Ricardo Wurmus

72196 Introduction to New Zealand Ecology

Assignment 1

Contents

Task 1: Definitions

1 Ecology

Ecology is the field of science which focuses on the study of biological systems. Subject to scientific inquiry in this branch of science are not only the species that make up an ecosystem and their distribution, but also the dynamically changing interrelations between them and their biotic and abiotic environment.

According to Haeckel (1866) who coined the term *Oecologie*, the abiotic environment is represented by the "physical and chemical properties of the habitat, the climate…, anorganic nutrients" (translation mine, Haeckel, 1866, p. 286) and so on. Haeckel further describes the biotic environment as the sum of relations of one organism to all other organisms it may encounter and which are either promoting or threatening its existence.

Ecologists predict changes in ecosystems based on population dynamics, the flow of energy and materials in biological communities and the influence that the life processes of their members have on them.

2 Ecosystem

An ecosystem is an ecological system which is described by a habitat, the organisms which live in it and the interactions between the two. Dependent on geological features, a given ecosystem may encompass different environments, habitats, niches and micro-climates and may thus be composed of a great variety of interdependent species. In some ecosystems disturbances are common and lead to a successive change in the composition of the system, which over time favours a different community of species.

Representing a network of interdependent species, threats to a single species can have great impact on the whole ecosystem and push it out of balance, into a different stable state. Such restructuring changes can trigger extinctions as well as evolutionary radiations.

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Task 2

1 New Zealand Sea Lion (*Phocarctos hookeri*)

Common name	New Zealand sea lion (or Hooker's sea lion)
Māori name	Whakahao
Scientific name	*Phocarctos hookeri*

1.1 Species Description

The New Zealand sea lion (*Phocartos hookeri*) belongs to the family of Otariidae (eared seals) and exhibit remarkable sexual dimorphism. While adult female specimens of *P. hookeri* are on average about 180cm long and weigh between 90 and 165kg, adult males are a lot bulkier and heavier—bulls can reach a length of about 350cm and may weigh in excess of 400kg (Perrin, Wursig, & Thewissen, 2008, p. 763). Newborn pups are about 75cm long and weigh about 10kg (Jefferson, Webber, Pitman, & Jarrett, 2007, p. 333). They are covered in dark brown fur and have a strip of lighter hair on the top of their heads. This coat is shed when the pup reaches two months of age and is replaced by grey and pale tan fur. This colouration characterises both juvenile sea lions and females. As male sea lions mature, their fur turns dark brown and coarse hair around their wide necks forms a conspicuous mane (Jefferson et al., 2007, p. 332).

P. hookeri have short, wide snouts with short whiskers.

1.2 Habitat

The New Zealand sea lion is endemic to New Zealand and has only a few breeding sites on the subantarctic islands south of the mainland, with the most productive one being on the Auckland Islands.

A marine mammal, the New Zealand sea lion forages in the subantarctic sea in coastal and oceanic waters (Gales, 2008). Capable of diving in depths of more than 120m (Perrin et al., 2008, p. 764) it catches prey both near the surface and on the bottom of the epipelagic zone.

Sea lions are known to haul out on sandy beaches and rocky shorelines throughout the year. During the breeding season, females alternate foraging trips with stays on the beach where they feed their pups.

Between foraging trips, individuals can move long distances inland. During population surveys, tracks of sea lions were traced leading uphill and into dense vegetation (Wilson, 1979; Maloney et al., 2009).

1.3 Distribution

The New Zealand sea lion is endemic to New Zealand and has a very restricted range which is centred around the subantarctic islands of New Zealand. According to estimates by B. L. Chilvers, Wilkinson, and Childerhouse (2007), the breeding sites at the Auckland Islands attribute to about 86% of the total annual pup production. There are two other important breeding sites at Campbell Island where most of the remaining 14% of all pups are born (Maloney et al., 2009).

According to Childerhouse and Gales (1998), fossil remains of New Zealand sea lions throughout the mainland demonstrate that their range before human settlement in New Zealand extended much farther north than today. Sea lion remains have been found as far north as Hawke's Bay.

