Weeding Notes: Raoul Rough

Julia Brooke-White[1]

On Raoul Island the Department of Conservation weed eradication follows a yearly cycle. A team of five, known as the 'permanents', arrives in October. They are there to complete two searches of all areas where targeted weed species have been found and one search of the fringing buffer zones, known as 'null plots'.

The island is approximately 3000 ha, or one and a half times the size of Kapiti Island. Moumoukai, the highest peak, is 518 m (fig. 1).

Fig. 1. Blue Lake, the largest of three lakes in the crater of Raoul Island. Named for the colour it was before the 1964 eruption. Moumoukai, the highest point at 518 m is reflected on the right. There are many weeding plots inside the crater as Brazilian buttercup and purple guava have infested this area. The steep sides are null plot, weeded once a year, an exhausting task. A small fertile area, an old crater by Tui Lake, had been cultivated by early settlers and Mauritius hemp has since been eliminated from this area.

Weeds are concentrated around the flatter areas that have been cultivated in the past, Denham Bay on the west coast, the Terraces on the northern side and in the crater. Sporadic attempts to settle were finally abandoned in 1937 and for the next 50 years New Zealand used the island as a weather station. A 12-member team was sustained by a small farming operation which brought in more weed species.

1 Julia Stace, 129 Aro St, Aro Valley, Wellington

The weeds that threatened to invade and alter the forest structure included passionfruit (fig. 2), peaches, guava and grapes. These plants were encouraged, eaten and spread by the people here. The World War II coast watchers, for example, grew them at their outposts.

Fig. 2. Weeder Tristan Riley with a thick, black passionfruit vine he has uprooted. He will cut out a section of the trunk to take back to the hostel as a trophy. He would have been alerted to the presence of the plant by one or two yellow leaves on the ground or perhaps by a fallen, ripe fruit The vine itself is difficult to spot amongst the pohutukawa trunks.

Dr. W.R.B. Oliver's 10-month stay in 1908 enabled him to make a comprehensive survey of the flora and fauna. For decades his work was the standard reference. In 1944 J.H. Sorenson was sent here for 7 months on a mission of pest and vermin destruction. He also made an extensive collection of exotic weeds at the request of the Botany Division of the D.S.I.R. W.R. Sykes was here for two days in 1964, even collecting in the crater, before it erupted early next morning. He returned in 1966–67 with the reconstituted Ornithological Society of New Zealand expedition to make a comprehensive evaluation of Raoul's vegetation. Weed eradication began in 1972 under the Department of Lands and Survey. In 1977 Sykes authored the *DSIR Bulletin 219* "Kermadec Islands Flora – an Annotated Check List" which was reprinted with some additional information by Manaaki Whenua Press in 2000.

Carol J. West's "Assessment of the Weed Control Programme on Raoul Island, Kermadec Group" Science and Research Series no 98, Department of Conservation, which explains the weeding programme in full detail, was published in 1996.

Today all policy, implementation and monitoring, is the responsibility of the Warkworth Area Manager at the Department of Conservation. Technical support is provided from the Department's Auckland Conservancy office. Mike Ambrose, based in Warkworth, is the Programme Manager. Using e-mail, he can be in daily contact with Raoul Island.

Mysore thorn, *Caesalpinia decapetala*, brought here to keep the wild goats out of garden plots 100 years ago in Denham Bay was the first weed species to be the target of control. By 1974 it had spread over 22 hectares of canopy of the Kermadec pohutukawa, *Metrosideros kermadecensis.*

Full time weed personnel, initially one per year, began working on the island in 1972. Since DOC took over the management of Raoul in 1989, weeding has been the main activity for the staff here. The launching of the daily weather balloon, the weekly seismological and vulcanology data are also done under contract by the Department's staff.

In 2003, an additional three weeders joined us for the summer. All had been to Raoul before and were familiar with the weed species. The terrain was grid searched and pink taped areas, where weeds had been found before, were intensively surveyed, as we came across them. There are approximately 113 native plant taxa on the island and twice as many weed species. It does not take long to learn to recognise the seventeen Category A weeds species, even as tiny dicotyledons. Category A refers to a system developed by the Department of Conservation to classify weeds into groups according to the threat they pose to indigenous plant communities. This is the highest risk group and the highest priority for control. Category A weeds are:
Caesalpinia decapetala – Mysore thorn
Senna septemtrionalis – Brazilian buttercup
Passiflora edulis – black passionfruit
Anredera cordifolia – Madiera vine
Psidium cattleianum– purple guava
Psidium guajava – yellow guava
Olea europaea subsp. *cuspidata* – African olive
Cortaderia selloana – pampas grass
Araucaria heterophylla – Norfolk pine (excluding the original 11 planted by the Bell family, see fig. 3)
Furcraea foetida – Mauritius hemp
Ricinus communis – castor oil plant
Phyllostachys aurea – walking stick bamboo
Brachiaria mutica – para grass
Foeniculum vulgare – fennel
Gomphocarpus fruticosus – swan plant
Populus nigra – Lombardy poplar
Senecio jacobaea – ragwort

