Nambucca Ecohealth Project 2016-2017

Assessment of River and Estuarine Condition

Final Technical Report

July 2018

Sarah Mika, Ben Vincent, Darren Ryder, Sam Lewis, Ana Baker and John Schmidt

NAMBUCCA VALLEY

NAMBUCCA SHIRE COUNCIL

NSW GOVERNMENT

Office of Environment & Heritage

Aquatic Ecology and Restoration

une University of New England

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A/Prof. Darren Ryder, Dr Sarah Mika, Mr Ben Vincent, Mr Sam Lewis and Mrs Ana Baker
School of Environmental and Rural Science, University of New England, Armidale, NSW, 2351

Mr John Schmidt
NSW Department of Environment and Heritage, 41 Belgrave St, Kempsey, NSW, 2440

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Project contact:
Dr Sarah Mika
School of Environmental and Rural Science
University of New England, Armidale, NSW, 2351
Email: sarah.mika@une.edu.au

Cover Photo: Missabotti Creek (B. Vincent, 2016).

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We thank the Local Aboriginal Land Council and the Gaagal Wanggaan Indigenous Protection Area for permission to sample in Warrell Creek. The people below provided significant support for the project including local knowledge, site access and project support. We thank them all.

Grant Nelson and Lisa Hall: Nambucca Shire Council
Dave McKay: landowner at Nambucca River #5

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Glossary of General Terms

Algal biomass	The mass of algae in a water body at a given time.
Aquatic macroinvertebrates	Larger aquatic invertebrates, functionally defined as those retained on a 500µm sieve. Their body length usually exceeds 1mm.
Bank slumping	The mass movement of bank material after failure.
Chlorophyll *a*	A green pigment found in plants that allows them to photosynthesise. Chlorophyll *a* measurements are an indicator of the amount of phytoplankton and algae in a water body.
Dissolved oxygen (DO)	The concentration of gaseous oxygen (O_2) dissolved in an aqueous solution.
Geomorphic condition	An assessment of bank condition (e.g. slope, bank slumping, exposed tree roots and undercutting), bed condition (active erosion and smothering of the bed substrate by high loads of fine sediment) and trampling by stock.
Ecohealth indicators	A selection of measurements that indicate if there are stresses to the aquatic ecosystem as a whole. Indicators include water quality (dissolved oxygen, salinity, acidity, turbidity, nutrients), riparian condition (vegetation composition, occurrence of riparian weeds, riparian habitat), geomorphic condition and composition of aquatic macroinvertebrate communities.
Oxides of nitrogen (NOx)	Compounds of nitrogen and oxygen, primarily NO, NO_2, N_2O and N_2O_5.
pH	The dissolved hydrogen ion concentration. Acidic solutions have a pH < 7, basic solutions have a pH > 7.
Riparian condition	The health of a riparian zone, based on an assessment of the occurrence of weeds, structure of riparian vegetation, habitat (e.g. logs) and management regime.
Riparian zone	The area of land adjoining rivers and streams that has a direct influence on the water and aquatic ecosystems within those rivers and streams. It includes stream banks and a strip of land of variable width along the banks.
SIGNAL2	SIGNAL stands for “Stream Invertebrate Grade Number – Average Level”. SIGNAL2 is a scoring system for Australian macroinvertebrates based on their sensitivity to pollution.
Soluble reactive phosphorus (SRP)	The concentration of inorganic ions of phosphorus (predominately HPO_4^{2-} and PO_4^{3-}) in water. These ions are available to be used by aquatic biota.
Total nitrogen (TN)	The concentration of nitrogen in the water, both in organic and inorganic forms.
Total phosphorus (TP)	The concentration of phosphorus in natural or anthropogenic substances that contain, or decompose to produce phosphate ions.
Total suspended solids (TSS)	All particles suspended in water that do not pass through a 1.2µm filter.
Turbidity	The cloudy appearance of water due to suspended material.

Glossary of Soil Terms

A horizon	The top soil layer containing the greatest concentration of organic material. Consists mainly of clay minerals and quartz with an absence of soluble minterals.
Anthroposol	Soils arising from human activities where soil horizons are profoundly modified, truncated or buried; the creation of new soil parent materials by mechanical means.
B horizon	The second soil layer comprising an illuvial concentration of silicate clay, iron, aluminium, humus, carbonates, gypsum or silica alone or in combination.
Dermosol	Soils having structured subsurface horizons with a lack of textural contrast between A and B horizons.
Ferrosol	Soils with subsurface horizons that are high in free iron oxide and that lack textural contrast between surface and subsurface horizons. Formed from basic or ultrabasic igneous rocks or alluvium derived from these.
Hydrosol	Soils other than organosols, podosols or vertosols in which the greater part of the soil profile is saturated for at least 2-3 months in most years.
Kandosol	Soils that lack strong textural contrast, have massive or weakly structured B horizons, have a maximum clay content exceeding 15% in the B2 horizon, and do not have a calcareous A horizon.
Kurosol	Soils with strong textural contrast between A horizons and strongly acid B horizons.
Podosol	Soils with B horizons dominated by the accumulation of organic matter, aluminium and/or iron.
Rudosol	Typically young soils with neglibile pedologic organization. These soils vary widely in texture and depth with many stratified and some highly saline.
Tenosol	Soils that have weak pedologic organization apart from the A horizon. These soils are diverse but includes soils having a peaty horizon or overlying a calcrete pan or hard, unweathered rock.
Vertosol	Clay soils (clay texture greater than 35%) with shrink-swell properties that exhibit strong cracking when dry and at depth, have slickensides and/or lenticular structure aggregates.

Glossary of Vegetation Terms

Canopy	Growth form: the tallest growing layer of vegetation in a plant community.
Continuity	The degree of continuous uninterrupted vegetation: is used as a measure of riparian condition.
Connectivity	Proximity of site to intact remnant stands of native vegetation.
EEC	Endangered Ecological Community, as determined by State and Federal Government.
Endemic	Refers to plants that have originated and are restricted to a particular area, range or place and therefore do not occur naturally anywhere else.
Fire regime	Refers to the pattern, frequency and intensity of fire.
Forb/herb	A small non-woody flowering plant found in the understory.
Fringing vegetation	The terrestrial riparian vegetation directly adjacent to a water body/channel, specifically graminoides.
Graminoid	Growth form: a collective term for all monocotyledons - grasses, sedges and rushes.
Intact remnant	An area of native vegetation that has had little-to-no disturbance or alterations. Remnant conditions can vary from being intact to disturbed.
Leaf litter	The collective term for fallen leaves on the ground.
Macrophyte	Plant species found growing in water or wetland, which may be submergent, emergent or floating.
Midstorey	Growth form: those plants found growing to a height of greater than c.1.5 metres and less than 5 metres.
Proximity	How close the patch of vegetation under assessment is to a good condition, large remnant stand of native vegetation.
Riparian condition	The health of a riparian zone, based on an assessment of the occurrence of weeds, structure of riparian vegetation habitat (e.g. logs) and management regime.
Riparian zone	The area of land adjoining rivers and streams that has a direct influence on the water and aquatic ecosystems within those rivers and streams. It includes stream banks and a strip of land of variable width along the banks.
Phase-out strategy	Strategically staggered removal of a weed species (e.g. Camphor Laurel). Such removal allows time for native plantings to replace weed species, while simultaneously maintaining bank stability and wildlife habitat.
TEC	Threatened Ecological Community
Weed control	Where environmental and noxious weed species are reduced or removed through chemical, mechanical, or physical means.
Weed monitoring	Where weed species are repeatedly surveyed for their range expansion and potential spread.
Understorey	Growth form: those plants found growing to a height of less than c.1.5 metres.
Vegetation	All flowering and non-flowering land and water plants.

Summary

The development of a standardised means of collecting, analysing and presenting riverine, coastal and estuarine assessments of ecological condition has been identified as a key need for coastal Local Councils who are required to monitor natural resource condition, and water quality and quantity in these systems. Thirty-one study sites were selected across the Nambucca River and Deep Creek catchments; 18 freshwater sites and 13 estuarine sites and these were sampled 6 times from July 2016 to June 2017 to contribute to the assessment of the ecological condition of the catchment.

The Nambucca Ecohealth program was divided into six major hydrological units across nine sub-catchments: Nambucca River (North Arm), tributaries of the Nambucca North Arm, Taylors Arm, tributaries of Taylors Arm, and Warrell Creek in the Nambucca catchment; and Deep Creek, an ICOLL (Intermittently Closed and Open Lake or Lagoon) to the north of the Nambucca catchment. The project aimed to:

- Assess the health of coastal catchments using standardised indicators and reporting for estuaries, and freshwater river reaches using hydrology, water quality, riparian vegetation and habitat quality, geomorphic condition and macroinvertebrate assemblages as indicators of aquatic ecosystem health, and
- Contribute scientific information to the development of a report card system for communicating the health of the estuarine and freshwater systems in the Nambucca River and Deep Creek catchments.

