Riparian vegetation assessment and management plan: Tweed Sands quarry

A Quarry Life Award project report for Heidelberg Cement, September 2014

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1. Abstract

Tweed Sands quarry management aims to improve the native biodiversity and ecosystem function within the site. A major biological asset of the quarry is the lake that has developed following sand extraction. Crucial to the biological value of this asset is the riparian vegetation interface between the lake and the land. The value of this vegetation applies to flora, fauna, quarry production and varied human interests (social, aesthetic, obligation). Ensuring that the vegetation can meet all of its requirements necessitates appropriate management. Management is informed by a Rehabilitation and Landscape Management Plan (2010), which incorporates short and long term objectives. This plan is comprehensive and should be commended, but fails to detail the management of the Swamp Oak (*Casuarina glauca*) riparian vegetation. This report proposes three additional objectives which will help Tweed Sands optimise the value of their site:

- Assessing and creating management targets for Swamp Oak riparian vegetation
- Using vegetation benchmarks to inform management
- Increasing the vegetation diversity and creating links with the community by introducing a beautiful and endangered vegetation community

These three items can work seamlessly in conjunction with the existing management plan, while providing large potential benefits to the quarry's riparian vegetation and associated biodiversity and ecosystem function.

2. Introduction

Native vegetation management aims to maintain or restore ecosystem structure and function. Typically, in Australia, the desired target for managers is to restore the vegetation towards the type and condition that existed on the site prior to European disturbance (see Gibbons et al. 2008; Gibbons and Freudenberger; 2006; Parkes et al. 2003). In many cases the landscape, vegetation, and ecosystem processes of a site will make it essentially impossible to recreate the pre-disturbance vegetation, but vegetation that closely meets these conditions within this new environment should remain a valuable target.

Vegetation benchmarks that resemble pre-European vegetation attributes are often used to inform management targets. These benchmarks are typically based on existing examples of remnant vegetation. Published summaries of these benchmarks exist for many vegetation types throughout Australia, but where the site conditions and management objectives do not align exactly with remnant vegetation targets it can be useful to use alternative relevant examples to inform management.

Tweed Sands quarry in Cudgen, northern NSW, has extracted sand from the site since 1989. The extraction lake forms a large part of the site and with the associated riparian vegetation is its key biological asset. Current management of the site is directed by the Rehabilitation and Landscape Management Plan (James Warren and Associates 2010). This plan has helped design and implement structural formation of the extraction lake margin and commence an ambitious vegetation management plan. However, there remains a key gap in the plan that could be targeted to provide great benefit to the ecological integrity of the site's riparian vegetation. Identifying required management and informing actions and targets using both published and observed benchmarks is a significant step forward for the quarry.

2.1 Objectives

This project describes the existing riparian vegetation of the site, and highlights areas currently not addressed in the Rehabilitation and Landscape Management Plan (2010) where management can increase its biodiversity value. In addition to these I propose an ambitious but potentially highly valuable plan for the creation of a new vegetation type, with great community involvement prospects.

The primary objectives of this project are:

1. Assess the existing riparian vegetation of the site using whole-vegetation survey methods.
2. Seek out and assess vegetation off-site that can be used to inform management targets.
3. Determine management actions that target cost effective and substantial gains that are not covered by the existing Plan.
4. Propose an ambitious but potentially highly valuable plan for the creation of a new vegetation type on-site. This action has scope for strong community involvement.
5. Describe, in brief, how the management actions can be applied at the site.

2.2 Background

The Rehabilitation and Landscape Management Plan (2010) indicated three separate communities dominated by Swamp Oak (*Casuarina glauca*), i.e. Communities 1, 2 and 8. Due to their relatively poor condition, none of these vegetation communities are described as representing Swamp Oak Floodplain Forest, which is known to have occurred in the area prior to clearing and is listed as endangered under the NSW Threatened Species Conservation Act (2005).

Swamp Oak Floodplain Forest was estimated to be less than 3% of its original extent on the Tweed lowlands in 1985 (Pressey and Griffith 1992).

