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Threatened plant translocation case study:

Ricinocarpos brevis, Euphorbiaceae

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The Species

- Non-lignotuberous, long-lived upright shrub.
- Endemic to Western Australia, classified Endangered (*WA Wildlife Conservation Act 1950*; *Environment Protection and Biodiversity Conservation Act 1999*).
- Three extant natural populations that occur over 100 km range to the north-east of Perth.

Threatening Processes

- Mining and exploration (direct removal, indirect effects).
- Weed invasion.
- Predation (foliage and seed).
- Inappropriate fire regimes.

Deciding to translocate

As part of an offset package to mine and subsequently remove *R. brevis* individuals from banded ironstone habitat, Cliffs Asia Pacific Iron Ore (Cliffs) were required to undertake research with the aim of contributing a scientific understanding of the ecology and conservation of this threatened species.

Cliffs commenced field translocations (2010 and 2011) on natural and disturbed landforms (drilling areas) with limited success (Cliffs 2011, 2012). In 2013, a comprehensive research program commenced, undertaken in collaboration with Department of Biodiversity, Conservation and Attractions (Kings Park Science; formerly Botanic Gardens and Parks Authority) and The University of Western Australia.

Further translocation research on establishing *Ricinocarpos brevis* on waste rock landforms was undertaken to build upon the existing knowledge for this species and assist in establishing populations in disturbed mining areas. This served a specific Interim Recovery Plan action that identifies the opportunity for translocation as a conservation strategy (DEC 2011).

Aim of the translocation

The proposed translocation was to improve the understanding of methods to translocate *Ricinocarpos brevis* and assist in the establishment of new populations on waste rock landforms and/or other areas disturbed by mine-related activities. If deemed successful, further translocations could reduce the overall impact to the species and assist in preserving the number of known individuals in the wild. This is consistent with the intent of the *Ricinocarpus brevis* Recovery Plan (DEC 2011).

Translocation working group and key stakeholders

- Department of Biodiversity, Conservation and Attractions (Kings Park Science) – oversee the development and implementation of translocation (research program, translocation proposal, propagation of material, installation); ongoing monitoring of translocation sites; and reporting to Cliffs.
- Cliffs Asia Pacific Iron Ore – develop translocation proposal; support implementation and ongoing monitoring of translocation; maintenance of translocation sites; and reporting to the (then) Department of Parks and Wildlife and relevant stakeholders.
- The University of Western Australia (School of Biological Sciences) – develop the experimental approach, analyse the data and report research findings.
- Department of Biodiversity, Conservation and Attractions (formerly Department of Parks and Wildlife) – advice on development and approval of translocation proposal.

Biology and Ecology

- Insect pollinated and monoecious.
- Long-lived (>100 years).
- Myrmecochorous (ant) and gravity seed dispersal.
- Physiologically dormant seeds.
- Application of germination stimulants (gibberellic acid, smoke water, karrikinolide) promote germination (Turner *et al.* 2018).
- Occurs on rocky outcrops and ridges associated with ironstone or basalt, in shallow or deep soils.
- Soil moisture is the primary driver of seedling emergence (Turner *et al.* 2018).

Site selection

Recipient sites (disturbed) for experimental translocations were selected based on:

- Being close to natural populations.
- Land tenure and risk of future mining activity.
- Safe and ongoing accessibility to sites.
- Landscape aspect.
- Rehabilitation stage of waste rock landform.
- Physical and chemical assessment of soils.
- Capacity to install infrastructure (e.g., irrigation).

Translocation proposal

A translocation proposal was developed by Cliffs in consultation with Kings Park Science to guide and provide justification for the translocation and the overall scientific approach. The proposal was submitted to (then) Department of Parks and Wildlife where it was independently reviewed. The proposal met the policy requirements on experimental plant translocations and was subsequently granted approval to proceed. Translocation approval conditions included submission of an annual report as well as additional proposals outlining any future translocation work.

Pre-translocation preparation, design, implementation and ongoing maintenance

Waste rock landforms were prepared to a mining standard that requires landform stability (i.e., erosion control) and a restoration standard that includes ripping to alleviate compaction, application of topsoil and surface sown seeds of local native species.

Provenance of material for translocation was determined by the species population genetic structure (Krauss *et al.* 2011) and material was collected under strict conditions. Material for translocation could only be sourced from the nearest natural population. To protect the sustainability of the natural population, limited material was collected from each plant for a proportion of the population.

