



# STEP Inc

Community-based Environmental Conservation since 1978

20 August 2020

Caroline Maeshian  
Hornsby Shire Council  
PO Box 37  
HORNSBY NSW 1630

Dear Ms Maeshian,

## **Hornsby Quarry Rehabilitation DA Deferral Submissions Report. DA/101/2019**

STEP Inc is a local community-based environmental group, with a membership of over 450 in the Hornsby/Ku-ring-gai area. Our main objective is to preserve natural bushland in northern Sydney from alienation or degradation and ensuring proper management of this bushland including ensuring its role as habitat for animal species. Our group has considerable experience in environmental issues and regenerating and preserving natural bushland and native vegetation.

### **Powerful Owls**

As a member of the Powerful Owl Coalition, STEP agrees with their submission. Statements for Powerful Owl management must lead to definite action for their protection, not the possibility of action. The rephrasing suggested by the Powerful Owl Coalition must be included in the consent conditions.

Careful monitoring by Birdlife Australia's Powerful Owl Project throughout the project must take place to ensure that the owls and habitat are protected. It is essential that the staging plan does not allow works to take place within 100m of the nesting tree during the breeding season.

### **Mountain bikes, tracks and trails**

STEP has had a position paper since 2010 on bushland tracks and trails as we are concerned about the impact of tracks on the biodiversity value of natural areas. We agree that the negative impacts listed on p48 for tracks and mountain bike trails are significant and the rehabilitation plan must include actions to remediate these impacts.

STEP would like to encourage carefully designed tracks for general recreation that reduce biodiversity impacts.

STEP opposes any extension to existing mountain bike tracks due to the damage to biodiversity values listed on p48. We are very concerned about the impact of current mountain bike trails, particularly the damage that has been done to the Blue Gum Diatreme Forest through the construction of switchbacks and obstacles. The tracks in this section should be closed and instead diverted into forest that is not critically endangered such as the Blackbutt Gully Forest.

### **Diatreme**

We have been pointing out the value of the diatreme walls in many submissions since October 2015, when we stated:

The diatreme is one of the most significant aspects of the site and the wall must be preserved for both its geological heritage and landscape values.

We are finally satisfied that Council has taken the advice of the Geological Society of Australia and will preserve the eastern wall. According to the letter from Ian Percival the agreed level of the lake floor is RL50 and the lake level is RL53. We support these decisions.

### **Forest clearing to create a lookout**

We understand that this DA is not intended to include works relating to the future recreational uses of the site. This aspect will be part of the next stage of design and consultation of the project. However this DA includes clearing of Blue Gum Diatreme Forest to the east of the north mound to create an access track and lookout. STEP opposes this clearing of the critically endangered forest.

### **Biodiversity offsets strategy**

We have assessed the three options for biodiversity offsets presented by Council and agree with Council that the third option, onsite offsets, using the Green Offset Code, and a Voluntary Conservation Agreement is the best option for biodiversity management.

Allocated funding must ensure sufficient money to ensure constant improvement and maintenance of vegetation quality over the long term.

We do have concerns about parts of the VMP. Many of our members are involved in the ecological restoration industry and are aware of the enormous changes in the philosophy of ecological restoration in the past 10 years. These changes are not reflected in the VMP and hence the document lacks industry currency. The following areas are of concern:

- the use of reference sites
- species selection
- provenance selection
- monitoring procedures

As the VMP is to be signed off by Council and the Biodiversity Conservation Trust these deficiencies must be fixed for the Biodiversity Offsets Strategy to effectively promote biodiversity on the site

### **Vegetation Management Plan and Habitat Creation and Enhancement Plan**

Four areas of the VMP and the HCEP must be updated to current industry best practice.

#### **1. Reference sites**

In our previous correspondence in January 2020 we raised the issue of reference sites. This has not even been discussed in this current report.

The use of the Hornsby/Thornleigh diatreme complex as the only reference site has a very high chance of perpetuating a very depauperate vegetation community. This whole complex has variously been damaged by a long history of logging, agriculture and quarrying and the species still present will presumably represent only a fraction of the original species.

Campbells Crater at Cowan, Smiths Creek in Ku-ring-gai Chase, Cobar Ridge and Fagan Ridge to the west of the Hornsby site, would be good reference diatremes as they are the least damaged by clearing. Additional local diatremes include Browns Field at Fox Valley and Peats Crater at Muogamarra.

As far as the rocky quarry sides go the best "localish" model for basalt breccia floras would be Saddleback, a breccia peak topping at 600 m asl 4 km out of Kiama. Principal trees there are warm temperate rainforest species like coachwood, sassafras, lillypilly and scattered featherwoods.

#### **2. Species selection**

STEP favours the inclusion of species that are no longer in the Hornsby/Thornleigh diatreme but are nearby in Blue Gum High Forest, Coastal Diatreme Forest and Blackbutt Gully Forest.

Unless species lists from nearby reference sites are consulted, and species judiciously added to the site, the site will remain depauperate and unable to carry out all ecological functions. Conspicuously absent species include *Livistona australis* which is present on Berowra Creek downstream of Boundary Road Pennant Hills and is present all around the district in nutrient rich sheltered sites but it is not mentioned in the planting schedule on p98. Also conspicuously absent is *Toona ciliata*, even though it is still present in the nearby Campbells Crater and it is highly likely that it was onsite before logging and clearing. The understory layers may also be species poor with important shrub and ground layer species missing.

Consultation with Environment NSW and the Save our Species unit is needed. Hornsby Shire is also lucky to have very skilled restoration staff and many knowledgeable citizens in the restoration field. STEP and AABR would be more than happy to workshop plant selection with staff.

### **3. Provenance selection**

In our previous correspondence in January 2020 we raised the issue of provenance selection. We understand the concern of Council that local provenance is used but we are worried about both inbreeding and climate change. Climate change is acknowledged in at least two places in the VMP, as a threatening process and for appropriate revegetation timing, but it is not discussed under provenance selection. Inbreeding for some species is possible as pollen and seed dispersal may have been disrupted for many years.

