USE OF REFERENCE SITES IN REHABILITATION OF NATIVE FORESTS ON SURFACE MINES IN AUSTRALIA

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Blakemere Consultants Ltd

Strip-mined overburden-
Surface coal mine in Bowen Basin, Moura, Queensland

Does the Concept of Novel Ecosystems Have a Place in Mine Closure and Rehabilitation?

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Shallow bauxite working,
jarrah forest,
Western Australia

Types of Reference Sites

- The area being mined – pre-mining features & condition
- Local paired un-mined area with similar features & condition
- Published accounts of areas with similar features & condition

Location of example sites

Gold Mine Surface Coal Mine
Mineral Sand Mine Bauxite Mine

Site Selection

Accounts of Selected Sites

Types of *Eucalyptus* Forest / Woodland Selected as Reference Sites
E. microneura – *E. creba* Low open woodland (gold)
E. marginata – *Corymbia calophylla* Open forest (bauxite)
E. marginata – *Corymbia calophylla* Open forest (bauxite)
E. pilularis Woodland/Open forest; *E. racemosa* Woodland; *Corymbia intermedia* Open forest; *E. planchoniana* Open forest (mineral sand)
E. pilularis Woodland/Open forest; *E. racemosa* Woodland; *Corymbia intermedia* Open forest (mineral sand)
E. populnea Woodland (coal)

