ERA Energy Resources of Australia Ltd

Revegetation Strategy and Practice at Ranger Uranium Mine

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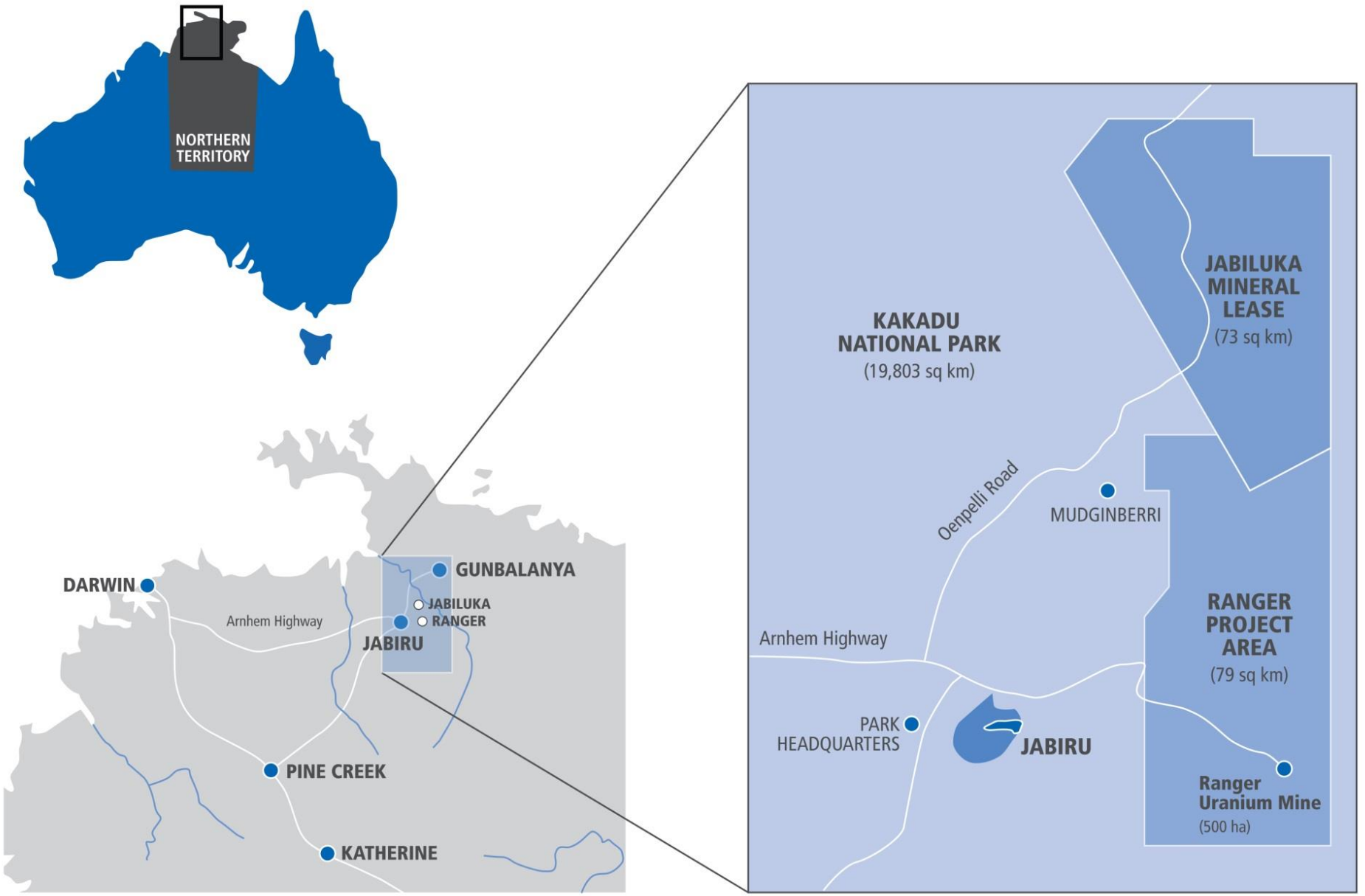
Acknowledgement of Traditional Owners

- The operations of Energy Resources of Australia Ltd (ERA) are located on Aboriginal land and are surrounded by, but separate from, Kakadu National Park.
- ERA respectfully acknowledges the Mirarr, Traditional Owners of the land on which the Ranger mine is situated.
- ERA respectfully acknowledges the Larrakia people, Traditional owners of the region where we are meeting.

