THREATENED SPECIES RECOVERY PLAN SERIES NO.16

Dactylanthus taylorii RECOVERY PLAN

Prepared by
C. E. Ecroyd
(N.Z. Forest Research Institute Ltd)
for the Threatened Species Unit

Threatened Species Unit
Department of Conservation
P.O. Box 10-420
Wellington
New Zealand

ISSN 1170-3806
ISBN 0-478-01708-1

Key words: *Dactylanthus taylorii*, woodrose, parasitic plants, recovery plan

Cover credits: Right: *Dactylanthus* plant attached to a host tree root. (Photo: David Blake); top box: Short-tailed bat carrying pollen after feeding on *Dactylanthus* nectar. (Photo: Eric Anderson and Chris Ecroyd). Middle box: *Dactylanthus* flower clusters with hundreds of very small flowers laden with white pollen. (Photo: Chris Ecroyd). Bottom left box: Possums eat the *Dactylanthus* and are a serious threat to its survival. (Photo: John Johns) Bottom right box: Ship rat feeding on nectar from *Dactylanthus* flowers. (Photo: Eric Anderson and Chris Ecroyd.)

CONTENTS

ABSTRACT

A recovery strategy is provided for *Dactylanthus taylorii,* an endemic parasitic flowering plant threatened with extinction. Survival of this unusual plant is threatened principally by possums browsing the flowers and wood rose collectors digging up the plants to obtain the fluted host root or "wood rose". The plan includes information on the distribution and ecology of *Dactylanthus taylorii,* an outline of management options and a work plan.

1. INTRODUCTION

Dactylanthus taylorii, otherwise known as pua o to reinga, wae-was-atua, the wood rose or flower of Hades, holds a special position in New Zealand's indigenous flora as the only fully parasitic flowering plant. As well, it is the only member of the genus *Dactylanthus* and the most southerly occurring representative of an otherwise tropical and subtropical family of root parasites, the Balanophoraceae.

The Maori name "pua o to reinga" meaning flower of the underworld, alludes to the way the flowers of *Dactylanthus taylorii* emerge from below ground. Hill (1908) only heard the name "wae-wae-atua", which translated means "the fingers, the foot, or toes of the atua" or god, being used by the Maori of Taupo and East Cape. He also mentions that Paul Rakino, a very old Maori from Taupo, gave him an old waiata referring to the flower. Unfortunately this knowledge of the plant seems to have been rapidly lost and Best (1924) states that "The words pua reinga, also met with in Maori songs, cannot now be explained by these natives". Servant (1973) suggests that the Maori "include among the medicinal plants the pua *[Dactylanthus taylorii]"* but this is the only reference found suggesting such a use and doubt has been expressed on the translation of the word "pua". However, other members of the same plant family are used for medicinal purposes in China and Africa (Naidoo et al. 1992).

Dactylanthus taylorii grows as a root parasite consisting mainly of a round warty rhizome up to 50 cm in diameter, attached to the root of a host tree or shrub. In response to the *Dactylanthus,* the attached area of host root moulds into the shape of a fluted wooden rose which gives it one of its common names. Through this placenta-like attachment *Dactylanthus* obtains its nutrients from the host plant. It has no green leaves or roots of its own and the minute flowers are clustered into inflorescences that emerge from the rhizome mainly from February to May.

These inflorescences have special features to attract an unusual pollinator - the short-tailed bat *(Mystacina tuberculata).* Unfortunately the strong scent and large quantity of sweet nectar now also attract other mammals including the possum *(Trichosurus vulpecula),* ship rat *(Rattus rattus)* and kiore or Polynesian rat *(Rattus exulans).* Possums, kiore and sometimes the ship rat browse the inflorescences, destroying the flowers and preventing regeneration. Possums also often damage the rhizome or host root in their efforts to get at the young inflorescences before they are fully developed.

The "wood rose" formed by the host root is considered a curio by some people, and over the years collectors have dug up thousands of *Dactylanthus* plants to obtain these ornaments, which are still being sold in souvenir shops.

Dactylanthus is found mainly in the central North Island, from near Hamilton in the west, across to East Cape and south to Mangaweka. It is also on Little Barrier Island and near Omahuta Forest, Northland. Since it grows underground it is impossible to estimate accurately the number of plants in any one area, but we know that the area of distribution and number of plants have declined this century and today there are likely to be only a few thousand in existence.

Dactylanthus taylorii is currently listed as "Vulnerable" by Cameron et al. (1993), a classification applied to a species believed likely to move into the Endangered category in the near future if causal factors continue. It is likely to be placed in the Endangered category when the list is next revised. *Dactylanthus* is in "Category A" (Urgency for Action - Highest Priority Threatened Species) in the Department of Conservation report "Setting priorities for the conservation of New Zealand plants and animals" (Molloy and Davis 1992). The key management goal of this plan is to ensure the perpetuation of *Dactylanthus taylorii* in the wild and the maintenance of its genetic diversity. The duration of the plan is ten years.

Implementation of the recovery strategy will be assisted by a recovery group consisting of representatives from those conservancies in which *Dactylanthus* occurs, Science and Research Division, Threatened Species Unit and researchers.

2. PAST DISTRIBUTION AND ABUNDANCE

Dactylanthus taylorii is much more common in the fossil record than would be expected from its current abundance. For example the distinctive pollen grains of *Dactylanthus* have been found in late Oligocene and middle to late Pliocene sediments in coal measure sequences from both the North and South Islands, down to Southland (Macphail and Mildenhall 1980). The pollen was also found in sediments in the Tongariro region dated between ca. 1,800 and 50,000 years ago indicating that it has been in the central North Island for a very long time (McGlone and Topping 1977, 1983).

Macphail and Mildenhall (1980) found fresh looking *Dactylanthus taylorii* pollen in an 8 m core of lake muds and peats from a site in the South Island 35 km south of Cape Farewell and they suggest that either *Dactylanthus* still occurs in North-West Nelson or it has done so until recently. Other reports suggesting it still exists in the South Island have, so far, not proven reliable.

The type locality for *Dactylanthus taylorii* is the upper Wanganui, where Reverend Richard Taylor collected it in 1845. Old herbarium specimens and published records of the last 150 years show *Dactylanthus* distribution from Hokianga in Northland to Kaitoke

near Wellington. It used to grow close to Warkworth and in the Waitakere Ranges near Auckland. Cheeseman (1906) and others record it at Cape Colville on the Coromandel Peninsula, near Thames, on the east coast of the North Island at Nuhaka, Wairoa and inland Hawkes Bay at Puketitiri.

Verbal accounts and published information indicate it was once common at Tarawera on the Napier-Taupo highway. At Opepe, near Taupo, Hill (1926) describes seeing the *Dactylanthus* "opening out, along the dry floor of the valley for a chain or more, appeared hundreds of flowers in clumps ... the perfume was overpowering." Extensive searching in 1989, revealed only six live plants at this site. At least two have since been dug up, presumably by a collector. Without protection from possums, kiore (on Little Barrier Island) and collectors, *Dactylanthus* plants will never again be seen flowering as profusely as they were at Opepe in 1923.

Dactylanthus has always been a difficult plant to find and it has never been considered common. It occurs in widely scattered sites but is usually in colonies.