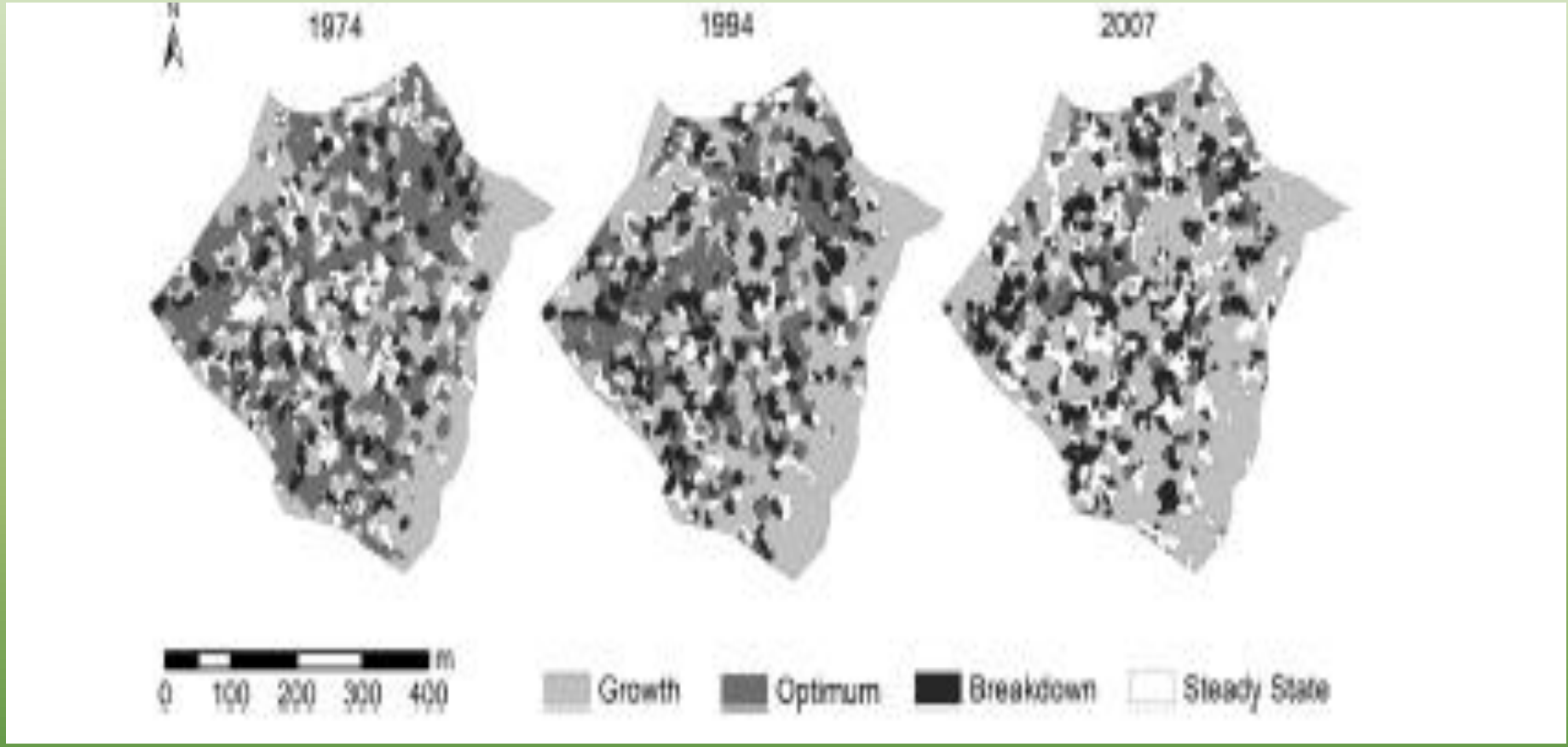
Eucalyptus Forest Landscape

Developing Structural & Functional State

Mature Structural & Functional State

Breakdown Structural & Functional State

Regeneration Structural & Functional State



Change in Structural Composition of Forest

Measurement Methods

Examples of Recommended Recording Formats

Vegetation Field Handbook	BioCondition	Ecosystem Function Analysis
Nested Plot Design	Nested Plot Design	Nested Transect Design
30m x 30m (900m2) – Trees >20m height; 20m x 20m Trees & Shrubs 1m–20m height	100m x 50m (5,000m2) – Large trees, tree richness, canopy cover	
50m transect – Tree crown and canopy gap	100m transect – Tree & shrub canopy cover	5m intervals 50m wide sub-transects along 100m transect – Vegetation attributes
1m–20m transect – understorey canopy	50m x 20m – Coarse woody debris	
5m x 5m – Understorey and ground layer <1m height	50m x 10m – Shrub, grass and forb richness	
50 x (1m x 1m) – Grass cover, litter cover; 50 x (0.02m x 0.02m) – Moss cover	1m x 1m – Grass cover, litter cover	

Examples of Recording Formats Used for Forest Vegetation

Types of *Eucalyptus* Forest / Woodland (mineral)	Recording Format & Specification
E. microneura – *E. creba* Low open woodland (gold)	Nested Transects – 3 x (100m transects) + 1m x 4m sub-plots at 10m intervals + 1m x 1m sub-plots at 10m intervals
E. marginata – *Corymbia calophylla* Open forest (bauxite)	Random Plots 20 x (2m x 2m quadrats)
E. marginata – *Corymbia calophylla* Open forest (bauxite)	Nested Plots – 12/15 x (20m x 20m plots) + 5 x (20m x 4m sub-plots)
E. pilularis Woodland/Open forest; *E. racemosa* Woodland; *Corymbia intermedia* Open forest; *E. planchoniana* Open forest (mineral sand)	Nested Plots – 50m x 20m + 50m transect + 5 x (2m x 2m sub-plots)
E. pilularis Woodland/Open forest; *E. racemosa* Woodland; *Corymbia intermedia* Open forest (mineral sand)	No details given
E. populnea Woodland (coal)	Varied between 100m x 10m / 200m x 20m / 50m x 20m / 50m x 3m plots

Attributes & Metrics Measured

Vegetation Attributes Used

Types of Eucalyptus Forest / Woodland	Vegetation Attributes Used
E. microneura – E. creba Low open woodland (gold)	Number of species (inc. richness); number of woody & shrub species; number of life-forms; foliage cover of ground layer; height and basal diameter of Eucalypts and Corymbia species; plant litter cover
E. marginata – Corymbia calophylla Open forest (bauxite)	Number of species; species density; species foliage cover; number of Eucalypts >2m height
E. marginata – Corymbia calophylla Open forest (bauxite)	Number of species (inc. richness); stem density of Eucalypts and legumes; stem sizes of Eucalypts and legumes; litter cover
E. marginata – Corymbia calophylla Open forest (bauxite)	Number of species (inc. richness); number of recalcitrant species; density of recalcitrant species
E. pilularis Woodland/Open forest; *E. racemosa* Woodland; *Corymbia intermedia* Open forest; *E. planchoniana* Open forest (mineral sand)	Number of species (inc. richness); canopy cover; number of trees >2m height
E. pilularis Woodland/Open forest; *E. racemosa* Woodland; *Corymbia intermedia* Open forest (mineral sand)	Number of species; density of tree species >2m height; canopy cover of trees, understorey and ground layer
E. populnea Woodland (coal)	Number of species; density of graminoids and forb species

Vegetation Attributes as Indicators of Ecosystem Structure and Function

(CARGIE Model – Humphries, JASMR, 2, 1–31)

Vegetation Attribute	Criteria	Metrics
Tree Canopy Cover	Tree layer; understorey; ground cover	Proportion thresholds/ranges
Age Class	Seedlings; saplings; young trees; mature trees; decaying trees; dead trees	Number/density; proportion thresholds/ranges
Regeneration Potential	Seed production/ sprouting shoots- rhizomes etc	Numbers; amounts/yield; proportion
Genetic Pool	Native/naturalised provenance	Number/density; proportion
Indicators	Notable species	Number/density; proportion
Exotic/Alien Species	Non-native/notifiable	Presence; thresholds/ranges

Some Thoughts for Improving the Use of Reference Sites:

- Should the aim of Reference Sites be to capture the range of forest variation and dynamics?
- Is it more appropriate Reference Sites represent the contemporary regenerating phase of forests?
- Standardised sampling methodologies and metrics would enable comparisons to be made between schemes and increase the knowledge base
- CARGIE structural and functional attributes and metrics could be adopted as essential indicators of sustainable rehabilitated forest ecosystems

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The opinions expressed are solely the author's