests in kiwifruit orchards, but attack rates on pest scales have been varied. Native scale insects are found on native New Zealand host plants only. We consider that these natural enemies of scales in New Zealand will only be found in and around environments where native scale insects live, which would largely be away from giant reed stands.

9.26. We consider that any effects of arundo wasp and arundo scale insect on valued insects in our environment to be localised and site-specific rather than general since habitat complexity and fragmentation away from giant reed stands is likely to mitigate incidences of apparent competition and diminish associated ecosystem effects.

Hybridisation of arundo wasp and arundo scale with valued New Zealand insects

9.27. Hybridisation is the result of sexual reproduction between two animals of different breeds, varieties, species or genera. Hybridisation events between arundo wasp and native *Tetramesa* wasp species and arundo scale and native *Rhizaspidiotus* scale species may compromise New Zealand's native genetic diversity.

9.28. The Checklist of New Zealand Hymenoptera lists *Tetramesa linearis* as the only species of wasp belonging in this genus to be present in New Zealand (Landcare Research 2009). This wasp is present throughout the world, including Western Europe, North America and the Russian Federation (Yu 1997-2012).

9.29. There are no native *Rhizaspidiotus* armoured scale insects in New Zealand, therefore, it is unlikely that the arundo scale insect will cross breed with native scale insects (Henderson 2011).

Potential effects of arundo wasp on bees

9.30. A submitter, Cecelia Martin, has concerns that arundo wasp might attack and kill bees if it is approved for release in New Zealand.

9.31. We consider that the arundo wasp is a solitary wasp and does not swarm, build nests or sting (Elbein 2011). It is a herbivore, therefore, it only attacks and feeds on plants. In the case of arundo wasp, it feeds on giant reed.

Our assessment of the potential indirect adverse effects on the environment

9.32. We consider it **unlikely** for arundo wasp and scale insect to have adverse impacts on ecosystem interactions and food webs. Any indirect adverse effects would be **minor** should they occur since we consider effects to be localised with no discernible ecosystem impact or species damage. Therefore, we consider the effects to be **negligible**.

Our assessment of the potential risks and costs to the economy

9.33. The applicant considered that the establishment of arundo wasp and arundo scale insect could have adverse effects on New Zealand's market economy if:

- damage to non-target plants reduce the value of ornamental plants, concomitantly impacting the nursery industry
- damage to giant reed by the candidate biocontrol agents eliminates the use as a feedstock for bioenergy production
- damage to giant reed significantly reduces the use of the plant as a shelter and erosion control plant.

9.34. We consider that there are no risks posed to any ornamental plant in New Zealand since host testing showed that the two agents are specific to giant reed with potential off-target attack on plants in the *Arundo* genus due to spill-over effects where giant reed and other *Arundo* plants grow in close proximities to one another. There are no valued exotic plants in this genus grown in New Zealand. Dr John Liddle, CEO of New Zealand Plant Producers Incorporated, noted in his submission to the applicant that he does not anticipate any impact on nursery production in New Zealand as a result of the two candidate agents.

9.35. Brian Cox from the Bioenergy Association of New Zealand noted giant reed is not a feedstock for biofuel production in New Zealand. Additionally, giant reed has unwanted organism status under the Biosecurity Act 1993. This means giant reed cannot be propagated, distributed or sold in New Zealand.

9.36. Giant reed was historically used to manage soil erosion and stabilise dunes and river banks. It is the use of giant reed in these areas that led to invasion of sensitive and protected habitats. Where giant reed has proven to be effective at controlling erosion, its adverse effects on the environment outweigh any benefits it might have.

9.37. We consider that biological control of giant reed would not have adverse effects on New Zealand's market economy.

10. Conclusion on benefits and risk assessment

10.1. After completing our risk assessment and reviewing the available information, we consider that the adverse effects of releasing arundo wasp and arundo scale insect to control giant reed are **negligible** and the environmental benefits are **significant** (Table 4). Therefore, our assessment is that the benefits from the release of the two agents outweigh the risks.

Table 4: Summary of our assessment of the benefits, risks and costs associated with the release of arundo wasp and arundo scale to control giant reed.

Potential outcomes	Likelihood	Consequence	Conclusion
Potential beneficial effects on the environment			
Improve biodiversity values and conservation of protected natural areas; reduce incidence of future flooding; limit extraction of water	Likely	Minor Moderate (future effects)	Significant
Potential beneficial effects to the market economy			
Reduce cost to control giant reed	Likely	Minor	Low
Potential adverse effects on the environment			
Risk to native New Zealand plants (direct effects)	Very unlikely	Minimal	Negligible
Risk to ecosystem interactions and food webs (indirect effects)	Unlikely	Minor	Negligible

11. Relationship of Māori to the environment

11.1. The potential effects on the relationship of Māori to the environment have been assessed in accordance with section 6(d) and 8 of the Act. Under these sections all persons exercising functions, powers and duties under this Act shall take into account the relationship of Māori and their culture and traditions with their ancestral lands, water, sites, waahi tapu, valued flora and fauna and other taonga, and the Treaty of Waitangi.

11.2. The applicant engaged with Māori via a Maori Reference Group (MRG) the EPA's national Te Herenga[4] network, and regional consultation with iwi in the Northland area. The EPA's Māori Policy and Operations Team, Kaupapa Kura Taiao, faciliated the applicant's consultation with the MRG and Te Herenga.

