Meeting Target Eight: *Rhododendron subgenus Vireya* in New Zealand as an example of *ex situ* conservation.

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Abstract

Target Eight of the Global Strategy for Plant Conservation requires knowledge and management of Red List species in cultivation, but what are the practical issues and difficulties associated with such *ex situ* management? Rhododendron is not native to New Zealand, but preliminary data indicates species are present in large numbers in collections and botanic gardens, and many of these accessions are of known wild-source. Following the Red List workshop in Singapore in 2008 it became apparent that New Zealand holds a considerable number of Red List species, particularly *Vireya* species, some not otherwise known in cultivation, and many of wild origin. This resource appears to have potential for *ex situ* conservation, and we are investigating this issue with a three part study. A survey of collections reinforces the role of the Pukeiti Rhododendron Trust collection as the major collection of *Vireya* species (about 160), but also highlights issues around nomenclature, recording and labelling. A DNA fingerprinting study is showing the extent of variation among different accessions, and therefore the usefulness of the collections in conservation. At the same time this study will inform some of the taxonomic issues within the Vireya group, which in turn influence conservation action and priorities. The data from these two studies will then be used to propose conservation action and priorities. This paper will outline our investigation into the potential of New Zealand collections of *Rhododendron subgenus Vireya* for *ex situ* conservation.

Keywords: Rhododendron, Vireya, Conservation

Introduction

The principles and theory of *ex situ* conservation have been recognised for many years (Given, 1987) and the use of this form of conservation is now accepted as part of an overall approach (Geurrant et al., 2004; CBD, 2002). In recent times Targets 2 and 8 of the Global Strategy for Plant Conservation have brought *ex situ* methods in to focus as those targets generate Red Lists (Target 2) and then search for those species in cultivation (Target 8), so that the germplasm may be used in conservation plans. Plant conservation remains an urgent problem (CBD, 2006) and every revision of the Red List increases the number of species at risk and, at the same time, we know that botanic gardens and plant collections around the world contain thousands of plant accessions. How applicable are those accessions to the conservation problem and do they have any useful role in *ex situ* conservation? In this paper we explore *ex situ* conservation in relation to collections of *Rhododendron* subgenus *Vireya* in New Zealand and relate this to the recently conducted Red List assessment for that genus (BGCI, 2008).

Principles of *ex situ* conservation

In 1987 Given (1987) considered *ex situ* conservation as a component of an overall conservation approach and suggested that it had several functions:

- Insurance against loss in the wild.
- Preservation of genetic diversity and genetically different forms.
- Provision of material for research and assessment.
- Educating public and community about the importance of conservation.
- Provide plants for exchange and re-introduction.

He also recognised the difficulties and suggested that the value of *ex situ* collections for conservation was negated by inadequate genetic variability in collections, pest and disease problems, poor commitment to conservation, lack of coordination between gardens, and inadequate record keeping and documentation. He outlined what he saw as institutional and structural barriers to *ex situ* conservation such as poorly defined mission, poorly formed collections policies, and lack of coordination between institutions. He believed a framework for *ex situ* conservation was needed that could address the size of the problem, the balance between *in situ* and *ex situ* methods, the necessary understanding of plant populations, and a process for areas where the flora had not been studied.

Many of these difficulties remain today and debate continues about genetic representation, pest and disease problems, invasive species, and sampling and documentation (Anon, 2010; Anon, 2007; Dosman, 2006; Ennos et al., 2005; Guerrant et al., 2004; Given, 1987; Heywood, 2010; Maunder and Byers, 2005). Maunder et al. (2001) highlighted *ex situ* problems in their study of threatened European flora in botanic gardens in Europe, where they found the majority of taxa concentrated in a small number of collections, very few wild-source accessions, and poor documentation of those collections. Do these problems occur in other countries and with other plant groups? How do we overcome such limitations to improve the usefulness of such collections?

In other aspects of *ex situ* conservation, significant progress has been made through the framework of the Global Strategy for Plant Conservation (CBD, 2002) and its forthcoming update (Anon, 2010), and through international associations like the Species Survival Commissions and Botanic Gardens Conservation International (BGCI) who facilitate documentation, research, and collective effort through their networks (Wyse-Jackson and Sutherland, 2000). BGCI is running a programme of Red List assessments under Target 2 of the Global Strategy (Gibbs and Chen, 2009; Cicuzza et al., 2007; Oldfield and Eastwood, 2007) and is also developing an extensive database to facilitate Target 8.