3. PRESENT DISTRIBUTION AND STATUS

Reliable records of *Dactylanthus* over the past twenty years indicate that it is now found mainly from East Cape down to Mangaweka in the central North Island (Fig. 1). It occurs in at least two areas near East Cape and there are reports of numerous dead plants washed down rivers by floods in that region. It grows near Lake Waikaremoana and in other parts of Te Urewera National Park. It is also present from near Opotiki to Lake Rotoiti but at some sites only dead plants have been found. There is one large colony of several hundred plants on the Mamaku Plateau and some further south on the Paeroa Range. By far the largest number of plants and sites are within 100 km of Lake Taupo especially to the south-west. A site near Mangaweka forms the southern limit of recent reliable records.

On the West Coast of the North Island it has been found at seven sites from Mt Pirongia near Hamilton down to Egmont National Park. At least eleven live plants were found on Little Barrier Island in 1992; this is the only population known to occur on an island. *Dactylanthus* pollen from short-tailed bat droppings collected in 1975 indicate it probably still exists near Omahuta Forest in Northland (Daniel 1976).

As *Dactylanthus* grows underground or at ground level it is impossible to accurately count the number of plants in any one area, but we know that the distribution of *Dactylanthus* has shrunk this century and it is estimated that only a few thousand now exist. At many sites a high percentage of the plants are dead and at other sites only dead plants can be found.

Many *Dactylanthus* sites are known only to the "locals" who have dug up plants in the past to obtain the wood roses. These people, if they are no longer interested in collecting

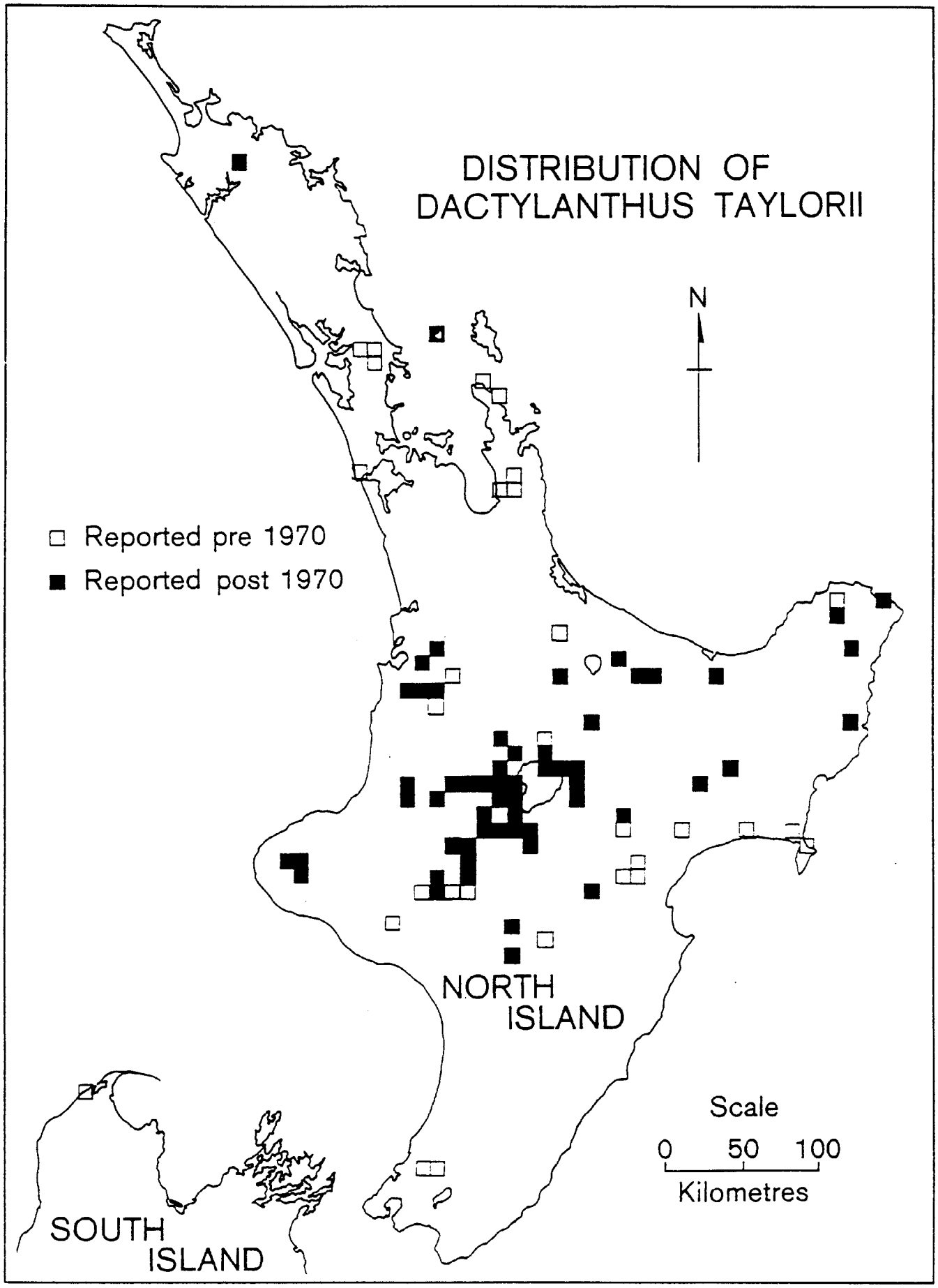


Figure 1. Distribution of *Dactylanthus taylorii* in New Zealand

the wood roses are generally the best source of information on precise locations of plants. Without this local knowledge *Dactylanthus* plants are very difficult to find, and yet they probably occur at many more sites than have been recently officially recorded.

Most *Dactylanthus* sites are on land controlled by the Department of Conservation but a significant number of sites are on Maori land (e.g. Mt. Tauhara) or on private farmland.

Unfortunately, plants are still being collected. There is, for example, evidence of plants being dug up at Mamaku, Pureora and at Opepe near Taupo, over the last three years. Continuing collecting, the widespread effect of possums and other factors such as trampling by cattle are causing further decline in numbers. This justifies upgrading the current listing from "Vulnerable" (Cameron et al. 1993) to "Endangered". The "Category A" classification by the Department of Conservation (Molloy and Davis 1992) takes other factors into account including the position of *Dactylanthus taylorii* as the only member of an endemic genus.

4. ECOLOGY

4.1 Habitat

Dactylanthus grows parasitically on the roots of about 30 species of native hardwood trees and shrubs (Appendix 1). Broadleaf *(Griselinia littoralis),* fivefinger *(Pseudopanax arboreus),* lancewood *(Pseudopanax crassifolius),* kamahi *(Weinmannia racemosa),* karamu *(Coprosma robusta),* kohuhu *(Pittosporum tenuifolium),* lemonwood *(Pittosporum eugenioides),* mamangi *(Coprosma arborea),* pate *(Schef era digitata),* putaputaweta *(Carpodetus serratus),* and wineberry *(Aristotelia serrata)* are common hosts. Many of these species are seral and found abundantly on forest margins, thus one of the most common sites for *Dactylanthus* is in old fire-induced vegetation at the edge of tall forest.

Dactylanthus prefers damp but well drained places and is never found on really dry sites. It is often found growing at the head of small streams. According to Moore (1940) it is found where trees form a dense, leafy canopy and the ground is well covered with humus, in tall forest or its remnants, or in marginal shrubland. The forest floor is usually comparatively bare although at some sites there is a dense covering of *Astelia fragrans* or kiokio *(Blechnum* "blackspot"). It can be found on flat sites or on vertical rock faces where roots are exposed. One unusual site is in pine forest at Waitaanga where *Dactylanthus* has colonised the roots of the native trees forming the understorey. *Dactylanthus* was probably able to colonise this site from seed remaining in the soil after the native forest was cleared.