Consultation with the Māori Reference Group

11.3. The MRG was made up of four members with expertise and experience relevant to biological control applications. The MRG was established to facilitate consultation with Māori interests that may be impacted by the release of new weed biocontrol agents. The MRG noted that they neither represent their individual iwi or hapū nor represent a unifying voice for Māori interests. The MRG also noted that they will not comment on every application for a new pest control agent but consider the principle level impacts of new biocontrols and provide guidance that should be covered in individual applications.

11.4. The MRG noted that the broad cultural principles that apply to considerations on the introduction of new biological control agents, pest management and environmental protection are Kaitiakitanga[5] and Manaakitanga[6]. The MRG considered that new biocontrol agents pose the potential to both have a positive impact by aiding in the restoration of balance and reduction in environmental degradation, and a negative impact by leading to further disturbance. This, the MRG considered, influence iwi or hapū's ability to 'manaaki' for their whanau and visitors.

11.5. The applicant noted that with reference to the cultural principles identified in the group's report (Appendix 3), the MRG recognised that the proposed introduction of biocontrol agents to control weeds may have significant direct beneficial effects on taonga, and indirectly on the wider native

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[4] Te Herenga is made up of Māori resource and environmental managers, practitioners, or experts who represent their iwi, hapū, or Māori organisation on matters of relevance to the activities and decision making of the EPA.

[5] The responsibility of Māori to manage the natural resources within and beyond their hapū and iwi boundaries for the benefit of future generations.

[6] The ability of iwi, hapū or whanau to 'manaaki' (support and provide for) their people and visitors, which is central to the maintenance and enhancement of 'mana'. It is noted as a key cultural principle and practice, and extends to physical, spiritual and economic wellbeing.

ecosystem. The MRG recommended that applicants should identify the beneficial role that particular biocontrol agents have for iwi and hāpu that may be most directly impacted by the weed and the proposed biocontrol programme. In addition, the MRG recommended applicants to consider how habitat restoration plans and monitoring will be undertaken to determine the long-term effects of new agents. The applicant noted that the MRG considered taxonomic analysis and host range testing to provide a degree of assurance that risk to non-target native organisms is likely to be minimal.

Consultation with Te Herenga

11.6. The EPA furnished Te Herenga with information about weed biocontrol release applications that the National Biocontrol Collective intend to submit to the EPA between 2015 and 2017, including the current application to release the arundo wasp and arundo scale insect. The applicant noted that no responses were received concerning the biological control of giant reed.

11.7. The applicant compiled a list of issues that Māori routinely comment on in weed biocontrol applications. They include direct effects on native plant species (by the introduction of a new biocontrol agent); indirect effects on native flora and fauna, and other valued species (by the introduction of a new biocontrol agent); the need to monitor future effects (following the introduction of a new biocontrol agent); benefits specific to Māori; and the integration of various control methods including indigenous solutions.

11.8. We consider the applicant provided sufficient information to determine the potential effects that arundo wasp and arundo scale insect will have on native or taonga species, ecosystems and traditional Māori values, practices, health and well-being. As noted in 9.18, we consider it very unlikely that the arundo wasp and arundo scale will attack native grass species. We consider it unlikely that the candidate agents will have indirect adverse effects on the intrinsic value of our ecosystems, including displacing native and valued fauna and disturbing food webs and that the wasp and scale insect will not hybridise with species once it establishes in the New Zealand environment (9.32).

11.9. With respect to monitoring future effects of the arundo wasp and arundo scale insect, Landcare Research Manaaki Whenua and the National Biocontrol Collective have developed a national assessment protocol to ensure that long-term monitoring of introduced biocontrol agents is undertaken in a consistent manner. Ecosystem consequences will be evaluated as part of the assessment and this will include measurements of weed abundance and agent population/damage every 5 to 10 years (Landcare Research 2015). This will allow biocontrol practitioners to better monitor future effects. We also consider that an assessment protocol will support the development of our understanding of the long-term impacts of new biocontrol agents on the receiving environment, including the ecosystem and economic consequences.

11.10. The applicant did not identify economic and environmental benefits specific to Māori.

11.11. The applicant noted that there are no known indigenous solutions to combat giant reed. We note that there were no native insects found associated with giant reed that had significant negative effects on the vigour of the weed in a survey of insect fauna undertaken in March/April 2016 (Winks 2016).

Consultation with regional iwi

11.12. The applicant consulted with Māori via iwi and treaty settlement authorities in Northland. The applicant did not receive feedback via this route.

11.13. Landcare Research made a presentation on weed biocontrol to the Ngāpuhi HSNO Komiti and tangata whenua at Mangāiti Marae, Kaeo, in May 2016. Landcare Research noted that they will continue discussions with Ngāpuhi about biocontrol projects and safety of candidate agents in the Northland region.

Submissions from Māori on this application

11.14. The Ngāi Tahu HSNO Komiti commented on the application. Gerry Te Kapa Coates notes that the presence of giant reed on waterways in particular, and conservation land is argued persuasively in the application. He further notes the fact it spreads by plant and rhizome fragments and current methods of dealing with it are to either use repetitive chemical sprays and/or labour intensive removal. Ngāi Tahu has consistently advocated for methods of weed control that have the lowest negative impacts on the environment. They are supportive of methods that will reduce herbicide residues in the environment, and look favourably on methods such as biocontrol, provided the risks of new biocontrol agents are negligible.

