



Limestone Cress

Pachycladon exile (Heenan) Heenan et A. Mich.
Ischnocarpus exilis is an old name.

Castles in the hills



Cages over limestone cress plants. Alice Shanks

Quickfacts

One of a suite of endangered species that grow on limestone outcrops, most of which are new to science and some are as rare as only 9 plants.

Only known from one site in the Waitaki Valley

Conservation involves clearing weeds from limestone 'castles'

Defending limestone castles

Limestone is formed in shallow seas as the shells and skeletons of billions of small organisms accumulate over a long period of time and their combined weight presses them into a soft rock. As the earth's crust buckles, the new limestone is lifted above the waves and forms distinctive flat-topped and steep-faced landforms that are often eroded by water and wind into fantastical shapes. Limestone and marble (a tougher rock formed when huge pressures and temperatures are exerted on a limestone bed) are found in many areas throughout New Zealand, but significant examples occur in the Waitomo area, near Napier, near Kaikoura, in the Kahurangi and Paparoa National Parks, at Castle Hill between Christchurch and Arthurs Pass, in southern Canterbury between Timaru and the Waitaki Valley, and near Te Anau. Each of the limestone areas varies in the type of limestone present, the climate they experience and the plants that cover them. Limestone hills are very high in certain minerals, such as calcium, and are also very dry because water soaks through the soft limestone very quickly. These features, plus limestone's tendency to form castles and cliffs, makes limestone hills different from those formed from other rock types. New Zealand's limestones are often





quite old (the oldest being formed about 510 million years ago) and they are also old landforms – they are older than most of New Zealand's mountains and some landforms are possibly as old as 25 million years.

The combination of the unique physical and chemical properties of limestone and its old age created challenging new places for New Zealand's plants to grow, with a range of different species taking on that challenge. Over time, the limestone-inhabiting species evolved into new species and, as the limestone areas are widely separated, each area evolved a unique set of species. Plants or animals which only live on limestone are termed calcicoles by scientists, however most of New Zealand's limestone-inhabiting plants are more correctly termed basicoles, as they also occur on other rock types which are base-rich with a high calcium or magnesium content. On limestone, the specialist plants usually occupy the bare rock faces of escarpments and the narrow band of relatively bare limestone along cliff edges, probably because the flat tops of the limestone escarpments are inhabited by shrubs and then forests which change the chemical and physical nature of the limestone on which they are growing.

Unfortunately, limestone is also a useful rock. It is used to create cement, as a building material and as a fertiliser. Even more unfortunate is that it is easier to quarry limestone by starting at the bare escarpment face, which is precisely the area occupied by the endemic plants. Limestone areas are also fertile places and are often smothered by rampant weeds. This combination of vigorous weed growth and quarrying, combined with the effects of introduced browsing animals like hares, rabbits and sheep, has resulted in the majority of New Zealand's limestone-inhabiting plants becoming endangered. Currently 24 limestone species are at high risk of extinction, and at least one of these species is as rare as only 9 plants. Many of these are new to science and there is a high risk they will become extinct before we know much more about them.

Limestone cress is one of these highly endangered limestone-inhabiting plants. A small, delicate, cress growing to 10 cm tall, its leaves are greyish and hairy which camouflages it against rocks and protects it from dehydration. It occupies patches of small limestone pebbles and fines that are produced by weather fretting away at the limestone rock surface. It is thought to have once occurred on thin terrace soils in dry areas of Central Otago and the Waitaki Valley, but is now only known at one area of limestone castles near Kurow. Here a population of between 11 and 130 plants shares space with a number of other highly endangered plants on the 15 m tall limestone towers.



Limestone cress conservation

The uniqueness of the plants inhabiting the limestone castles near Kurow were first recognised in the 1990's by the botanist Brian Molloy. He revisited the area many times and found a total of sixteen species of endangered plants, and realised that some of these were probably new to science. Today, the site is thought to be the only home for six plant species (a seventh species, the grass *Poa spania*, has recently been found on a limestone outcrop at nearby Wai-o-Toura). Because of the extraordinary range of plants a Queen Elizabeth II (QEII) Covenant was established in 2000. The plants face a range of threats, including being swamped by red fescue grass *Festuca rubra*, cocksfoot grass *Dactylis glomerata*, mouse-ear hawkweed *Pilosella officinarum*, viper's bugloss *Echium vulgare* and stonecrop *Sedum acre*. For over a decade, Brian, QEII, and Department of Conservation (DOC) staff, supported by volunteers, have invested a great deal of time working to carefully hand-pull weeds and monitor and protect the endangered and unique plants. It is their efforts that prevented the extinction of any of these very rare plants.