Report Card

The Overall Grade for the Nambucca Ecohealth program was C-, ranging from an F in Tom Maras Creek, to a C+ in Warrell Creek. Overall Ecohealth grades were very consistent among the nine subcatchments, with aquatic macroinvertebrates and geomorphic condition the most variable across the program. Water quality scores were consistently poor across the catchment, driven by high nutrient concentrations and low dissolved oxygen, both indicative of the below average streamflow experienced during the study period. Riparian and geomorphic scores were relatively consistent among and within each system, highlighting that issues with physical condition are affecting the long-term condition of the streams.

Geomorphic Condition

Geomorphic condition in the Nambucca Ecohealth program shows most (76%) of the stream network is in good or moderate condition. Three subcatchments have more than 30% of their stream network in good condition. These are the estuarine Oyster Creek, Warrell Creek and Buckrabendinni Creek. Two subcatchments had more than 50% of their stream network in poor condition: Missabotti Creek and South Creek. These subcatchments have been significantly cleared of catchment and riparian vegetation in the reaches with poor geomorphic condition.

Riparian Condition

The area within a riparian zone can contain valuable water resources, highly fertile soil and supports high levels of biodiversity as well as many social and economic functions. Overall, riparian condition for the Nambucca catchment was moderate across the 31 sites of the Nambucca Ecohealth program. Warrell Creek and Deep Creek subcatchments had good riparian condition, although disturbance intensified in the freshwater reaches. Similarly, riparian condition was better in the estuarine reach of the Nambucca River than the freshwater reach. While Taylors Arm had less disturbance and better overall riparian condition than the Nambucca River (North Arm), tributaries of Taylors Arm were in similar poor condition as the tributaries of the Nambucca River (North Arm).

Of the 308 dominant riparian vegetation species recorded from the 31 Nambucca Ecohealth sites, 91 were exotic species, while 217 species were native species. The main stressors to riparian condition were the dominance of invasive weeds, vegetation clearing causing reduced riparian continuity and isolation from large patches of remnant vegetation, and access by livestock. The most common dominant weed species were Lantana (*Lantana camara*) in 87% of sites, Broad-leaved Paspalum (*Paspalum mandiocanum*) in 77% of sites, Wild Tobacco (*Solanum mauritianum*) in 65% of sites, Fireweed (*Senecio madagascariensis*) in 55% of sites, Camphor Laurel (*Cinnamomum camphora*) in 48% of sites, Small-leaved Privet (*Ligustrum sinense*) in 45% of sites, and Paspalum (*Paspalum dilatatum*), Pigeon Grass (*Setaria sphacelata*), Blue Billy Goat Weed (*Ageratum houstonianum*), Wandering Jew (*Tradescantia fluminensis*) and Cobbler Pegs (*Bidens pilosa*) in 42% of the 31 Nambucca Catchment Ecohealth sites in 2017. Thirty-five weed species were listed as having a biosecurity risk (formally known as noxious weeds). The influence of clearing and physical stressors (trampling and grazing) has reduced the recruitment of native vegetation in the riparian zone.

Strongly linked to riparian condition, the active restoration of native riparian vegetation as a long term action for improving geomorphic condition and aquatic macroinvertebrate habitat should be a priority in the Nambucca catchment. Management recommendations are given in Part 4.

Mangrove, seagrass and saltmarsh cover

Estuarine macrophytes are essential components of estuarine ecology. They improve water quality, contribute to the food chain, stabilise morphology by binding sediments, and provide both habitat and a nursery ground for fish and other marine species. Unlike neighbouring North Coast catchments, satellite imagery used to assess the cover of estuarine macrophytes has only been collected once in the Nambucca Catchment in 2004 (Creese et al. 2009). Due to the absence of subsequent data collection, we were unable to make a temporal assessment of estuarine macrophyte cover change in the major estuaries of the Nambucca Catchment. We have therefore provided the most recent data on total estuarine macrophyte cover (i.e. grouped - mangroves, saltmarsh and seagrass) for Nambucca River, Warrell Creek and Deep Creek. Mangroves were the dominant estuarine macrophytes in both the Warrell Creek and Nambucca River estuaries, closely followed by saltmarsh and lastly seagrass. In the Deep Creek estuarine system, saltmarsh was by far the dominant estuarine macrophyte, followed by mangroves and then seagrass.

Over the last 30 years, temporal change in estuarine macrophyte cover has been recorded in neighbouring North Coast catchments with the general pattern being an increase in mangroves and decreases in both saltmarsh and seagrass. The significant decreases observed in seagrass and saltmarsh cover are concerning. In addition to naturally occurring weather events such as storms, cyclones and floods, anthropogenic factors that can lead to seagrass degradation and decline include excessive turbidity and siltation that reduces light intensity, elevated nutrient levels, stormwater discharge, heavy metal and toxin deposition, erosion, coastal development, moorings, boat propellers and introduced species. To gain a better understanding of estuarine processes in the Nambucca Catchment, management priorities should be focused on long-term monitoring and mapping of estuarine macrophyte cover change. It is therefore our recommendation that a current up-to-date assessment is undertaken in order to explore the potential for temporal change in estuarine macrophytes of the Nambucca Catchment. Such an assessment will assist in informing current and future management directives and directly relates to each of the top ten prioritized management strategies in the Nambucca River Estuary Management Plan (BMT WBM, 2008).

Water Quality

Water quality was poor across the Nambucca and Deep Creek catchments, with an overall grade of D. Water quality was lowest in Newee Creek estuary and Taylors Arm estuary. It is worth investigating the decline in water quality from the freshwater reaches of Taylors Arm to the estuary, specifically respecting total and bioavailable phosphorus. Freshwater reaches of Taylors Arm and its tributaries of Baker Creek and Thumb Creek had the best water quality scores in the Nambucca Ecohealth project.

Low levels of dissolved oxygen were frequent in the catchment and likely due to the below average rainfall resulting in smaller stream discharge during the study period. Nonetheless, many sites in the Nambucca catchment consistently exceeded the ANZECC or NSW OEH nutrient guideline values. This was particularly the case for nitrogen and we suggest a management investment in reducing non-point source inputs of nitrogen in most of the subcatchments would significantly improve water quality across the Nambucca catchment. Yet, even with widespread high nutrient concentrations, algal biomass as measured by chlorophyll *a* rarely exceeded ANZECC or NSW OEH guideline values suggesting these values require refining for this region to better predict ecosystem change associated with elevated nutrients.

In contrast to the surrounding catchments in the Mid North Coast and Northern Rivers, there was no consistent trend of very poor water quality at the tidal limits or upper estuaries in the Nambucca River, and this was despite the reduced flushing flows experienced during the study period. This is a positive finding for the Nambucca catchment as it suggests that nutrients and suspended sediments are not being stored and recycled in the upper estuaries, and indicates that estuarine water quality may respond relatively quickly to improvements to the water quality of inflowing freshwater systems.

Aquatic Macroinvertebrates

Because many macroinvertebrates live in a river reach for an extended period of time, they can integrate the impacts on the ecosystem over an extended period of time, rather than just at the time of sampling. Overall, the Nambucca catchment received a poor score (D+) for aquatic macroinvertebrate communities. Thumb Creek and upper Buckrabendinni Creek had the greatest richness with 38 families observed at each site. The lower freshwater reach in Taylors Arm had the greatest abundance with 746 individual macroinvertebrates within a 10m linear sweep sample. Thumb Creek and the lower Taylors Arm also contained significant stoneflies, mayflies and caddisflies (EPTs) that are sensitive to pollution. The most depauperate macroinvertebrate community was found in the lower Tom Maras Creek, which had low abundance and diversity, and was characterized by families that can withstand pollution.

From a management perspective, sites assessed as having moderate aquatic macroinvertebrate condition generally contained an abundant and diverse macroinvertebrate community, but still reduced from the maximum potential found in the catchment. Typically, the upper reaches of subcatchments had better riparian vegetation and lower intensities of anthropogenic disturbance, and this was reflected in the higher abundances and diversities of aquatic macroinvertebrates. This high richness and abundance of aquatic macroinvertebrates in the reference sites means that these populations of macroinvertebrates indicative of good water quality will be able to colonise sites elsewhere in the catchment when good water quality and the availability of appropriate habitats co-occur.