11.15. Gerry Coates notes that the benefit of biocontrol agents is that their effects persist and increase over time. He also notes that host range tests performed in the USA and New Zealand provide some comfort that the risk of host shift to non-target native species or plants of economic or cultural importance to be negligible.

11.16. Ngāi Tahu supports the application since it appears that their past concerns of monitoring the outcome of the long term effects of biocontrol agents will be carried out. However, Mr Coates notes that the National Biocontrol Collective endeavours to perform post-release monitoring and measurement of the impacts of the biocontrol insects when appropriate. Ngāi Tahu is requesting for further information about what the qualifier “when appropriate” means.

12. Minimum Standards

12.1. Prior to approving the release of new organisms, the EPA is required to determine whether the arundo wasp and arundo scale insect meet the minimum standards set out in section 36 of the HSNO Act.

Can arundo wasp and arundo scale cause any significant displacement of any native species within its natural habitat?

12.2. The applicant provided information from host range testing and studies in the native range of the arundo wasp and arundo scale insect that the two candidate biocontrol agents are specific to giant reed (9.6-9.18). Therefore, we consider it very unlikely for the arundo wasp and arundo scale to have any adverse effects on native plant species in our environment. We considered the adverse indirect effects on ecosystem interactions, such as food webs, that could occur following the introduction of arundo wasp and arundo scale insect (9.19-9.32). We concluded that it is unlikely the two agents would cause excessive pressure on native insect species through interactions such as apparent competition and cross-breeding in New Zealand.

12.3. The action by the two agents would not result in dramatic declines in giant reed stands. The results of a survey of invertebrates found on giant reed plants showed limited diversity and numbers of species that either live on or use giant reed for shelter or food. Any native species that associates with giant reed plants would be able to use alternative plants for shelter or food when giant reed biomass declines.

Can arundo wasp and arundo scale insect cause any significant adverse effects on human health and safety?

12.4. There are no mechanisms of interactions between humans and the two candidate agents that may cause adverse effects to human health and safety.

Can arundo wasp and arundo scale insect cause any significant adverse effect to New Zealand's inherent genetic diversity?

12.5. There are no native *Tetramesa* wasps or *Rhizaspidiotus* scales present in New Zealand (9.27-9.29), therefore, it is unlikely that the two candidate agents could cross-breed with native species thereby adversely affecting New Zealand's inherent genetic diversity.

Can arundo wasp and arundo scale insect cause disease, be parasitic, or become a vector for human, animal or plant disease?

12.6. Arundo wasp and arundo scale insect are not known to cause disease or become a vector for animal, plant or human disease in their native range. They also do not parasitize invertebrates.

12.7. The applicant noted that the arundo wasp reproduces parthenogenetically due to the activity of bacteria in the genus *Wolbachia* that infect cells in female wasps. *Wolbachia* bacteria have become inseparable organisms to arundo wasps and are transmitted vertically in egg cytoplasm from infected mothers to their offspring. Transmission of *Wolbachia* by males is prevented by the low volume of cytoplasm in mature sperm. Therefore, arundo wasp individuals would be introduced to New Zealand with a population of associated *Wolbachia* bacteria, if approved for release. The potential for *Wolbachia* bacteria to be horizontally transmitted to other organisms the wasp might encounter in its new environment is considered to be unlikely since the barriers to enable horizontal transfer are challenging to overcome (Floate, Kyei-Poku et al. 2006). Horizontal transfer can occur only when *Wolbachia* in cells of the infected host come into contact with, and are incorporated with and survive in cells of, a novel host organism. Furthermore, *Wolbachia* bacteria would only be able to survive and be maintained for successive generations in newly infected host organisms if they are female, if *Wolbachia* colonise germ cells, and if *Wolbachia* bacterial numbers are sufficient in mature and viable eggs to permit transmission to the offspring of the new host.

12.8. Heath and co-authors documented a horizontal transfer route for *Wolbachia* between insect species (Heath, Butcher et al. 1999). *Wolbachia* have undergone horizontal transmission between insect parasitoids because many parasitoids inject their eggs into the body cavity or haemocoel of their host and if the host is a carrier of *Wolbachia*, this may expose the developing parasitoid's stem cells and somatic cells to infection. Stable vertical transmission between new host parasitoids and their offspring would need to occur for *Wolbachia* to spread within a new host population after horizontal transmission. The researchers in this study noted that they have observed loss of *Wolbachia* infection during vertical transmission in novel parasitoid hosts due to asynchrony between the replication of *Wolbachia* bacteria in host cells and oogenesis (creation of egg cells). This has resulted in proportions of host eggs being *Wolbachia*-free and thus not being transmitted to successive generations.

12.9. We consider that the risk of successful horizontal transfer and persistence of *Wolbachia* bacteria in new parasitoid hosts due to vertical transfer to be low due to the barriers that must be overcome. Moreover, we note that arundo wasp will live in and around giant reed stands in New Zealand. We consider that arundo wasp is unlikely to be an important host to parasitoids since it has no ecological analogue in New Zealand and immature arundo wasps would be protected inside galls and giant reed stems (9.20-9.26).