We suggest consulting the Restore and Renew project of the Royal Botanic Gardens and the Australian Network for Plant Conservation, work from Macquarie University's Biodiversity Node and Environment NSW.

The Restore and Renew project lists 10 of the species on the Planning Schedule. Examples of four species are given in Appendix 1. All species have a large collection area.

### **4. Monitoring procedures**

STEP is concerned that the monitoring procedures proposed are inadequate for such a large and important project; important to Hornsby residents, the Powerful Owls and the maintenance of healthy Blackbutt Gully Forest and Blue Gum Diatreme Forest.

The National Trust method has presumably been selected as it is a rapid and easy assessment of proportional canopy cover by weeds and natives. STEP is concerned that this methodology can lead to misleading results, for example 100% privet can be replaced by 100% pittosporum and this would be a successful outcome by this methodology. We agree photos points must be used but these techniques need to be supplemented with current industry tools.

Two tools stand out: the SERA Recovery Wheel and quadrats used in the collection of biodiversity data.

- **SERA Recovery Wheel**

National standards for the practice of ecological restoration in Australia (2018) have been accepted by the restoration industry. While this assessment method initially appears complex, it asks the right questions about the ecosystem to ensure adaptive management. It is fast gaining industry currency.

We have attached several examples in Appendix 2 (apologies about the quality).

STEP recommends that this assessment is carried out annually in each management zone.

- **Biodiversity assessment method**

The field data sheet in the Biodiversity Assessment Method Operational Manual – Stage 1, provides a basic methodology for vegetation and habitat assessment in 400 m<sup>2</sup> and 1000 m<sup>2</sup> plots. STEP recommends that this methodology is used in each zone once every five years, before revision of the plan. This methodology is time consuming, but Council could investigate engaging their skilled bush regenerators as citizen scientists or cooperating with TAFE Conservation and Land Management classes.

This methodology collects an abundance of data and long-term trends should be obvious.

### **Minor comments**

- Fire is not mentioned as a management tool.
- The term 'climber' is used throughout the report and we presume it refers to weedy climbers. This needs to be clarified.
- A general proofread is needed.

Yours sincerely



Jill Green

President

## References

STEP Inc 2010 Position Paper on Bushland Tracks and Trails

<https://step.org.au/images/STEPimages/PDFdownloads/PositionPaperTrackTrail.pdf>

Martyn, J. 2010. *Field Guide to the Bushland of the Lane Cove Valley*. Step Inc.

Martyn, J. 2018. *Rocks and Trees. A photographic journey through the rich and varied geology, scenery and flora of the Sydney region*. Step Inc.

Restore & Renew <https://www.rbgsyd.nsw.gov.au/Science/Restore-renew>

National standards for the practice of ecological restoration in Australia. Edition 2.1 September 2018

<http://seraustoralasia.com/standards/National%20Restoration%20Standards%202nd%20Edition.pdf>

**Appendix 1 Examples of collection areas centred on Hornsby, from Restore and Renew**  
<https://www.restore-and-renew.org.au/>

*Toona ciliata*



*Angophora costata*



*Doryphora sassafras*



*Acacia linifolia*



## Appendix 2: SERA Recovery Wheel

### Using the National Standard's Recovery Wheel at Your Site: a useful tool



Created by: Tein McDonald, Paul Gibson-Roy, Jen Ford  
and Damien Cook for SERA 2018 Conference

Revised by Suzanne Pritchard  
for AABR workshops 2019



### What is ecological restoration?

The Society for Ecological Restoration Australasia (SERA) supports the practice of ecological restoration as a means of sustaining the diversity of life on Earth and establishing a healthy relationship between people and the natural world.

There are few areas on Earth that have not been touched by the actions of humans. More than 50% of the Earth's land surface is dominated by human uses, with a further 25% showing a clear human footprint. We have cleared forests for towns and agriculture, converted native grasslands to introduced pasture, dammed rivers and fished the depths of the ocean. Even those places where few people tread are threatened by our actions: remote alpine and wet forests are now regularly devastated by human-made fires intensified by a changing climate.

Ecological restoration assists the recovery of an ecosystem that has been degraded, damaged or destroyed. It is a rapidly expanding practice undertaken by landholders, community groups, non-government organisations, private industry and public land managers, and encompasses the planning, implementation, monitoring and on-going management of a restoration project.

Through the work of ecological restoration, restoration practitioners seek to guide the recovery of damaged ecosystems. Their knowledge of local, relatively intact ecosystems—the species they contain, the interactions between species, and the relationships between species and their environment—informs the process.

The activities undertaken by restoration practitioners are continuously informed by the outcomes they seek to achieve. The process of ecological restoration is one of adaption and refinement, guided by the characteristics of the site and its relationship with the landscape and its climate.

### Why do we need national standards?

SERA developed the National Standards for the Practice of Ecological Restoration in Australia (the Standards) to assist Australian restoration practitioners attain the best outcomes they can for their ecological restoration projects.

Restoration practitioners can use the Standards to improve the success of their restoration projects, make the best use of resources (including public funds) and improve their knowledge and skills. The Standards outline the steps required to plan, implement and monitor a restoration project.

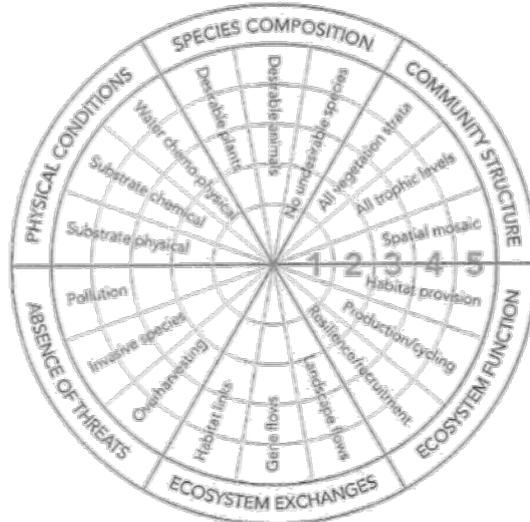
Ecological restoration is guided by a set of six key principles applicable to all restoration projects—large or small, terrestrial or aquatic. They are equally applicable in the planning and implementation of a community-led bushland regeneration project as they are to the mandatory restoration of a mine site after closure.