1.4 Threat classification

P. hookeri is considered a threatened species and is listed by the New Zealand Department of Conservation as 'Nationally Critical' (Baker et al., 2010) with the qualifiers 'Range Restricted' and 'Conservation Dependent'.[1]

Childerhouse and Gales (1998) argue that human predation has been the main cause of decline in sea lion abundance. The discovery of fossil bones at more than 40 sites of former Māori middens suggests that the first human inhabitants of New Zealand hunted sea lions (as cited in Childerhouse & Gales, 1998).

Shortly after their arrival in New Zealand, European settlers quickly began to commercially exploit sea lion populations which led to a dramatic reduction in population size by 1830 (Childerhouse & Gales, 1998, p. 4). By the end of the 19th century efforts were made to shut down seal fisheries and prohibit the sealing of *Phocarctos hookeri* (Childerhouse & Gales, 1998, p. 5). By that time only sea lion populations on inaccessible offshore islands had survived.

Despite the ban on sealing and conservation efforts throughout the decades, human interaction continues to threaten the New Zealand sea lion populations. Research by B. L. Chilvers (2009) indicates that sea lions are competing with one another for prey animals which are in limited availability due to fishing, which could be a reason for the decline in pup production.

Trawl fishing poses another threat to sea lions. Entanglement in trawling nets causes a significant number of sea lions to drown every year (B. L. Chilvers, 2008).

1.5 Current status

As *P. hookeri* were reduced to very low numbers following human predation in the 19th century, recovery has been a slow process. The pup production on the Auckland Islands has been

[1] See Townsend et al. (2008, pp. 28-29) for an explanation of these qualifiers.

in steady decline since 1998 (Department of Conservation, 2009, p. 11) with only 1501 pups born in 2009. Due to the small population size, colonies are especially vulnerable to disease and are likely to further decline.

Resource competition with fisheries and fisheries-related by-catch are considered to be the major drivers of this decline (Robertson & B. L. Chilvers, 2011). Under the Fisheries Act (1996) the Ministry of Fisheries annually imposes a fishing-related mortality limit (FRML) for *P. hookeri* on the squid fishing industry. The limit for the 2010 fishing season has been reduced from 113 to 76 sea lions as a response to the low level of pup production (Ministry of Fisheries, 2009).

Trawl fisheries are using SLEDS[2], which are designed to help sea lions to escape from trawl nets to further minimize the risk of by-catch (Ministry of Fisheries, 2010). More research is needed to determine how effective these devices are.

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2 New Zealand Flax Snail (*Placostylus hongii*)

Common names	New Zealand flax snail, Hongi's turret snail
Māori name	Pupu harakeke
Scientific name	*Placostylus hongii*, also *Placostylus (Maoristylus) hongii*

2.1 Species Description

The New Zealand flax snail (*Placostylus hongii*) is a large nocturnal land snail with an elongated coiled shell. Dr A. Powell states the maximum shell height as 85mm with a maximum shell width of about 37mm (as cited in McGuinness, 2001, p. 104). The shell is covered with a thin dark-brown to acorn-brown coating (the periostracum) which reveals the chalky white base colour of the shell at some places in older specimens. The inside of the shell as seen at the aperture is normally red-orange, though Brook and McFadden (1998) describe a population with cream-coloured apertures, which was discovered on the Mokohinau islands in 1995.

Flax snails reach maturity at about five years of age and can live to more than 20 years (R. Parrish, Sherley, & Aviss, 1995, p. 10).

2.2 Habitat

As the name suggests, flax snails can be found under flax, but also under leaf litter and shrub thickets. Adult snails live on the floors of coastal broadlead forests and shrubland where they feed on shed leaves. Newly hatched snails climb up into trees and live on the underside of leaves until they are too large and heavy to stay there (R. Parrish et al., 1995, p. 10).

Flax snails thrive in wet conditions and they depend on sufficient moisture to mate and lay eggs, yet they seem to be capable of surviving in arid conditions, too (R. Parrish et al., 1995, p. 10).