Conclusion on the minimum standards

12.10. We consider that the arundo wasp and scale insects meet the minimum standards as stated in the HSNO Act.

13. Can arundo wasp and arundo scale insect establish undesirable self-sustaining populations?

13.1. Section 37 of the Act requires EPA staff to have regard to the ability of the organisms to establish undesirable self-sustaining populations and the ease with which the organisms could be eradicated if they established such a population.

13.2. We note that the purpose of the application is to release arundo wasp and arundo scale insect and to allow the organisms to establish and develop self-sustaining populations, and disperse to attack its host, giant reed, in our environment. This is the foundation of a classical biological control strategy and therefore we consider that any population of arundo wasp and scale insect will not be undesirable.

14. Recommendation

14.1. Our assessment has found that the benefits of releasing arundo wasp and arundo scale insect outweigh any identified risks or costs. We therefore recommend that the application be approved.

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Appendix 1: Summary of submissions

#	Submitter	Support/ Oppose	Summary of submission
112085	Clinton Care	Support	Requests for care to be taken when the gall forming wasp and scale insect are introduced.
112087	Cecelia Martin	Oppose	Opposes the introduction of more insect life to New Zealand. There is already a serious wasp problem from imported species. Introduced wasps are killing bees.
118844	Dr John Liddle, Chief Executive, New Zealand Plant Producers Incorporated (NZPPI)	Support	The NZPPI does not anticipate any impacts on nursery production in New Zealand as a result of the proposed release of the two biocontrol agents. The NZPPI notes that giant reed is a serious future threat to wetlands, riparian areas and other habitats in New Zealand. The NZPPI endorses proposed biocontrol programmes for use in New Zealand where robust peer reviewed research undertaken elsewhere is applied in New Zealand, without needing to repeat the entire body of work.
119063	Davor Bejakovich, Manager Biosecurity, Greater Wellington Regional Council (GWRC)	Support	GWRC recognises the potential threat this pest plant poses to the greater Wellington region. Giant reed is still noticeably absent from the Wellington region, as a precautionary measure, GWRC supports the proposal to introduce biological control agents to control giant reed elsewhere in New Zealand. With finite resources to control an ever-growing number of problem species, growing expense and public resistance to traditional chemical control, biocontrol is a cost effective and largely publicly acceptable technique.
120346	Holly Cox, Auckland Council	Support	Where giant reed is present in the region it forms monocultures in wetland and stream banks. It has also been found growing in dump sites in parks. Giant reed is saline tolerant so it potentially has not reached its full range. Current control methods are resource hungry requiring frequent follow up. Only a few sites are managed by Auckland Council due to budget restrictions and recently a site controlled in a road corridor by Auckland Transport and a local board led to road and bank subsidence. Having a slower form of control would enable desirable plants becoming established at these sites.
120335	Gerry te Kapa Coates, Ngāi Tahu HSNO Komiti	Support	Ngāi Tahu note that Landcare Research are very experienced in research in the area of biocontrol, and have previously engaged in consultations with Ngāi Tahu on other proposed releases. Ngāi Tahu supports the application as it appears that past concerns of monitoring the outcomes of the long term effects of the two insects will be carried out.

#	Submitter	Support/ Oppose	Summary of submission
120391	David Havell, Department of Conservation (DOC)	Support	DOC submit that the release of the candidate biocontrol agents is very unlikely to have adverse impacts on non-target native species and are likely to benefit natural heritage values through the control of a serious environmental plant pest.
120393	Philippa Rawlinson, Industry Advisor, Federated Farmers	Support	Federated Farmers members report giant reed stands on roadsides or in other areas that make it extremely hard to control or eradicate. Current methods for controlling giant reed are herbicide application and physical removal. Members report these methods to be labour intensive, ineffective and uneconomic. Although giant reed is not currently widespread, it has the potential to spread further afield and become more difficult to control. Federated Farmers support the proactive approach the applicant is taking to control giant reed, before it becomes more widespread.

Appendix 2: Submission from Department of Conservation

Statutory Role of the Department of Conservation

The Department of Conservation (DOC) has a statutory role to protect and advocate for natural heritage which includes native species and ecosystems.

Under this role where the introduction and release of new organisms is likely to have adverse impacts on natural heritage, the Department has a mandate to advocate for natural heritage and oppose introductions of exotic species.

However, the Department also carries out control of pest species to protect natural heritage and supports the development of additional management tools to improve management outcomes where these do not have adverse impacts on the natural heritage values we are protecting and advocating for.

DOC and the National Biocontrol Collective

The Department of Conservation is a member of the National Biocontrol Collective and provides funding support to the collective. The Biocontrol Collective works with Landcare Research to develop biocontrol agents for pests. DOC also provides information on the impacts of plant pests and Departmental weed programmes which may be used in applications to the EPA for the release of biocontrol agents. In general DOC supports the introduction of biocontrol agents where robust research shows the agents will not have an adverse impact on natural heritage and there are benefits for natural heritage from the release of a biocontrol agent. DOC will oppose introductions of biocontrol agents where there is evidence of adverse impacts on native species and ecosystems.

Giant Reed, (*Arundo donax*)

In New Zealand, giant reed forms dense sprawling patches that can extend over large areas, (Photos 1 & 2). I have personally observed patches of giant reed covering over 1000 square metres. One DOC patch is over 6000 squares metres (figure 1, table 1). Examination of giant reed clumps in Auckland found that aerial shoots were at least 5 metres high, and aerial shoots occurred in densities of at least 40 shoots per square metre, many thickets were so dense that shoots could not be counted, (photo 3), and the thickets could not be easily entered. Similar results are found overseas where aerial shoots may extend over 8 to 10 metres. The high density of shoots and corresponding deep shade within giant reed patches is due to a combination of the dense core of primary shoots and an outer mass of secondary finer shoots which form a closed canopy, (photos 2 and 5).