Fish

Across 21 sites in the Nambucca catchment, freshwater fish communities were in good condition. Fish communities in the Nambucca River (North Arm), Taylors Arm and South and Missabotti Creeks were in good condition (B, Figure 3.2e). The moderate fish community condition in Warrell Creek was the lowest observed condition in the Nambucca catchment, with a score of 64, a grade of C+. A detailed report of the fish survey has been prepared by the the NSW DPI (Fisheries) for the Nambucca Shire Council (www.nambucca.nsw.gov.au).

Partnerships

This project was a successful partnership among Nambucca Shire Council, NSW Office of Environment and Heritage, NSW DPI Fisheries and the University of New England. Continued partnerships are essential to ensure project outcomes are maximized.

PART 1

ECOHEALTH PROGRAM AND OBJECTIVES

1.1 Background

The NSW Natural Resources Monitoring Evaluation and Reporting (MER) Strategy was prepared by the Natural Resources and Environment CEO Cluster of the NSW Government in response to the Natural Resources Commission standard and targets and was adopted in August 2006. The purpose of the Strategy is to refocus the resources of NSW natural resource and environment agencies and coordinate their efforts with local governments, landholders and other natural resource managers to establish a system of monitoring, evaluation and reporting on natural resource condition.

At this time there was no consistent monitoring of estuarine or freshwater ecological condition in NSW. Working groups were formed to consider the most appropriate indicators and sampling designs to enable a statewide assessment of the ecological condition of rivers and estuaries. This report outlines the approach taken by stakeholders in the Nambucca Catchment to supplement the MER monitoring and is aligned with the objectives of the Nambucca River Estuary Management Plan (BMT WBM 2008).

1.2 Scope

Estuarine systems are focal points for the cumulative impacts of changed catchment land-use, and increasing urbanisation and development in coastal zones (Davis and Koop 2006). As a result, these ecosystems have become sensitive to nutrient enrichment and pollution, and degraded through habitat destruction, changes in biodiversity and loss of floodplain wetland health form excessive floodplain drainage.

The development of a standardised means of collecting, analysing and presenting riverine, coastal and estuarine assessments of ecological condition has been identified as a key need for coastal Local Land Services and local councils who are required to monitor and report on natural resource condition and water quality and quantity in these systems.

This project uses the Ecohealth framework that integrates the NSW Monitoring, Evaluation and Reporting (MER) Program currently monitoring NSW estuaries and coastal rivers on a bi- or tri-annual basis; NSW State of Environment (SoE) and State of Catchments (SoC) reports, EHMP Healthy Waterways program; proposed estuary report cards from the NLWRA (through WA Department of Water), NSW Estuary Management Policy and Coastal Zone Management Manual and relevant Estuary Management Plans; and sampling protocols developed by the CRC for Coastal Zone, Estuary and Waterway Management.

The Ecohealth Waterways Monitoring Program outlines a framework for the development of a catchment-based aquatic health monitoring program for rivers and estuaries with the aim of providing consistency in monitoring and reporting, and establishes the partnerships required for local and regional dissemination of outcomes. This project brings together major stakeholders in the management of coastal catchments in Northern NSW including state agencies (OEH, DPI Fisheries and Local Land Services), local councils and university researchers (UNE) to develop, refine, report and promote a standardised river and estuary health assessment tool.

This report provides the first baseline dataset for water quality, freshwater macroinvertebrates, and freshwater riparian and geomorphic condition in the Nambucca catchment. This framework provides an effective reporting mechanism to communicate water quality and resource condition to the general public, stakeholders and managers through simple report cards. Additionally, this program provides specific monitoring and management plans for the study area using the generic framework that outlines a standardised (and tested) set of partnership, monitoring, data management and reporting protocols implemented in coastal catchments throughout the Northern Rivers region.

1.3 Project objectives

1. Assess the health of coastal catchments using standardised indicators and reporting for estuaries and freshwater river reaches using hydrology, water quality, macroinvertebrate assemblages, condition of riparian and aquatic vegetation, and geomorphic condition as indicators of ecosystem health in streams of the Nambucca catchment;
2. Inform management priorities and actions for the subcatchments of the Nambucca River; and
3. Contribute scientific information to the development of a report card system for communicating the health of the estuarine and freshwater systems in the Nambucca catchment.

1.4 Report structure

Part 1 of the report provides the **rationale and background** of the Ecohealth program as well as outlining the specific structure of this Nambucca Ecohealth program.

Part 2 of the report outlines the **catchment characteristics** of the Nambucca catchment as context of the need for river and estuarine monitoring, and to provide the background to the study design and site selection processes:

2.1 **Study Area** provides information on the catchment characteristics of the rivers and estuaries of the Nambucca River such as area, hydrology and landuses.

2.2 **Study Design** provides the detailed description of the study design and protocols for site selection.

2.3 **Study Sites** provides locations and the sampling regime for the 32 study sites.

2.4 **Sampling Methods and Indicators** includes the range of water quality conditions measured, analysis of aquatic macroinvertebrate communities in freshwater sites, geomorphic measures of channel and bank characteristics, riparian condition, and local management issues.

Part 3 of the report details the **results** of water chemistry and biophysical data collected from June 2016 to May 2017. Results for water chemistry, macroinvertebrates, riparian and geomorphic condition are reported for sites, subcatchments and the Nambucca catchment overall (Figure 2.1).

Water chemistry variables assessed include nutrients (nitrogen and phosphorus), chlorophyll *a* and suspended solids, as well as water column profiles for pH, salinity and dissolved oxygen. Exceedances of NSW MER or ANZECC guideline thresholds are identified.

Macroinvertebrate assemblages collected from freshwater sites in spring 2016 and autumn 2017 were used to assess long-term condition of in-channel habitats and health indicators using diversity, SIGNAL2 scores and percent EPT (see Section 2.4.3). Freshwater fish communities were sampled by NSW DPI (Fisheries) and are provided as a separate report.

The *riparian condition* assessments include habitat, native species presence, percentage cover, woody and non-woody debris, management issues, as well as identification of local-scale disturbances to riparian zones. The *geomorphic condition* assessments include site-scale bank and bed condition and management issues, as well as a sub-catchment scale assessment of geomorphic condition.

Condition scores are calculated for water chemistry, aquatic macroinvertebrate community assemblages (freshwater sites only), freshwater fish communities (where sampled), riparian condition and geomorphic condition. These form the basis of the report cards and are collated for the whole Nambucca catchment, subcatchments and sites.

The catchment, subcatchments and sites are organised accordingly:

3.1 Nambucca catchment overall
3.2 Nambucca River (North Arm)
3.3 Tributaries of the Nambucca River
3.4 Taylors Arm
3.5 Tributaries of Taylors Arm
3.6 Warrell Creek
3.7 Deep Creek.

Part 4 provides **management recommendations** for the future management of the instream and riparian condition in rivers and estuaries of the catchment, and identifies priorities for future monitoring within the Ecohealth framework.

PART 2

STUDY AREA, DESIGN AND SITE DESCRIPTIONS

2.1 Study area

The Nambucca River Catchment covers 1,426km^2, with its head waters draining the Great Dividing Range on the western boundary where elevations reach 1013 meters above sea level. The western half of the catchment is predominantly hilly and rugged. The headwater areas are mostly densely timbered slopes and ranges, with deep incised valleys due to particularly erodible lithology. This lithology intensifies the propensity for landslips. It is bordered by the Macleay catchment to the south and west, and the Bellinger catchment to the north. Heading east, the valley floors widen as the slopes decline to the gentle rolling hills of the midlands and then onto the coastal floodplains (alluvial) and sandplains. Towns in the area include Nambucca Heads, Macksville, Taylors Arm, Bowraville, Scotts Head and Valla Beach (Alluvium 2012).

The original inhabitants of the Nambucca River Catchment are the Aboriginal people of the Gumbaynggirr Nation to the north of the Nambucca River and the Dunghutti to the south (Tindale 1974). Mount Yarrahapinni (at 498m above sea level) is a dominant feature of the local landscape and coastal plains. The mountain and surrounding area are signficant to Gumbaynggirr, Dunghutti and Ngambaa culture. (OEH 2014).

The Gumbaynggirr country covers the area of the Mid North Coast extending from the Nambucca River north to the Clarence River and east to the coast. The name Nambucca dates from 1835 and comes from the Aboriginal name *ngambukka*, which means 'winding or crooked river' (Townsend 1993). The river and the coastline of the Nambucca area provided plentiful food for the traditional landowners. Clement Hodgkinsons, the first European to make contact with the local tribes, stated that bream were fished from the river on his trip and "the waves which broke on the beach were full of Mullet and Salmon that seemed to swim among the breakers in search of prey" (Hodgkinson 1845).