The Standards clarify the minimum performance levels and outcomes required for a project to be classified as ecological restoration. The generic nature of the Standards means that they can be used in conjunction with other, more specific guidelines relating to a particular aspect of an ecosystem, funding purpose or a restoration activity.



# What is the recovery wheel?

- Tracks recovery level over time
- on a 5-star scale for 6 attributes of the reference ecosystem



## Six key attributes of a reference ecosystem



**Physical conditions**  
The suitability of soils, water, landforms and other physical properties.



**Species composition**  
The array and relative proportion of organisms (e.g. plants and animals).



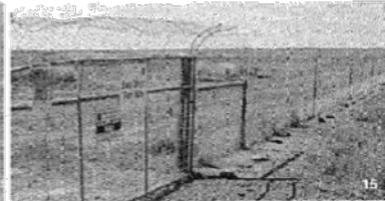
**Community structure**  
The physical organisation of living and non-living elements (e.g. layers and food webs).



**Ecosystem function**  
The roles and processes arising from interactions among living and non-living elements.



**External exchanges**  
The two-way flows between sites and their surrounding environments.



**Absence of threats**  
Degree any factors impacting the health of the ecosystem are managed.

### Some key points:

- It works best for an area where the condition is not highly patchy (e.g. best at site level rather than landscape level).
- The wheel is only as reliable as the reliability of the information that goes into it so you need to state degree of formality of the evidence (and be ready to defend its validity).

**Table 1: National Restoration Standards**

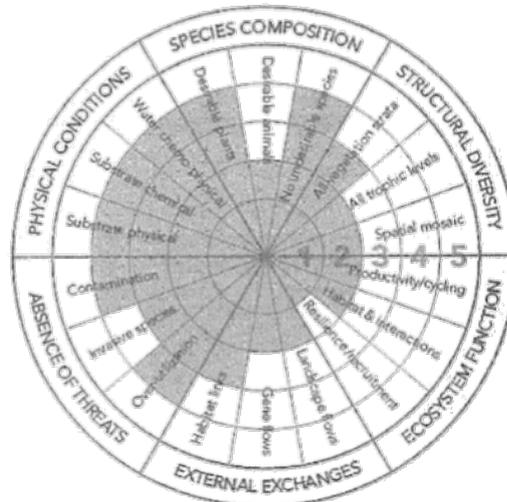
[Note 1: Each level is cumulative. Note 2: The different attributes will progress at different rates –see Table 3 that shows more detailed generic standards for each of the six key ecosystem attributes. Note 3: This system is applicable to any level of recovery where a reference ecosystem is used]

Number of stars	SUMMARY OF RECOVERY OUTCOME <i>(Note: Modelled on an appropriate local native reference ecosystem)</i>
★	Ongoing deterioration prevented. Substrates remediated (physically and chemically). Some level of native biota present; future recruitment niches not negated by biotic or abiotic characteristics. Future improvements for all attributes planned and future site management secured.
★★	Threats from adjacent areas starting to be managed or mitigated. Site has a small subset of characteristic native species and low threat from undesirable species onsite. Improved connectivity arranged with adjacent property holders.
★★★	Adjacent threats being managed or mitigated and very low threat from undesirable species onsite. A moderate subset of characteristic native species are established and some evidence of ecosystem functionality commencing. Improved connectivity in evidence.
★★★★	A substantial subset of characteristic biota present (representing all species groupings), providing evidence of a developing community structure and commencement of ecosystem processes. Improved connectivity established and surrounding threats being managed or mitigated.
★★★★★	Establishment of a characteristic assemblage of biota to a point where structural and trophic complexity is likely to develop without further intervention. Appropriate cross boundary flows are enabled and commencing and high levels of resilience is likely with return of appropriate disturbance regimes. Long term management arrangements in place.

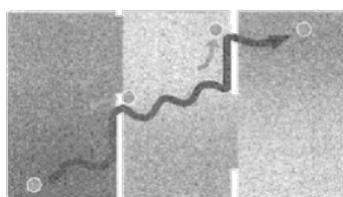
The Recovery Wheel illustrates the degree to which the project is achieving its ecosystem goals over time

Evaluation of Ecosystem Recovery progress Site: \_\_\_\_\_  
 Assessor: \_\_\_\_\_ Date: \_\_\_\_\_

ATTRIBUTE CATEGORY	RECOVERY LEVEL (1-5)	EVIDENCE FOR RECOVERY LEVEL
<b>ATTRIBUTE 1. Absence of threats</b>		
Overutilization		
Invasive species		
Pollution		
<b>ATTRIBUTE 2. Physical conditions</b>		
Substrate physical		
Substrate chemical		
Water chem-physical		
<b>ATTRIBUTE 3. Species composition</b>		
Desirable plants		
Desirable animals		
No undesirable species		
<b>ATTRIBUTE 4. Community structure</b>		
All vegetation strata		
All trophic levels		
Spatial mosaic		
<b>ATTRIBUTE 5. Ecosystem function</b>		
Productivity, cycling, etc.		
Habitat and plant-animal interactions		
Resilience, recruitment, etc.		
<b>ATTRIBUTE 6. External exchanges</b>		
Landscape flows		
Gene flow		
Habitat links		



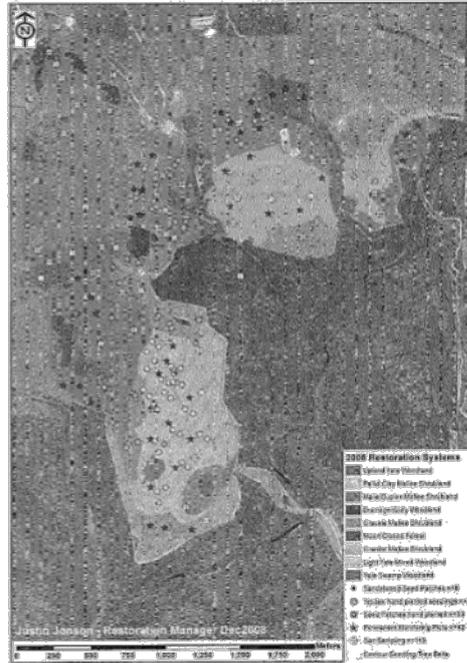
A project might start at a low condition ... or at a medium condition or better.