In comparison to adjacent shrub-land – woodland, understorey plants and a ground cover of ferns and seedlings were often absent within giant reed patches, (photos 3, 4, 5 and 6), and giant reed patches had low plant diversity. Photo 1 shows a diverse woody plant fringe and low plant diversity within the giant reed patch. There was no evidence of native plant establishment within 4 patches of giant reed examined (Swanson, Puhoi, Henderson, Henderson Valley).

Giant Reed can grow as high as small trees, for example in the Swanson patch, mahoe and tree ferns on the fringe of reed patches were partially smothered by secondary shoots and aerial shoots of giant reed were as high as manuka/kanuka trees. At Henderson, giant reed was at least twice the height of adjacent revegetation plantings of karamu and manuka.

I have personally observed giant reed occurrence in a variety of habitats from sand dune ridges, (photo 9), river and road margins, ephemeral streams, clearing within bush and bush margins.

Distribution of giant reed patches along Swanson and Puhoi road sides indicates that dispersal can occur at least 40 to 100 metres from adjacent patches. Patches of giant reed within the Uretiti Reserve are at least 500 metres apart, (figure 1a). Twenty scattered plants occurred within the giant reed infestation in the river banks at Hokitika, (figure 1c).

Data obtained from the Virtual Herbarium maintained by NZ herbariums and DOC weed control databases and shown in figure 1b, indicates that giant reed has a wide distribution throughout New Zealand.

Control

Giant Reed can be controlled by glyphosate sprays and glyphosate injected into aerial stems. Amitrol and Haloxyfop can also be used to control giant reed. However, eradication of giant reed patches by both herbicides and physical removal can take over ten years as patches often contain deep rooted rhizomes and patches can be widely scattered through a site. The herbicides listed above are ecotoxic to varying degrees to aquatic organisms. Table 1 lists some giant reed sites and the resources used to control giant reed by DOC staff.

Site	Hectares	Hours	Litres of herbicide mixture used.
Cameron	0.0369	1	4
Wadeston	0.417	6	10
Uretiti 1	0.0338	15 (two years)	33
Uretiti 2	0.4169	8.5 (two years)	34
Paradise	0.0209	9	35
Puhoi	0.673	12	20
Holcim	0.0253	1.5	20

Table 1. Size of site and resources used to control to Giant Reed by DOC staff.

Risk to New Zealand native species from Arundo shoot galling wasp *Tetramesa romana* and Arundo scale-armoured scale *Rhizaspidiotus donacrisa*

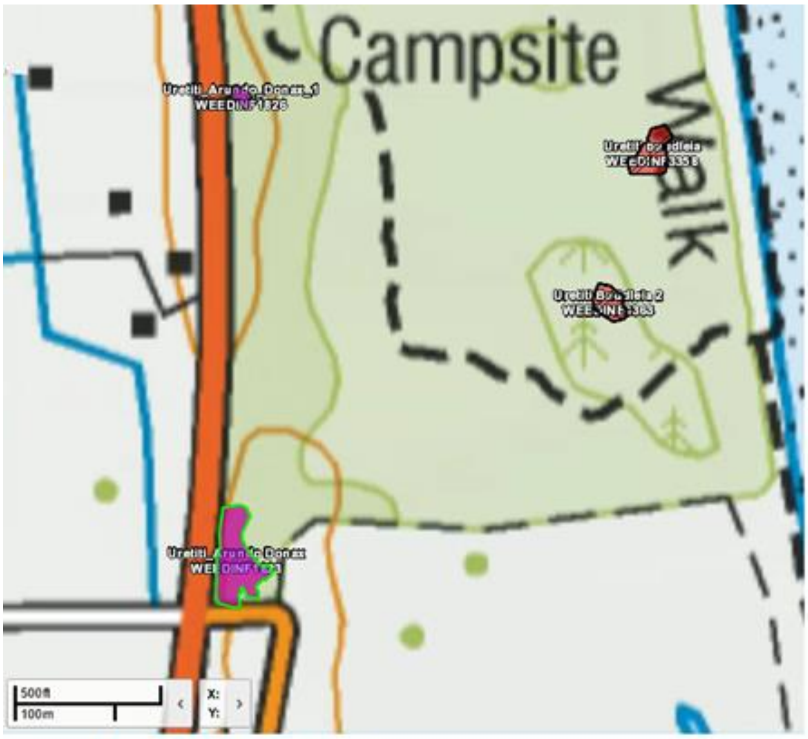
While old classifications place several New Zealand tussock grasses in the genus Arundo, modern classifications place New Zealand endemic and native grasses in different grass sub families and tribes to Arundo. While we are aware that one of the biocontrol agents is a diaspid scale, one of our worst pest insect groups, overseas testing and testing by Landcare Research indicates that both biocontrol agents are highly host specific to Giant Reed. In our view the risk of non-target damage to native species or displacement of native species by either *Tetramesa romana* and *Rhizaspidiotus donacrisa* is very low. The most closely related exotic grasses (Phragmites) to giant reed in New Zealand are serious plant pests. Accordingly, we have no concerns for New Zealand natural heritage or conservation management from the introduction of either biocontrol agent.