Rehabilitation measures in the plan thoroughly describe actions for wetland and open space areas, neither of which includes the Swamp Oak communities. Presuming that these vegetation communities are purposed for conservation and biological function, the vision for their future should be to maximise their conservation significance given the constraints of the quarry operations and available resources. It is clear that the exclusion of detailed management of particularly the younger Swamp Oak stands (Communities 2 and 8) is failing to address a vital aspect of the existing and future native riparian vegetation of the site. Despite their small size, enhancement of these areas towards this endangered and valuable vegetation type should be strongly considered by the quarry managers.

Other vegetation types known to have existed in the area prior to land clearing (which still exist on the nearby Stotts Island Nature Reserve) include Lowland Floodplain Rainforest, which is listed as critically endangered under the EPBC act (Department of the Environment 2014). Incorporating aspects of this vegetation type into the quarry rehabilitation plan would be highly valuable for increased biodiversity, dependent fauna, intrinsic value, and biodiversity and carbon offsets. Creation of this new vegetation type imbedded in community involvement could be the centerpiece for the community link to the quarry.

2.3 Methods

Methods for this project describe the vegetation mapping and on-site and off-site flora surveys. All on-site mapping and surveys were conducted within the property boundary of the Tweed Sands quarry, Lot 2 Crescent St, Cudgen, NSW. Off-site survey site was Lot 11 Pacific Hwy, Banora Point, NSW.

Vegetation mapping

On-site surveys were firstly used to categorise the existing vegetation and define its extent. Vegetation types identified in this report differ slightly to those of the existing Management Plan in order to maintain relevance to this study. For this project, riparian vegetation includes that associated with either the extraction lake or the drainage lines. Mapping was done by combining aerial photos of the study site with GPS points recorded on-site during the survey. Non-riparian vegetation, bare ground, and roads were excluded from the mapped area.

Vegetation surveys

Flora surveys for this project were designed to characterise the general structure and composition of each of the vegetation communities and use this to inform targeted but flexible management actions. It was not within the scope of this project to determine full species inventories of each community. On-site and off-site surveys were conducted in the same way on 21st and 22nd of July 2014. Surveys were recorded on detailed flora recording sheets (see Appendix 3), and the cover and height of all vegetation were visually estimated.

3. Riparian vegetation of Tweed Sands quarry and reference states

The structure and composition of the riparian vegetation types surveyed within the quarry site (Table 1) and external to the site are described in this section of the report. Photos of each vegetation type are included in Appendix 1, and survey sheets are included in Appendix 2.

3.1 Mapping riparian communities

Riparian vegetation types mapped and surveyed are shown in Appendix 1. Riparian vegetation includes that existing on the current margin of the lake, as well as the margin of its future extent. The existing riparian vegetation can be categorised into 6 types:

Table 1. Riparian vegetation communities recorded within the study area

	Vegetation Communities	ID
1	Mature Swamp Oak Forest (*Casuarina glauca)*	SOF
2	Regrowth Swamp Oak Forest (*Casuarina glauca)*	SOF_R
3	Open space native planting	OS
4	Exotic grassland/herbland	EG
5	Sedge/Bullrush zone on water's edge	S
6	Mixed sedge wetland	W

3.2 Pre-cleared vegetation types

Many vegetation types are likely to have existed in the study area prior to clearing, one of which is Swamp Oak Floodplain Forest and degraded stands of *C. glauca* are common in the surrounding lands. This vegetation type is clearly well suited to the study area and enhancing this vegetation type is a sensible management target for rehabilitation. A list of expected species within this vegetation type is shown in Appendix 5

Another vegetation type known to have existed in the area is the EPBC listed critically endangered Lowland Floodplain Rainforest. Reconstruction of this vegetation type is more ambitious than the Swamp Oak Floodplain Forest due to the lack of natural regeneration capacity for many key species but could provide huge biodiversity benefits and would be iconic for the site. A list of expected species within this vegetation type is shown in Appendix 6.

3.3 Vegetation surveys

The three vegetation communities described here include communities 1 and 2 from Table 1, and the off-site survey in Banora Point (see survey sheets in Appendix 3). Vegetation descriptions of other communities were excluded from this report due to their irrelevance to this project and their coverage in the existing Management Plan.

Mature Swamp Oak Forest (SOF)

This is currently the greatest vegetation asset of the quarry property, an aged stand of *C. glauca* Swamp Oak Forest. Although it is itself disturbed and bordered on both sides by cleared exotic pasture, it is a good example of this vegetation type that can exist in such conditions.