When discovered, the population of limestone cress was estimated as less than 50 plants. In 1996, 36 plants were counted and in 2005, 21 plants, indicating a declining population, but an experimental translocation bolstered the population by 50 plants. This translocation showed that the ability of limestone cress to propagate naturally is limited by the very few seeds the plant produces, a lack of dispersal of that seed (wet cress seeds are dispersed through gluing themselves to passing animals), and by competition for space with weeds. An unsuccessful attempt has been made to reintroduce limestone cress to the Wai-o-Toura limestone escarpment by planting four plots of ten seedlings grown from seed of the captive population. Seed of limestone cress is held in the New Zealand Indigenous Flora Seed Bank as an insurance against its extinction.

In 2008, a plan for how to manage the plants at Awahokomo was produced. The objectives of this plan are:

- To train staff to identify threatened species,
- To improve communication with the landholder to minimize the risk of accidental aerial oversowing and top dressing ,
- To enhance habitat by hand weeding to provide additional habitat to new populations,
- To reduce herbivory by controlling rabbits and possums,
- To improve seed banking and collection systems, and to collect seed from threatened species,
- To conduct population census monitoring of threatened species,
- To increase the population size of threatened species by broadcasting seed into suitable habitat at the central limestone tower,



- To enhance habitat at other limestone outcrops in the covenant,
- To determine the taxonomic status of threatened species and the threat status of unranked species,
- To develop a coordinated approach to research,
- To improve knowledge of biology and ecology of threatened species to facilitate conservation.

Some of the limestone cress plants are protected under a mesh cage and some are held in cultivation by Landcare Research in Christchurch who is expanding their seed production. In an unexpected spin-off of the discovery of limestone cress, genetic studies have found that limestone cress is an ideal scientific subject for studying genetics and evolution on islands as it is closely related to the well-studied thale cress *Arabidopsis thaliana*.

What next?

The threats to the survival of limestone cress are:

1. Only being found at one site.
2. Limestone habitat prone to being swamped by weeds.
3. Low seed production and lack of seed dispersal.
4. Being eaten by possum, hares, rabbits and probably rodents.

Successfully protecting limestone cress from these threats must continue in order for the conservation programme to succeed. Ideally, this should be done by:

1. Maintaining weed-free zones around limestone cress.

Competition for space with weeds is the largest problem facing limestone cress and the other endangered plants, and removing weeds from the areas it grows is essential. This weeding needs to be done carefully to minimise the impact on the native plants. At the main site where most endangered plants are present the weeds need to be carefully hand-pulled, or cut below ground level with a sharp blade. The cocksfoot grass and viper's bugloss in the area surrounding the limestone castles should be spot sprayed to minimise reinvasion. The current DOC weed control programme must continue.

Increasing the amount of effort by recruiting more people into the existing weeding programme will increase both the conservation gains and share the load between more people. A careful watch must also be made for the arrival of weeds known to be problematic on other limestone sites such as wallflower *Cheiranthus cheiri*, alyssum *Lobularia maritima*, climbing saltbush *Chenopodium nutans* subsp. *nutans* and rough speargrass *Austrostipa scabra*. This weed control will need to be undertaken for at least



the next 10 years, with the emphasis on keeping sites weed-free.

The possibility of removing all weeds from the area known locally as Plateau 4, and including a 5 m wide buffer zone enclosed in a ring-fence, should be investigated.

Weeding at Awahokomo is currently being undertaken by DOC. Weeding is likely to cost \$52,000 over ten years.

2. Maintaining the rabbit proof fence.

Rabbits, hares and possums, attracted by fresh plant growth, should be prevented from moving onto the limestone towers by the existing rabbit proof fence. But, like any fence, it needs regular maintenance to ensure it continues to keep rabbits, hares and possums out.

Maintaining the rabbit proof fence is currently being undertaken by QEII and DOC. Maintaining the fence for ten years may cost \$8,400 (depending on wear and tear).

3. Keeping rabbits, hares and possums at zero densities within the fenced area.

Rabbits, hares and possums eat many of the endangered plants. They also dig up many plants. All three are fairly easy to shoot at night using spotlights, or by using Pindone®, and needs to be done when rabbit, hare or possum numbers increase to the point they become a pest within the fenced area.

Shooting of poisoning rabbits, hares and possums is currently being undertaken by DOC when required, though the fence keeps these animals out of the covenant. Regularly checking the fence costs \$400 per year and is currently being undertaken by DOC. Removing a population of rabbits, hares or possums that could invade the covenant if the fence fails is likely to cost approximately \$5,000.

4. Increasing the number of limestone cress plants.

Limestone cress has been successfully established by scattering seed over the area, and there is no reason why this should not be successful in other weeded areas. Producing sufficient seed to attempt this will require growing 100 limestone cress plants in cultivation at facilities where it cannot interbreed with related cress species. Limestone cress is reasonably easy to grow, but it is susceptible to powdery mildew and insect attack so will require careful attention. The seed from the cultivated plants would be harvested annually and scattered over weed-free sites during the weeding trips.