Plants have been found growing at altitudes ranging from near sea level to 1,200 m. Richard Taylor suggests that he found it growing at 4,000 ft in the Wanganui but that altitude is not reached in the area. It also grows in a wide variety of climates, from the

relatively mild frost-free slopes of Little Barrier Island to near National Park in the central North Island where frosts and snow are common.

4.2 Flowering Biology

Dactylanthus is dioecious, i.e. it has separate male and female plants, and it reproduces from seed. Vegetative reproduction may occasionally take place if part of a rhizome is isolated by intrusive growth of the host root but it is unlikely to be significant (Moore 1940).

Flowering usually starts in February and extends into May with the main flowering period in March and April. Occasional flowers appear at other times and flowers have been seen in June and August but inflorescences observed outside the main flowering period have not set seed. Most mature plants, but not all, produce some flowers every year. There are more male plants than female and the ratio of male inflorescences to female is often about seven to one. Each male inflorescence lasts about ten days during which time, on average, 5 ml of nectar are produced. The female inflorescence is probably receptive to pollen for about ten days and then, if pollinated, gradually matures with the spadices (stalks approximately 2 cm long, covered with the minute flowers) elongating and the seed ripening over the next six months.

4.3 Pollination

The inflorescences are adapted to attract the short-tailed bat. They are large, dull-coloured, robust, bowl-shaped and produce large quantities of musky smelling nectar. These features are typical of bat-pollinated flowers.

Although *Dactylanthus* is principally bat-pollinated other animals can also be effective pollinators. Insects do visit the inflorescences and are probably responsible for pollinating a very small percentage of the flowers. Wasps are the most common insect visitor but they usually chew their way through the side of the inflorescence to reach the nectar, thus avoiding contact with the stamens.

In the absence of short-tailed bats, ship rats are probably the most important pollinator. Ship rats are frequent visitors to *Dactylanthus* inflorescences and abundant seed set has been observed on female plants they have visited. However, recent video monitoring has confirmed that they will also sometimes destroy the flowers. Other animals such as mice and lizards could also be pollinators.

Hand pollination can be easily carried out if required, by taking a spadix (ca. 2 cm stalk covered with the minute flowers) from a male inflorescence in good condition and moving it around inside the female inflorescence.

4.4 Seed Dispersal

The seed usually remains attached to the inflorescence for a considerable period, ranging from about 6 months to four years, until the whole structure starts to break down and become buried in the forest litter. Most of the seed is likely to be dispersed only very short distances, aided mainly by gravity and water. When it first matures the seed has a thin fleshy coat which could attract ground feeding birds, lizards and insects resulting in occasional longer distance dispersal.

Within a few months the fleshy coat dries out but the seed is protected by a woody, much-hardened ovary wall. Provided the embryo doesn't become desiccated the seed will be viable for at least five years.

4.5 Germination and Cultivation

Using standard techniques most fully parasitic plants are very difficult to grow artificially from seed. For the seedlings to survive they need to find suitable host plants as quickly as possible and they have special mechanisms to assist them with locating their hosts. One strategy is for the seed to require a chemical stimulant from the host root before it will germinate (Kuijt 1969). For this method to be successful vast numbers of seeds must be produced, for their chances of becoming lodged in the immediate vicinity of a suitable host root are slim. This in turn implies a small seed size and greater longevity of seeds.

Results from current research indicate that this is the strategy used by *Dactylanthus*. Seeds sown close to young vigorously growing roots of broadleaf seedlings have successfully germinated and attached to the host roots. However the rate of success for the number of seeds sown was very low and after three years one plant grown from seed was only 9 x 8 x 5 mm. Four years after the seed was sown, some seed was recovered and 62% was found to be sound and probably viable. Ensuring long term survival of the young plants in cultivation is difficult because root systems are constantly changing and under dry conditions the young roots are particularly susceptible to dieback. Two host plants with *Dactylanthus* seedlings attached have been successfully moved from their original planter box to a forest situation, indicating that it is possible to move *Dactylanthus* plants once they are established in cultivation.

Judging from sites where the plants grow naturally, good drainage is essential but the seed must be kept moist. Stratifying the seed is probably necessary unless the seed is subjected to natural over-wintering and the seed may also require a maturing period corresponding to the time it would take for the seed to become buried deep enough in the soil to be close to host roots. Moore (1940) found germinating *Dactylanthus* seed in August, evidence that germination probably occurs in late winter or early spring. Some seed was recovered in September 1994 nearly four years after being sown near host roots and 6% was found to be split and starting to germinate.

It should be relatively simple to grow *Dactylanthus* under conditions resembling the natural habitat by sowing the seed just below the soil surface close to suitable host roots.

Unfortunately it is very difficult to observe whether plants are forming without risk of disturbing the seed or host roots, and the plants will only show above the ground when large or flowering. Seed was sown at eight forest sites in 1989 and after five years there is no visible sign of any *Dactylanthus* plants. However, there is still hope because the seed can take several years to germinate and growth rates are slow.

4.6 Pests/Diseases

Hyphae of the fungus *Armillaria novae-zelandiae* were extensive in four out of eight collections from recently dead *Dactylanthus* plants or their host roots (Hood 1991) and may have contributed to their death by killing either the rhizome or the host root. Another fungus, a species of *Cephalosporiopsis,* not regarded as pathogenic, and abundant bacteria, were isolated from a rotting area of an otherwise healthy plant.

Damage by possums, adverse climatic conditions, and soil compaction by deer, goats, cattle and sheep could all contribute to root dieback and the consequent death of the attached *Dactylanthus* plants. The health of *Dactylanthus* is dependent on the health of the host tree and its root system - if the host tree or host root dies so will the parasitic *Dactylanthus.*

4.7 Browsing

Attracted by the scent, possums very effectively locate and browse *Dactylanthus* inflorescences, preventing seed set. Even inflorescences on plants hidden under logs have been browsed. Possums will dig for the newly emerging inflorescences and often damage the host root and the *Dactylanthus* rhizome. Over the last three years very few unbrowsed inflorescences have been found at sites without some form of protection from possums. Of thirteen mainland sites inspected in 1993, unprotected and unbrowsed flowers were found at only two sites. At one of these sites there were about 60 plants and there should have been hundreds of inflorescences but only two intact male inflorescences were found and they would probably have been browsed in the next few evenings.

Possum control operations have resulted in some seed set on otherwise unprotected plants. The best result was observed at a site near Pureora where 26 plants had full crops of seed present in August 1993. This site was centrally located in an area treated in June 1992 with 1080, using carrots as bait (Butcher 1992). Much of the nearby bush/pasture margin had also had permanent bait stations installed for up to two years previously. The quantity of seed set at this site was considerably greater than that achieved at a Mamaku site where intensive trapping and cyanide paste were used to reduce possum numbers. A much smaller area was covered in the Mamaku operation and there appeared to be a constant influx of new animals into the area.

Ship rats have been filmed visiting *Dactylanthus* inflorescences on numerous occasions and seed has set on plants they have visited. However, video monitoring of plants in

1994 showed these rats at one site destroying the inflorescences and leaving broken spadices scattered over the ground. Similar damage was noted at two other sites.

Kiore were filmed browsing *Dactylanthus* inflorescences on Little Barrier Island in 1992. In that year and in 1993 all observed inflorescences on the island were completely destroyed by browsing. Perhaps kiore and ship rats damage the flowers when their numbers are high or food is scarce.