The canopy is dominated by *C. glauca* to 30 m tall, but includes a mixed midstorey canopy of mature individuals of *Cinnamomum camphora, Guioa semiglauca, Cupaniopsis anacardioides* and *Melaleuca quinquenervia*. The dominant climber is the exotic species *Ipomoea cairica* (Coast Morning Glory) and is a significant threat to the health of the trees. *Parsonsia straminea* and *Maclura cochinchinensis* occur in lower abundances. Immediately beneath the trees the understorey cover is low due to the dense canopy shading. The species persisting are primarily exotics such as *Cynodon dactylon* and *Paspalum dilitatum*. Further from the tree cover, very high cover of exotic herbs and grasses dominate the understorey.

Swamp Oak Forest regrowth (SOF_R)

There are two different areas within the site that can be classified as Swamp Oak Forest regrowth. In this case, regrowth includes immature individuals that have either been planted or naturally regenerated. These are areas SOF_R1 and SOF_R2 in Figure 1. Both are almost entirely composed of a *C. glauca* overstorey and exotic understorey.

For both patches, the canopy is formed by dense stands of *C. glauca* to 10–15 m tall with few large gaps between trees. Only a few other tree species exist and they are uncommon. Along the western drain (SOF_R2) mangroves (*Avicennia marina*) occur sporadically. Both vegetation patches are highly invaded by *I. cairica*. The mid-storey is essentially absent in this vegetation due to both the lack of species diversity and the relatively young age of the trees. Immediately beneath the regrowth trees the understorey cover is low due to the shading as well as the dropped *C. glauca* phyllodes. The species persisting are primarily exotics.

Swamp Oak Forest and Lowland Rainforest complex, Banora Point

This site lies between a major road, a creek, and developed land in Banora Point. The outer edges of the forest patch are very weedy but the centre is in quite good condition considering its suburban location. The vegetation type is a complex of Swamp Oak Forest and Lowland Rainforest.

The canopy reaches around 30 m tall and is variably dominated by *C. glauca* and *M. quinquenervia*. Stem densities are high, forming tall trees with few low lateral branches and a nearly closed canopy causing little light penetration to the ground. Epiphytes (*Platycerium* sp.) were seen only on the trunks of *C. glauca*. A number of native forest species (e.g. *Cupaniopsis anacardioides*, *Archontophoenix cunninghamiana*) dominate this layer, which is species diverse and dense in patches but also open enough to walk through due to the low light conditions.

Towards the outer edges of the patch, the understorey was dominated by exotic and native herbs and grasses, particularly *Imperata cylindrica*. Towards the centre of the patch where the vegetation was denser the understorey was relatively open with a continuous litter cover of fine and course woody debris. Without the dense grass cover, ferns (*Hypolepis muelleri*), tufted graminoids (*Lomandra longifolia*), and small herbs (such as *Viola banksii*) were common. This also allowed recruitment of species from the upper strata. There were many different native climbers within the site (*Stephania japonica*, *Parsonsia straminea, Smilax australis, Geitonoplesium cymosum*), as well as *I. cairica* – although this was uncommon in the centre of the patch.

4. Vegetation management

Management actions described in this report refer only to those areas believed to be insufficiently detailed in the existing management plan, as well as the creation of the new vegetation community. Managing these areas will increase the vegetation structure, function, and diversity, while increasing the capacity provide food resources for fauna such as the Glossy Black Cockatoo (*Calyptorhynchus lathami lathami*), and Yellow-tailed Black Cockatoo (*Calyptorhynchus funereus*) (Marchant and Higgins 1990).

4.1 Management objectives

The management plan described here refers to three different areas, each with its own management prescription. These three areas are the Mature Swamp Oak Forest, the Swamp Oak regrowth, and the proposed new community (see map Appendix 4).

The objectives for management are:

- Increase the biological condition of riparian vegetation, in terms of biodiversity, structural diversity, and community diversity.
- Identify and address gaps in the existing Rehabilitation and Management Plan in order to increase condition.
- Inform management targets using a combination of published expectations of vegetation types, as well as surveyed reference patches.
- Incorporate aspects of management that could foster community involvement.