2.3 Distribution

P. hongii is the most wide-spread of the flax snails of New Zealand and once inhabited several offshore islands, as well as the area north of Whangarei in Northland (McGuinness, 2001). Hayward and Brook (1981) argue that some of the populations on offshore islands (such as the Poor Knights Islands, the Great Barrier Island, Chickens Islands and Fanal Island) were introduced there by the prehistoric Māori who likely used them as an occasional food source.

While the Māori increased the range of the flax snails by likely translocating them from from Whangaruru to offshore islands (the Poor Knights Islands in particular) (Hayward & Brook, 1981; McGuinness, 2001), the introduction of mammalian predators (such as rats and possums) and grazers has had a devastating effect on the flax snails.

P. hongii populations on only seven sites are known to have survived, with the biggest remaining populations being on the Poor Knights Islands, Peach Cove (in the Whangarei area) and Whangaruru North (R. Parrish et al., 1995). All of the mainland populations are severely reduced and many of them are now extinct (R. Parrish et al., 1995; McGuinness, 2001).

2.4 Threat classification

Hitchmough, Bull, and Cromarty (2007) list *P. hongii* as 'Range Restricted' with the qualifier 'RC' (recovering). The surviving snail populations are isolated and many of them are rather small, which puts them at further risk of sudden extinction through stochastic events and predator invasion (Brook & McFadden, 1998).

Introduced predators, such as rats and possums, have been a major threat to the flax snails, but the snail populations are also negatively affected by habitat destruction and modification by introduced browsers and grazers like sheep, horses, cattle and pigs (R. Parrish et al., 1995, p. 9).

Forest clearing by the prehistoric Māori as well as the European settlers presumably destroyed much of the original habitat of the snails on the Poor Knights Islands and the mainland (Brook & McArdle, 1999).

2.5 Current status

P. hongii is currently being managed under the *Giant Snail Recovery Plan Placostylus spp., Paryphanta sp.* which has been approved in 1995. Management consists mainly of eradicating rodents, controlling of grazers and browsers by fencing to minimize further habitat destruction, and habitat restoration through planting projects (R. Parrish et al., 1995).

One of three populations at Tauranga Kawau Point is now extinct and the remaining two have been in decline as a result of predation by rats (Brook & McArdle, 1999).

While currently none of the offshore island populations are threatened by introduced predators, all remaining mainland populations of *P. hongii* are still vulnerable to predation by rodents and some still suffer from habitat modification by pigs and cattle (Brook & McArdle, 1999). The Department of Conservation seeks the cooperation with landowners to protect the colony on the Orokawa peninsula, which is located on privately owned land (R. Parrish et al., 1995, p. 19).

Attempts to breed *P. hongii* in captivity have been successful according to Stringer and Grant (2007), yet the snails failed to establish new populations after their release into the wild (Stringer & R. G. Parrish, 2008).

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Task 3: Report

The relationship of the root parasite *Dactylanthus taylorii* to pollinators and pests

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Summary

Introduction

This report examines the link between the endangered parasitic flowering plant *Dactylanthus taylorii* and its pollinators, as well as the implications these relationships have on conservation.

Background

Dactylanthus traversii is New Zealand's only fully parasitic flowering plant. Upon infection with dactylanthus, the host's root enlarges and forms a grooved disk known as 'wood rose'. Over the past decades, collectors of wood roses have contributed to the dramatic decline of the few and scattered dactylanthus colonies. Originally covering much of the North Island, populations have been severely reduced by browsing possums and rodents. Dacylanthus is listed as 'Nationally Vulnerable'.

The root parasite's main pollinator is the short-tailed bat, though many colonies depend on rodents for pollination, as there is little overlap of dactylanthus with populations of the endangered bat. As many colonies are failing to reproduce, further decline is to be expected.

Conclusions

After the eradication of rats on Little Barrier Island, there is now one population which is no longer acutely threatened. Most colonies on the mainland are subject to management by caging, hand-pollination and pest control. Cultivation of dactylanthus was successful in trials and is ongoing, but the establishment of new colonies has failed so far.

The application of 1080 might have a negative impact on the short-tailed bat and could reduce pollination success. As pest control must continue to ensure the species' recovery, alternative methods are being researched.