4.8 Longevity

Growth ring counts of host roots may be a reliable way to estimate the age of *Dactylanthus* plants. If these rings are annual then plants have been aged at approximately 30 years. The size of the host roots is not an accurate indication of age because the *Dactylanthus* plant stimulates abnormal root growth.

Mortality of *Dactylanthus* has been significant at about 20% of plants at a site under observation for the last four years. Host plants have died from natural causes, and diseases have killed the host root or the *Dactylanthus* rhizome.

5. REASONS FOR DECLINE

The decline of *Dactylanthus* can be attributed to the effects of habitat destruction and modification, wood rose collectors, and browsing animals. The loss of pollinators and seed dispersing animals are other factors possibly causing a decline in numbers.

Large areas of forest containing *Dactylanthus* have been cleared for farming, forestry and other uses. Cattle grazing under forest remnants damage and eventually destroy *Dactylanthus* rhizomes by trampling. Natural changes to the seral forests in which *Dactylanthus* is commonly found could also reduce *Dactylanthus* populations as the seral host species decline. Goats and deer are likely to modify the habitat and damage exposed plants growing on frequently used tracks and wild pigs probably accidentally damage some plants while rooting for food. Browsing of flowers and other damage by possums is the most important factor currently causing the decline of *Dactylanthus*. On Little Barrier Island, the only known possum-free *Dactylanthus* site, kiore browse the inflorescences. Sometimes ship rats also destroy the flowers.

Collectors have had a major effect on the numbers of *Dactylanthus* plants in certain areas, including reserves. Collecting is still occurring but is hopefully diminishing as collectors become better informed about the plant and its importance.

Decline in numbers of short-tailed bats may have contributed to the decline of this plant. Many of the ground feeding species of native birds, lizards and large insects which may have had a role in dispersing *Dactylanthus* seed are now either extinct or greatly reduced in abundance due to the effects of introduced animals.

6. THREATS TO LONG TERM SURVIVAL

The single most important threat to long term survival of *Dactylanthus* is the possum. Collectors may further deplete some populations if the trade and interest in wood roses continues. The presence of kiore on Little Barrier means that there is no place where the species can be considered secure at present.

7. ABILITY OF THE SPECIES TO RECOVER

Mature *Dactylanthus* plants generally flower profusely providing they are protected from browsing animals, and female inflorescences will usually produce large quantities of seed if the flowers are pollinated.

Protecting *Dactylanthus* plants from possums with simple exclosures has proved effective in allowing the plants to flower and produce seed. Hand pollination, although extremely effective at ensuring pollination, is probably not necessary if bats and rats are present in the vicinity and exclosures allow these animals access to the flowers. Rats sometimes browse the flowers and their numbers need to be reduced if damage occurs. Exclosures have assisted wood rose collectors in locating plants and should be camouflaged to reduce the chances of this happening.

Attempts to protect *Dactylanthus* flowers by controlling possum numbers have had limited success. There was a full crop of seed on *Dactylanthus* plants at one site near Pureora in the 1993 flowering season just after the area was treated with an aerial drop of 1080 and the same poison was placed in bait stations along the forest edge. The control operation was carried out to control the spread of bovine tuberculosis by possums. Unfortunately by the 1994 flowering season possum numbers had recovered sufficiently to enable them to destroy all the flowers. In the most successful year of possum trapping at a Mamaku site the level of seed production was approximately 10 % of that on a similar number of inflorescences protected with exclosures. Possums need to be kept at very low levels before and during the main flowering season before reasonable flowering success can be achieved. Continual movement of new possums into areas where control is being attempted is an ongoing problem.

Moth balls (naphthalene), black pepper, commercial cat repellent, and paint mixed with egg have been tried as possum repellents around *Dactylanthus* flowers but have not been successful. In a recent experiment a mustelid odour was found to be the most successful possum repellent for protecting pine seedlings (Morgan 1993) and could be worth trying on *Dactylanthus* flowers.

8. OPTIONS FOR RECOVERY

Five options for recovery are presented below. The options range from a do-nothing option to the ideal, option 4, which is probably not achievable.

OPTION 1: DO NOTHING.

This is not an acceptable option, as *Dactylanthus* can be expected to decline drastically over the next few years with many more local extinctions unless there is effective management. Within the next 10-20 years it will be extinct or very close to it.

OPTION 2: MANAGE THE SPECIES ON POSSUM AND KIORE FREE ISLANDS.

An important part of this option would involve eradicating kiore from Little Barrier Island, as it is the only island where *Dactylanthus* occurs. This would be an expensive operation but many other native species, both plant and animal, would benefit, including other endangered species such as the kakapo, tuatara and large lizards.

Dactylanthus could be transferred to other islands with suitable habitat, but the lack of pollinators may be a problem. Codfish Island is the only other island with short-tailed bats but kiore are also present. Islands with ship rats are a possibility but these rats are generally being eradicated from islands and there is the risk that they will destroy the inflorescences.

Dactylanthus seed probably takes at least six or seven years to germinate and grow into a mature flowering plant and it may take that long to determine whether the species has been successfully established.

OPTION 3: PROTECT PLANTS AT CAREFULLY SELECTED SITES IN AN ATTEMPT TO REPRESENT THE FULL RANGE OF REMAINING GENETIC DIVERSITY.

There is apparently considerable genetic diversity, both between and within sites, as indicated by the remarkable variation in flower colour.

The difficulty with this option is that we do not know which sites to select to cover the full range of remaining genetic diversity. Research could be carried out to determine this and sites selected accordingly. In the interim sites could be selected on a geographic basis.

OPTION 4: FULLY PROTECT PLANTS FROM POSSUMS AND OTHER DESTRUCTIVE ANIMALS AT ALL SITES.

Using exclosures or possum control techniques it should be feasible to protect some plants at each known site. One problem with using exclosures at some sites is the possibility

of drawing attention to the plants and having them dug up by collectors. There are, however, ways to reduce the risk of the plants being found.

Sites are on private, public and Maori land and in various stages of decline. Effective advocacy would be needed for sites on private land and some sites may be beyond saving, for example sites where only dead plants have been found in recent years. Populations at other sites with for instance plants of only one sex remaining may not survive even with intensive management.

OPTION 5: MAINTAIN THE SPECIES IN CULTIVATION.

Most flowering plant species can be maintained in cultivation, but cultivation is difficult when the plant is an obligate parasite. Only two or three small *Dactylanthus* plants are thought to have survived from many hundreds of seeds sown in 1990.

9. RECOVERY STRATEGY: GOAL AND OBJECTIVES

MANAGEMENT GOAL

To ensure the perpetuation of *Dactylanthus taylorii* in the wild and the maintenance of its genetic diversity and natural range.

Objectives

The following objectives are based on the assumption that options 2, 3 and 5 are selected.

Objective 1. As a minimum, to protect representative plants from possums, rats and other recognised threats at all known sites on land administered by the Department of Conservation.

Objective 2. Promote public interest and involvement in the recovery of *Dactylanthus taylorii*, encourage its protection on private land.

Objective 3. Advocate for the listing of *Dactylanthus taylorii* in CITES to prohibit the export of wood roses.

Objective 4. Obtain better information on the distribution, condition and trends of *Dactylanthus taylorii*.

Objective 5. Carry out or promote research on the propagation, genetics, ecology and protection of *Dactylanthus taylorii*.

Objective 6. Establish *Dactylanthus taylorii* on at least one island free of kiore and possums.