Even those that are rarely encountered would stand out as very unusual. One immature plant of ragwort (*Senecio jacobaea*), was destroyed in 1980, and fennel (*Foeniculum vulgare*) was found intermittently in one location from 1967 to 1997.

Nine volunteers arrived in May 2003. This was a multi-talented, fit and enthusiastic bunch who joined the island staff for the second coverage of the terrain. Three of them were geology graduates. At last some of our questions about curious rock formations and interesting topography all over this active, volcanic island were answered.

Fig. 3. The Bell family were put ashore with almost no food in 1879, and scavenged for some months until their gardens flourished. Their diet was greatly enhanced when Mr Bell remembered that sugar could be had from *Cordyline terminalis* which occurs in Coral Bay, Denham Bay and Low Flat, the flatter areas. The big parsnip like root, will, with slow cooking, yield sugar. *C. terminalis* is thought to be one of the plants, with shore hibiscus and candlenut, brought by Polynesians around 600 years ago.

Their enthusiasm for the intense Raoul experience reminded us that what has become so normal is really extraordinarily interesting. We live in a very remote place, yet in a close group situation. It is rather like being trapped in a city flat of fifteen, without the city. Luckily, 2003 was one of the harmonious years.

The new arrivals were first shown the 'pet' plants, a cultivated line up of our main weeds that are replaced with juveniles as they approach maturity. They spent time in a teaching plot set up by the team leader, Marion Rhodes. All the various problems that can occur with the pink tapes in the bush, such as missing or faded tapes, or two tapes for different weeds at the same site, were explained whilst we could still hear one another over the roar of the wind and the surf. They then went out to grid search at five metres apart. They began to dream about weeds. They wanted to find the entire range of weed species.

Table 1 provides an overview of the results of the weeding programme from 1999 to 2003. The most significant points to note are the numbers of mature plants of each species being found. For example, 93 mature passionfruit (*Passiflora edulis*) plants were found in 1999, and only 34 in 2003. Five hundred and seventeen mature Brazilian buttercup (*Senna septemtrionalis*) were found in 1999, and only 33 in 2003.

Table 1: Overview of results from the weeding programme, 1999–2003.

Species	1999			2000			2001			2002			2003		
	Seedlings	Ados	Mat's	Seedlings	Ados	Mat's	Seedlings	Ados	Mat's	Seedlings	Ados	Mats	Seedlings	Ados	Mat's
African olive	2	2	1	1	3	1	2	9	3		2	1	7	8	3
Black passionfruit	3,004	271	93	455	473	65	1,191	251	45	538	121	23	1,746	156	34
Brazilian buttercup	101,901	5,252	517	49,506	1,243	128	46,364	2,647	458	27,256	852	41	25,218	245	33
Candlenut	459	12	10	99	53		32	69		78	7		78	8	
Castor oil	14	7		12	10	4	12	2	2	3	2		5	10	3
Macadamia														3	
Mysore thorn	585	87	34	315	268	19	222	71	18	247	82	13	709	95	3
Norfolk pine	53			25	6	8	29	7		4	3		8		
Peach	401	42	5	1073	303	4	438	103	3	911	102	6	1453	88	
Pinus radiata												1			
Poplar															1
Purpple guava	19	18	7	16	4	6	28	30	3	6	5		25	31	3
Swan plant			1	3						1					
Yellow guava	13	2	3	4	1	1	5	2			3	1	10	4	5

Timing affects the numbers of seedlings found. For instance, the huge number of passionfruit seedlings was due to searching the plots so soon after germination. Many of those seedlings would not have survived more than a few weeks. Over half of the Mysore thorn seedlings were at the new site near Prospect (found by helicopter last year); this site will continue to produce large numbers for some time. The good news is the number of mature Mysore thorn being found continues to decline. The poplars, found in 2003 in long grass near the 'air strip', appeared to be growing from both ends of a piece dropped there, probably from the penultimate poplar to be disposed of, reminding us that thorough destruction of all weed material is essential.