Maintaining a cultivated population of limestone cress for five years is likely to cost \$75,000, of which \$72,000 is the cost of labour which would likely be donated by the plant growers. The \$3,000 remainder is for purchasing cultivation materials and sending seed to be sown.

5. Creating large restored, weed-free limestone areas.

Infestation by weeds is the greatest threat faced by endangered limestone plants like limestone cress, and all lowland limestone outcrops are heavily infested by weeds. Careful hand-pulling of weeds around endangered plants is tricky, time-consuming and costly. What is needed is the ability to create large weed-free areas of limestone. Creating these areas using herbicides is technically feasible, but is complicated by the often steep nature of the terrain and the safety issue of working beside cliffs. This means the site would have to be evaluated as safe to work. Netting should be draped over some areas of the restored limestone escarpment to stabilise the soil, but the material for these must be carefully selected as some metals are biologically toxic. Direct application, using a weed wipe technique, of a selected herbicide that does not translocate to other plants through contact between roots should also be trialled at these sites. A system of movable aluminium walkways that protect the fragile soil surface should also be trialled. Plantings of native shrub and tree species along the base and behind the lip of the escarpment will both minimise reinvasion by weeds by intercepting wind-blown seed and begin the restoration of the wider limestone ecology. This technique should first be trialled at a site where the endangered plants are found only in a small area, such as at in the DOC reserve at Wai-o-Toura or in the QE II covenant at Blands Bluff (Canterbury).

Being able to clear weeds and restore limestone habitats will have great benefits for a number of endangered plants.

Creating two restored weed-free areas is likely to cost \$111,900 over five years.

6. Reintroducing limestone cress to other sites.

Increasing the number of sites inhabited by limestone cress will increase its security from extinction. Limestone cress was once more widespread, particularly in the Waitaki Valley where there are other limestone outcrops suitable for limestone cress. An attempt to reintroduce limestone cress to a site at Wai-o-Toura was unsuccessful, but it is not known why. Seeds of limestone cress should be scattered in weed-free shallow soil areas at other protected limestone outcrops like Earthquakes near Dunroon and Wai-o-Toura.



Reintroducing limestone cress to two other sites for 5 years is likely to cost \$7,100.

7. Avoiding oversowing and topdressing the limestone towers.

It is important that the limestone towers and immediate area are not included within the farm's aerial oversowing and topdressing work.

8. Regularly estimating the size of the reintroduced limestone cress population.

Previous experience has shown that it is very difficult and costly to accurately monitor the endangered plants on limestone bluffs as plants are small and inconspicuous and can be misidentified. The movement of people causing damage to the fragile habitat while counting plants is also a concern. For these reasons an estimate of the population size of limestone cress at the reintroduction site should be done annually (with the view that if there are a lot of plants then what is being done is working, but if there are very few plants then a rethink of what we are doing is required). This estimate should involve a stratified technique by firstly delineating population sites on an aerial photograph and then determining the number of plants at each site by counting individual plants (if there are few visible plants) or by estimating in ten's or hundred's if plants are common. The annual census of limestone cress at its original site should continue.

Estimating the limestone cress population size and analysing the data every year for ten years is likely to cost \$30,000.

More information

Website: New Zealand Plant Conservation Network - *Pachycladon exile*. [Link](#)

Website: NZ Indigenous Flora Seed Bank. [Link](#)

Book: Threatened Plants of New Zealand. By Peter de Lange, Peter Heenan, David Norton, Jeremy Rolfe, John Sawyer. University of Canterbury Press, Christchurch, 2010.

Report: Management plan for threatened species at Awahokomo Karstland QEII Covenant, Waitaki Valley, North Otago. By Kate Wardle. Unpublished report held by Department of Conservation, Twizel, 2008.

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Department of Conservation, Christchurch, 2005.

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Scientific paper: Molecular systematics of the New Zealand *Pachycladon* (Brassicaceae) complex: generic circumscription and relationships to *Arabidopsis* sens. lat. and *Arabis* sens. lat. By P.B. Heenan, A.D. Mitchell, M. Koch. New Zealand Journal of Botany Vol. 40, pages 543-562, 2002. [PDF](#)

Scientific paper: New species of *Poa* (Gramineae) and *Ischnocarpus* (Brassicaceae) from limestone, North Otago, South Island, New Zealand. By B.P.J. Molloy, E. Edgar, P.B. Heenan and P.J. de Lange. New Zealand Journal of Botany Vol. 37, pages 41-50, 1999.

Photos



Limestone castles. Mike Thorsen



Limestone cress plant in protective cage. Alice Shanks

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