Effectiveness of *Tetramesa romana* and *Rhizaspidiotus donacrisa* Biocontrol Agents

Overseas references sighted by us confirm that both biocontrol agents reduce the growth of giant reed.

Conclusion

1. In our experience, giant reed is a serious plant pest, capable of suppressing native plant regeneration, successively competing against native species, and transforming plant communities. Ecosystems such as sand dunes prioritised for national protection are at risk from giant reed.
2. Giant reed has a wide distribution across New Zealand and appears to be adapted to a range of NZ environments, and has some ability to spread. Therefore, giant reed may invade more areas and landscapes within New Zealand.
3. While limited control of giant reed especially small patches is feasible using herbicides, containment especially in warmer and more northern areas is difficult because of species biology of giant reed and the number of sites.
4. For the control of widespread infestations, both biocontrol agents appear to pose less environmental risk than current herbicides.
5. There are no close native plant relatives to giant reed in New Zealand.
6. Hosting testing by both NZ and overseas authorities indicates both biocontrol agents are highly host specific to giant reed. While there was some evidence that other arundo species, spartina, and phragmites species can be utilised by the proposed biocontrol agents these are more closely related to giant reed, (*Arundo donax*) than are native species, and are also pest plants.
7. Both biocontrol agents affect giant reed, reducing growth of aerial shoots, rhizome weight, and photosynthetic activity.
8. There is a benefit to conservation from the release of ***Tetramesa romana*** and ***Rhizaspidiotus donacrisa***.



Uretiti Figure 1a

Puhoi, Figure 1b

Wadeston Island, Figure 1c

Figure 1, DOC Giant Reed Control Actions.

Figure 2. Plot of giant reed distribution data obtained from the New Zealand Virtual Herbarium, (http://www.virtualherbarium.org.nz/home) and DOC weed databases.

Photo 1. Giant reed patch, Swanson. Patch extends over 200 metres, and sprawls down a hill slope.

Photo 2. Giant reed patch, river bank, Henderson, at least 12 metres across, 5m long aerial shoots sprawl out from a central clump, (photo 3).

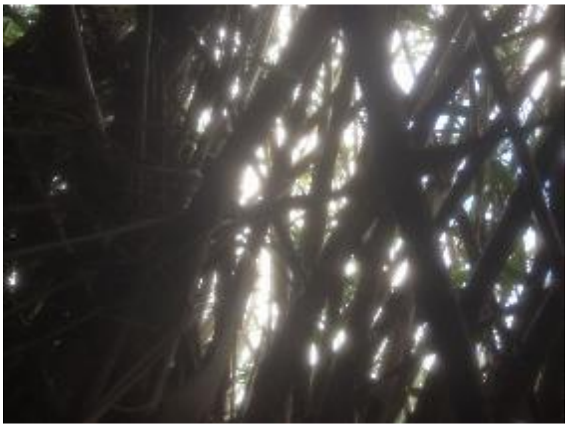


Photo 3a & 3b, Interior of giant reed patch, Henderson. Clumps appear to regenerate through the production of new primary shoots.

Photo 4, interior of Swanson giant reed patch, secondary clump of 11 primary shoots approximately 30 cm across. Transition zone

Photo 5, Giant reed clump, forest fringe, Swanson. Adventitious roots.

Photo 6, Interior of woody fringe, Swanson. Mahoe, tree ferns and hangehange present, giant reed secondary shoots present in the background.

Photo 7, transition zone between forest (right) and giant reed (left) taken from the centre of a giant reed clump, Swanson.

Photo 8, developing giant reed patch within roadside vegetation. Possible parent patch approximately 3 metres in the background behind tree ferns, presumably spread by a rhizome.

Photo 9, re-sprouting giant reed clump, sand dune ridge, Uretiti, Whangarei, weedinf 1823. Annual control.

Appendix 3: Māori Reference Group Report

Introduction

This document summarises some key Māori cultural principles identified by a Māori reference group compiled to consider the suite of proposed biological control agent applications made on behalf of the National Biocontrol Collective by Manaaki Whenua Landcare Research Ltd (Manaaki Whenua). This is not an exhaustive set of principles, and may be developed further as a result of subsequent discussions or applications.

This document may therefore be a source of reference material for future biocontrol applications.

Background

The National Biocontrol Collective includes representatives from 12 regional councils and unitary authorities, and the Department of Conservation. Manaaki Whenua is the primary science provider to the Collective and coordinates many of its application proposals.

As the reference group is considering several potential applications, they will be providing principle level comment on the Māori interests potentially impacted by the release of the biological control agents. Therefore the reference group will not be providing substantive or detailed comment on the issues raised by each application, but rather identifies issues the applicants should aim to address in each application. In addition the reference group has provided some guidance or recommendations to the Collective on how to approach such applications in future in terms of their engagement with Māori and the way they address potential impacts on Māori interests.

Opening statements

The reference group notes that the overall aspiration of its members is to restore native ecosystems, and in the context of biocontrol proposals that aspiration relates to an active reduction in pest plant species. Its members also recognise that only iwi can define what a restored native ecosystem means within their respective rohe or takiwa (tribal area), noting that some exotic species now provide considerable value to different communities (including exotic commercial species).