New Zealand plant collections and international Red List species

It has been estimated that New Zealand contains around 40,000 taxa of exotic plants in cultivation (Carver et al., 2007; Parsons, 2009) – which vastly outweighs our approximately 2800 native taxa. Approximately 2200 naturalised taxa have been recorded (Webb et al., 1988) but the bulk of cultivated flora are inadequately documented in government datasets and national herbaria (Parsons, pers.comm., 2009). The Ministry of Agriculture and Forestry “Biosecurity Index” lists some 27,000 taxa but this is acknowledged as only a partial description of cultivated flora (Parsons, 2009) and comparisons indicate that it covers ½ to $^{2}/_{3}$ of taxa present in collections (MacKay, 2008, 2005). A Plantfinder describes some 30,000 taxa in commercial trade (Gaddum, 2000), but commercial trade does not cover all taxa present in collections (MacKay, 1996). Thus there is no comprehensive description of cultivated flora in this country and there are many unrecorded taxa in collections.

Studies of exotic woody flora in New Zealand reveal about 12,000 taxa in about 120 plant collections and about 80 sources in commercial trade (Cliffin, 2001; MacKay, 2005; MacKay 1996; MacKay, 1995; Smith 1983; Smith 2009). There is a wide diversity of woody taxa in collections, with only partial overlap between collections and trade, and with the most significant collections on private or Trust properties, not in government institutions. The temperate tree collection at Eastwoodhill Arboretum and the conifer collection at Torwood Arboretum are two examples. (New Zealand does not have government-funded botanic gardens, sites such as Christchurch and Dunedin Botanic Gardens are run by local authorities – thus we do not have a 'botanical infrastructure' like most other countries.) Some of the studies considered Red List species, with varying numbers of taxa found, including wild-source material (Brockerhoff et al., 2004; Jamil, 1998; MacKay, 1996). A 2005 study examined 238 genera using the World Conservation Monitoring Centre database and found 952 Red List species in New Zealand collections, concentrated in certain genera (MacKay, 2005), suggesting that New Zealand collections may have some potential for conserving some groups. *Rhododendron* was not included in those studies, nevertheless about 1200 taxa, including about 250 taxa of species or subspecies rank, were picked up in those surveys (MacKay, 2005, 1996, 1995). Major *Rhododendron* collections had not been considered so there were clearly more *Rhododendron* taxa present, and some of those were rare in cultivation (Smith, pers.comm. 2007). It appeared that New Zealand collections may have potential for conservation (MacKay, 2008a) and the draft Red List for vireya provided a framework to examine the resource in New Zealand.

***Ex situ* conservation and Vireya Rhododendron**

Rhododendron is a large genus of some 1250 species which is broadly divided into about 900 temperate species, largely found in mainland Asia, and about 350 subtropical species of the *vireya* subgenus which are found in various countries throughout the Malesian archipelago and into northern Australia. Most of the *vireya* group are shrubs, many epiphytic and from high altitude regions. A high level of endemism coincides with occurrence in countries where habitat loss and deforestation are problems, yet only three species had previously been Red Listed (BGCI, 2008).

Conservation of *Rhododendron* is being addressed by BGCI, initially with a Red List assessment of the genus, as part of their programme of assessments under Target 2 of the Global Strategy for Plant Conservation. The draft Red List (BGCI, 2008) suggests that of the 373 species in subgenus *Vireya*, 187 are likely to be Red Listed in some form. This assessment prioritises species and focuses studies for Target 8; to find those species in cultivation and use that data in conservation planning.

Conservation of this genus, however, is confounded by taxonomic complexity. If species A is Red Listed, but is not clearly distinguished from species B, should species B also be subject to conservation action? Or, can species A be omitted from conservation action because it is not distinguishable from the more common B, and the larger population of B does not need conserving? *Rhododendron subgenus Vireya* is taxonomically complex with division into 11 series, and frequent groups of subspecies. Many species fit neatly into a series, but others do not, and there are many queries over the relationship between species, and sometimes between series (Argent, 2006). Ennos et al. (2005) argue that the conservation approach should be different (broader) with taxonomically complex groups – potentially having a huge effect on conservation action for Vireya Rhododendron.