Objective 7. Establish *Dactylanthus taylorii* plants in cultivation for transfer purposes, research and public education, and establish a seed bank.

10. RECOVERY STRATEGY: WORK PLAN

To meet each objective and fulfil the management goal the following actions are required:

Objective 1: As a minimum, to protect representative plants from possums, rats and other recognised threats at all known sites on land administered by the Department of Conservation.

Explanation

Dactylanthus populations are generally declining and a strategy for holding their numbers is necessary until there is an improved knowledge of the species to enable careful selection of populations. Plants need to be protected from possum and rat browsing, wood rose collectors, cattle trampling and pig rooting.

Plan

Dactylanthus plants should be protected using exclosures or effective possum control, whichever is practical. Exclosures can be camouflaged if necessary. On Little Barrier Island where kiore are browsing the flowers, the plants should be protected with rat-proof exclosures. The flowers may need to be hand-pollinated if an exclosure constructed of fine mesh is used.

Outcome

This protection should ensure survival of the species at a number of sites until research results enable sites to be more carefully selected. Protecting the plants on Little Barrier Island will help ensure their survival until the kiore are eradicated.

Key personnel

Protection, Pest Control, Scientific and Field Staff in Auckland, Waikato, Bay of Plenty, East Coast, Hawkes Bay, Tongariro-Taupo and Wanganui Conservancies.

Objective 2: Promote public interest and involvement in the recovery of *Dactylanthus taylorii*, encourage its protection on private land.

Explanation

The assistance of the general public is essential if we are to prevent widespread loss of plants to wood rose collectors. There are land owners interested in protecting plants on

their property and many members of the public are willing and enthusiastic about assisting with this work. Under the Conservation Act, Reserves Act, and National Parks Act it is an offence to take a plant from land administered by the Department of Conservation.

Plan

To form a network of people, preferably a self-motivated "Friends" group, willing to assist with locating and protecting plants and to use publicity in the form of talks, displays, media releases, a poster, brochures or other handouts to inform the general public of the importance of conserving *Dactylanthus*, to seek their assistance with its protection from possums and collectors and to gain sponsorship for this work. The *Dactylanthus* - short-tailed bat relationship and the exploitation of *Dactylanthus* for wood roses provide focus points for publicity. The integration of publicity on *Dactylanthus* with other conservation-related activities will be encouraged; for example *Dactylanthus* is an excellent example of a plant at risk due to possum browsing. Publicity should be targeted at landowners with *Dactylanthus* on their property, wood rose collectors, hunters, possum trappers and others most likely to find *Dactylanthus* plants, conservationists and rural communities in *Dactylanthus* areas. Visits by DoC staff should be made to all retail outlets which sell, or have been known to sell, wood roses to discourage retailers from accepting wood roses for sale.

Outcome

Public awareness and support for the recovery goal, as well as a wider appreciation of conservation issues. Reduced collection of wood roses and protection of plants on some private land.

Key personnel

Advocacy personnel in Northland, Auckland, Waikato, Bay of Plenty, East Coast, Hawkes Bay, Tongariro-Taupo, Wanganui, Wellington and Nelson Conservancies, Public Awareness Unit staff, Queen Elizabeth II National Trust, and non-government organisations such as Royal Forest and Bird Protection Society, Maruia Society, and Botanical Societies.

Objective 3: Advocate for the listing of *Dactylanthus* in CITES to prohibit the export of wood rose.

Explanation

Collectors dig up *Dactylanthus* plants for interest and ornament, supplying wood roses for tourist and local markets. Listing under Appendix I of CITES would help curtail the export of wood roses by tourists.

Plan

At future CITES meetings, work towards the inciusion of *Dactylanthus* in Appendix 1 of CITES.

Outcome

No export of *Dactylanthus* plants from New Zealand.

Key personnel

Protected Species Policy Division.

Objective 4: To obtain better information on the distribution, condition and trends of *Dactylanthus taylorii*.

Explanation

Dactylanthus has been recorded in the past from many sites where it may still be present. Priority should be given to relocating old sites in Ecological Districts where it is currently not known to occur and to sites near or beyond the present limits of distribution such as Northland, East Cape, Hawkes Bay, Wellington and North-West Nelson. Given its apparent poor seed dispersal and the long isolation of widely separated sites these areas are likely to have genetically different populations. Monitoring is essential for understanding the population trends and rates of change.

Plan

Prepare a report for publication in the Ecological Management bulletin on survey methodology, collection of data at *Dactylanthus* sites and design of cages. For each location where *Dactylanthus* is found a rare plant survey form should be completed and sufficient details recorded to ensure the site can be relocated. Historic data will be distributed to relevant conservancies to follow up but enquiries should also be made to people likely to be familiar with *Dactylanthus* sites. The condition and trends of all protected populations should be monitored. The following areas which are listed by conservancy, are considered potential sites which could be worth surveying for *Dactylanthus:*

Northland Conservancy

Survey Omahuta Kauri Sanctuary and Waipoua Forest.

Auckland Conservancy

Survey sites near Mt Hobson (Great Barrier Island), at Warkworth and near the Huia Dam (Waitakeres).

Waikato Conservancy

Survey old sites on the Coromandel Peninsula between Port Charles and Cape Colville, near Crosby's Track (Kauaeranga Valley), Tawerau Forest, Headwaters of the Marokopa River, Hauhungaroa Range, Northern Pureora block/Waipapa Ecological Area.

Bay of Plenty Conservancy

Survey possible sites in the Waiotahi Valley, near Lake Rotoiti, Maungawhakamana, Mt Edgecumbe, Mamaku Plateau, Te Kopia Scenic Reserve and near Pohokura (near Napier-Taupo Highway).

East Coast Conservancy

Survey sites in the Waikura Valley, near Te Araroa at East Cape, Willow Flat (Mohaka) and sites near Waikaremoana.

Tongariro-Taupo Conservancy

Survey sites near Opoto Scenic Reserve and Kaimanawas (Access 10).

Hawkes Bay Conservancy

Survey sites near Puketitiri, above the Ngaruroro River near the Napier-Taihape Road and in the Ahimanawa Range near Tarawera.

Wanganui Conservancy

Survey sites on the Pouakai Range and other areas of Egmont National Park, Mangamahu (Whangaehu Valley), Hihitahi Forest Sanctuary, Waitaanga Conservation Area and Ngaurukehu Scientific Reserve.

Wellington Conservancy

Survey sites near Kaitoke, and Karapoti Road in the Akatarawa Valley.

Nelson Conservancy

Survey potential sites between the Patarau and Anatori Rivers, and near the Anatoki Forks Hut, Anatoki Valley.

Outcome

This information will help fill the gaps in our knowledge of *Dactylanthus* distribution. Any sites found will be important for the genetic diversity research and potential sites for long-term protection. Monitoring will indicate trends and provide data showing whether further action is necessary for the population to survive.

Key personnel

All conservancies listed above, non-government organisations such as Botanical Societies, Maruia Society, Royal Forest and Bird Protection Society, and other members of the public.

Objective 5: To carry out or promote research on the propagation, genetics, ecology and protection of *Dactylanthus taylorii*.

Explanation

Although seedlings of *Dactylanthus* have been established in cultivation their growth rate has been very slow and only a very small percent of the seed sown has germinated and established.

Currently, intensive long-term management of all *Dactylanthus* sites is impractical due to the number of sites. Information on the genetic diversity of the species could allow insight into patterns of gene flow and contribute to a selection of sites to be managed so that a representative portion of the species diversity is protected.