What is your reference ecosystem?

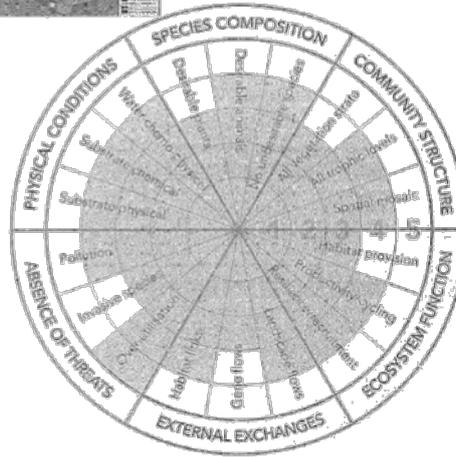
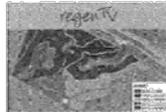
**2008 Restoration Systems**

- Upland Yate Woodland
- Pallid Clay Mallee Shrubland
- Malle Duplex Mallee Shrubland
- Drainage/Gully Woodland
- Gravels Mallee Shrubland
- Moort Closed Forest
- Granitic Mallee Shrubland
- Light Yate Mixed Woodland
- Yate Swamp Woodland
- Sandalwood Seed Patches n=8
- 'Nodes' hand planted seedlings n=31
- Seed Patches hand planted n=53
- ★ Permanent Monitoring Plots n=42
- ⊕ Soil Sampling n=115
- ▭ Contour Seedling Tree Belts



**What if you are starting from scratch?**

e.g. Peniup, Gondwana Link WA. (Justin Jonson)

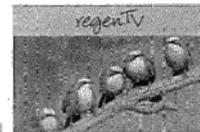


# Evaluation of ecosystem recovery proforma – Peniup

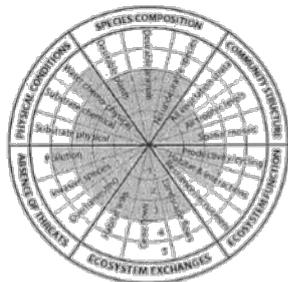
ATTRIBUTE CATEGORY	RECOVERY LEVEL (1-5)	EVIDENCE FOR RECOVERY LEVEL
<b>ATTRIBUTE 1: Physical conditions</b>		
Substrate physical	4	Soil structure largely unchanged from pre-existing ecosystem state. Cryptogamic crust well-developed and A-horizon building with accumulating leaf litter.
Substrate chemical	4	Not tested – but reduction in agricultural weeds indicates any elevated nitrogen and phosphorus loads from agricultural phase likely to be declining.
Water chem/physical	4	Not tested – but there are indications of natural hydrological cycle returning
<b>ATTRIBUTE 2: Species composition</b>		
Desirable plants	3	About 30-40% of the local plants found, with species representation across most local genera, particularly trees and shrubs. Some native grasses and chenopods recruiting in patches. Characteristic sedges under-represented.
Desirable animals	4	Characteristic fauna groups are present including Emu, Echidna, Western Brush Tail Wallaby, Western Bobtail and Rosenberg Monitor lizards.
No undesirable species	4	Undesirable plants and animals low due to ongoing management. Agricultural weeds have largely disappeared (except African lovegrass) and rabbit and fox presence low.
<b>ATTRIBUTE 3: Community structure</b>		
All vegetation strata	3	Tree and shrub strata are re-established across most of site; with some species overrepresented. Less commonly found sub-shrubs largely absent and ground stratum less diverse or abundant as reference.
All trophic levels	4	Herbivores present plus wide variety of asynchronous flowering plants support many invertebrates, nectarivorous birds and small mammals. Carnivorous birds (incl Wedge tailed Eagles), mammals and reptiles, in turn, present. Profuse seed production (in particular Acacia species) supporting developing ant fauna.
Spacial mosaic	4	Heterogeneity high and likely similar to reference as different vegetation "systems" were designed and matched to soil type. Specially established species-specific nodes were added onto these systems.
<b>ATTRIBUTE 4: Absence of threats</b>		
Phytodion	4	Phytophthora dieback threat managed at landscape scale (current risk is moderate, none detected).
Invasive species	3	Ongoing management of invasive fauna (e.g. foxes, rabbits) and weed species (e.g. African lovegrass)
Over-utilisation	5	Clearing, grazing and cropping entirely ceased and site is secured for conservation. Native seed harvesting is limited and regulated.
<b>ATTRIBUTE 5: External exchanges</b>		
Habitat links	4	Site adjoins nature reserves on two sides. Increased food resources (sink) and potential habitat developing for species exchanges.
Gene flow	min. 3	Likely to be on way to reinstatement as barriers to gene flow removed and large nature reserves nearby. Currently under investigation in ARC Linkage Project.
Landscape flow	4	Now high as fragmentation now significantly reduced by the project. Provision of corridor adjoining Peniup Creek and large blocks of remnant vegetation at Bush Heritage's Beringa Reserve and Peniup Nature Reserve. Part of the Gondwana Link initiative (Fitz-Stirling).
<b>ATTRIBUTE 6: Ecosystem function</b>		
Habitat provision	3	Low and prickly Acacia and Hakea species provide excellent nesting habitat for small birds. Flowering and leguminous seed production high for Singing and White eared Honeyeaters, Rufous Whistler and Emu. Some rock piles present; little to no deadwood as yet, aside from short lived shrubs.
Production / cycling	4	Nodules functioning on nitrogen-fixing species, leaf litter and woody debris being produced and decomposing. Overall biomass increasing and, pollination evident as prolific seed production from almost all species established.
Resilience/recruitment	4	Some unassisted recruitment (e.g. Poaceae, Gastrolobium, Atriplex, Enchylaena species) evident; presume a developing soil seed bank; serotinous fruit pods on standing vegetation highly evident.