Overall, the numbers are showing a strong downward trend for all the main species, so the weeding process is definitely making a difference. Although the seeds may be viable for many years, weeding out mature plants combined with finding young plants before they have a chance to set seed reduces the seed bank and brings the date of elimination of those species from Raoul ever closer.

There are two areas of Madiera vine (also a Category A weed) that are a concern. The most extensive is high up on cliffs over the sea, near Fishing Rock, the landing platform. The other area is also close to the coast, up a ravine. As no weed killer or combination of chemicals kills the tubers it must be hand pulled. Spraying knocks back the leaves allowing us to locate the tubers from the re-growth. It grows from the smallest piece and develops huge tuber reserves underground. This is dug out by four people for a day every week. Every bit of vine and tubers is then desiccated in the hot exhaust fumes from the generators, which run 16 hours a day. We dug up and hauled away over 3.3 tonnes of Madiera vine in 2003.

Bamboo, Moreton Bay fig, pampas grass and puriri, all with hindsight misguidedly introduced, have not been found for several years. Although the last *Pinus radiata* was ringbarked in 2000, one mature tree that had yet to seed was found in 2003. Occasionally macadamia nut seedlings occur, as in 2003, although the mature trees of early plantings have long gone and rats loved the nuts. Candlenuts, cherimoya, citrons, date palms, figs, Norfolk pines, shore hibiscus, and a peach tree are contained at their original, historic sites. They are reminders of Polynesian and subsequent settlement attempts.

Grape, which the Bell family cultivated here for thirty years to sell to passing ships, had scrambled over huge areas by the end of the 20th century. In the last two years it has been cleared away and is now almost destroyed. Every few weeks we clear the sites of weed regrowth, leaving the native plants to reestablish. Kermadec ngaio (*Myoporum kermadecense*) and *Homolanthus polyandrus*, in particular, like the clearings. Occasionally we find grape re-growth from roots on lengths not reached by stumps painted with the herbicide Vigilant. Grape has continued to send up shoots all year round in its struggle to survive.

Fig. 4. On Raoul the elegant, endemic nikau, *Rhopalostylis baueri* var. *cheesemaniii* can have 1–4 inflorescences per year. Bees visit the flowers for nectar and ensure a good pollination rate.

There are isolated patches of vetch, para grass and *Selaginella kraussiana* at which all regrowth is sprayed regularly. Rats were eradicated by aerial poison drop in 2002. There will be changes to the flora consequently, as rats no longer move, eat and destroy the seeds of many species. These include nikau (fig. 4), karaka, candlenut, *H. polyandrus* and the citrus trees that are remnants of a plantation scheme from fifty years ago.

There will now be improvement in the survival rates of ground-nesting sea birds, a few of which are still attempting to nest here. Early settlers' stories show that they survived by eating big quantities of the eggs and chicks. Raoul's future lies in being the haven it once was for breeding populations of petrels and shearwaters, terns and noddies, boobies and tropic birds that live in these relatively landless latitudes. These birds still breed in vast numbers on the Herald Islets, only a few kilometres from Raoul. Spotless crakes and red crowned kakariki should also successfully re-establish from the Herald Islets to Raoul.

The guano will increase the fertility of the soil at seabird nesting sites. This will favour some plants like NZ spinach (*Tetragonia tetragonioides*, fig. 5), *Senecio kermadecensis* and the native cucumber, *Sicyos australis,* as it did before.

Compared to the nearest land, Australia, Polynesia and New Caledonia, Norfolk and Lord Howe Islands, the flora has its strongest affinity with that of New Zealand. There is a smattering, a disharmonic flora, of the New Zealand plants on Raoul and a smaller selection of that on South Meyer Island, 2 kilometres off the northern coast. This steep little island is only 12 hectares and reaches an altitude of 99 m. Rats have never lived there and goats and pigs put ashore by 19th century whalers did not last long. We visited South Meyer in September 2003, at a time when the fewest sea birds are breeding there, to weed out Brazilian buttercup (*Senna septemtrionalis*).

I recorded the following plant species on South Meyer Island. There could be other annual species at other times of the year. An asterisk denotes those that are native to the Kermadec Island group.

Fig. 5. NZ spinach, which grows amongst Kermadec petrel nests, has almost disappeared from Raoul island, but flourishes in conjunction with nesting seabirds on the Meyer Islets, 2 km offshore.