Reference group members also note that exotic (including pest) species have and continue to arrive in New Zealand as a result of natural migration, accidental introduction and purposeful release. Some of the species that have become pests are the result of purposeful releases allowed either through the absence of regulation, or through inadequate regulation.

In addition, members acknowledge that historically Māori were alienated from significant tracts of land, which were subsequently cleared of native vegetation in favour of alternative land uses often involving exotic commercial and other species. A portion of those alienated lands has now been either returned to iwi or placed under joint management arrangements through Treaty of Waitangi Settlements. Reference group members noted from their own settlement experiences, that often lands are returned in a poor state placing significant burden (financial, cultural and spiritual) on Māori.

Members note that although as Treaty partners both the Crown and Māori have a responsbility to work together to address the impacts of pest species, it is the Crown as the partner responsible for setting regulatory policy, who is obliged to resource such measures.

Finally members acknowledge that established pests cause significant economic, environmental, cultural and social impacts to our unique environment and natural advantage. As one of the tools for pest management, biological control aims to reduce risk and reverse harm from damaging organisms. The reference group fully supports this aim and has provided its comments below in the hope of further advancing continuous improvement across the pest management regime.

Principles

Tiaki - Kaitiakitanga

The reference group acknowledged the well recognised kaitiakitanga responsibility of Māori to manage the natural resources within and beyond their hapū and iwi boundaries for the benefit of future generations.

Members also noted the reciprocal relationship of kaitiakitanlagarga, highlighting the primary principle of 'tiaki'. This principle is expressed as the responsibility of the atua (spiritual guardians) for supporting their offspring or elements within the environment, including tangata whenua (literally meaning people of the land). Some noted the atua provide for their children (including people), rather than people taking from the atua. This reciprocal responsibility is an intergenerational one, that recognises the enduring and interdependant relationship between the environment and its component parts (including people). Unnatural changes (e.g. artificially dispersing species in new areas) disrupt this delicate relationship though if allowed the tiaki – kaitiaki relationship returns to balance where enabled. It could also be argued that the introduction of biocontrol species aims to support enabling the tiaki relationship by dampening down the negative impacts of pest or weed species on ecosystem health.

Recognising this relationship requires Māori to take an extraordinarily long term view, including of making changes to the environment that may have unanticipated implications well beyond our current and foreseable needs. This long term view is difficult to reconcile in terms of individual biocontrol applications. However members consider the work of Manaaki Whenua as primary science provider to many of the introductions, important in terms of maintaining a repository of information and monitoring data in a form accessible by kaitiaki Māori. Such information can inform future introductions, and enable Māori to better understand potentially uncertain disruptions to the tiaki – kaitiaki relationship.

Manaakitanga

Tangata whenua continue to observe their cultural rights and ownership over taonga within the boundaries of each iwi or hapū. One of the key outcomes of kaitiakitanga (explained above) is to ensure the maintenance of balance in the environment to provide for everyone within their region. The ability of iwi, hapū or whanau to 'manaaki' (support and provide for) their people and manuhiri (visitors), is central to the maintenance and enhancement of 'mana'. Often noted as a key cultural principle and practice, manaakitanga extends to physical, spiritual and economic wellbeing.

Members noted that the actions of others (including Crown agencies – who are themselves considered manuhiri or visitors) impact on the ability of tangata whenua to manaaki by modifying and disturbing the balance within the environment. This includes impacting on the ability of Māori to continue to access taonga, or to manage their resources which in turn degrades their wellbeing and inhibits their physical ability to manaaki.

On considering the principle of manaakitanga, members agreed that biocontrol agents pose the potential to both positively impact by aiding in the restoration of balance, and negatively impact by disturbing it further. The recommendation noted above will aid in enabling tangata whenua to monitor this, but will have particular relevance at a regional level. The reference group agreed if appropriate for regional councils and the Department of Conservation to work with iwi and hapū in their areas on pest management strategies that include monitoring impacts in terms of manaakitanga.

Broad biophysical considerations

Kaitiakitanga exists within a mātauranga Māori framework, founded on whakapapa which is a system of ordering and outlining the relationships and interconnections between elements within the natural environment. In accordance with this framework Māori will be concerned to know the anticipated and unanticipated potential impact of the introduction of biocontrol agents across the breadth of trophic and ecosystem levels.

For example.....

The group will expect the applicants to consider these impacts at their broadest level, and to provide comment and/or data to inform that comment. In addition, members felt it important for the applicants to clearly outline the regional existence and extent of each pest weed species. This would more effectively enable hapū and iwi in those regions to consider the potential risks, costs and benefits of specific relevance to them. The absence of this information is likely to inhibit the ability of iwi to provide comment because of the local nature of their kaitiakitanga responsibilities.

Specific impacts to culturally valued species

The reference group recognises that standard host range testing and taxanomical analysis has been conducted, or is in progress, for each of the proposed agents. To date this data provides some assurance that any direct adverse effect from the non-target feeding and hybridisation of native species is likely to be minimal.

In addition, the results indicate there is likely to be significant direct beneficial effect to culturally valued species arising from the reduced health of the weed species. For example in some cases the feeding of biocontrol agents on canopy smothering weed species (e.g. Privet) will lead to significant damage and defoliation opening up the canopy for native regeration beneath. This also has indirect beneficial effects to the wider native ecosystem.