## What if you are not starting from scratch?

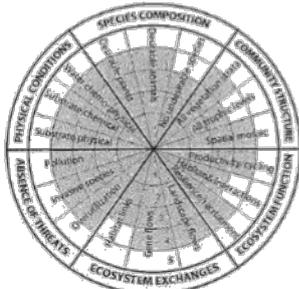
e.g. Coreen, Riverina TSRs (Murray LLS and Ian Davidson)



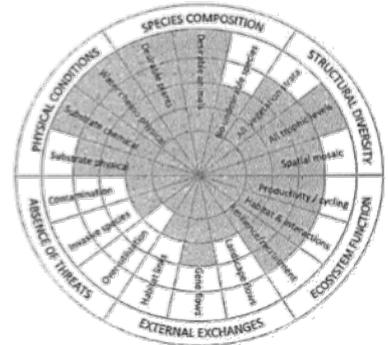
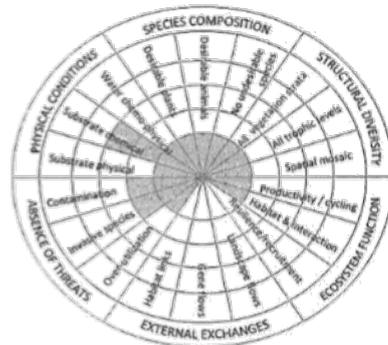
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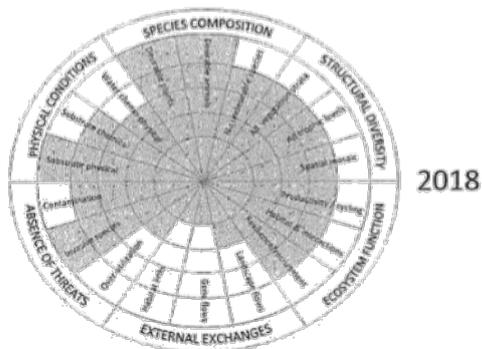
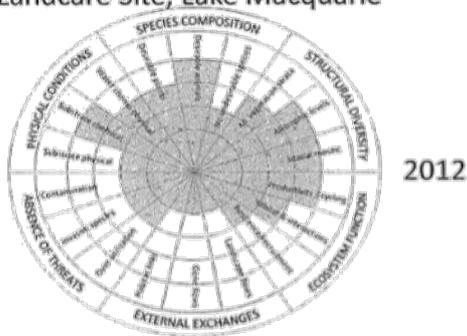


# The Waterways, Victoria (Damien Cook)

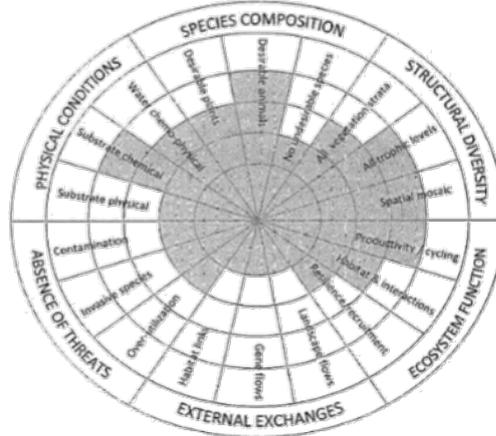


## What if you are not starting from scratch? A detailed example

e.g. Carey Bay Wetlands – Reference community: Swamp Oak Floodplain Forest Landcare Site, Lake Macquarie



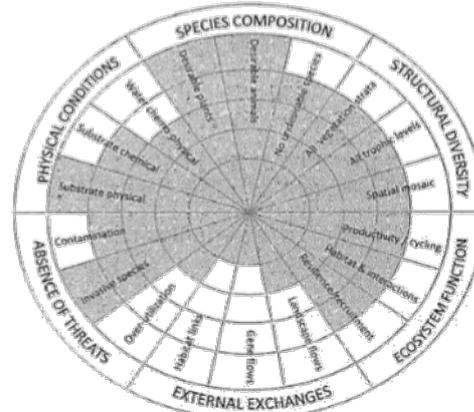
ATTRIBUTE CATEGORY	RECOVERY LEVEL (1-5)	EVIDENCE FOR RECOVERY LEVEL
<b>ATTRIBUTE 1. Absence of threats</b>	2	Threats from adjacent areas beginning to be managed or mitigated.
Over-utilization	2	Sportground encroaching on EEC.
Invasive species	2	Garden waste dumping on Exclosure Pile. Major weeds Buffalo Grass, Asparagus Fern, Bridal Creeper, Chinese Trumpet Creeper, Morning Glory Guinea Grass
Pollution	2	Maintenance of drainage channels carrying sediment to Puntel Creek- no silt mesh, overflowing
<b>ATTRIBUTE 2. Physical conditions</b>	3	Substrate stabilized within natural range and supporting growth of characteristic biota
Substrate physical	3	Maintenance of drainage lines results in scouring the channel bed and sides, instability of creek edge evidenced by tree fall in storm events.
Substrate chemical	4	
Water chemo-physical	3	Hunter Water pipelines through the reserve, blockage/overflow sometimes occurs. Altered hydrology producing debris in mature trees
<b>ATTRIBUTE 3. Species composition</b>	3	A subset of key native species (e.g., ~25% of reference) establishing over substantial proportions of the site. Very low onsite threat from undesirable species.
Desirable plants	3	From 8/1/13 flora survey, 32% native cover across the site
Desirable animals	4	22 Bird Species recorded 15/1/13, ants
No undesirable species	2	Garden escapes compromising native species
<b>ATTRIBUTE 4. Community structure</b>	3	All strata present. Spatial patterning evident and substantial trophic complexity developing, relative to the reference ecosystem
All vegetation strata	3	Trees, shrubs & herbaceous layers present although lower levels compromised by weeds.
All trophic levels	4	Evidence of decomposition of logs, high bird diversity and insect abundance.
Spatial mosaic	4	Different areas present across the site with canopy and groundcover changes in species.
<b>ATTRIBUTE 5. Ecosystem function</b>	3	Evidence of functions commencing - e.g., nutrient cycling, water filtration and processes of habitat resources for a range of species.
Productivity, cycling, etc.	4	Highly productive weed growth, supporting insects and birds
Habitat and plant-animal interactions	3	Lantana providing habitat for Bowerbirds, greatest diversity of bird species in the area
Resilience, recruitment, etc.	2	Indigenous flora still present along with bird disperses. Weeds preventing establishment
<b>ATTRIBUTE 6. External exchanges</b>	3	Potential for exchanges (e.g. of species, genes, water, fire) with surrounding landscape or aquatic environment identified.
Landscape flows	3	Puntel Creek connection to Mt Waring possible but not part of landscape site
Gene flow	3	Isolated patch. Connectivity of remnant to Hampton St and Mt Waring possible
Habitat links	3	Isolated patch. Connectivity of remnant to Hampton St and Mt Waring possible.