Recommendations

- Increase rate of hand-pollination for caged plants.
- Supplement declining colonies by cultivation.
- Research alternative methods for possum control.

1 Introduction

This report examines the link between the endangered parasitic flowering plant *Dactylanthus taylorii* and its pollinators, as well as the implications these relationships have on conservation.

2 Background

2.1 *Dactylanthus taylorii*

Dactylanthus taylorii[3] is a parasite which does not photosynthesise, but solely depends on the root system of its host for food (Aiken, 1957). *Dactylanthus* is a monotypic genus in the family *Balanophoreae* (T. Kirk, 1895, p. 493).

2.1.1 The Wood Rose

When dactylanthus seeds germinate, fine hairs connect to the vascular bundles of the host root (Shivamurthy, Arekal, & Swamy, 1981). In response the root enlarges and forms a petal-like surface with grooves radiating from the centre (Hill, 1926, p. 89), closely matching ridges on the parasite's tuberous rhizome. The expanded host root can reach a diameter of 30cm (Dawson, 1986, p. 66). This decorative deformation—the wood rose— attracts collectors who harvest the root, thereby killing the plant.

2.1.2 Plant Sexuality and Flowering

The plant grows in clusters, which makes distinguishing individuals difficult (C. E. Ecroyd, 1996, p. 82). The species is dioecious, but in rare instances inflorescences are bisexual (C. E. Ecroyd, 1996, p. 88). Male inflorescences outnumber female ones 7:1 (C. Ecroyd, 1995, p. 6).

The brown tuber which is attached to the host root is partially buried. In line with its Māori name "pua o te reinga" (Flower of the Underworld), dactylanthus only becomes visible when its flowers emerge from underground (C. Ecroyd, 1995) during the flowering season (February through May) (C. E. Ecroyd, 1996, p. 87). The bowl-shaped inflorescences produce large quantities of sweet scented nectar, which attracts pollinators but also rodents and possums (*Trichosurus vulpecula*) (C. E. Ecroyd, Franich, Kroese, & Steward, 1995). Rodents sometimes benefit dactylanthus by pollinating inflorescences (La Cock, Holzapfel, King, & Singers, 2005, pp. 6-7). Pollination by insects occurs but is almost insignificant (C. E. Ecroyd, 1996, pp. 89 and 96).

[3]The common name "dactylanthus" is used throughout this report.