Our Location



Introduction to ERA

- **ASX listed – 68.4% owned by Rio Tinto**
- **Mining commenced in 1981 and ceased in 2012, processing of stockpiled ore will cease by January 2021**

- **Rehabilitation involves:**
  - Dredging over 24 million cubic metres of tailings into pits
  - Moving over 90 million tonnes of material to create the final landform

Revegetation Scope

950 ha area to be rehabilitated before 2026

- 760 ha waste rock final landform
- 190 ha irrigated woodland areas
- Over 1.2 million trees and shrubs will be established

Rehabilitation Objectives

- **Revegetation of disturbed areas:**

  "using local native plant species in similar density & abundance to … adjacent areas of KNP"

  "form an ecosystem the long-term viability of which would not require a maintenance regime significantly different for that appropriate to adjacent areas of the Park"

  (Ranger Authorization)

Similar to Reference Sites

- The Ranger final landform will be constructed with waste rock.

- The waste rock substrate has no exact analogue/reference site in the surrounding environment, yet will largely dictate what final revegetation will be achievable.

- A conceptual reference system will be established based on a large data set from vegetation sites in adjacent natural areas, including some rocky sites within the KNP, with due consideration of climate change.

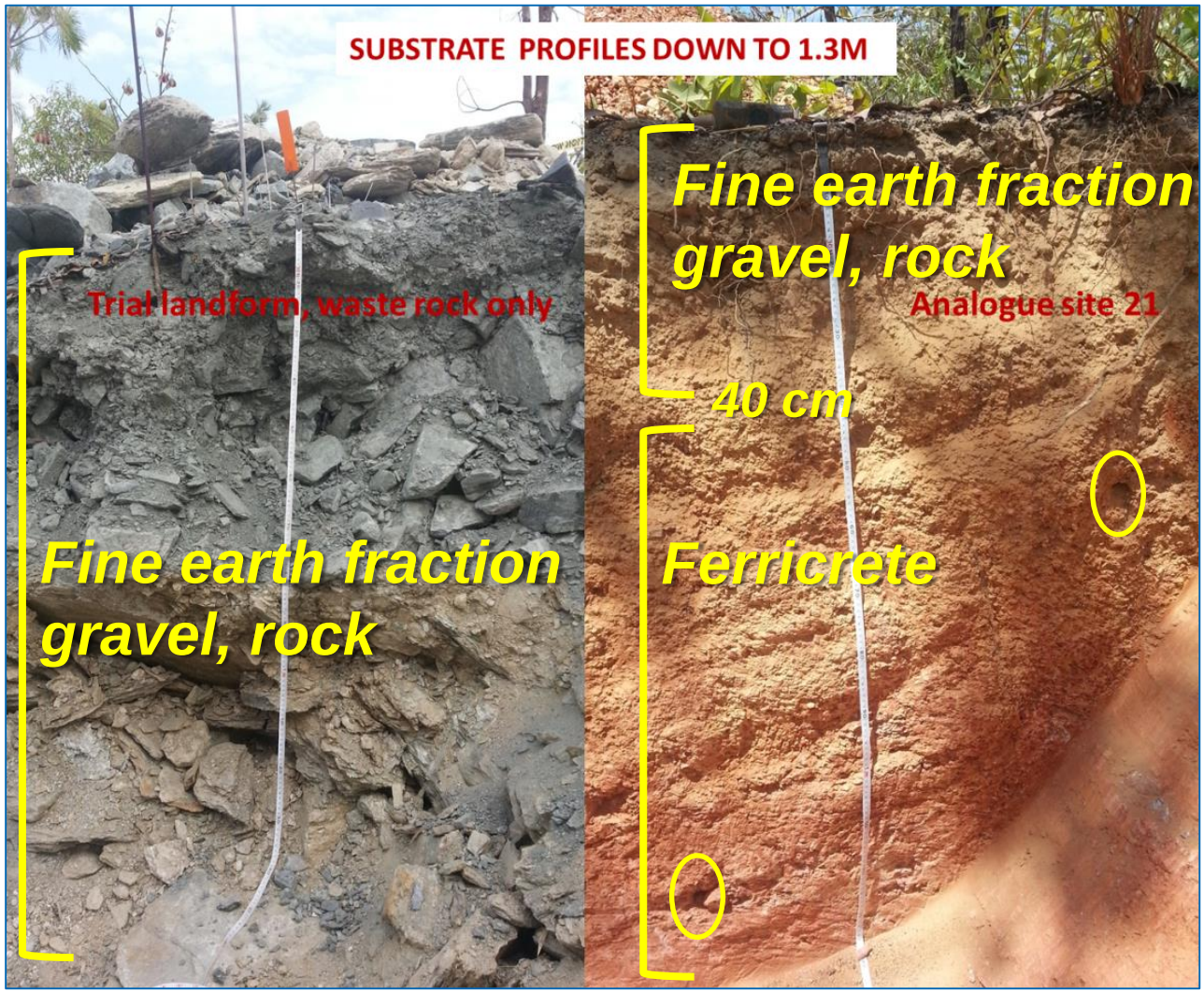
A Challenging Environment for Revegetation