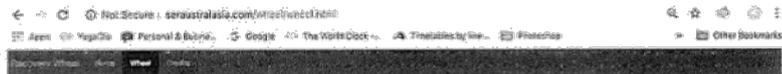
10 Threatened Species Last Stand on the Coal Point Peninsula

Final Photopoint & Monitoring Report

ATTRIBUTE CATEGORY	RECOVERY LEVEL (1-5)	EVIDENCE FOR RECOVERY LEVEL
<b>ATTRIBUTE 1. Absence of threats</b>	3	All adjacent threats managed or mitigated to an intermediate extent.
Over-utilization	2	Sportground encroaching on EEC.
Invasive species	3	No evidence of garden waste dumping. Buffer planting around all edges. Major weeds mitigated to high extent Buffalo Grass, Asparagus Fern, Bridal Creeper. Weeds still requiring management Chinese Trumpet Creeper, Morning Glory, Guinea Grass.
Pollution	4	Maintenance of drainage channels carrying sediment to Puntel Creek- LMC advised silt mesh to be utilised as updated procedure.
<b>ATTRIBUTE 2. Physical conditions</b>	3	Substrate securely maintaining conditions suitable for ongoing growth and recruitment of characteristic biota.
Substrate physical	3	Mangrove/cor log trial in place, recruitment of new species and colonisation of new areas.
Substrate chemical	4	
Water chemo-physical	3	Hunter Water pipelines through the reserve, blockage/overflow sometimes occurs. Altered hydrology producing debris in mature trees.
<b>ATTRIBUTE 3. Species composition</b>	4	High diversity of characteristic species (e.g., >80% of reference) across the site, with high similarity to the reference ecosystem, improved potential for colonisation of more species over time.
Desirable plants	5	From 24/1/18 flora survey, 72% native cover across the site
Desirable animals	5	52 bird species recorded over project period
No undesirable species	4	Garden escapes controlled, daily site landscaping
<b>ATTRIBUTE 4. Community structure</b>	4	All strata present. Spatial patterning evident and substantial trophic complexity developing, relative to the reference ecosystem.
All vegetation strata	4	Trees, shrubs & herbaceous layers present. Increased complexity of herbaceous layer
All trophic levels	4	Evidence of decomposition of logs, high bird diversity and insect abundance.
Spatial mosaic	4	Different areas present across the site with canopy and groundcover changes in species.
<b>ATTRIBUTE 5. Ecosystem function</b>	4	Substantial evidence of key functions and processes commencing including reproduction, dispersal and recruitment of species.
Productivity, cycling, etc.	4	Highly productive, supporting insects and birds
Habitat and plant-animal interactions	4	Lantana retained as habitat for Bowerbirds, increase of 30 bird species identified in the area
Resilience, recruitment, etc.	4	Indigenous flora reproducing, % native cover of site comparable to reference David's 2
<b>ATTRIBUTE 6. External exchanges</b>	3	Potential for exchanges (e.g. of species, genes, water, fire) with surrounding landscape or aquatic environment identified.
Landscape flows	3	Extension of landscape site in process, neighbours of Puntel Creek been in support landscaping along riparian zone.
Gene flow	3	Isolated patch. Connectivity of remnant to Hampton St and Mt Waring possible.
Habitat links	3	Isolated patch. Connectivity of remnant to Hampton St and Mt Waring possible. LMC has identified corridor but unsupportive of actions to implement it.



# The Recovery Wheel Tools

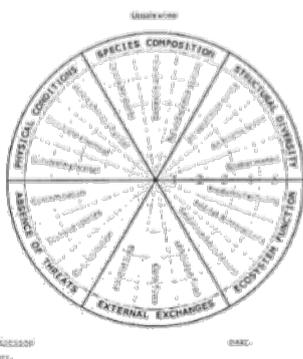


- A web-based tool that allows you to attribute rankings and download an image of the wheel.
  - <http://seraustoralasia.com/wheel/index.html>

**RECOVERY WHEEL**

Site: \_\_\_\_\_  
 Assessor: \_\_\_\_\_  
 Date: \_\_\_\_\_

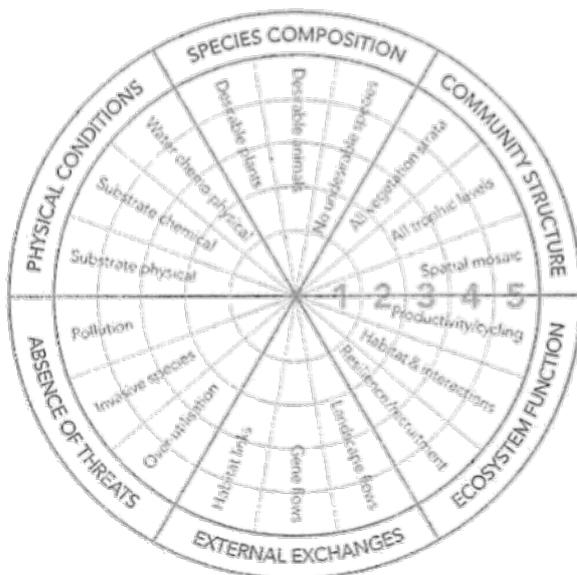
<b>1. Absence of threats</b>	<b>2. Physical conditions</b>	<b>3. Species composition</b>
Over-utilization: _____	Substrate physical: _____	Desirable plants: _____
Invasive species: _____	Substrate chemical: _____	Desirable animals: _____
Contamination: _____	Water chemo-physical: _____	No undesirable species: _____
<b>4. Structural diversity</b>	<b>5. Ecosystem function</b>	<b>6. External exchanges</b>
All trophic levels: _____	Productivity/cycling: _____	Landscape flows: _____
All trophic levels: _____	Habitat interactions: _____	Gene flow: _____
Appropriate: _____	Resilience, recruitment: _____	Habitat links: _____