DICOTYLEDONS

Ageratum houstonianum – a common, non-targeted annual weed. Wild honey bees were working the fuzzy, mauve flowers.
Alocasia brisbanensis – two clumps on either side of the ridge. This is the most widespread naturalised plant on Raoul. It is not targeted for removal, rather it is hoped it will die out as the canopy cover intensifies.
Canavalia maritima – growing from the shoreline to the ridge top.
**Coprosma petiolata* – shrubs, almost prone.
Cordyline terminalis – ti, one clump near summit, leaves shredded by gales.
**Corycarpus laevigatus* – karaka, short, with many trunks.
Coronopus didymus – very common.
**Cotula australe* – in flower
**Disphyma australe* ssp. *stricticaule* – some with white flowers, others the lighter pink that is more common on Raoul.
Fumaria muralis – scrambling fumitory
**Homolanthus polyandrus* – one seedling about 20 cm high.
**Melicytus ramiflorus* – mahoe, a few, one with variegated foliage.
**Metrosideros kermadecensis* – Kermadec pohutukawa, noddies nesting on branches, grey ternlets roosting in trees at night. Blossom just beginning.
**Myoporum kermadecense* – growing well in guano enriched soil, possibly the main canopy sp., more in number than pohutukawa.

Nicotiana tobacum – one plant with pink flowers, a relic of the Bell family's self sufficiency.
**Parietaria debilis* – N.Z. pellitory
**Pisonia brunoniana*– bird catching tree, in flower. Stunted, many trunks.
**Samolus repens* var. *stricta* – sea primrose, one plant growing in a rock crevasse, well within the sea's splash zone.
**Senecio kermadecensis* – plenty, in flower, growing amongst the ageratum.
Senna septemtrionalis – Brazilian buttercup, the plant we went to remove. We found 395 seedlings, 168 adolescents (those over 30 cm high) and five matures, two of which had a total of three pods, which we removed for incineration. This weed species was not flourishing in the guano.
**Sicyos australis* – native cucumber. Rampant, still in flower.
Sida rhombifolia – two plants seen, kakariki are known to feed on this.
Solanum nodiflorum
**Tetragonia tetragonioides* – NZ spinach, Large areas of lush plants in areas used by petrels for burrows.
Three unidentified spp.

MONOCOTYLEDONS

**Carex kermadecensis* – growing at old petrel burrow sites.
**Cyperus ustulatus* – mariscus.
**Lachnagrostis littoralis var. littoralis* (?) – plants not flowering.
**Poa anceps* subsp. *polyphylla* – not yet flowering.
**Isolepis nodosa* – a few clumps in rocks close to shore line.
One unidentified sp.

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**Asplenium oblongifolium* – pinnae, more slender and duller then those on Raoul.
**Asplenium obtusatum* subsp. *northlandicum* – shore spleenwort.
**Asplenium shuttleworthianum* – very common on the steep, tuff slopes, uncommon on Raoul I.
**Hypolepis dicksonioides.*
**Pteris tremula*
**Pyrrosia eleagnifolia*

The weeding work on Raoul has been most worthwhile. It is an island less damaged by human activity than most, due mainly to the great difficulty of getting ashore. The rugged, volcanic, earthquake and cyclone prone island has defeated all settlers. With the eradication of first goats, then rats and cats, the seabirds will be able to nest here again and the island should return to a near pristine state, without any invasive weeds.

To quote Johnny Wray in his New Zealand sailing classic, "South Sea Vagabonds":

> *I would like to stay at Sunday (Raoul) Island longer, but it is no place for a ship when the weather cuts up rough. If there were only an anchorage it would, I think, be one of the best islands in the Pacific, if not the world.*

Fig. 6. There is one *Hebe* species on Raoul island, *H. breviracemosa.* Because it was very palatable to goats only one plant was known to survive in the 1990s. This plant was layered, the layering outliving the parent plant. Seed is collected and seedlings raised for distribution around the island. Isolated plants in remote and inaccessible places have since been found in the wild and from being one of the most endangered plants in the world there are now over 200 known specimens growing on Raoul Island.

Fig. 7. *Scaevola gracilis,* a perennial ground cover with copious white flowers and a faint almond perfume, occurs in the Kermadecs and on two volcanic islands in Tonga, the nearest land to the north. This, along with the nettle tree, *Boehmeria australis*, and New Zealand poplar, *Homolanthus polyandrus,* are in the New Zealand flora only because New Zealand annexed the Kermadecs illegally in1887 and correctly in 1896. They don't occur naturally further south.