4.2 Mature Swamp Oak Forest (SOF)

The mature Swamp Oak Forest along the southern boundary of the quarry site is a valuable biological asset. The large trees and dense canopy provide habitat and food for a vast array of fauna. Its age and diversity make it a valuable indicator of what the Swamp Oak regrowth may become, however it requires management in order to maintain and increase its condition. Primarily, management of this community requires removal of weeds (woody and herbaceous, see section 4.4) as well as planting of underrepresented structural elements and species. These elements are an essentially absent ground and midstorey, and key species

known to occur in good condition Swamp Oak Floodplain Forest (see Appendix 5).

4.3 Swamp Oak Regrowth (SOF_R1 and 2)

Regrowth of *C. glauca* within the site exists as dense stands with few other species*. C. glauca* trees are particularly good at developing dense monocultures due to their ability to readily reproduce from seed as well as vegetatively via root suckering. It is clear from the existing stand structure, and a number of very high density regrowth areas in the south-western part of the property that in the absence of manipulation through supplement planting and thinning where appropriate, the stand is likely to become a low diversity thicket. *C. glauca* monocultures can occur naturally in coastal fringes, however it is unlikely that such high densities would have been present at the quarry site prior to clearing. The low diversity of such stands conflicts with the aims of managers to maintain and increase biodiversity at the site. Very high density stands also reduce the growth rate and production of seeds due to competition between plants, which slows and reduces the habitat and food provision of these trees for fauna (Vesk et al. 2008). Therefore this an inappropriate management target.

Allowing natural regeneration within the site to create natural communities is a highly cost-effective method of restoration. However, it is often the case that the regrowth vegetation does not possess all of the attributes that are desired for a good quality site. In this case the regrowth may require facilitated management in the form of supplement planting of species notably absent from the site, as well as control of the density of regrowing plants. Crucially, this decision is informed by using reference examples, i.e. the mature Swamp Oak Forest on-site (SOF, Figure 1) and the expectation of good quality Swamp Oak Floodplain Forest (Appendix 5). Species and structures which are notably absent compared with these reference benchmarks should be considered for supplement planting. A species list of recommended plants is shown in Appendix 5 but the feasibility of each species' inclusion will be highly depended on its accessibility and cost.

In the absence of management, this regrowth vegetation is likely to follow a trajectory of overly dense Swamp Oak Forest that is biologically mediocre compared to its potential (Figure 3). Supplementing the regrowth with low-density planting of key species, as well as thinning stems within overly dense patches, will greatly facilitate the progression of this regrowth vegetation towards a high quality patch, by increasing the species and structural diversity as well as the vegetation extent.

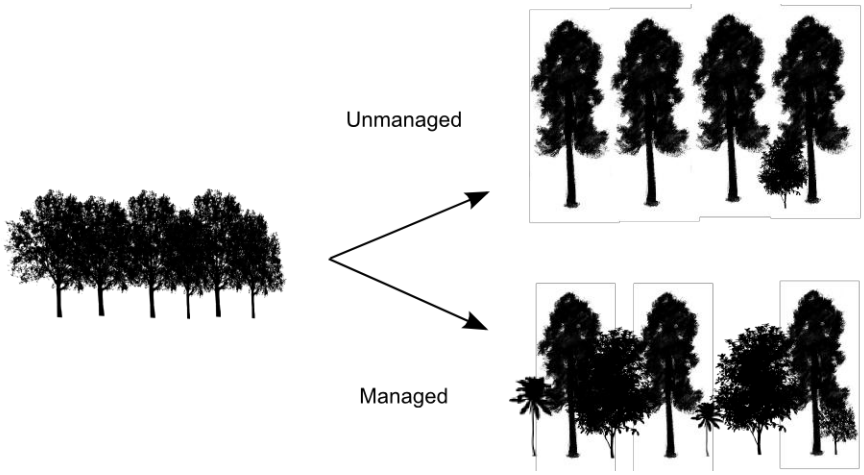

Figure 3. Expected vegetation trajectories of dense Swamp Oak regrowth with and without proposed management.