## The Recovery Wheel Tools

Pen & paper or upgrade available ... coloured pencils

Download the blank tools from the Appendix 5 of the National Restoration Standards <http://www.seraustoralasia.com/standards/appendix5.html>



Evaluation of Ecosystem Recovery proforma Site: \_\_\_\_\_  
 Assessor: \_\_\_\_\_ Date: \_\_\_\_\_

ATTRIBUTE CATEGORY	RECOVERY LEVELS (1-5)	EVIDENCE FOR RECOVERY LEVEL
<b>ATTRIBUTE 1. Absence of threats</b>		
Over-utilization		
Invasive species		
Pollution		
<b>ATTRIBUTE 2. Physical conditions</b>		
Substrate physical		
Substrate chemical		
Water chemo-physical		
<b>ATTRIBUTE 3. Species composition</b>		
Desirable plants		
Desirable animals		
No undesirable species		
<b>ATTRIBUTE 4. Community structure</b>		
All vegetation strata		
All trophic levels		
Spatial mosaic		
<b>ATTRIBUTE 5. Ecosystem function</b>		
Productivity, cycling, etc.		
Habitat and plant-animal interactions		
Resilience, recruitment, etc.		
<b>ATTRIBUTE 6. External exchanges</b>		
Landscape flows		
Gene flow		
Habitat links		

## Handouts:

- National Restoration Standards –A brief Overview
- One-to-five star recovery scale and notes for interpreting the five-star system (p14-15 NRS)
- Templates
  - Evaluation of Ecosystem form
  - Recovery Wheel



### What is ecological restoration?

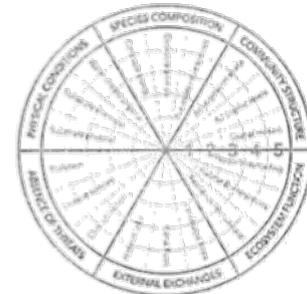
The Bureau of Ecological Restoration in Australia supports the practice of ecological restoration in a wide range of ecosystems, from natural to human-modified. Ecological restoration is the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed. It involves a range of activities, from planting native plants and animals to managing the land and water resources. The Bureau provides guidance and support to land managers, scientists, and the public. The Bureau's work is based on the principles of ecological restoration, which are outlined in the National Standards for the Practice of Ecological Restoration in Australia.

### Why do we need national standards?

The Bureau of Ecological Restoration in Australia supports the practice of ecological restoration in a wide range of ecosystems, from natural to human-modified. Ecological restoration is the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed. It involves a range of activities, from planting native plants and animals to managing the land and water resources. The Bureau provides guidance and support to land managers, scientists, and the public. The Bureau's work is based on the principles of ecological restoration, which are outlined in the National Standards for the Practice of Ecological Restoration in Australia.

Table 2. Summary of the five star recovery scale, interpreted in the context of the six attributes used to evaluate ecosystem recovery.

Attribute	Star 1	Star 2	Star 3	Star 4	Star 5
Absence of threats	No threats present	Threats present but managed or mitigated			
Physical conditions	Substrate physical, chemical, and biological conditions are poor	Substrate physical, chemical, and biological conditions are poor	Substrate physical, chemical, and biological conditions are poor	Substrate physical, chemical, and biological conditions are poor	Substrate physical, chemical, and biological conditions are poor
Species composition	No desirable species present	Desirable species present	Desirable species present	Desirable species present	Desirable species present
Structural diversity	All strata absent				
Ecosystem function	No evidence of functions				
External exchanges	No landscape flows				



Evaluation of Ecosystem Recovery systems

Assessor: \_\_\_\_\_ Date: \_\_\_\_\_

ATTRIBUTE CATEGORY	RECOVERY LEVEL	EVIDENCE FOR RECOVERY LEVEL
<b>ATTRIBUTE 1 - Absence of threats</b>		
Over-utilization:		
Invasive species:		
Contamination:		
<b>ATTRIBUTE 2 - Physical conditions</b>		
Substrate physical:		
Substrate chemical:		
Water chemical-physical:		
<b>ATTRIBUTE 3 - Species composition</b>		
Desirable plants:		
Desirable animals:		
No undesirable species:		
<b>ATTRIBUTE 4 - Structural diversity</b>		
All strata present:		
All trophic levels:		
Spatial mosaic:		
<b>ATTRIBUTE 5 - Ecosystem function</b>		
Productivity, cycling:		
Habitat interactions:		
Resilience, recruitment:		
<b>ATTRIBUTE 6 - External exchanges</b>		
Landscape flows:		
Gene flows:		
Habitat links:		
Site Use:		
Comments:		

## RECOVERY WHEEL

Site:

Assessor:

Date:

### 1. Absence of threats

Over-utilization:

Invasive species:

Contamination:

\*\*\*\*\* Threats from adjacent areas beginning to be managed or mitigated.

### 2. Physical conditions

Substrate physical:

Substrate chemical:

Water chemical-physical:

\*\*\*\*\* Substrate stabilized within natural range and supporting growth of characteristic biota.

### 3. Species composition

Desirable plants:

Desirable animals:

No undesirable species:

\*\*\*\*\* A subset of key native species (e.g., ~25% of reference) establishing over substantial proportions of the site. Very low onsite threat from undesirable species.

### 4. Structural diversity

All strata present:

All trophic levels:

Spatial mosaic:

\*\*\*\*\* All strata present. Spatial patterning evident and substantial trophic complexity developing, relative to the reference ecosystem.