The Dreamtime story of Birrugan is the great storyline of the Gumbaynggirr people. It describes the events of the hero ancestor in creating the landscapes of Gumbaynggirr country. The story tells of Birrugan making his canoe from the saltwater oak at its namesake; Wirriimbi, near Bowraville. The story signifies the connections between place, the creative ancestor and the transfer of knowledge to young men. The story describes travel along the river from Bowraville and the strand of oak trees where Birrugan made paddles and crossed the river.

Dispossession began in the mid-nineteenth century with the arrival of timber-getters in the Nambucca Valley. As land was taken by white settlers, local indigenous people became unable to access important sites (Sommerville and Perkins 2010). The land between Warrell Creek and South Beach from Nambucca to Scotts Heads, has significant Aboriginal cultural values and is now under joint management with Gumbaynggir traditional owners and the National Parks and Wildlife Service (Gaagal Wanggaan National Park). A Native Title consent was granted in 2010 after a 26 year battle (OEH 2017).

The Nambucca River Catchment is divided into five major hydrological units; Nambucca River that includes North Arm (the main arm of the Nambucca River) and Nambucca estuary including the tributary of Newee Creek; Missabotti Creek; South Creek and its tributary of Buckrabendinni Creek; Taylors Arm and its tributaries of Thumb Creek, Bakers Creek and Tom Maras Creeks; and Warrell Creek including its tributary of Eungai Creek (Figure 2.1).

The catchment comprises four distinct landform units: Escarpments and Ranges across the western half of the catchment draining to Midland Hills, and Coastal Floodplains and Sandplains in the east (Alluvium, 2012). The source of the Nambucca arises from a breached dome in the upper Bellinger Valley, in the escarpment and ranges landform unit, creating a broad radial drainage system integrating Missabotti Creek, Buckra Bendinni Creek and Taylors Arm (Warner 1981). Taylors Arm is the longest stream in the basin with a length of 69km. The upper reaches of Taylors Arm flow to the southeast, differing to the mostly easterly flow of the other streams, and changing to east-north-east when it reaches the township of Taylors Arm. The tidal limit of Taylors Arm is at Utungun and the stream joins the Nambucca River at Macksville. North Arm and South Arm converge to form the Nambucca River; with the tidal limit of the south arm near Bowraville. The confluence of Eungai Creek and Allgomera Creek form Warrell Creek in the southwest of the catchment. At Yarrahapinni Mountain, the flow changes from easterly to northerly, the tidal limit is 2.5km downstream from the Allgomera Creek confluence, and Warrell Creek converges with the Nambucca River at Nambucca Heads (Doyle 2003).

Broad-scale changes have impacted the landscape since European settlement, beginning with the arrival of loggers that worked in the Nambucca catchment as early as 1833 (Doyle 2003). However, permanent white settlement didn’t occur until the 1850s. Although the area was abundant in high-value timber such as rosewood, mahogany and red cedar, logging operations were restricted from the upper slopes until post WWII when trucks and tractors were able to penetrate previously inaccessible Eucalypt forest in the less fertile uplands. In these areas, blackbutt, spotted, grey and red gums were common. Ringbarking and clearing was undertaken on the lower slopes to create grazing land for dairying. Floodplains were cleared to crop the fertile alluvial soil. The decline in the dairy industry since the 1960s has resulted in a gradual return to open woodland cover (Raine 1994). Forestry is still a dominant land-use, as well as cattle and sheep grazing. Recreational and commercial fishing, and oyster faming are also economically important in the Nambucca catchment. Other large-scale changes that have occurred include floodplain drainage and floodplain alterations for agriculture and urban settlement. Several studies detail catchment characteristics, ecological condition, historic and current landuses in the Nambucca River catchment (Doyle 2003, NSC 2015, Skorulis 2016)

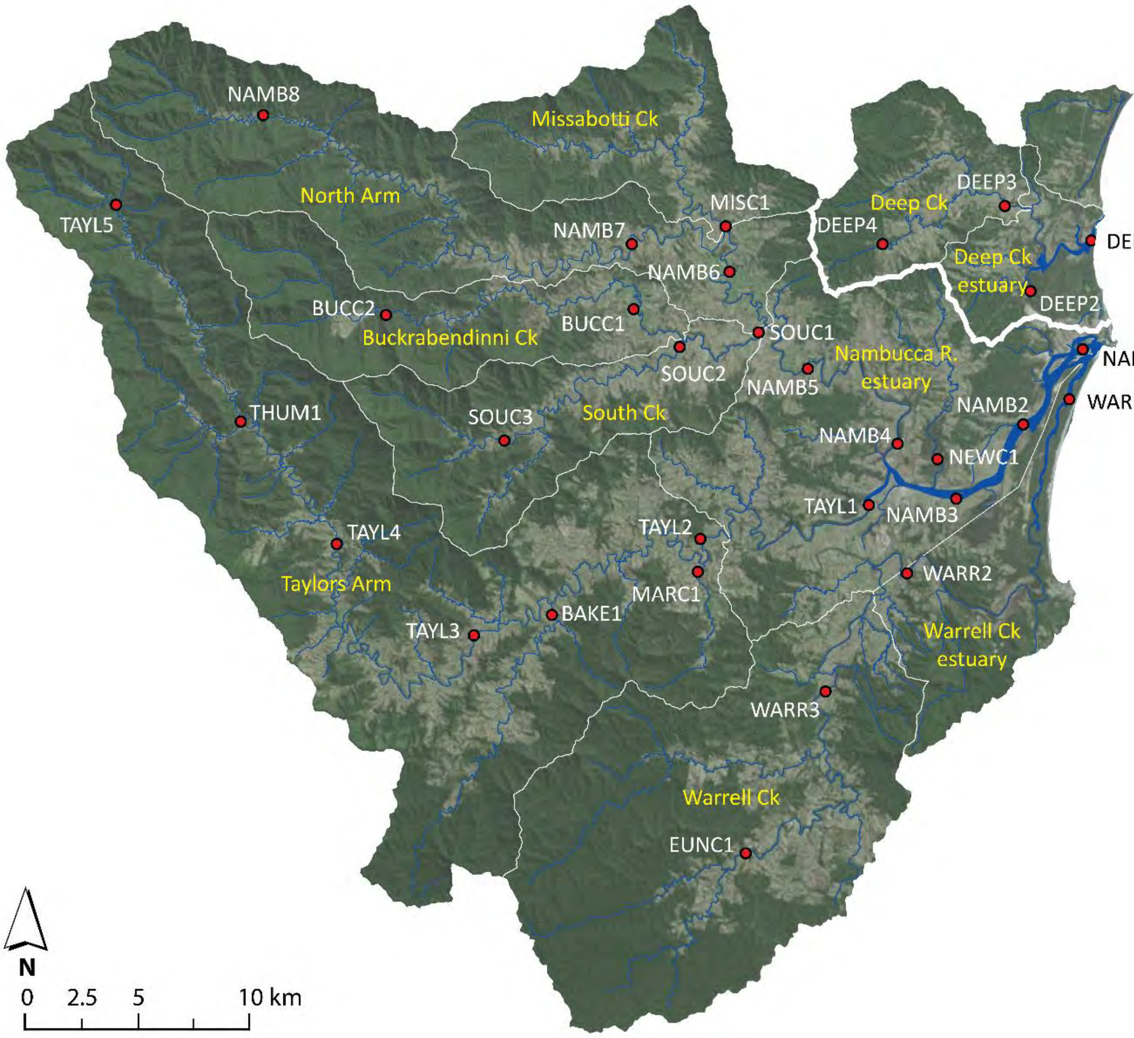


Figure 2.1 *The location of the Nambucca catchment in the Northern Rivers of NSW showing the subcatchments (separated by white lines with names in yellow text) and locations of Ecohealth sites (red dots with names in white text).*

2.1.1 *Geology*

The Nambucca catchment is dominated geologically by the Permian metamorphic sedimentary rocks of the Nambucca Block, which are further classified as the Pee Dee beds (slatey siltstone, lithic sandstone and minor diamictite) and phyllites (phylite, schist and metabasalt). The phyllites are dominant in the northern, central and western parts of the catchment and the Pee Dee beds outcrop in the south and south east of the catchment. Further south, Carboniferous sediments of the Hastings Block (siltstone, sandstone, mudstone) are present. Outcroppings of coastal granitoids of Yarrahapinni and Valla Adamellite occur in the physiographic region of Yarrahappinni Hills, including Picket Hill, Mount England and Bald Hill. Isolated Tertiary volcanics of basalt, dolerite, and trachyte are present in the upper Taylors Arm and Nambucca River valleys. A small amount of Tertiary basalt cap is present on peaks in the far west of the catchment (Gilligan et al. 1992). Along the coasts are quaternary sediments of alluvial mud, silt, sand and gravel deposits associated with coastal sand beaches, dunes and swamp deposits. An older, less fertile Pleistocene beach-ridge swale and dune-deflation backbarrier strip extends between Scotts Head and Nambucca. Holocene and Pleistocene muds, silts and sand are deposited in bays, tidal channels, estuaries and swamps of coastal creeks. The main creeks and rivers contain extensive alluvial landform deposits, including Holocene backswamps, levees, lagoons and channels (Troedson and Hashimoto 2008).