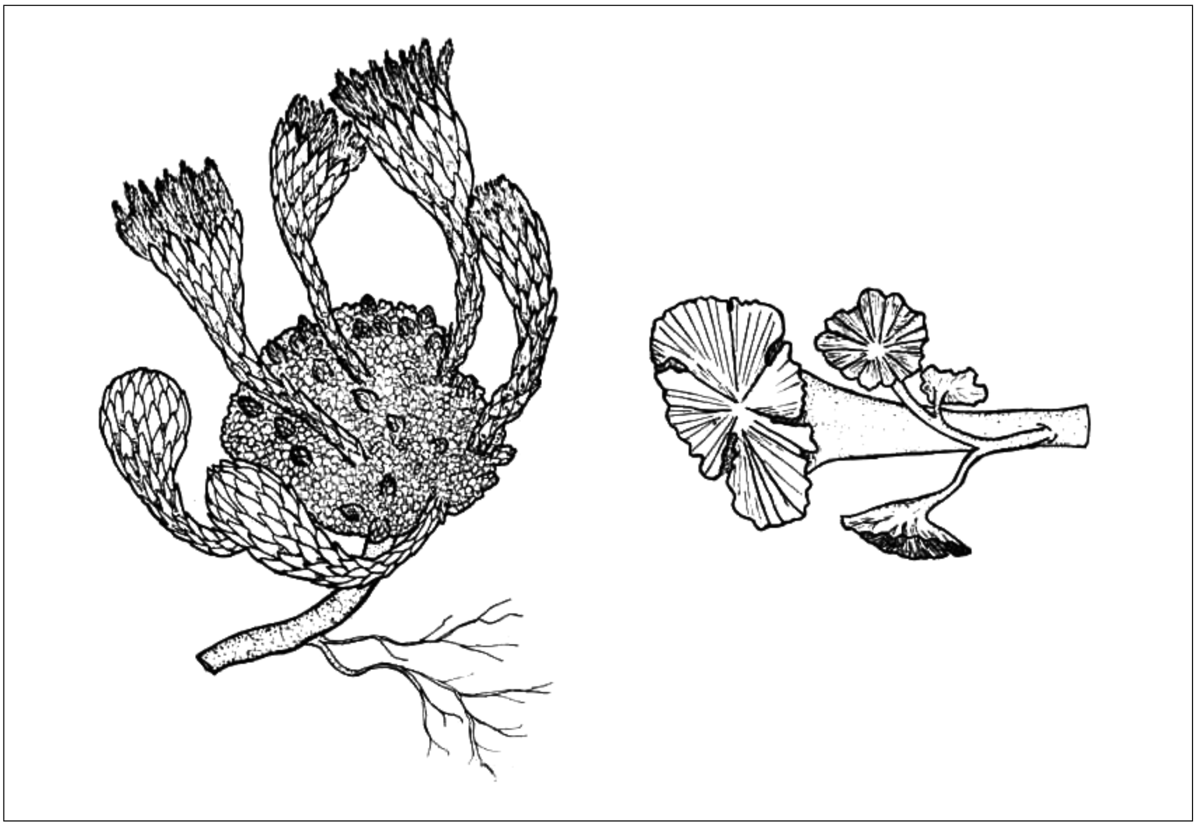

Figure 1: The warty tuber of *Dactylanthus traversii* with inflorescences *(left)* and the wood rose *(right)*; adapted from Aiken (1957).

2.1.3 Habitat and Distribution

About 30 host species are known, most of which are native shrub hardwoods (C. E. Ecroyd, 1996, p. 95) occurring on forest margins or disturbed forests. (C. Ecroyd, 1995; La Cock et al., 2005). Dactylanthus grows in a wide range of climates and altitudes and is usually found in damp but well-drained areas (C. Ecroyd, 1995, p. 5).

Pollen grains in lower sediments indicate a wide dispersal even as far south as Southland before human settlement (C. E. Ecroyd, 1996, p. 81), though no plants have been found there (La Cock et al., 2005, p. 8). Growing underground, new dactylanthus colonies are difficult to discover. Surveys on sites with historical reports of large colonies (see Hill, 1926, p. 89), however, have indicated a dramatic decline of the species in recent decades (C. Ecroyd, 1995, p. 3). Dactylanthus colonies are currently known at only a few scattered sites on the North Island and on Little Barrier Island (La Cock et al., 2005). The confirmed historic range of dactylanthus and its change over time is shown in Figure 2.

2.2 The Short-Tailed Bat

Only recently the short-tailed bat (*Mystacina tuberculata*) was confirmed as the primary pollinator of dactylanthus (C. E. Ecroyd, 1996). This endemic species of bat is adapted for terrestrial locomotion and feeds on the nectar produced by dactylanthus inflorescences (C. E.