- **Climate**
  - Strong seasonality (6 months dry, >1500mm wet season)
  - High inter-annual rainfall variability (consecutive *dry* years)
  - Extreme events (eg cyclones)

- **Physical and biological condition of the final landform**
  - High wild fire and weed pressure in the KNP
  - Hostile waste rock growth medium (no soil)
    - Temperatures
    - Difficult plant available water
    - Near zero organics and microbial populations

Limitations of Waste Rock

The waste rock substrate is fundamentally different to local substrates



ERA's Revegetation Strategy

- **Based on**
  - Over 30 years of research and trials
  - The ecology & dynamics of the local natural vegetation

- **Initial formal endorsement of the Strategy by stakeholders in 2004**

- **Continues to be developed including ongoing monitoring, research and stakeholder consultation**

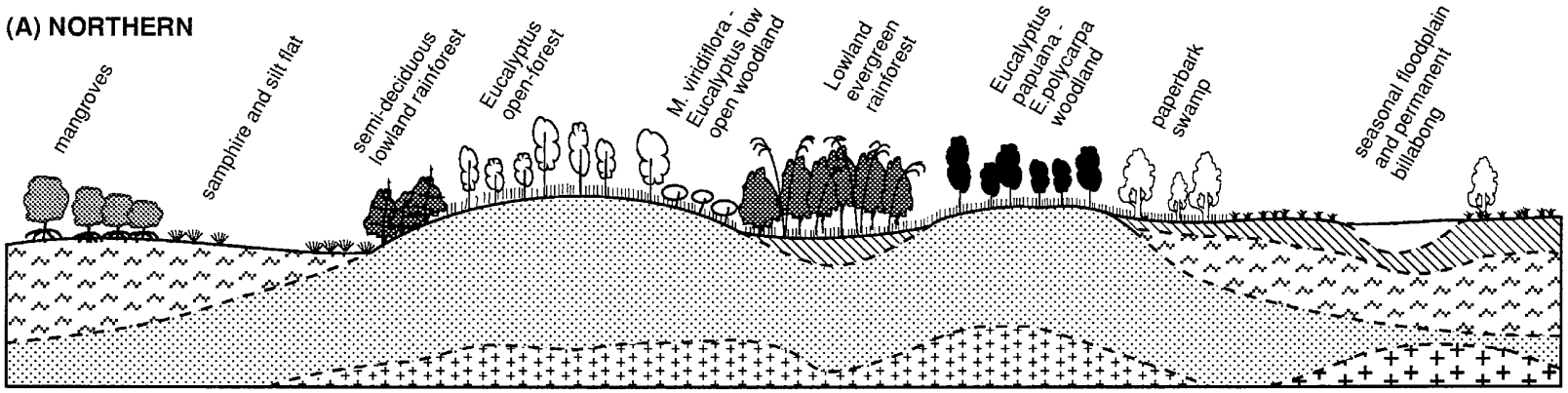
Ecology & Dynamics of the Natural Vegetation

Main considerations:

1. Landscape-vegetation relationships
2. Vegetation structure & composition
3. Vegetation dynamics

1. Landscape-vegetation Relationships

- **Vegetation distribution patterns occur at a number of scales and are influenced by:**
  - Geomorphic & edaphic features
  - Site hydrology
  - Nutrient availability & soil chemical limitations
  - Fire frequency
  - Other contingent factors (proximity, local historical events, etc)