4.4 Swamp Oak Forest/Lowland Rainforest complex creation

There is potential to extend beyond the facilitated regeneration of the Swamp Oak Forest, to create a patch of vegetation currently not existing within the site but that would have existed in the area prior to clearing. Although small in area, this new vegetation type could have great biodiversity benefits for the site by increasing the diversity of vegetation communities, and providing an additional example of a now rare vegetation type within a highly modified landscape. Due to the increased density and diversity of planting required, this is a relatively high cost exercise, although requires less intensive management than the open space areas of the site, and could be a vegetation icon for the quarry's revegetation efforts.

Lowland Floodplain Rainforest is both structurally complex and species diverse (Major 2011a). Recreating a pure stand of this rainforest vegetation type would be difficult due to the constraints on site size and resources, which is why a complex or mosaic with the adjacent Swamp Oak Forest would be ideal. Swamp Oak forests are known to form complexes with other floodplain forest communities (Major 2011b), and the diverse and dense nature of the stand ensures that *C. glauca* resprouting and domination is not a problem.

In order to ensure that the new vegetation type conforms to a realistic and desirable state, the off-site remnant can be used to great effect (see photo in Appendix 2). This remnant has species affinities to both Swamp Oak and Lowland Rainforest vegetation types that existed prior to clearing and now occur in small remnant patches, e.g. Stotts Island Nature Reserve.

The proposed site for this new vegetation type is a small spur or possible future island of land that will protrude into the lake even at its greatest extent (John McQueen pers. comm., see Figure 4 and Appendix 4). This site is currently devoid of shrubs or trees, save for a few tall *C. glauca* trees that would remain. To facilitate native plant growth and establishment, some form of weed control

should be used across the site, such as herbicide or, preferably, physical removal. The plants that should be considered for this proposal are a combination of those described in section 3.3, and those listed in Appendix 6. Planting is likely to consist of a one off large-scale planting event, followed up with supplement planting and weed management as required.

This is a clear example of where community involvement could be increased at the site. At a minor scale, this could involve a community planting day, but at a larger scale it could be highlighted as a long term community project. The latter would increase a sense of ownership and connection to the site and provide long-term management. In either case this would increase the local public awareness of the quarry's biodiversity values, increase the sense of community involvement and ownership for the quarry, and also provide volunteer labour and expertise. There are many potential avenues that could be explored as part of this proposal depending on the accepted restoration objective and the level of community involvement.

Figure 4. Current view of approximate location of the potential new habitat type.

4.4 Management of weeds

The existing Weed and Pest Management Plan (Appendix 3, Rehabilitation and Landscape Management Plan 2010) is a thorough and well considered plan that if followed will help improve the vegetation condition of the site. All riparian communities surveyed in this report were negatively affected by weeds. In many cases, future weed populations can be reduced with current well-timed intervention, such as slashing/spraying prior to seed-set.

5. Conclusion

Based on the Rehabilitation and Landscape Management Plan (2010), much revegetation and landscaping work has already been done, in particular the formation of a stable structural gradient on the banks of the extraction lake, planting of wetland plants on the waterway margin, and planting and mowing of open space. This is an impressive achievement in a relatively short space of time, however the aspects missing from this plan mean that benefits associated with the site's uncommon vegetation and location aren't fully realised. This report aims to provide an evaluation of the riparian vegetation of the quarry to inform management that can build upon and alongside the existing Management Plan. There are clear gaps in the existing Management Plan that are the focus of this report, and by addressing them it adds substantial value to the biological integrity of the riparian vegetation of the site.

5.1 Management

By necessity this report provides only the essential information to explain the need, the purpose, the rationale, the actions and the outcomes; however if these actions were to be implemented they would require a more in depth proposal that would include greater detail on timelines, costs, methods, species, etc. as determined by the quarry managers. I would be happy to be involved in any capacity that was required if this were the case.

5.2 Benefits

The benefits of the proposed management actions are:

- Increased species diversity of the site, to more closely represent the pre-cleared vegetation. This vegetation is also more structurally diverse and will benefit a greater range of fauna.
- The expected gains from the proposed management can be made with relatively modest expense.
- Potential to involve the local and interested community in management actions to increase the community awareness of the quarry and its biodiversity values.
- Rehabilitating these endangered vegetation types is inherently valuable but may provide a great potential biodiversity and carbon offset for the quarry, which requires further investigation.