The phyllite rock of the Nambucca Beds is particularly erodible, giving rise to the deep incised valleys of the upper catchments of the Nambucca River. Intensified by the propensity for landslips on steep slopes, fluvial transport produces fine textured alluvium within the floodplains. The headwaters of the catchment are characterized by quartz, phyllite, and schistose sandstone boulders. Sediment transport results in the more resistant quartz sediment remaining as quartz cobbles, making up the bulk of the bedload, with the sand and silt from the weathered phyllite and schistose sandstone forming the overbank deposits and in-stream fine sediments (Alluvium 2012, Doyle 2003).

Mineral deposits in the Nambucca catchment include the Taylors Arm group of metasedimentary vein deposits of antimony (Sb) that extend from Point Lookout to Burrapine on Taylors Arm. Antimony mineralization was first discovered in the upper reaches of Buckra Bendinni Creek and mining in the region has generally been on a small scale (DPI 2017). Molybdenum, silver, gold, tin, antimony and arsenic deposits are present in the Carrai Urunga – Macksville areas and are related to granitoids. Additional geological descriptions of the Nambucca Catchment can be found in the Dorrigo – Coffs Harbour Metallogenic Map (Gilligan et al. 1992)

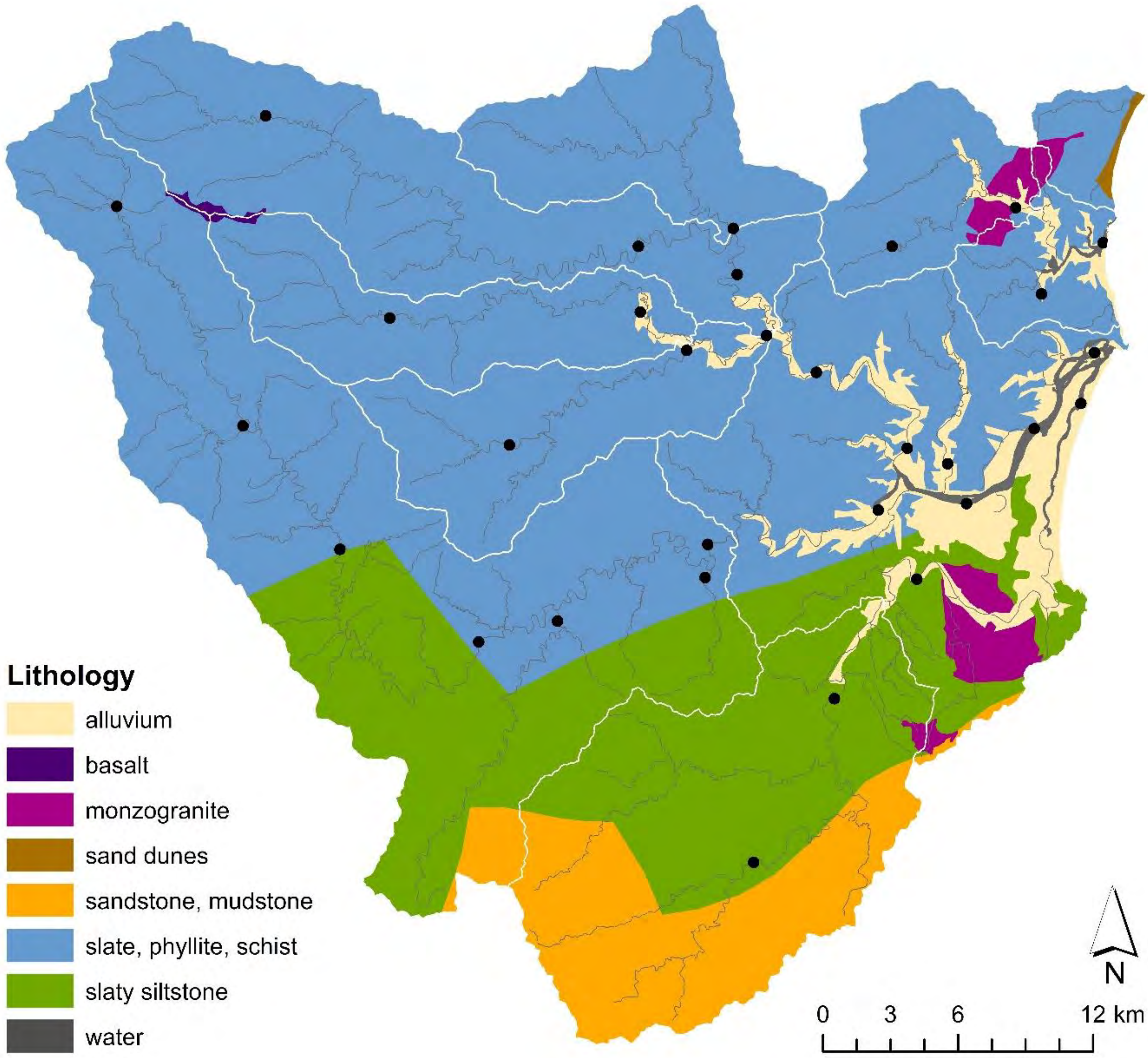


***Figure 2.2** Lithology of the Nambucca catchment.*

2.1.2 Soils

Soil formation is a result of the variable rates of weathering of the parent material, mineral composition and chemistry, topography, moisture and time. The dominant soil types in the Nambucca catchment are kurosols (46.4%), dermosols (27.8%), and the closely related rudosols and tenosols (14.2%). Tenosols (alluvial) (6.7%) and hydrosols (1.6%) are a dominant feature of the alluvial and swamp environments. The remaining <10% of the catchment area comprises a variety of soil types (Figure 2.3).

Kurosols are the dominant soil type in the catchment. They form from highly siliceous to intermediately siliceous metasedimentary material, such as sandstone and mud. Because they have a strong textural contrast between A horizons and strongly acidic B horizons, they are considered to have low agricultural potential due to lower fertility and poor structure. They occur predominantly across the midland hills and coastal floodplains in the Nambucca catchment, though some are present in the escarpment and ranges.

Dermosol soils are associated with both granite and metasediment parent materials, e.g. conglomerates, mudstone, granites and basalt. They are present mostly in the escarpment and ranges in the west of the catchment, as well as in the Yarrahapinni area. They also occur in the midland hills and to a much smaller degree in the coastal plains of the Nambucca catchment. They are well structured, fertile soils with good water holding capacity and support a range of agricultural practices. They usually have a gradual increase in clay content with depth (i.e. they lack contrast between A and B horizons).

Rudosols and tenosols are present in the escarpment and ranges in the west of the catchment, around the Mt Yarrahapinni and also small areas of the midland hills. These are associated with highly siliceous parent materials such as sandstone, mudstone, siltstone and monzodiorite. They are typically shallow, easily erodible soils of low fertility and low water holding capacity. Alluvial tenosols occur in the alluvial plains, have weak pedological development (with exception to the A horizons) and arise from highly siliceous parent material. Hydrosols are present in areas where tidal influence saturates the soil profile for prolonged periods, including the Gumma Gumma wetlands. The soils of the alluvial and swamp environments also comprise small areas of kandosols, rudosols, hydrosols and organosols. Sand-dunes and tidal flats comprise soils from aeolian, beach and estuarine deposits (Gray and Murphy 2002, McKenzie et al. 2004).

The alluvial soils of the Nambucca catchment support agricultural and rural industry, with accelerated erosion and nonpoint source delivery of fine sediments to river channels a significant consequence of land clearing, agriculture, human settlement and recreation. Acid sulphate soils in floodplain wetlands have been impacted by flood drainage works, but are actively managed to reduce acid runoff to estuaries (WetlandCare Australia 2017).