### 5. Ecosystem function

Productivity, cycling:

Habitat interactions:

Resilience, recruitment:

\*\*\*\*\* Evidence of functions commencing - e.g., nutrient cycling, water filtration, and provision of habitat resources for a range of species.

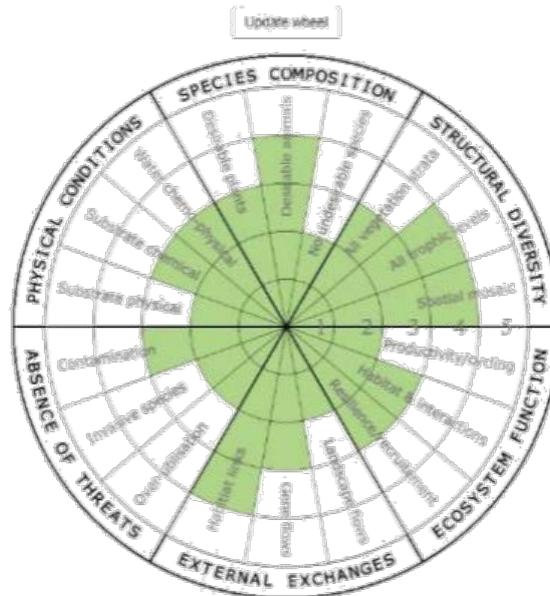
### 6. External exchanges

Landscape flows:

Gene flows:

Habitat links:

\*\*\*\*\* Connectivity increasing and exchanges between site and external environment starting to be evident (e.g., more species, flows etc.).

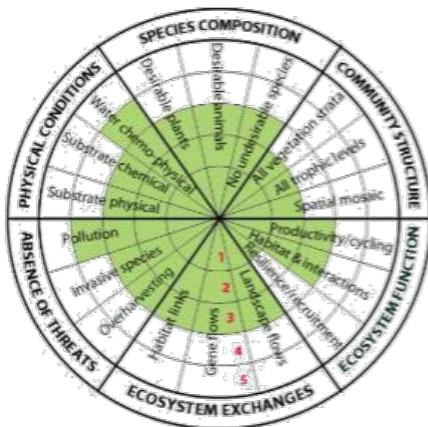


ASSESSOR: Agata Mitchell  
 SITE: CLC - Wallaroo Mulgoa

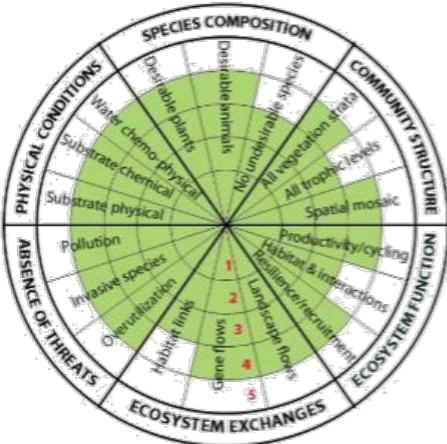
DATE: 31-9-19

e.g. Coreen, Riverina TSRs (Murray LLS and Ian Davidson)

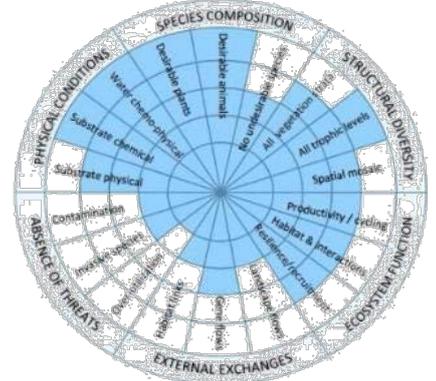
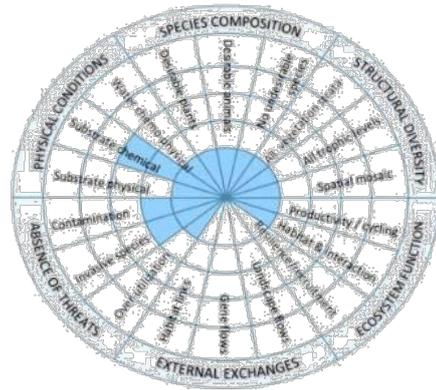
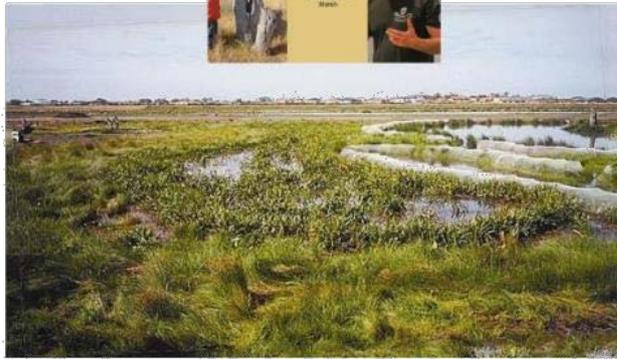
2006



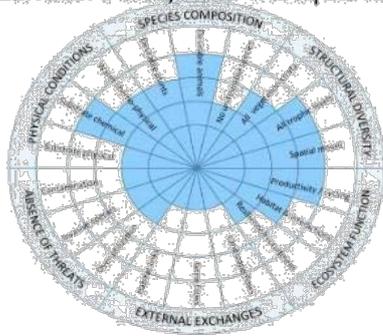
2016



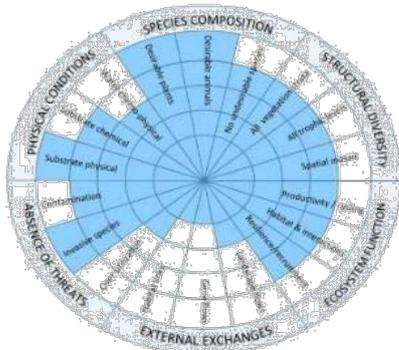
# The Waterways, Victoria (Damien Cook)



e.g. Carey Bay Wetlands – Reference community: Swamp Oak Floodplain Forest Landcare Site, Lake Macquarie



2012



2018