5.3 Informing management at other sites

Two key elements of this project can be applied to many other quarry sites: the manipulation of regrowth vegetation to gain high quality vegetation at relatively low cost, and the use of reference sites to inform management targets. Another consideration for quarry rehabilitation is the potential for rehabilitated vegetation to be used as biodiversity or carbon offsets for the site or other sites.

References

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Appendix 1: Mapped riparian vegetation communities

Appendix 2: Photos of different vegetation types surveyed

Mature Swamp Oak Forest (SOF)

Swamp Oak Forest regrowth (SOF_R1)

Swamp Oak Forest regrowth (SOF_R2)

Swamp Oak Forest and Lowland Rainforest complex, Banora Point

Open space planting

Exotic grassland/herbland

Wetland

Sedge/Bullrush water's edge

Appendix 3: Survey sheets

Mature Swamp Oak Forest (SOF)

Flora Recording Sheet Is this a Quadrat or a Definable Area ✓ ?

Site Identifier: TS1 - SOF
Lat:
Long:
A.M.G.
Date: 21-7-14 Time:
Observer: CHRIS JONES
Topographic position:
Aspect: Gully Slope:
Alt. m

Locality description: Australia, NSW, Cudgen. Tweed Sands quarry, drainage line along southern boundary of property, south of access road.

Vegetation Structure: Swamp Oak (Casuarina glauca) forest with mixed species midstorey and very minor understorey

EVC: NA
Floristic Community/Sub-community Code:
Quadrat Area: m^2 Definable Area: ha
Number of Taxa:
Sampling Time:

LIFE FORM	HEIGHT (m) Mean	Min.	Max.	% Cover
Trees				
Casuarina glauca			30m	>50
Cupaniopsis anacardioides			10m	<5
Cinnamomum camphora			20m	<5
Guioa semiglauca			15m	<5
Melaleuca quinquenervia			10m	<5
Shrubs				
Maclura cochinchinensis			2m	<1
Acacia longissima			2m	<1
Herbs				
* Ipomoea cairica	Climber		NA	<5
* Parsonsia straminea			NA	<1
Grasses				
* Cynodon dactylon			Mown	10-20
* Paspalum dilatatum			"	<5
Sedges/Rushes				

LIFE FORM	% Cover
Ferns	
Mosses/Liverworts	
Lichens	
Fungi	

SUBSTRATE	% Cover
Rocks	
Logs	
Branches	
Litter	
Bare Ground	
Water	

GEOLOGY

Metamorphic	Sedimentary	Igneous
	✓	

SOIL PROFILE

Depth	Colour	Texture	pH	Org.

VEGETATION QUALITY

Large Trees	
Tree Canopy Cover	
Lack of Weeds	
Understorey	
Recruitment	
Organic Litter	
Logs	Very few

NOTES: e.g. time since fire, fire frequency and severity, age class structure, dieback, tree hollows, flowering/ fruiting, seedling recruitment, grazing impacts, animal signs, threats & disturbances, plot uniformity or heterogeneity, etc.

Mature stand of Swamp Oak forest along a narrow drain, on both sides. Width of vegetation not greater than 10m. Very scarce understorey cover due to dense canopy overshadowing. Coast Morning Glory is common and a significant threat to the native vegetation.

Swamp Oak Forest regrowth (SOF_R)

Flora Recording Sheet Is this a Quadrat or a Definable Area ✓ ?

Site Identifier: TSZ - SOF_R	Locality description: Australia, NSW, Cudgen, Tweed Sands quarry, southern bank of extraction lake (~5m wide) and along the western boundary gully of quarry property
Lat:	
Long:	
A.M.G.	
Date: 21.7.14 Time:	
Observer: CHRIS JONES	Vegetation Structure: Swamp Oak (Casuarina glauca) Forest regrowth, with exotic understorey
Topographic position:	EVC: NA
Aspect: GULLY E N Slope:	Floristic Community/Sub-community Code:
Alt. m	Quadrat Area: m^2 / Definable Area: ha
	Number of Taxa:
	Sampling Time:

LIFE FORM	HEIGHT (m) Mean	Min.	Max.	% Cover
Trees				
Casuarina glauca	10	6	16	>50
Avicennia marina			10	<5
Cinnamomum camphora			2	<1
Shrubs				
Herbs				
* Ipomoea cairica	Climber		NA	<5
Grasses				
* Cynodon dactylon			10cm	10-30
Phragmites australis			2m	10-20
Pennisetum purpureum			3m	<10
Sedges/Rushes				

LIFE FORM	% Cover
Ferns	
Mosses/Liverworts	
Lichens	
Fungi	
SUBSTRATE	**% Cover**
Rocks	
Logs	
Branches	
Litter	
Bare Ground	
Water	

GEOLOGY

Metamorphic	Sedimentary	Igneous
	✓	

SOIL PROFILE

Depth	Colour	Texture	pH	Org.