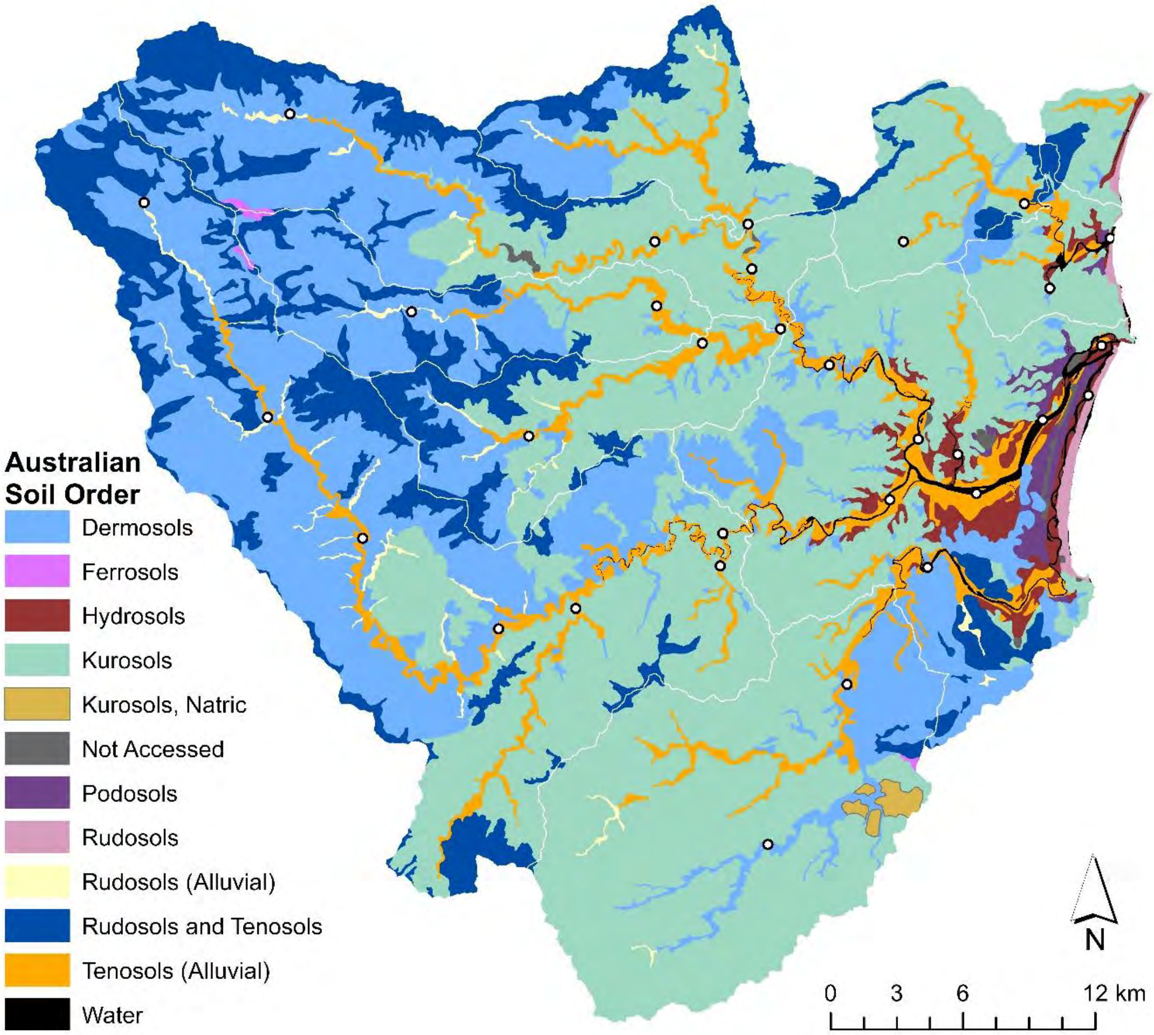


***Figure 2.3** Soils of the Nambucca catchment.*

2.1.3 Climate, rainfall and stream discharge

The Nambucca River catchment experiences a subtropical climate with predominantly summer rainfall, warm to hot humid summers and mild winters, influenced by the nearshore location of the East Australian Current (ABCB 2017). Slight variation is observed between the lowland coastal region (e.g. Nambucca using the nearest station at South West Rocks (SWR)) and the upland escarpment and ranges region in the upper catchment (e.g. Dorrigo and Bellingen stations).

Mean annual temperatures on the Nambucca catchment coastal floodplain range from 18.7°C in July to 26.9°C in January (nearest BOM gauge 059030 at SWR). Maximums range from 20.5°C in July to 30.1°C in January and minimums range from 16.8°C in July to 24.3°C in February. In Dorrigo (nearest BOM gauge 059140 for the escarpment and ranges), mean annual temperatures are slightly cooler and range from 14.5°C in July to 23.8°C in February. Here, maximums range from 16.2°C in June to 27.4°C in December and minimums range from 13.1°C in July to 21.6°C in February (BOM 2017). The catchment was slightly warmer than average during the study period, with higher monthly maximum temperatures in both the escarpment and coastal areas. Temperatures in Dorrigo were particularly high over the summer months when compared to averages (Figure 2.4a, 2.4b).

Total rainfall over the study period (1434.8mm) was similar to the average annual amount (1414.0mm). Both the escarpment (Dorrigo gauge 059140) and coastal areas (SWR gauge 059724) experienced a dry start to summer, followed by heavy rainfall in March 2017. Above average rainfall was also observed in August 2016 and June 2017 in both escarpment and coastal areas. Below average rainfall occurred during all other months in both locations (Figure 2.5a, 2.5b).

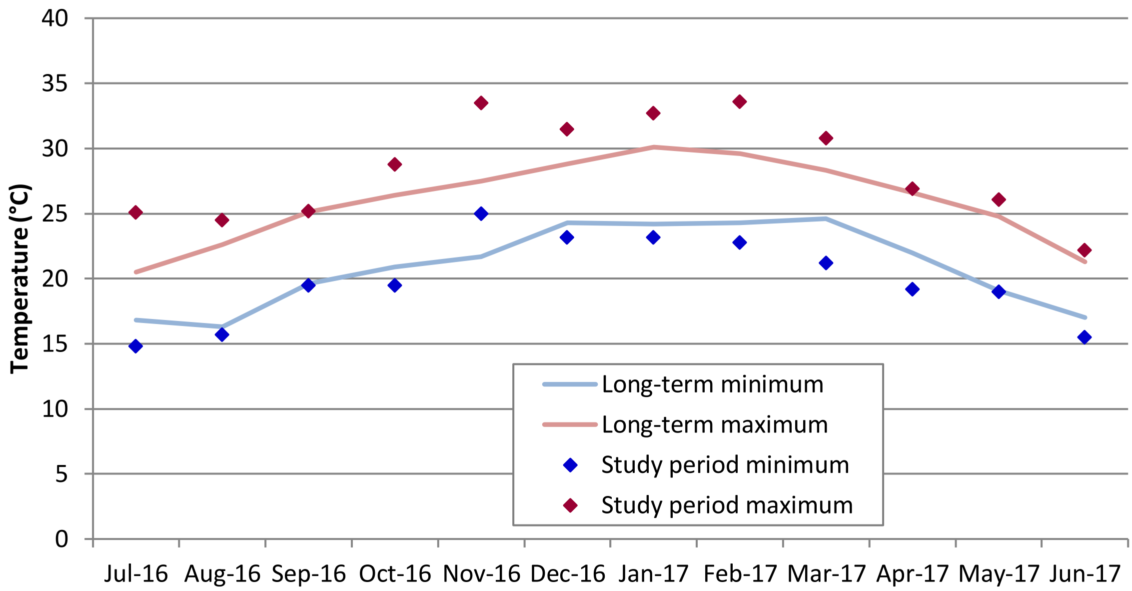


***Figure 2.4a** Average monthly maximum and minimum temperatures of coastal areas over the study period in comparison to long-term average monthly maximum and minimum temperatures at South West Rocks (SWR) (BOM gauge 059030 for study period and long-term averages).*