Fortunately taxonomy of *Vireya* is comprehensively covered in recent monographs (Argent, 2006; Argent et.al., 2007) where each species is described and taxonomic issues and queries are outlined; giving a taxonomic framework for further research. Molecular studies provide some insights, for example, a proposed relationship between *R. loranthiflorum* and *R.luralense* (Argent, 2006) was supported by molecular work (Brown et al., 2006). Other molecular work suggests that some series should be amalgamated (Brown 2006, 2006a), or that some *vireya* series may be more closely related to mainland temperate species (Craven, 2008). These molecular studies suggest some likely revision of relationships, but those studies do not cover all the taxonomic queries raised by the classical studies. Thus we have a subgenus of about 370 species with many unresolved taxonomic complexities that may, or may not, impact on conservation action.

When resources are scarce conservation action must be focussed on the most important species and with the best possible germplasm. The draft Red List establishes an initial priority for *Vireya Rhododendron*, but to which accessions of which taxa in which collections should this be applied? New Zealand collections appear to have some potential, but do they contain species and accessions that are useful? How will plans be altered by the taxonomic complexity of the group? Our study of New Zealand collections will illustrate some of these issues.

Method

To examine the potential role of New Zealand collections of *Vireya Rhododendron* in conservation we propose five steps:

- Examination of the Red List and establishment of initial priorities indicated by that data.
- Determination of the range and distribution of species in New Zealand collections.
- Examine the taxonomic issues and queries associated with Red List species, to establish a priority set of species for testing.
- Molecular testing of those species, using samples from New Zealand collections.
- Interpretation of data and proposal for conservation action.

The draft Red List sorts taxa into greater and lesser priority, but other issues may be evident from examination of the list. How many species were Red Listed? What level of conservation problem does this represent? Did species from a certain region dominate? The draft Red List was examined for geographic or taxonomic patterns and compared to other recent Red Lists. For this analysis some modifications were made to the list to take account of species that had been omitted from the list, so BGCI's base list of 345 taxa was increased to 373 taxa. The Singapore workshop did not complete the assessment of the entire list, so for this analysis the principal author has made an estimate of which of the remaining species are likely to be Red Listed.

The second step was to characterise the *Vireya* resource in New Zealand. Previous studies had not focussed on *Rhododendron* in either collections or commercial trade, so additional data was needed. Over 2008-2009 Smith completed a database of the collection at Pukeiti Rhododendron Trust (Smith, 2009). In 2009 data was gathered on other *vireya* collections – of about 12 relevant collections we were able to gather information from five of them. The others were inaccessible for various reasons, but it is likely that most of the species they contain are in the Pukeiti collection (Smith, pers.comm.). Next, five additional commercial trade sources were added to existing data. From these data the range and distribution of *Vireya Rhododendron* in New Zealand could be described.

Next we addressed the interplay between conservation and taxonomic complexity. Consider the example of Red Listed species in the *Phaeovireya* series. If we conserve *R. bryophilum* (Red Listed) should we also conserve *R.dielsianum* which was not Red Listed but which is difficult to separate from *R.bryophilum?* If we conserve *R.superbum ssp. ibele* should we also conserve *R.gardenia*, which was found in the same location but then never found again, but similar plants key to *R.superbum*. And what of *R.helwigii* which hybridises with *R.superbum* and may have some relationship to it, or *R.inundatum* which also hybridises with *R.superbum*, but *R.inundatum* is in another series. Perhaps all four are more closely related than previously thought, perhaps not, but the best conservation plan will come from being sure about those relationships (Table 1).

Relationships and queries of this nature occur throughout the *vireya* subgenus (Argent, 2006), so diagrams and tables were created in which these factors for each series and Red List species were shown. Those diagrams were reduced to the subset of species that are in New Zealand, thus focussing the selection of species for further testing (Fayaz, 2010). Molecular methods are being used to examine those species (Fayaz, 2010). 132 tissue samples were collected from four collection sites and DNA extracted used a modified Kobayashi method (Kobayashi, et al., 1998). A further 18 samples were obtained from the Rhododendron Species Foundation in United States of America. RAPD analysis (Random Amplified Polymorphic DNA) was used for preliminary tests of DNA quality and this method was used to form a benchmark set of *R.jasminiflorum* samples which were used as comparison in later analysis (Fayaz, 2009). The samples are now being tested with 27 SSR (Simple Sequence Repeat) or microsatellite markers, which have been kindly contributed by Ben Hall (University of Washington) and Frank Dunemann (Bundesforschungsinstitut für Kulturpflanzen, Dresden, Germany). This work is still in progress (Fayaz, undated) but some preliminary results are presented.