VEGETATION QUALITY

Large Trees	None
Tree Canopy Cover	
Lack of Weeds	
Understorey	Mostly exotic
Recruitment	Yes - dominated by C. glauca
Organic Litter	
Logs	None

NOTES: e.g. time since fire, fire frequency and severity, age class structure, dieback, tree hollows, flowering/ fruiting, seedling recruitment, grazing impacts, animal signs, threats & disturbances, plot uniformity or heterogeneity, etc.

Regrowth Swamp Oak forest on previously cleared land. Width of vegetation no more than 5m. Regrowth forming continuous canopy apart from occasional gaps of a few metres. Low understorey cover directly beneath trees but high weed cover adjacent.

Mangroves only occur in the section along the western gully.

Elephant grass forms large clumps along the western lake boundary

Off-site Swamp Oak Forest/Lowland Rainforest complex

Flora Recording Sheet Is this a Quadrat or a Definable Area ✓ ?

Site Identifier: REF-1	Locality description: Australia, NSW, Banora Point, Lot 11 Pacific Hwy, centre of tall forest patch.
Lat:	
Long:	
A.M.G.	
Date: 22.7.14 Time:	
Observer: CHRIS JONES	Vegetation Structure: Swamp Oak and Broad-leaved Paperbark forest with diverse mid- and understorey including climbers.
Topographic position:	
Aspect: NONE Slope:	
Alt. m 0	

EVC: NA
Floristic Community/Sub-community Code:
Quadrat Area: m^2 | Definable Area: ha
Number of Taxa:
Sampling Time:

LIFE FORM	HEIGHT (m) Mean	Min.	Max.	% Cover
Trees				
Casuarina glauca			30	30-50
Melaleuca quinquenervia			30	20-40
Cupaniopsis anacardioides			10m	<5
Archontophoenix cunninghamiana			10m	<1
Shrubs				
Bursaria spinosa			2m	<1
Genista sp.			1.5m	<1
Pittosporum undulatum			5m	<1
Herbs				
Viola banksii			5cm	<5
Stephania japonica			NA	<5
Parsonsia straminea			NA	<5
Smilax australis			NA	<1
Ceratopetalum gymnosum			NA	<5
Grasses				
Imperata cylindrica			1.5m	10-50
Pennisetum clandestinum			0.5m	5-10
Sedges/Rushes				
Lomandra longifolia			0.5m	<5

LIFE FORM	% Cover
Ferns	
Hypolepis cylindrica	<5
Platycerium sp.	<1
Mosses/Liverworts	
Lichens	
Fungi	

SUBSTRATE	% Cover
Rocks	
Logs	
Branches	
Litter	
Bare Ground	
Water	

GEOLOGY

Metamorphic	Sedimentary	Igneous

SOIL PROFILE

Depth	Colour	Texture	pH	Org.

VEGETATION QUALITY

Large Trees	Very few trees w/ large DBH
Tree Canopy Cover	
Lack of Weeds	
Understorey	
Recruitment	Yes - of many species
Organic Litter	
Logs	some but none large

NOTES: e.g. time since fire, fire frequency and severity, age class structure, dieback, tree hollows, flowering/ fruiting, seedling recruitment, grazing impacts, animal signs, threats & disturbances, plot uniformity or heterogeneity, etc.

A high diversity mature stand of Swamp Oak and Melaleuca dominant canopy but with strong rainforest affinities. Midstorey is diverse and dense, as is understorey but remains easy to walk through the vegetation in most parts. Diverse climbing flora and many epiphytes.

Appendix 4: Mapped management areas

Appendix 5: Characteristic species of Swamp Oak Forest

The species list presented here was sourced from Major R. (2011b). A detailed description of this vegetation type including species names can be found in Department of the Environment (2014a).