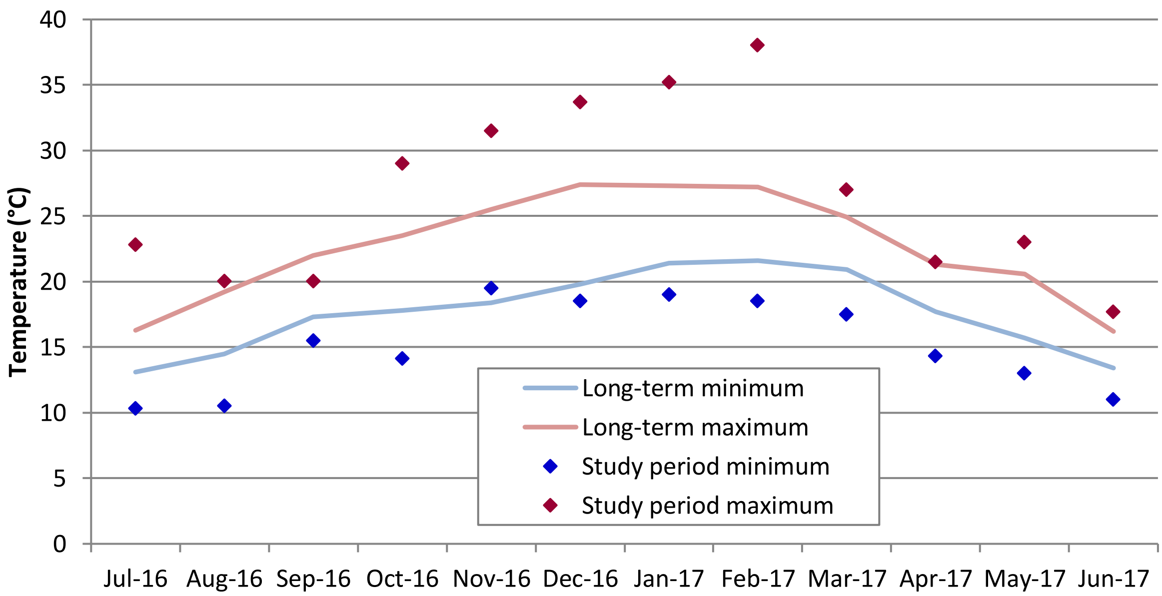


***Figure 2.4b** Average monthly maximum and minimum temperatures of escarpment and ranges over the study period in comparison to long-term average monthly maximum and minimum temperatures at Dorrigo (BOM gauge 059140 for study period and long-term averages).*

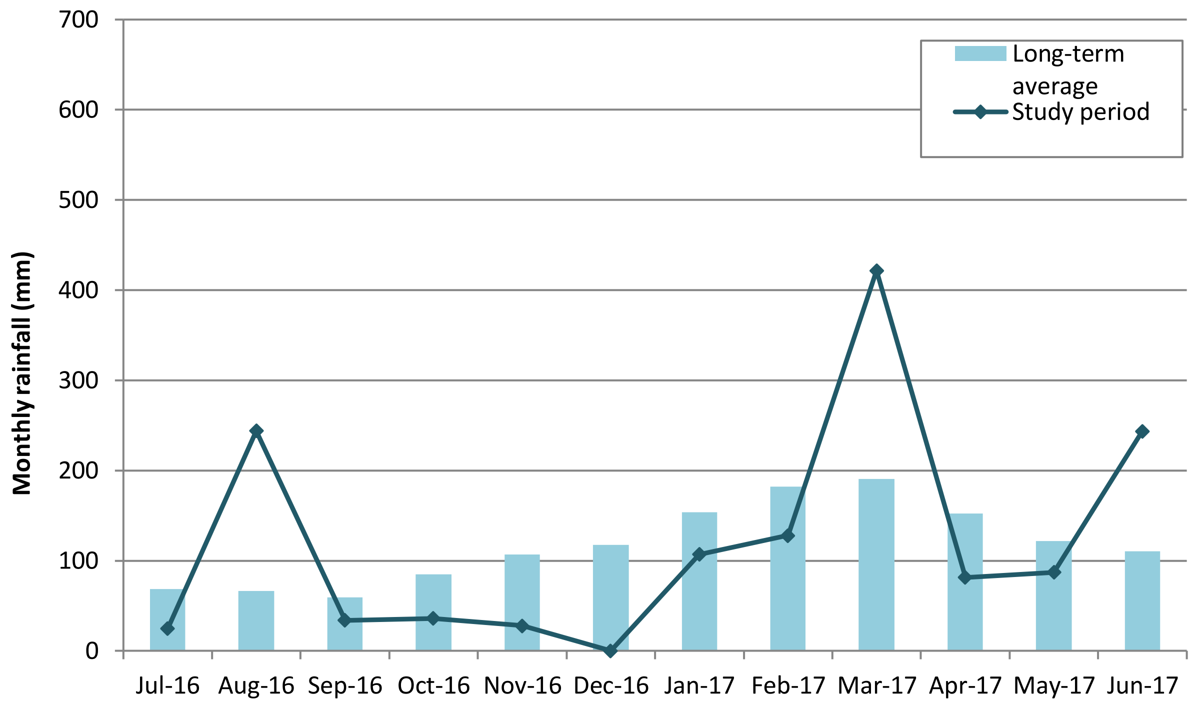


***Figure 2.5a** Monthly rainfall over the study period in comparison to the long-term average monthly rainfall at Nambucca (BOM gauge 059724 for study period and long-term averages).*

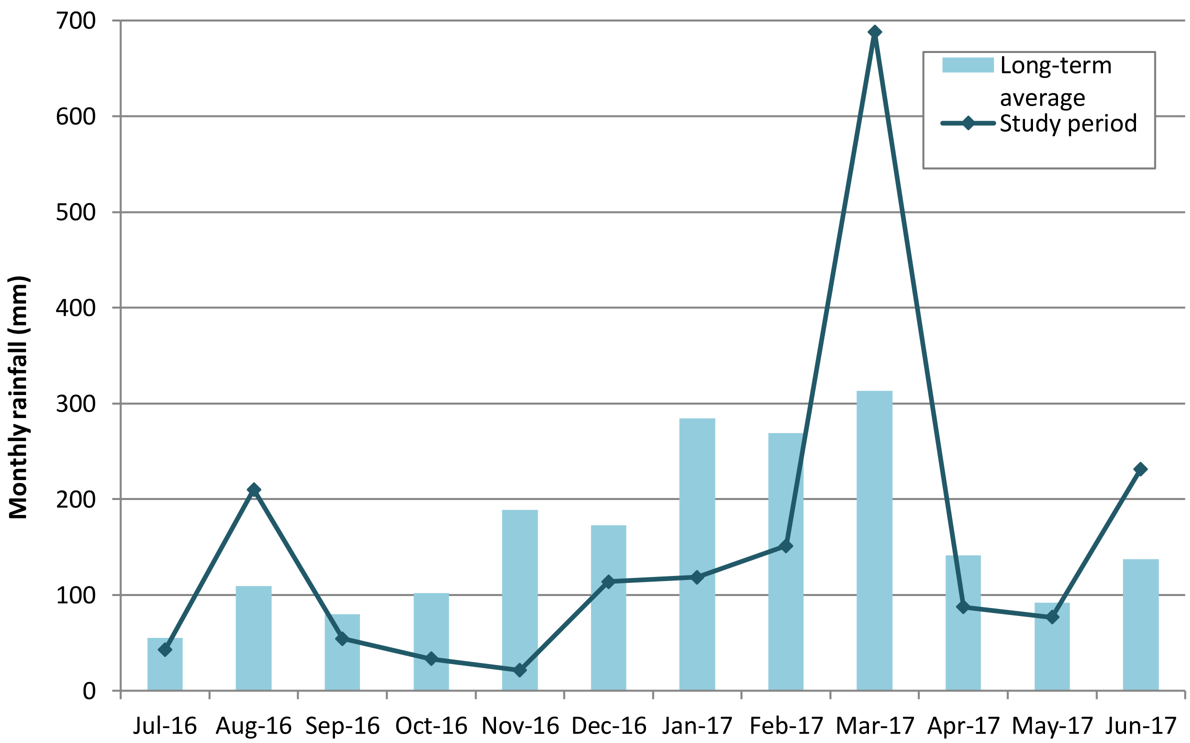


***Figure 2.5b** Monthly rainfall over the study period in comparison to the long-term average monthly rainfall at Dorrigo (BOM gauge 059140 for study period and for long-term averages).*

There have been 28 significant floods in the Nambucca catchment (i.e. floods exceeding 5.5m at Bowraville) since records began. The most significant flood at Bowraville was the 1890 flood when the gauge height reached 11.47m. It is most likely this flood was also the largest recorded flood at Macksville, but there are fewer flood peak height data observed for Macksville. The Nambucca River has recorded two recent floods in 2011 and 2012 (FloodSafe 2017), but no significant floods have occurred since 2001 (WMA 2013).

Discharge is recorded at several gauges in the Nambucca catchment. Two key gauges are located at Bowraville (NOW gauge 205015) and Taylors Arm (NOW gauge 205017). The Bowraville gauge is upstream of the tidal limit and measures the majority of the discharge from the Nambucca River (North Arm) and South Creek (catchment area of 430km^2). Taylors Arm contributes slightly less discharge and has a smaller catchment area (340km^2) (Doyle 2003, DPI 2017).