Results: the draft Red List

Of 373 taxa of vireya Rhododendron, 187 (50.1%) were Red Listed in some form (BGCI, 2008). Of the 187 rated species, 99, or 52.9%, were given a Data Deficient rating indicating that additional study is needed to clarify the status of these species. About two thirds of rated species come from the islands of New Guinea (86 species) and Borneo (33 species) with the rest from other locations in Malesia (Table 2). The largest number of Data Deficient species came from New Guinea (61 species) whereas Borneo had only 4 species with that rating. Sulawesi (Indonesia) has fewer species, but 69% were Red Listed, as were 69% of mainland species.

Next, given the taxonomic complexity issue, do Red List species occur evenly among the 11 series of the subgenus? (Table 3). The greatest number of rated species were in *Euvireya: euvireya, Euvireya: malesia*, and *Phaeovireya*, but by percentage the worst problem is in *Euvireya: linnaeopsis* with 60% rated - which highlights a geographic issue as this series is solely from New Guinea. *Siphonovireya* (45% listed) is also solely from that island and *Phaeovireya* (46% listed) has all but two species from there, so a geographical issue potentially threatens a whole taxonomic group. *Pseudovireya* at 60% listed also indicates a problem, but most of these are Data Deficient due to inadequate knowledge of mainland species. *Discovireya* was 'best' with only 35% listed, and this series has a wide geographic spread so the conservation issue is less in this group than some others.

These figures appear to indicate an enormous conservation problem but how does this relate to other recently assessed groups? Both *Acer* (Gibbs and Chen, 2009) and *Quercus* (Oldfield and Eastwood, 2007) are comparable to *Vireya Rhododendron* with about half the taxa Red Listed (Table 4), but Magnoliaceae is worse with 87% of taxa Red Listed (Cicuzza et al., 2007). *Acer* and *Quercus* had about a third of rated taxa designated Data Deficient, indicating the need for additional research. In contrast, Magnoliaceae had only 7.6% of taxa rated Data Deficient; so while that group has a conservation problem it is a relatively well-understood problem. *Vireya Rhododendron* stands out from these other groups with the high percentage of Data Deficient rating.

Some geographic trends were also evident in the other assessments. In *Acer* 87% of listed species were from China and other countries in Asia. In Magnoliaceae the split was about 50:50 between Asia and South America, while in *Quercus* about half the listed species came from Mexico and South America, and another third from Asia. These patterns do not equate with the geographic origins of the genera – both *Acer* and *Quercus* are found in Asia, Europe and the Americas but the Red List species were concentrated in Asia and South America. By contrast, in *Vireya Rhododendron* both geographic origin and the conservation issue are focussed on one region, Malesia. When this is combined with the number of species Red Listed and given Data Deficient, *Vireya Rhododendron* appears to have a conservation problem more acute than other recently assessed groups.

Results: *Vireya Rhododendron* species in New Zealand

In total we found 158 taxa of species or subspecies rank of which 63 are of known wild source, and 44 are likely to be Red Listed. The largest collection was that of Pukeiti Rhododendron Trust which contains about 155 taxa of species or subspecies rank, plus three natural hybrids. Using the BGCI database as a measure of international frequency, 128 of the 158 taxa were found in three-or-less collections (noting that this database does not cover the Pukeiti collection), indicating that there are few other collections of *vireya* world-wide.

Geographically, our collections reflect the distribution of the subgenus, with the majority of taxa coming from the island of New Guinea (67 taxa) and then the island of Borneo (39 taxa). The better representation is Borneo with 56% of those taxa present in our collections (Table 5).

When considered by series the greatest number of taxa found in New Zealand are from *Euvireya:euvireya, Phaoevireya, Euvireya:solenovireya*, and *Euvireya:malesia* (Table 6). When species not in cultivation (Argent, 2006) are removed from the list, our collections contain about 65% of taxa in cultivation, but this varies with different series. We have 80% and 79% of *Albovireya* and *Phaeovireya* respectively, down to 45% of *Discovireya* and 37% of *Malayeovireya*.