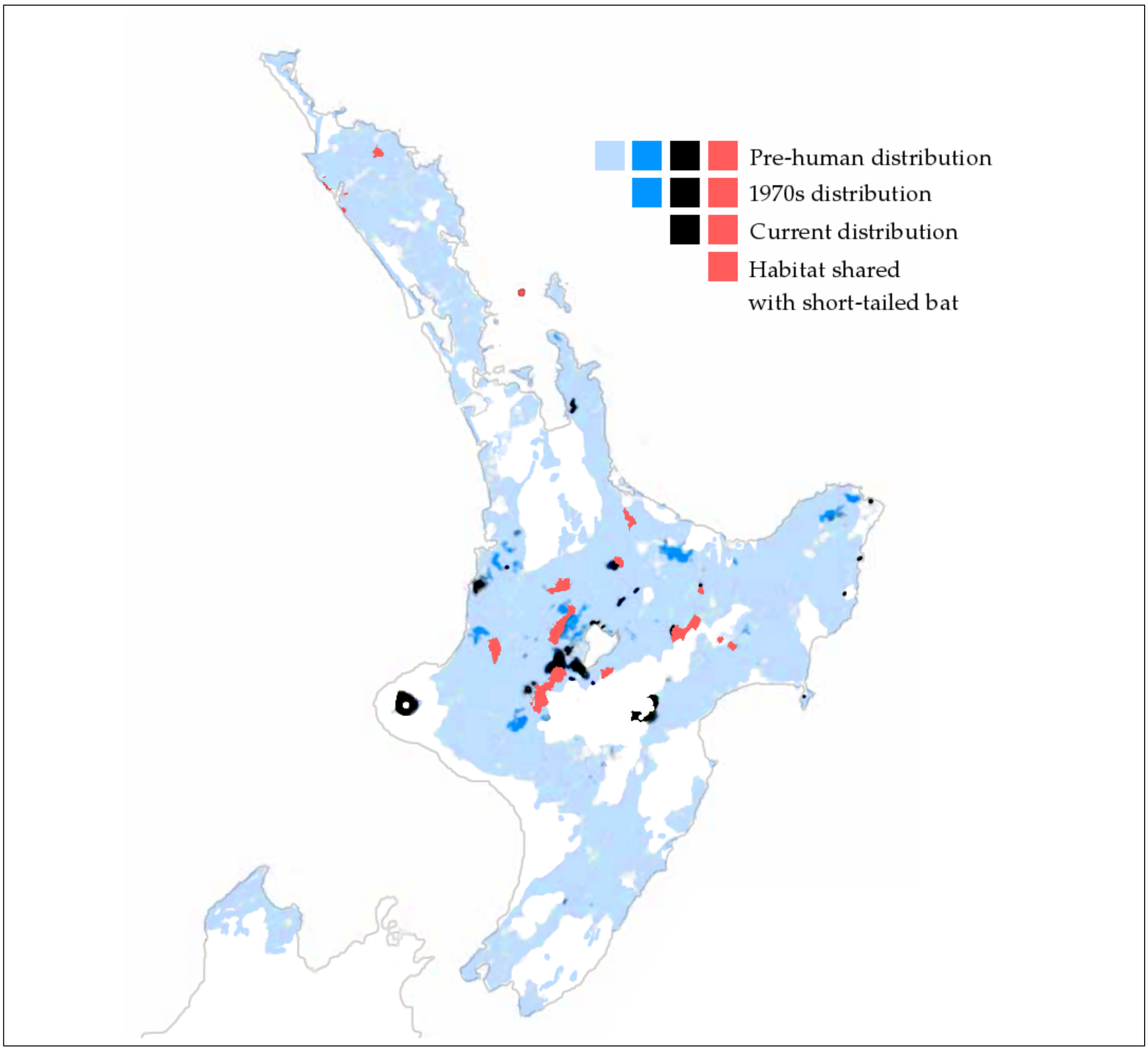

Figure 2: The historic distribution of *Dactylanthus traversii* and its change since human settlement. (Based on data from the Department of Conservation; adapted from *Environment New Zealand 2007*)

Ecroyd, 1996). On their long foraging flights the bats disperse pollen across their range (B. D. Lloyd, 2001, p. 73).

Like dactylanthus, the short-tailed bat is threatened with extinction. O'Donnell, Christie, Hitchmough, B. Lloyd, and S. (2010) report its status as ranging from 'Declining' to 'Nationally Endangered'. Predation and habitat loss are the main threats, though secondary poisoning following pest control operations might also be an issue (B. D. Lloyd & McQueen, 2000).

2.3 Threats to Dactylanthus Colonies

Though never considered a common plant, dactylanthus is now acutely threatened. P. de Lange et al. (2009) updated the threat rating for *Dactylanthus traversii* from 'Serious Decline' (Hitchmough, Bull, & Cromarty, 2007) to 'Nationally Vulnerable'[4].

[4]see appendix for qualifiers.