There is a need for new methods to protect plants from possums because wood rose collectors have found plants protected with exclosures, and methods such as trapping, using cyanide or aerial application of 1080 poison have serious disadvantages in many situations. Research is required to determine the effects of different densities of possums on flowering and seeding. The effects of other introduced animals such as rats, deer and goats also needs further research. The effectiveness of animals other than short-tailed bats as pollinators needs to be studied.

Plan

To fund/support research on:

- the propagation and genetic diversity of *Dactylanthus*.
- *Dactylanthus* ecology.
- repellents and various methods of reducing possum numbers using the presence of seed on *Dactylanthus* plants as an indicator of success. Accurate details need to be kept of any possum control operation in a *Dactylanthus* area and notes kept on the quantity of *Dactylanthus* seed produced.

Outcome

Improved cultivation techniques, faster seedling growth rates and better methods for controlling possums which could have benefits for a wide range of plants and animals. Increased understanding of the genetic diversity of *Dactylanthus* and information to assist the careful selection of sites to be managed over the long term, in order to maintain the genetic diversity and thereby the resilience of the population.

Key personnel

Science and Research Division, Estate Protection Policy Division, North Island Conservancies, John Barkla (coordination of monitoring on possum control operations), Chris Ecroyd, universities, nurserymen.

Objective 6: Establish *Dactylanthus taylorii* on at least one island free of kiore and possums.

Explanation

It may be difficult to ensure long term survival of *Dactylanthus* on the mainland, even with possum control, and establishing the species on islands could be an effective means for conserving the species. However, pollinators such as the short-tailed bat should be present, otherwise hand pollination may need to be carried out. Transferring *Dactylanthus* to such sites, and subsequent monitoring, would be of interest to members of the public and their involvement should be encouraged.

Plan

To eradicate kiore from Little Barrier Island and to select other islands free of possums and kiore but with suitable habitat for *Dactylanthus*, and to sow seed close to potential host roots or transfer infected host plants. Suggested islands include: Taranga (Hen), Lady Alice, and Whatupuke (Northland Conservancy), Fanal and Tiritiri (Auckland Conservancy), Cuvier, Red Mercury and Stanley (Waikato Conservancy), Mokoia and Mayor (Bay of Plenty Conservancy), Kapiti (Wellington Conservancy), Chetwodes (Nelson Conservancy). Islands must have an abundance of suitable host species, habitat which does not suffer severe drought, suitable pollinators present and no possums or kiore. The tangata whenua should be consulted before any transfers are undertaken and the nearest seed source should be used. A trial introduction of *Dactylanthus* should be attempted on at least one of these islands during the term of this plan.

Outcome

Dactylanthus will be secure from browsing damage at one or more sites.

Key personnel

Northland, Auckland, Waikato, Bay of Plenty, Wellington and Nelson Conservancies, tangata whenua, non-government organisations and other members of the public.

Objective 7: Establish *Dactylanthus taylorii* plants in cultivation for transfer purposes, research and public education, and establish a seed bank.

Explanation

Plants should be grown in cultivation and a seed bank established to support conservation of the species diversity, supply plants for establishment on islands, and provide material for scientific study and for advocacy purposes.

Plan

To establish a seed bank and cultivate plants in appropriate plant collections, but not to start a commercial trade in this species. Before a seed bank can be established research is needed to devise suitable germination tests and to find the best ways to store the seed.

Outcome

Plants established in cultivation would be used for transfers to islands, research, display, and together with the seed bank, help ensure that some of the genetic diversity of the species survives.

Key personnel

Chris Ecroyd, New Zealand Botanic Garden Network (Mike Oates).

11. RECOVERY STRATEGY : TIMELINE AND COSTS

Costs exclude DoC staff salaries but effort is given as person day equivalents. Shaded areas = high level of effort.

Financial Year	94/5	95/6	96/7	97/8	98/9	99/01	01/02	02/03	03/04	04/05
Protection of plants	500 hrs $3000	500 hrs $3000	500 hrs $3000	250 hrs $1500	250 hrs $1500	250 hrs $1500	250 hrs $1500	250 hrs $1500	250 hrs $1500	250 hrs $1500
Advocacy	200 hrs $7000									
CITES	80 hrs									
Survey	2000 hrs $1000	2000 hrs $1000	2000 hrs $1000	2000 hrs $1000	2000 hrs $1000	1000 hrs $500	1000 hrs $500	1000 hrs $500	1000 hrs $500	1000 hrs $500
Research - Germination	$5000	$5000	$5000	$5000	$5000					
- Predation reduction	$2000	$2000	$2000	$2000	$2000					
- Autecology	$10,000	$10,000	$10,000							
- Physiology	$10,000	$10,000	$10,000							
- Translocation techniques	$10,000	$10,000	$10,000							
- Genetics	When funds and personnel available $7000 over a 2 year period.									
Cultivation										
Translocations to safe islands				80 hrs $1000	80 hrs $1000	80 hrs $1000	40 hrs $500	40 hrs $500	40 hrs $500	40 hrs $500
Establishment of seedbank		$500	$100	$100	$100	$100	$100	$100	$100	$100
Promote development of legislation to protect threatened plants										
Recovery group meeting costs, consultation.	$2000	$3000	$3000	$3000	$3000	$3000	$3000	$3000	$3000	$3000

REFERENCES

Best, E. 1924. The Maori. Memoirs of the Polynesian Society, vol. 5.

Butcher, G.D. 1992. Report to Waikato Regional Council Rural Services Committee, Animal Health Board and Department of Conservation. Waikato Regional Council, August 1992, 9 p.

Cameron, E.K., de Lange, P.J., Given, D.R., Johnson, P.N., Ogle, C.C. 1993. New Zealand Botanical Society, threatened and local plant lists (1993 Revision). New Zealand Botanical Society Newsletter, 32: 14-28.

Cheeseman, T.F. 1906. Manual of the New Zealand Flora. John Mackay, Government Printer, Wellington.

Cheeseman, T.F. 1914. Illustrations of the New Zealand Flora. John Mackay, Government Printer, Wellington, Volume 2.

Daniel, M.J. 1976. Feeding by the short-tailed bat (*Mystacina tuberculata*) on fruit and possibly nectar. New Zealand Journal of Zoology 3: 391-398.

Ecroyd, C.E. 1993. In search of the wood rose. Forest and Bird 267: 24-28.

Hill, H. 1908. On *Dactylanthus taylori*. Transactions of the New Zealand Institute, 41: 437-440.

Hill, H. 1926. *Dactylanthus taylori*, Order Balanophoreae; Tribe Synomorieae. Transactions of the New Zealand Institute, 56: 87-90.

Hood, I. 1991. Dying *Dactylanthus taylori* in podocarp hardwood forest, Mamaku Plateau. Unpublished report, New Zealand Forest Research Institute Project Record No. 2803, 10 p.

Kuijt, J. 1969. The biology of parasitic flowering plants. University of California Press, Berkeley and Los Angeles, 246 p.

Macphail, M.K., and Mildenhall, D.C. 1980. *Dactylanthus taylori*: in North-West Nelson, New Zealand? New Zealand Journal of Botany, 18: 149-152.

McGlone, M.S., and Topping W.W. 1977. Aranuian (post-glacial) pollen diagrams from the Tongariro region, North Island, New Zealand. New Zealand Journal of Botany, 15: 749-760.

McGlone, M.S., and Topping W.W. 1983. Late Quaternary vegetation Tongariro region, central North Island, New Zealand. New Zealand Journal of Botany, 21: 53-76.