When the data are reduced to just the Red List species, our collections contain 44 taxa or about 24% of Red Listed *Vireyas*. While there are 63 species of known wild source, only 12 are both Red Listed and wild sourced. The greatest number of Red List species in New Zealand are from *Euvireya:euvireya*, followed by the *Euvireya:solenovireya*, *Euvireya:malesia* and *Phaeovireya* groups. By percentage the *Albovireya* group is noted as we have 37.5% of Red Listed species from that group (Table 7).

Geographically our collections have the greatest number of species from New Guinea, Borneo and then Sulawesi. By percentage Borneo is followed by Philippines and then Sulawesi (Table 7). These data must be read with caution though as species have been assigned to one geographic location when some come from more than one place, which would vary these figures.

With respect to Red List species the taxa in our collections follow the patterns of the subgenus with greatest representation from *Euvireya:euvireya, Phaeovireya, Euvireya:solenovireya, Euvireya:malesia*, and geographically on the islands of New Guinea and Borneo.

Results: molecular studies

The segment of the study is still in progress and only preliminary results are available at this stage. Samples have been tested with about 20 of the 27 available microsatellite markers and these data are presently being processed. Some preliminary findings (Fayaz, 2010, undated) are as follows:

- RAPD analysis indicates that *R .jasminiflorum* and *R. jasminiflorum ssp. oblongiflorum* are distinct entities rather one continuum. If the *R. jasminiflorum* subspecies are distinct this may have conservation implications for *R. jasminiflorum ssp. copelandii,* which was Red Listed, but we were unable to test this species as we do not have it in New Zealand.

- Analysis of data from 6 microsatellite markers supports a close relationship between *R. loranthiflorum* and *R. luraluense*. This is potentially important as *R.luraluense* was Red Listed and *R .loranthiflorum* was not.
- Microsatellite data suggests that *R. lochiae* (syn. *R. notiale*) is distinct from the closely related *R. viriosum*, but at the same time there appears to be a gradation of types within the *R.viriosum* samples. Again this may be important as *R.lochiae* was Red Listed and *R.viriosum* was not.
- Microsatellite data suggests a relationship between *R.archboldianum* and *R.herzogii* (which is in different series), supporting Argent's proposition that there is a relationship between them. *R.archboldianum* was Red Listed while *R.herzogii* was not.

The conservation implications of the molecular data are yet to be fully understood as the data is not yet complete. When these data are fully processed relevant results will be reported.

Discussion

This work shows that New Zealand, and more particularly Pukeiti Rhododendron Trust, contains a significant collection of *vireya rhododendron*. There are 158 taxa, including 44 Red List taxa and 63 taxa of known wild-source, although there are few accessions of some of those taxa. Variability among the accessions is yet to be finalised through molecular testing. There were no other collections of any comparable size in New Zealand, thus important collections are concentrated on few sites with limited accessions. This problem of limited accessions has long been recognised (Given, 1987; Maunder et al., 2001), and Target 8 stresses the need for genetic representation (Anon, 2010), but what are the solutions? Gathering more accessions from native habitat is unlikely to be feasible for most species, so the answer must lie in greater international integration between collections. In this example exchanging material between Pukeiti Rhododendron Trust and other international collections would improve representation in all collections – unfortunately plant importation into New Zealand is very difficult under current legislation (Douglas, 2005), but exportation to other sites is possible.

Although our data shows limited accessions, this problem can be restated as limited accessions in the recorded collections. Of the approximately 12 *vireya* collections in this country another four may contain different material, but we could not access these: one was dispersed without documentation, in another the owner passed away and the new owner has no documentation, in another the owner has also passed away, and in a fourth we could not access the collection. There may not be additional species in those collections, but it is highly likely that there are different accessions present.

In turn this highlights a key issue in advancing the cause of *ex situ* conservation – detailed field work is needed to discover and verify the accessions on which a conservation plan might be based. In other countries such field work might be focussed on botanic gardens and science institutions with formal databases, but in New Zealand that is not where significant collections are found (MacKay, 1995). In this study only two collections are in formal institutions and only one has a database, the rest are on private sites where plant identification and records must be generated from field work. This highlights the next issue, that field work is not a simple task. A high level of taxonomic skill is needed to identify and separate conservation species, which are usually more difficult to identify than common species, and there are limited personnel with this level of skill. In addition, field work must be supported by a comprehensive taxonomy, and this may not always be available.