With only a few colonies within the range of the plant's primary pollinator (see Figure 2), many colonies depend on introduced pollinators, all of which are considered pests. A large number of populations will depend on hand-pollination or cultivation the more successfully rodents are controlled (C. E. Ecroyd, 1996, p. 96).

The most serious threat to remaining populations is browsing of inflorescences by possums and rats. The damage caused by rodents, however, is assumed to be partly offset by the benefit of occasional pollination (Holzapfel, 2005; Ferreira, 2005). Collecting of wood roses and poor health of forests with host species have also contributed to the species' decline (C. E. Ecroyd, 1996, p. 97).

3 Conclusions

Possum-proof caging has increased flowering and fruiting success significantly from 1994 to 2000 (Holzapfel, 2005, pp. 13-14). Aluminium exclosures and cages with tighter mesh sizes, however, have had a negative effect on dactylanthus as they excluded bats. Although caging plants on Little Barrier Island improved flowering success, the resilience of the dactylanthus populations did not improve as the cages impaired pollination (Ferreira, 2005).[5] To offset this effect, the rate of hand-pollination should be increased (Ferreira, 2005).

About 83% of all known populations are under protection, though some colonies on DOC-administered land remain unprotected, partly out of fear that cages might assist collectors in finding the plant (Holzapfel, 2005, p. 14).

3.1 Pest control

Pest control operations using the poison sodium fluoroacetate (1080) have effectively increased the number of intact inflorescences (C. E. Ecroyd, 1996), albeit only for one flowering season (Holzapfel, 2005). Trapping, poisoning with cyanide or pindone, and the application of possum-repellents had almost negligible effects on flowering success (C. E. Ecroyd, 1996, p. 93).

There is some concern that the application of 1080 may negatively affect the short-tailed bat (B. D. Lloyd & McQueen, 2000, 2002) and, in turn, pollination. B. D. Lloyd and McQueen (2002) could not show an increased mortality through secondary poisoning after a pest control operation with 1080, though the results may have been influenced by heavy snow fall before the operation (B. D. Lloyd & McQueen, 2002, p. 58).

In 2009 about 70 bats were found dying after a rodent control operation using anticoagulants (Scrimgeour, 2009), yet it is unclear whether the deaths were caused by the poison.

[5] The island was confirmed rat-free in 2006 after the paper was published (NZ Government Press Release, 2006).

Table 1: Planting of *Dactylanthus taylorii* on predator-free islands(La Cock et al., 2005). No colonies could be established.

Location	Conservancy	Planted	Reference
Tiritiri Matangi	Auckland	1998	La Cock et al., 2005
Whanga o Keno	East Coast / Hawkes Bay	1999	La Cock et al., 2005
Mokoia Island	Bay of Plenty	2000	Christensen and Sutton, 2007

Alternatives to 1080 and anticoagulants in rodent control are being researched (Eason et al., 2010).

3.2 Cultivation and establishment on predator-free islands

A primary objective of the recovery plans was to establish colonies on predator-free islands (C. Ecroyd, 1995; La Cock et al., 2005). This objective was met when rats on Little Barrier Island were completely eradicated in 2006 (NZ Government Press Release, 2006). Caging of plants which led to the exclusion of bats (Holzapfel, 2005, p. 14) is no longer needed there and the colonies are now able to recover.

Following successful seeding trials in 1989 and 1999 (Holzapfel & Dodgson, 2004, 2010), attempts have been made to establish colonies on three predator-free islands, though to date dactylanthus has not taken hold on any of the sites (see Table 1). As seeds on managed sites are in no rare supply (Holzapfel & Dodgson, 2004), declining populations could be supported by sowing.

4 Recommendations

- Increase rate of hand-pollination for caged plants.
- Supplement declining colonies by cultivation.
- Research alternative methods for possum control.

5 Appendix

The following qualifiers apply to the threat classification of *Dactylanthus traversii* (see A. J. Townsend et al., 2008):

Conservation Dependent
: Likely to move to a higher threat category if management ceases

Partial Decline
: Decline in most of its range, but a few secure populations remain

Recruitment Failure
: The age structure of seemingly stable populations hints at a dramatic decline in the near future.

Sparse
: Only small and widely scattered populations exist.

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