Experimental translocations were designed to compare the success of tubestock planting and direct seeding. Tubestock experiments used 24 plants per treatment and tested up to five treatments in each translocation year. Treatments investigated to determine tubestock survival included shading, fertiliser, irrigation, propagation source (seed or cuttings), plant age, water holding crystals and biodegradable pots. Direct seeding experiments, used eight replicates of 25 seed for each treatment and tested up to six treatments each year. Treatments that were investigated included aspect (north or south-facing), shade, irrigation, seed burial, seed enhancement (priming or pelleting) and water holding crystals. Each replicate (tubestock or seed) was individually fenced to protect against herbivory (Figure 1).

Figure 1. Plant guard mock up used for the *R. brevis in situ* experimental seeding trial. Top left: wire guard + wooden stakes; Bottom left: wire guard + shadecloth + wooden stakes; Top right: wire guard + wooden stakes – top view and; Bottom right: wire guard + shadecloth + wooden stakes – top view. Photo: Shane Turner

Experimental translocations were implemented yearly from 2013–2017 on two waste rock landforms. An automated, gravity fed irrigation system was maintained for one year (typically on one half of the experiment) to ensure one summer of supplemental watering for each year's translocation program. Cliffs maintained the irrigation system, and controlled weeds and pests on all sites to ensure the best possible outcome.

Monitoring and evaluation

Intensive monitoring of tubestock and direct seeding was conducted regularly after installation – at 1–2 months (late autumn); 4–5 months (spring); 7–8 months (early summer); 9–10 months (late summer) and 12 months (early autumn) for every year of the translocation program. Monitoring involved quantification of seedling emergence, survival, growth, health, and reproduction.

Evaluation showed that shading, irrigation and older tubestock increased seedling emergence, survival, plant health and growth. However, the magnitude of these increases depended on seasonal rainfall, as these approaches were more effective in better rainfall years. For example, overall seedling emergence (autumn to spring) for 2015 was lower (1.7%) than 2016 (4.5%), despite experimental irrigation, and was most likely affected by reduced rainfall over this period (2015 was 54% below average and 2016 was 13% below average).

Translocated plants have been observed to produce flowers (male and female), and insects have been observed visiting flowers.

Subsequent actions

This research will be incorporated into a restoration manual that outlines the best approaches, monitoring procedures and key targets for the future translocation and restoration of *R. brevis* to offset losses due to mine-related activities (Elliott *et al.* 2018).

Outcomes

Ricinocarpos brevis has a viable conservation strategy developed and optimised for the ongoing protection and management of the species, in the form of translocations on waste rock landforms.

What we learned

- Knowledge of population genetic structure is important for making informed decisions on sourcing material.
- It is possible to establish *R. brevis* on waste rock landforms from tubestock and seed.
- Soil moisture is the primary driver of seedling emergence, establishment and plant survival.
- Shading and irrigation improved establishment, growth and survival of tubestock and seedlings.
- Older tubestock (8–18 months) establish better than younger tubestock (<6 months) due to reduced impact on root systems during planting.

Figure 2. *Ricinocarpos brevis* translocation images. Top left: Translocation set up on waste rock landform, with gravity-fed irrigation (2017 translocation); Bottom left: Seventeen month old greenstock plant (2015 translocation); Top right: Newly emerged seedlings (~2-3 months old) *in situ* (2016 translocation); Bottom right: Two year old seedling that emerged *in situ* (2015 translocation). Photo: Carole Elliott

- Greater survival of tubestock derived from seed rather than cuttings.
- Investment in research provides critical information for successful plant establishment and an experimental framework that identifies and refines the best approach for future translocations.

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Threatened plant translocation case study:

Prostanthera eurybioides (Monarto Mintbush), Lamiaceae

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The Species

- Small, erect, aromatic, perennial shrub with violet flowers during spring (Figure 1).
- Endemic to South Australia.
- Two disjunct populations at Monarto (near Murray Bridge) and Mount Monster Conservation Park (near Keith).

Threatening Processes

- Habitat loss and fragmentation through agricultural development and quarrying.
- Weed competition.
- Herbivore grazing.
- Lack of natural recruitment, particularly at Monarto.

Deciding to translocate

Approximately 1200 wild plants were estimated to occur in the Monarto and Mount Monster populations in 2010 (Pound *et al.* 2010). The species is listed as Endangered under the Australian Commonwealth *Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)*, and Critically Endangered under IUCN criteria.

Figure 1. *Prostanthera eurybioides* in flower. Photo: M Jusaitis

Translocation trials were conducted at both population centers with the aim of enhancing natural populations while at the same time testing various techniques and management options (Jusaitis 2010). This case study focusses on a trial originally designed to examine the influence of herbivory on translocant establishment, but long-term monitoring additionally revealed an intriguing interaction of climate with herbivory (Jusaitis 2012).