2. Vegetation Structure & Composition

- **Multi-strata, spatially heterogeneous, ecosystems**
- **Long-lived 'framework' species**
  - Control most site water & nutrient resources
  - Provide core habitat values for other plants & animals
  - Critical for functioning & stability of the ecosystems
- **Other species, especial in the ground layer**
  - Highly variable: inter-annual & between site measures
  - A major contributor to diversity BUT total diversity not strongly related to either ecological function or resilience in these ecosystems

3. Vegetation Dynamics

- **Two main plant strategies**
  1. Persistence (long-lived, slower-growing, framework woody species)
  2. Opportunism (mainly short-lived, faster-growing, ground-layer species)

- **Recognition of the attributes of persistent and opportunistic plants underpins the proposed approach to vegetation establishment**
  - Persistent species disadvantaged if establishing in direct competition with high densities of 'opportunist' species
  - Opportunistic species can be introduced (or naturally colonise) successfully where established persistent species are present

Predictability of Performance

Initial floristic composition profoundly influences:

- Long-term prospects & likely development trajectories
- Effort of future management required

Subsequent events also important BUT

If right initial composition & robust strategy, risk of deviation from trajectory can be reduced by

- Good management
- Monitoring program to provide ‘early-warning’

Initial Floristic Composition is Crucial

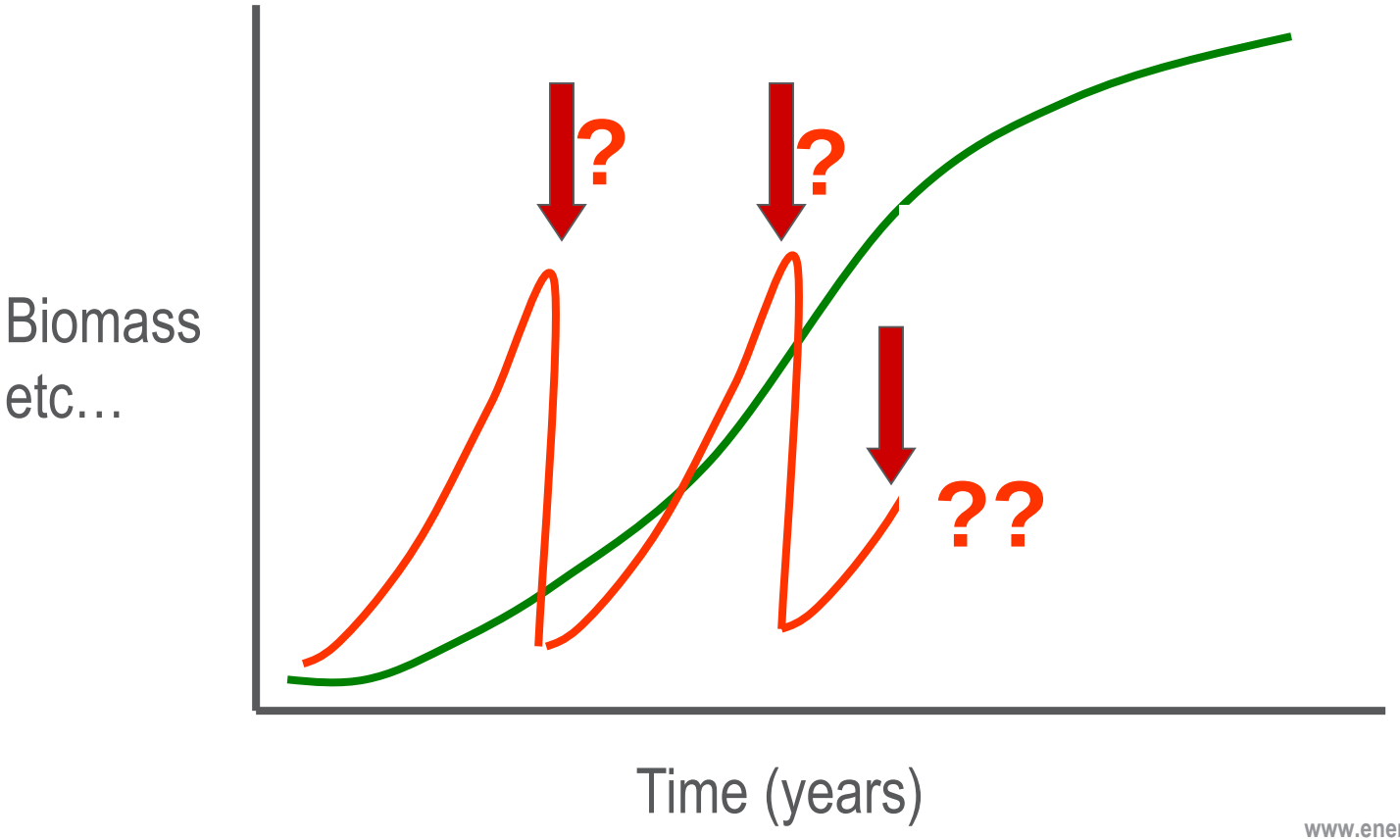
Strategies based on using acacias to 'initiate' succession don't work