However the research methodology and results do little to address indirect impacts to culturally valued species. In particular the group noted examples of pest weed species now filling potentially beneficial niches for native species arising from the decline or absence of native habitats.

Relevant to the current proposals, reference group members noted that Tradescantia had in some regions replaced native habitats for inanga spawning. Members also noted that at a local level (e.g. Waikato region) that mullet were observed to have been feeding on *Lagarosiphon major.* Reference was also made to the biocontrol agent application previously lodged to manage broom where Te Rūnanga o Ngāi Tahu noted in their submission that broom had become a food source for Kereru. In other instances at the bush margins, weed species were providing valuable nurseries for regenerating native species, though there is now evidence that the regenerating ecosystem will be different to the native predecessor.

Members were concerned that these indirect effects required closer scrutiny to identify whether pest weed species had replaced native habitats in supporting native species. However members also noted a clear preference for native habitats rather than relying on exotic replacements, particularly recognising that the exotics posed the risk of complete displacement over time. With this in mind members noted that without committment to targetted native restoration plans, the viability of local populations of culturally valuable species such as inanga and mullet could be placed at risk.

Recommendations:

1. That Manaaki Whenua and/or other research providers, maintain information and monitoring data in an accessible form for kaitiaki Māori.
2. That regional councils and the Department of Conservation work with iwi and hapū in their areas in the development and implementation of pest management strategies that include the identification and monitoring of impacts to manaakitanga.
3. That the applicants map the existence and extent of each pest weed species in each of the applications so Māori are able to consider impacts at their specific rohe level.
4. Section 36 of the HSNO Act requires decision makers to consider a set of minimum standards which includes consideration of any displacement of native species from their natural habitat, or cause any significant deterioration of natural habitats. In accordance with this requirement, the reference group considered the need for applicants to provide comment on, or model the potential broader trophic impacts of introducing each biological control agent. This is consistent with a kaitiakitanga framework and would better enable Māori to provide comment from that perspective.
5. That applicants continue to provide information in each of the applications about the potential beneficial role each pest weed species may have for local populations of native species.
6. That applicants provide comment on any native habitat restoration plans of relevance that would manage the depletion or removal of weed species providing beneficial effects to native species.

Regional / rohe based priorities informing national decision making

Reference group members were clear from the outset of this process that they are not participating in the group as ‘representatives’ of their individual hapū or iwi. Instead they were appointed because of the skills and experience they bring to the discussion. However, as locally and regionally based kaitiaki it became apparent through the course of discussion that bringing local and regional issues and priorities to a national forum could be both beneficial and challenging.

Benefits arise from the provision of information based on the intergenerational observation of the natural environment at a local level. These observations are valuable to decision makers to ensure they have the best available information, and are fully informed of the potential impacts to Māori interests. Challenges arise when you bring that locally based information together and then assess and weigh it through a national lens.

This is problematic because iwi and hapū provide their experience and knowledge in good faith on the assumption that it will be assessed and weighed in a manner consistent with their tikanga and their locally based priorities. For example Waikato iwi may give greater weight to indirect adverse effects to Tradescantia which provide inanga spawning grounds than other iwi or Councils who give greater weight to the adverse effects posed by Tradescantia.

The reference group acknowledged that most of the Regional Councils would have specific relationships with hapū and iwi in their regions (some required by settlement statute). The Councils should also have some understanding of the interests and concerns of those iwi of relevance to the weed species and biocontrol agents subject to the proposed applications. Members requested that the applicants include available information of this nature in the applications, in order that at a local level hapū and iwi can more readily comment through submissions. The reference group also noted that the Council and Department members of the Biocontrol Collective recognise the value of their individual relationships with iwi and more proactively work with them to prioritise its work programme moving forward.

Recommendations

7. That the applicants consider including information about hapū and iwi interests and priorities relating to the proposals at a regional level to provide context for decision makers so appropriate weight can be attributed to risks, costs and benefits. The reference group is aware that some iwi have planning and pest management priority agreements or relationships with Councils that could provide a useful source of this information.
8. That the Biocontrol Collective, through their Regional Council members, work more proactively with hapū and iwi in their regions to better understand their interests and priorities so they can be effectively incorporated in future work programmes and applications.

Treaty Issues & Settlement Principles

Reference group members noted frustration at the use of Court defined Treaty principles in risk assessments, rather than mutually agreed principles between the Crown and iwi in Settlement negotiations. Given the increasing number of Treaty settlements it is difficult to assess each application at a national level against regionally defined and agreed Treaty principles so members accepted the need to use well defined and nationally referenced principles in national decision making. Applicants will need to consider collating those principles through their engagement with applicants.

However members also noted that many Treaty settlements include or result in agreements with local pest management agencies including councils and Department of Conservation. Members were keen that when engaging with Māori on future applications, the members of the biocontrol collective work with the iwi and hapū in their area to ensure recognition and assessment of impacts against appropriate Treaty principles and provisions.

Recommedation:

That biocontrol collective members work with the iwi and hapū in their respective areas on the development of future biocontrol applications to ensure recognition and assessment of impacts (both positive and negative) against appropriate Treaty principles and provisions.

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1. That biocontrol collective members work with the iwi and hapū in their respective areas on the development of future biocontrol applications to ensure recognition and assessment of impacts (both positive and negative) against appropriate Treaty principles and provisions.

Environmental Protection Authority
Te Mana Rauhī Taiao

New Zealand Government