In combination it is clear that for an *ex situ* investigation to be successful, five elements are needed:

- A comprehensive baseline taxonomy of the group, to provide an understanding of the classification and relationships of the genus and therefore the queries that should be posed about Red List species. In this case provided by the Argent monographs.
- A Red List assessment, to prioritise further examination of the genus and any potential action.
- An integration of the Red List with the taxonomic issues of the group, such that a 'Red List plus associates' group of species can be examined for ex-situ plans.
- Field assessment work to determine where the priority species exist in cultivation, the extent to which they are wild source, and the range of accessions.
- Some form of testing to clarify the taxonomy and identity of accessions and to assess the level of variation among the samples.

After these steps conservation potential can be examined and a conservation approach determined. From this study we propose that elements of a conservation plan for *Vireya Rhododendron* might be:

- International cooperation to accumulate the limited number of accessions worldwide into 'world' collections.
- Examination of the 'world' collection to relate its composition to the Red List.
- Further DNA testing to compare international accessions with New Zealand accessions.
- Integration and prioritisation of taxonomic or geographic issues into a conservation plan that:
  - Develops *in situ*, or in country *ex situ*, conservation in priority countries.
  - Focuses *ex situ* conservation on 'world' collection sites.
  - Integrates the above through exchange of knowledge, plant material and personnel.

Each of these elements should be used in an "*ex situ* conservation assessment" method. This method could be applied to other plant groups, for example temperate Rhododendron, of which New Zealand also has a large collection. The method could also be applied to other plant groups.

Conclusion

For more than 25 years the principles and issues of *ex situ* have been known, and while science continually develops greater knowledge, new processes, and better networks, at another level the original problems remain. Local knowledge, robust data and field work, and international cooperation remain both the problems and the solutions – and every project makes a small advance for the cause. In this project we have shown that New Zealand holds collections of *Vireya Rhododendron* that could contribute to an international *ex situ* collection for that group, and we believe our approach could be applied to *ex situ* conservation of other plant genera.

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Tables

Table 1

Red Listed Phaeovireya species	**Associated species (Argent, 2006)**
bryophilum	*dielsianum* – no clear distinction from *bryophilum*
dianthosmum	
rhodochroum	*haematophthalmum* – found in the same location.
solitarium	
superbum ssp. ibele	*inundatum* (Siphonovireya) – found in the same location and a hybrid between species was collected. *hellwigii* – hybridises with *superbum* *gardenia* – Originally found in the same location as *superbum ssp. ibele*, not found again although similar plants key to *superbum*

Table 2: Number of Red Listed taxa of Vireya Rhododendron according to geographic origin

Origin	**Number of taxa from that origin**	**Number of taxa Red Listed**	**Percentage of taxa Red Listed**	**Number of taxa rated as DD**	**Number of taxa rated DD as percentage of total number rated**
Island of New Guinea	183	86	45.3 %	61	73.4%
Island of Borneo	69	33	47.8 %	4	12.1%
Philippines	28	14	50 %	5	35.7%
Sulawesi (Indonesia)	26	18	69 %	12	66.6 %
Sumatra (Indonesia)	25	14	56 %	9	64.2%
Mainland Asia	13	9	69.2 %	1	11.1 %
Other islands of Indonesia	16	8	50%	3	37.5%
Malaysian Peninsula	11	4	36 %	4	100%
Australia	2	1	50 %	0	50%
Total	373	187	50.1 %	99	52.9%

Table 3: Number of Red Listed taxa of Vireya Rhododendron according to taxonomic series

Series	**Number of taxa in that series**	**Number of Red Listed taxa in that series**	**Percentage of taxa Red Listed**	**Number of taxa rated as DD**	**Number of taxa rated DD as percentage of total number rated**
Albovireya	15	8	53 %	5	62.5%
Discovireya	40	14	35 %	8	57%
Euvireya: Euvireya	108	54	50 %	24	44.4 %
Euvireya: Linnaeopsis	15	9	60 %	6	66.6%
Euvireya: malesia	60	31	52 %	15	48 %
Euvireya:saxifragoides	1	0	0 %	0	0
Euvireya: solenovireya	43	23	53.4 %	16	69.5 %
Malayeovireya	17	8	47 %	3	37.5 %
Phaeovireya	49	25	51 %	16	64 %
Pseudovireya	12	9	60 %	1	11.1 %
Siphonovireya	11	5	45 %	3	60%
Unknown	2	2	100 %	2	100%
Total	373	187		99	