Framework Species Gives High Predictability

Predictability of performance

Dominance by:

- Framework species gives high predictability
- Grasses & acacias produce unpredictable & unstable systems



Overachieving Guiding Principles – Ranger Mine

- There are 291 plant species, of which 65 > 2m high, in the adjacent area.
- We initially use ‘framework’ and other key species to establish relatively stable vegetation; this creates suitable conditions for other species to colonise.
- We value natural processes in the ecosystem development, especially in biodiversity enrichment; many species can be naturally introduced through biotic and abiotic vectors.
- We apply ‘adaptive management’ practice to ensure the revegetation is developing along a desired trajectory.

Key Elements of Revegetation Strategy

- **Species selection based on reference sites, trials and cultural consultation**
  - Allowance for potential (localised) waste rock water limitations and for future climate change with more drought tolerant species
  - Adjustment of density/species composition to suit landform 'sites'

- **Two-stage approach to introductions**
  - Initially, use *Eucalyptus* dominant framework species, other overstorey tree and shrub species, some non-aggressive acacias, and hardy but non-competitive understorey species
  - Delayed introduction of overly competitive or sensitive species until framework species established and/or conditions suitable

Key Elements of Revegetation Strategy

- 82 local native woody species & >10 grasses, legumes and herbs of agreed provenance to be grown
- Use tubestock for most species, direct seeding for the few with proven success
- Irrigation initially but managed to ensure natural rooting pattern
- Slow release fertiliser applications at initial establishment
- Fire resilient species & fire exclusion in the first 5 or so years
- Pre- and post- planting ‘weed’ control

Site Preparation

- Preventative weed control
- Contour ripping
- Irrigation installation
- Planting site cultivation

Revegetation Trial on a Waste Rock Landform

- 8 ha revegetation trial on waste rock
- Constructed 2008/09
- Will be integrated into the final landform

Revegetation of Trial Waste Rock Landform
(>11k plants of 41 local native species)

Plants in waste rock area with irrigation (May 2009)


April 2010, 1 year post planting


Feb 2015, 6 years post planting

Burns on the Trial Landform

- Prescribed weed management cool burns (17 May 2016 & 19 July 2019)

Resilience to Fire of the Trial Landform Revegetation

- High level of recovery after both burns
- Large majority of trees above 2.5 m height and 4 cm DBH survived and showed signs of regeneration (except aggressive *Acacia holosericea*)
- 2019 burn substantially reduced weed-dominated groundcover from 48-98% to 0-10%

Nov 2016, six months after burn

June 2019

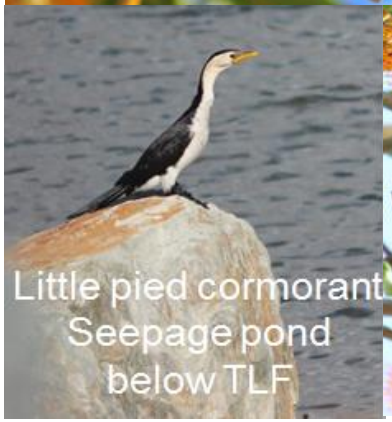
10 Year-Old Revegetation on Waste Rock Only Media

>35 Species Flowered and Fruited, Many Regenerated

Natural regeneration from seed

Corymbia dunlopiana and Green Plums:
Fruiting in November 2016, seedlings in February 2017

Animal Colonisation on the Trial Landform



Thanks

A full paper on **Ranger Revegetation Strategy** can be found at https://papers.acg.uwa.edu.au/p/1915_57_Lu/

Mine Closure Plan is available online, will be updated annually *http://www.energyres.com.au/sustainability/closureplan/*