Molloy, J., Davis, A. 1992. Setting priorities for the conservation of New Zealand threatened plants and animals. Department of Conservation, Wellington. 44 p.

Moore, L.B. 1940. The structure and life-history of the root parasite *Dactylanthus taylori* Hook. f. The New Zealand Journal of Science and Technology, 21-22: 206B-224B.

Morgan, D., and Woolhouse, A.D. 1993. Evaluation of repellents to prevent possum browsing. Proceedings 46 th New Zealand Plant Protection Conference, pp. 302-306.

Naidoo, L.A.C., Drewes, S.E., Van Staden, J., and Hutchings, A. 1992. Exocarpic acid and other compounds from tubers and inflorescences of Sarcophyte sanguinea. Phytochemistry, 31(11): 3929-3931.

Servant, Father C. 1973. Customs and habits of the New Zealanders, 1838-42. Translated by J. Glasgow, edited by D.R. Simmons, A.H. & A.W. Reed, Wellington. 84 p.

APPENDIX 1: LIST OF HOSTS

BOTANICAL NAME		COMMON NAME
Aristotelia serrata		wineberry
Brachyglottis repanda		rangiora
Carpodetus serratus		putaputaweta
Coprosma arborea		mamangi
Coprosma grandifolia		kanono
Coprosma sp. (aff. *C. parviflora*)		small-leaved coprosma
Coprosma tenuifolia		
Coriaria arborea	(1)	tutu
Geniostoma rupestre var. *ligustrifolium*		hangehange
Griselinia littoralis		broadleaf
Hebe stricta	(2)	koromiko
Hedycarya arborea		pigeonwood
Melicytus ramiflorus		mahoe
Myrsine australis		mapou
Myrsine salicina		toro
Nothofagus sp.	(3)	beech
Phyllocladus trichomanoides		tanekaha
Pittosporum ellipticum		
Pittosporum eugenioides		lemonwood
Pittosporum ralphii		
Pittosporum tenuifolium		kohuhu
Pseudopanax anomalus		
Pseudopanax arboreus		fivefinger
Pseudopanax colensoi		mountain fivefinger
Pseudopanax crassifolius		lancewood
Pseudopanax edgerleyi		raukawa
Pseudopanax simplex		haumakaroa
Pseudowintera sp.	(4)	horopito
Quintinia serrata	(5)	tawheowheo
Schefflera digitata		pate
Streblus heterophyllus		turepo
Weinmannia racemosa		kamahi

New or unverified host record sources:

1. Arthur Little pers. comm.
2. Arthur Little pers. comm.
3. Cheeseman, 1914.
4. Nan Garland pers. comm.
5. Auckland Institute and Museum Herbarium specimen, AK 165701.

APPENDIX 2: GUIDELINES FOR USING AND CONSTRUCTING EXCLOSURES

LOCATION AND TIME OF YEAR

Exclosures should not be erected at sites where they are likely to assist wood rose collectors locate and destroy the plants. Buds can start emerging above ground in January, or even earlier depending on the site and how far the plant is buried, so to give protection for the duration of the flowering season plants should be protected from January, or earlier, to the end of April.

NUMBER OF EXCLOSURES PER SITE

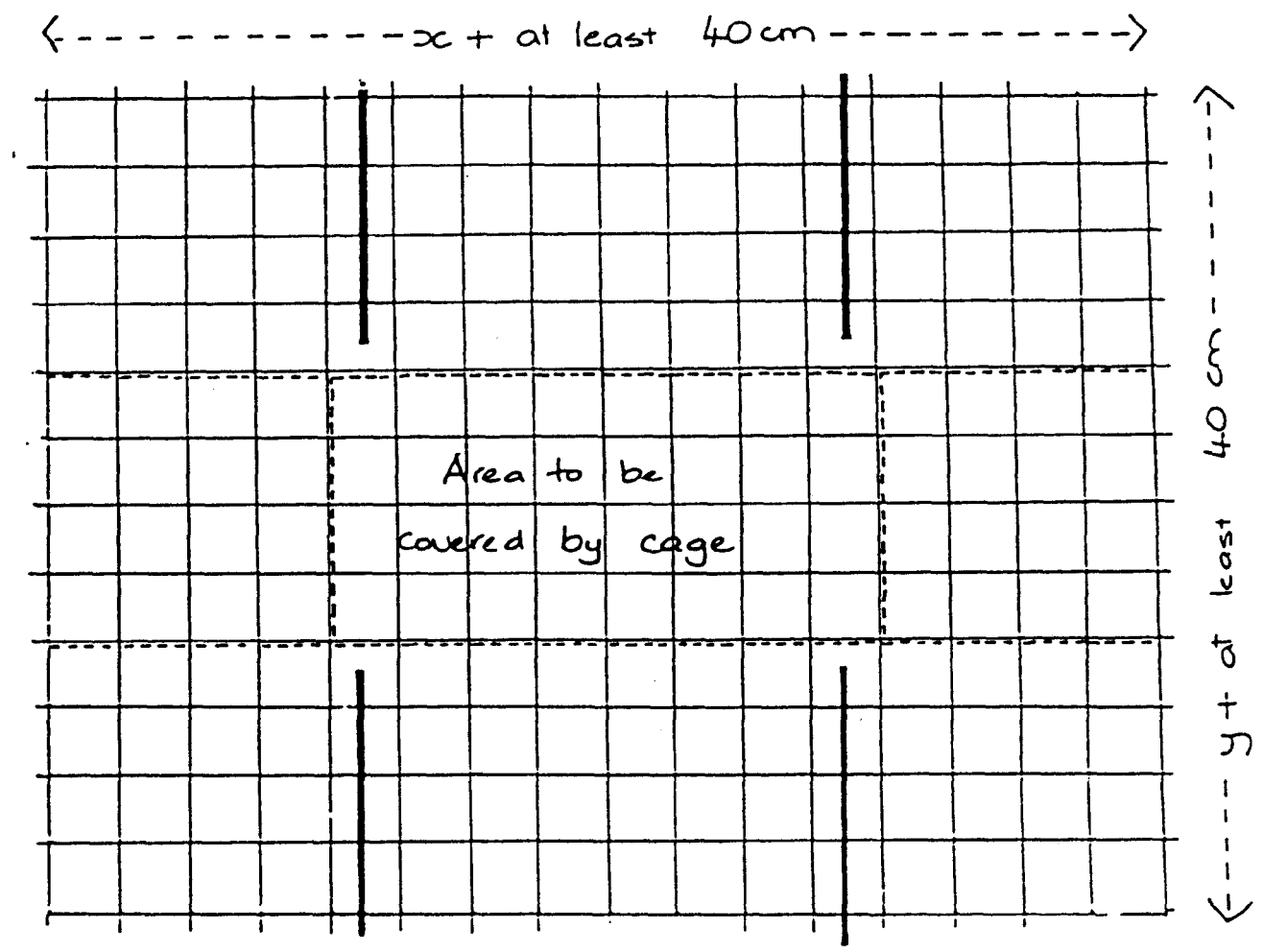
Sufficient exclosures must be erected at any one site to ensure at least one female plant is protected. There are more male plants than female and at least five, but preferably ten, exclosures should be erected at each site to ensure a female plant is protected.

MATERIALS REQUIRED

- Hurricane "Welfab" wire netting, available in 15 m rolls, 900 mm wide, 50 x 50 mm mesh and 1.6 mm or 2 mm gauge wire.
- 4 x 45 cm lengths of No. 8 (3 mm) or similar wire.
- Black and brown spray paint.
- Wire cutters.
- Identification tag.