Scientific name	Common name
Acmena smithii	Small-leaved Lillypilly
Alphitonia excelsa	Red Ash
Alternanthera denticulata	Lesser Joyweed
Baumea juncea	Bare Twig-rush
Blechnum indicum	Bungwall
Callistemon salignus	Willow Bottlebrush
Carex appressa	Tall Sedge
Casuarina glauca	Swamp Oak
Centella asiatica	Centella
Commelina cyanea	Scurvy Weed
Crinum pedunculatum	Swamp Lily
Cupaniopsis anacardioides	Tuckeroo
Cynodon dactylon	Couch
Dianella caerulea	Blue Flax-lily
Entolasia marginata	Bordered Panic
Enydra fluctuans	Helencha
Flagellaria indica	Supplejack
Gahnia clarkei	Tall sawsedge
Geitonoplesium cymosum	Scrambling Lily
Glochidion ferdinandi	Cheese Tree
Glochidion sumatranum	Umbrella Cheese Tree
Hypolepis muelleri	Ground Fern
Imperata cylindrica var. major	Blady Grass
Isolepis inundata	Swamp Club-rush
Juncus kraussii subsp. Australiensis	Sea Rush
Juncus planifolius	Grass-leaved Rush
Juncus usitatus	Common Rush
Lobelia alata	Angled Lobelia
Lomandra longifolia	Spiny-headed Mat-rush
Lophostemon suaveolens	Swamp Mahogany
Maundia triglochinoides	Maundia
Melaleuca alternifolia	Narrow-leaved Paperbark
Melaleuca ericifolia	Swamp Paperbark
Melaleuca quinquenervia	Broad-leaved Paperbark
Melaleuca styphelioides	Prickly-leaved Paperbark
Myoporum acuminatum	Waterbush
Oplismenus imbecillis	Pademelon Grass
Parsonsia straminea	Common Silkpod
Persicaria decipiens	Slender Knotweed
Persicaria strigosa	Spotted Knotweed
Phragmites australis	Phragmites
Selliera radicans	Swampweed
Smilax australis	Lawyer Vine
Stephania japonica var. discolor	Snake Vine
Viola banksii	Native Violet

Appendix 6: Characteristic species of Lowland Rainforest

The species list presented here was sourced and modified from Major R. (2011a). A detailed description of this vegetation type including species names can be found in Department of the Environment (2014b).

Scientific name	Common name
Aphananthe philippinensis	Native Elm
Araucaria cunninghamii	Hoop Pine
Archontophoenix cunninghamiana	Bungalow Palm
Argyrodendron trifolioatum	White Booyong
Arthropteris spp.	Arthropteris
Atractocarpus chartacea	Narrow-leaved Gardenia
Castanospermum australe	Black Bean
Ceratopetalum apetalum	Coachwood
Cryptocarya obovata	Pepperberry
Cyathea cooperi	Lacy Tree Fern
Dendrocnide excelsa	Giant Stinging Tree
Dysoxylum molissimum	Red Bean
Elaeocarpus grandis	Blue Quandong
Elaeocarpus obovatus	Hard Quandong
Elatostemna reticulatum	Rainforest Spinach
Ficus coronata	Sandpaper Fig
Ficus macrophylla	Moreton Bay Fig
Ficus obliqua	Small-leaved Fig
Ficus superba var. henneana	Deciduous Fig
Ficus watkinsiana	Strangler Fig
Flindersia schottiana	Cudgerie
Flindersia xanthoxyla	Long Jack
Gossia bidwillii	Python Tree
Grevillea robusta	Silky Oak
Linospadix monostachyus	Midgin-bil
Livistona australis	Cabbage-tree Palm
Microsorum scandens	Fragrant Fern
Piper novae-hollandiae	Giant Pepper Vine
Pollia crispata	Pollia
Pothos longipes	Pothos
Sloanea australis	Maiden's Blush
Sloanea woollsii	Yellow Carabeen
Streblus brunonianus	Whalebone Tree
Syzygium australe	Brush Cherry
Syzygium francisii	Giant Water Gum
Toona ciliata	Red Cedar
Tristaniopsis laurina	Kanooka
Waterhousea floribunda	Weeping Lillypilly