Table 4: Number of Red Listed taxa in recent Red List assessments

Group	**Number of taxa assessed**	**Number of taxa Red Listed**	**Percentage of taxa Red Listed**	**Number of taxa rated as Data Deficient**	**Number of DD taxa as percentage of total number rated**
Vireya Rhododendron	373	187	50.1 %	99	52.9 %
Magnoliaceae	151	131	86.7 %	10	7.6 %
Acer	191	83	43.5 %	29	34.9 %
Quercus	208	111	53.4 %	33	29.7 %

Table 5: Number of taxa of Vireya Rhododendron in New Zealand, by geographic origin

Origin	Number of taxa from that origin	Number (and percentage) of taxa from that origin found in New Zealand
Island of New Guinea	183	67 (36.6%)
Island of Borneo	69	39 (56.5%)
Philippines	28	13 (46%)
Sulawesi (Indonesia)	26	11 (42%)
Sumatra (Indonesia)	25	8 (32%)
Mainland Asia	13	4 (25%)
Other islands of Indonesia	16	7 (43.8%)
Malaysian Peninsula	11	6 (54.5%)
Australia	2	2 (100%)

Table 6: Number of Vireya Rhododendron taxa in cultivation, and present in New Zealand, by taxonomic series

Series	Number of taxa in that series	Number of taxa in cultivation	Percentage of taxa in cultivation	Number of taxa in cultivation present in New Zealand	Number of taxa in New Zealand as percentage of those in cultivation
Albovireya	15	10	67%	8	80 %
Discovireya	40	24	60%	11	45.8 %
Euvireya: Euvireya	108	81	75%	59	72.8 %
Euvireya: Linnaeopsis	15	7	46.7%	5	71.4 %
Euvireya: malesia	60	34	56.7%	20	58.8 %
Euvireya: saxifragoides	1	1	100%	1	100%
Euvireya: solenovireya	43	29	67.4%	21	72.4 %
Malayeovireya	17	16	94.1%	6	37.5 %
Phaeovireya	49	24	48.9%	19	79.1 %
Pseudovireya	12	11	91.6%	5	41.6 %
Siphonovireya	11	6	54.5%	3	50 %
Unplaced	2	0		0	
Total	373	243	65.1%	158	65%

Table 7: Number of Red Listed taxa of Vireya Rhododendron present in New Zealand, by taxonomic series

Series	Number of taxa in that series	Number of Red Listed taxa in that series	Number of Red Listed taxa present in New Zealand	Number of Red Listed taxa in New Zealand as % of number Red Listed
Albovireya	15	8	3	37.5 %
Discovireya	40	14	1	7.1
Euvireya: Euvireya	108	54	19	35.2
Euvireya: Linnaeopsis	15	9	1	11.1
Euvireya: malesia	60	30	6	20.0
Euvireya: saxifragoides	1	0	0	0
Euvireya: solenovireya	43	22	6	27.2
Malayeovireya	17	8	1	12.5
Phaeovireya	49	25	5	20.0
Pseudovireya	15	9	2	22.2
Siphonovireya	11	5	0	0
Unplaced	2	2	0	0

Table 8: Number of Red Listed taxa of Vireya Rhododendron in New Zealand, by geographic origin

Origin	Number of taxa from that origin	Number of taxa from that origin that were Red Listed	Number (and percentage) of those Red Listed taxa found in New Zealand
Island of New Guinea	183	83	15 (18%)
Island of Borneo	69	33	12 (36.3%)
Philippines	28	14	5 (35.7%)
Sulawesi (Indonesia)	26	18	5 (27.7%)
Sumatra (Indonesia)	25	14	2 (14.2%)
Mainland Asia	13	11	2 (18.1%)
Other islands of Indonesia	16	8	2 (25.0%)
Malaysian Peninsula	11	4	0 (0%)
Australia	2	1	1 (100%)