CONSTRUCTION

1. Spray paint the wire netting black and brown while it is still in a roll. Ensure all sides of the wire are painted - turn the roll upside down after applying the first coat and spray the lower edges of the wire.
2. Cut the wire netting large enough to easily cover the *Dactylanthus* plants and allow sufficient for sides at least 20 cm high (see Fig. 2).
3. Cut four or five strands of wire in each corner so the corners can be folded in.
4. Fold the wire netting to form an open box. Bend sufficient cut ends to hold netting in shape.
5. Place netting over the *Dactylanthus* plant and secure to the ground with a loop of No. 8 wire through each corner. Make sure the wire does not go into a buried *Dactylanthus* plant or a root. Avoid gaps around edges of cage - block with litter or branches.
6. Tag the cage with a number and brief details of what the cage is for, complete a site location form and ensure sufficient details are recorded to easily relocate the site.



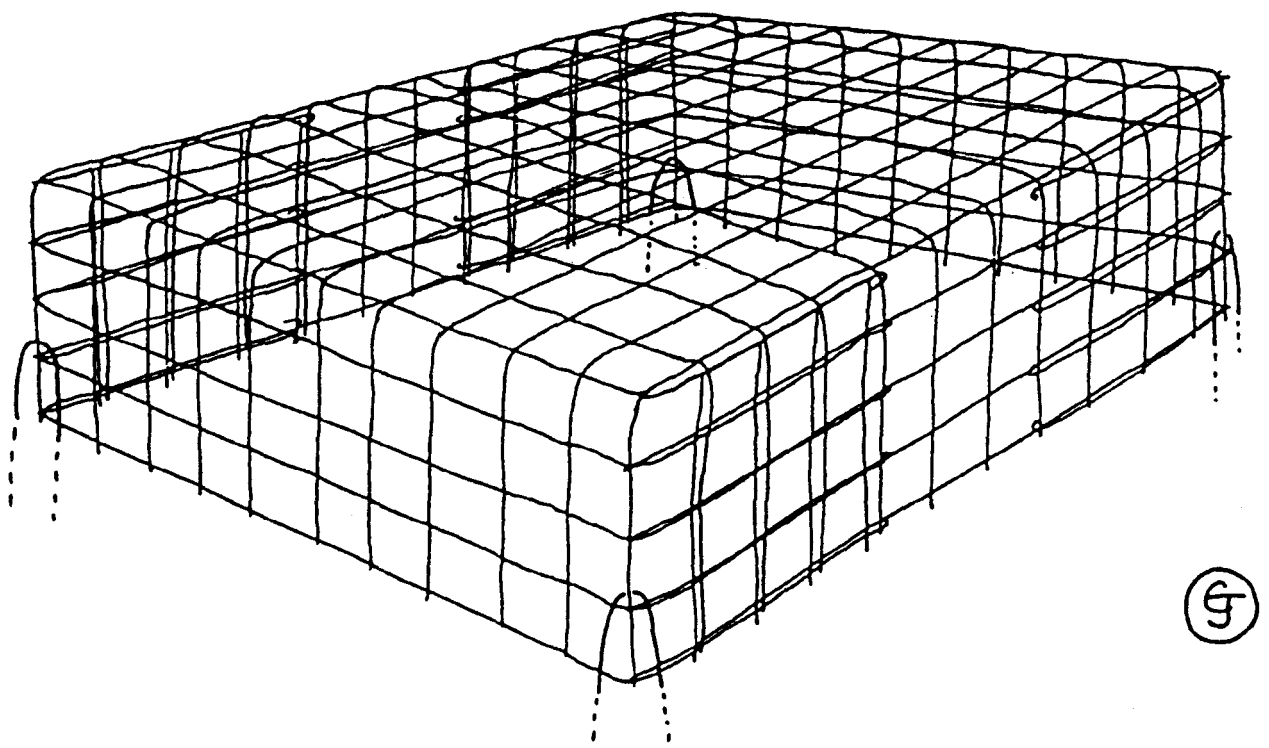


Figure 2. Construction of exclosure for protecting *Dactylanthus* plants from possums.

APPENDIX 3: KEY CONTACTS

Research

C.E. Ecroyd *
New Zealand Forest Research Institute
Private Bag 3 020
ROTORUA

W.B. Silvester
Department of Biological Sciences
University of Waikato
Private Bag 3105
HAMILTON

A. Holzapfel
Department of Biological Sciences
University of Waikato
Private Bag 3105
HAMILTON

Department of Conservation

C. Jones (Recovery Group Leader)*
Tongariro/Taupo Conservancy
Department of Conservation
Private Bag
TURANGI

J. Molloy *
Threatened Species Unit
Department of Conservation
P.O. Box 10 420
WELLINGTON

P.J. de Lange *
Science and Research Division
Department of Conservation
Private Bag 68908
Newton
AUCKLAND

Regional Contacts

L. Forrester
Northland Conservancy
Department of Conservation
P.O. Box 842
WHANGAREI

C. Smuts-Kennedy *
Little Barrier Island
C/- Auckland Conservancy
Department of Conservation
Private Bag 68908
Newton, AUCKLAND

J. Mason *
Pureora Field Centre
Waikato Conservancy
Department of Conservation
RD 7
TE KUITI

K. Owen *
Bay of Plenty Conservancy
Department of Conservation
P.O. Box 1146
ROTORUA

J. Barkla *
Wanganui Conservancy
Department of Conservation
Private Bag 3016
WANGANUI

G. Walls *
Hawkes Bay Conservancy
Department of Conservation
P.O. Box 644
NAPIER

S. Courtney
Nelson Conservancy
Department of Conservation
Private Bag 5
NELSON

Private Individual

J. Dodgson
Box 742
TOKOROA

D. King *
East Coast Conservancy
Department of Conservation
P.O. Box 668
GISBORNE

R. Empson
Wellington Conservancy
Department of Conservation
P.O. Box 5086
WELLINGTON

* Current Recovery Group members.

PUBLISHED RECOVERY PLANS

Dactylanthus taylorii ($15) . . . . . Approved 1995

Bat (Peka peka) ($15) . . . . . Approved 1995

Otago and grand skinks ($15) . . . . . Approved 1995

Giant land snail ($15) . . . . . Approved 1995

South Island saddleback ($15) . . . . . Approved 1994

Takahe ($15) . . . . . Approved 1994

Dotterel ($15) . . . . . Approved 1993

Tuatara ($15) . . . . . Approved 1993

Mohua ($15) . . . . . Approved 1993

Subantarctic teal ($15) . . . . . Approved 1993

Kowhai ngutukaka ($15) . . . . . Approved 1993

Chevron skink ($15) . . . . . Approved 1993

Black stilt ($15) . . . . . Approved 1993

Whitaker's and robust skinks ($15) . . . . . Approved 1992

North Island kokako ($15) . . . . . Approved 1991

Kiwi ($15) . . . . . Approved 1991

Yellow-eyed penguin . . . . . Approved 1991

Available: from Otago Conservancy,

Department of Conservation, Dunedin

Blue duck ($10) . . . . . Approved 1991

Available: *Science & Research Internal Report No.30*

Science & Research Division, Department of Conservation,

Wellington

Kakapo . . . . . Approved 1989

Out of print

Copies may be ordered from:

Department of Conservation

P.O. Box 10-420

Wellington, New Zealand