Long-term average discharge in the Nambucca catchment peaks in late summer. A comparison between long-term data and the study period reveals lower than average discharge for all months except August 2016, and March and April 2017 at both Bowraville and Taylors Arm gauges, and September 2016 and October 2016 at Taylors Arm. Peak discharge for the study period was observed in March 2017, with an average of 700ML/day at the Bowraville gauge and 710ML/day at the Taylors Arm gauge (Figures 2.6a, 2.6b). This reflected the above average rainfall recorded in March 2017 (Figure 2.5a, 2.5b). Outside of the peak discharge period, Nambucca baseflows were well below average for the majority of the study period, also reflecting the dry period observed over Spring and Summer 2016-2017 (Figure 2.6a, 2.6b).

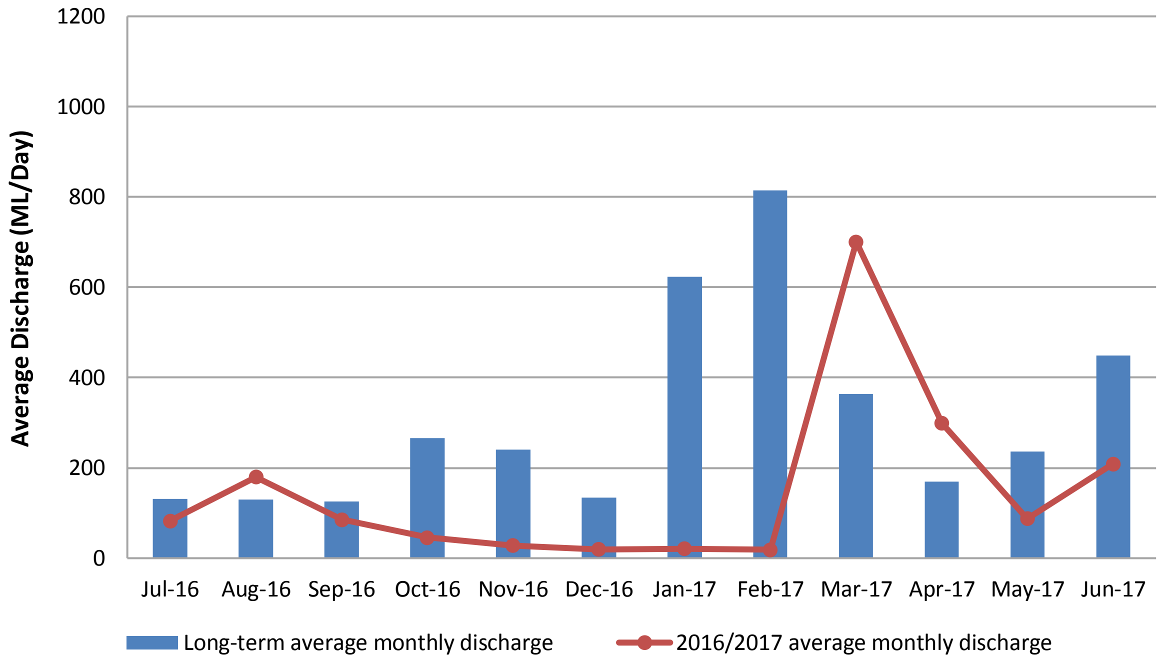


Figure 2.6a *Average monthly discharge over the 2016-2017 study period (July 2016 to June 2017) in comparison to the long-term average monthly discharge of the Nambucca River at Bowraville (NOW gauge 205015).*

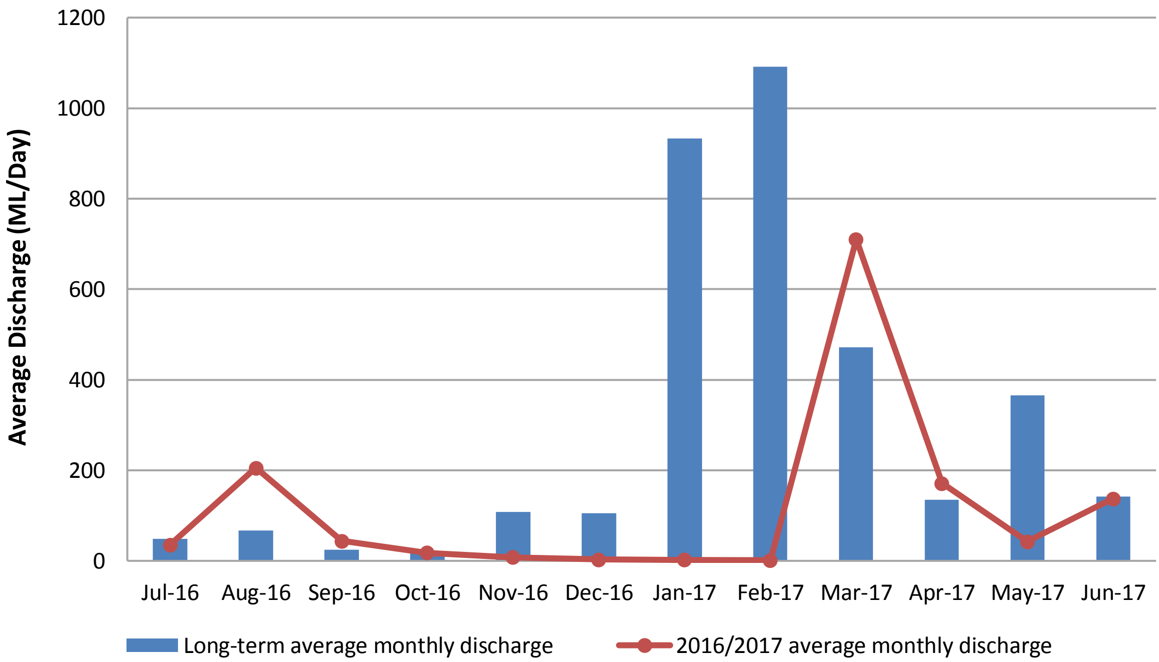


Figure 2.6b *Average monthly discharge over the 2016-2017 study period (July 2016 to June 2017) in comparison to the long-term average monthly discharge of the Nambucca River at Taylors Arm in the Nambucca River (NOW gauge 205017).*

2.1.4 Landuse

The dominant landuse throughout the Nambucca Catchment comprises conservation areas (553km^2 or 39%), the majority being unprotected State Forest (552km^2 or 25%), with protected areas comprising nature reserves (8%) and National Parks (5%). These areas are situated in the midland hills in the south of the catchment and the escarpment and ranges to the west of the catchment. The alluvial plains are heavily cleared for grazing (449km^2 or 31.5%), with other agriculture, horticulture and intensive animal production contributing less than 1% of total landuse. Unprotected tree and shrub cover, predominantly native forest, comprises a large area (244km^2 or 24%), and is dispersed throughout the alluvial plains, low elevation hills and the escarpment and ranges.

Grazing has declined as a proportion of total landuse in the Nambucca catchment since the 1950s. Although it is still a dominant landuse, timber regrowth has increased in privately owned and crown land areas, represented as unprotected tree and shrub cover (Figure 2.7). This has been suggested to be a result of the decline in the dairy industry in the catchment (Doyle 2003).

The coastal plains encompasses the majority of the smaller landuse categories, consisting of river drainage systems (1.8%), urban development (1.2%) and wetland areas (1%). A large area of Crown Land and conservation tenure is present on the coastal strip along Warrell Creek. Transport and other corridors also form a small proportion (0.5%) of landuse in the coastal plains. The current Pacific Highway upgrade contributes to this, with the project building new bridges, new interchanges and access ramps at North Macksville as well as other sites in the catchment (RMS 2017). The Gumma Gumma wetland complex is located directly east of Macksville and includes a number of Endangered Ecological Communities (EECs) including saltmarsh, swamp sclerophyll forest, swamp oak forest and freshwater wetlands, and is of high ecological value (WetlandCare Australia 2017).

Urban areas in the Nambucca Catchment comprise the populated townships of Nambucca (population of 6,957), and Macksville and Scotts Head (population of 4,952) (ABS 2010 census). Although the Nambucca catchment is largely unregulated, a number of reservoirs are present in the area, including a recently completed dam at Bowraville (Bowra Dam with a capacity of 4,640 ML) to store water obtained from an aquifer in the same location. Sewerage treatment plants are located in Nambucca Heads, Scotts Head, Macksville and Bowraville (Nambucca Shire Council 2017).

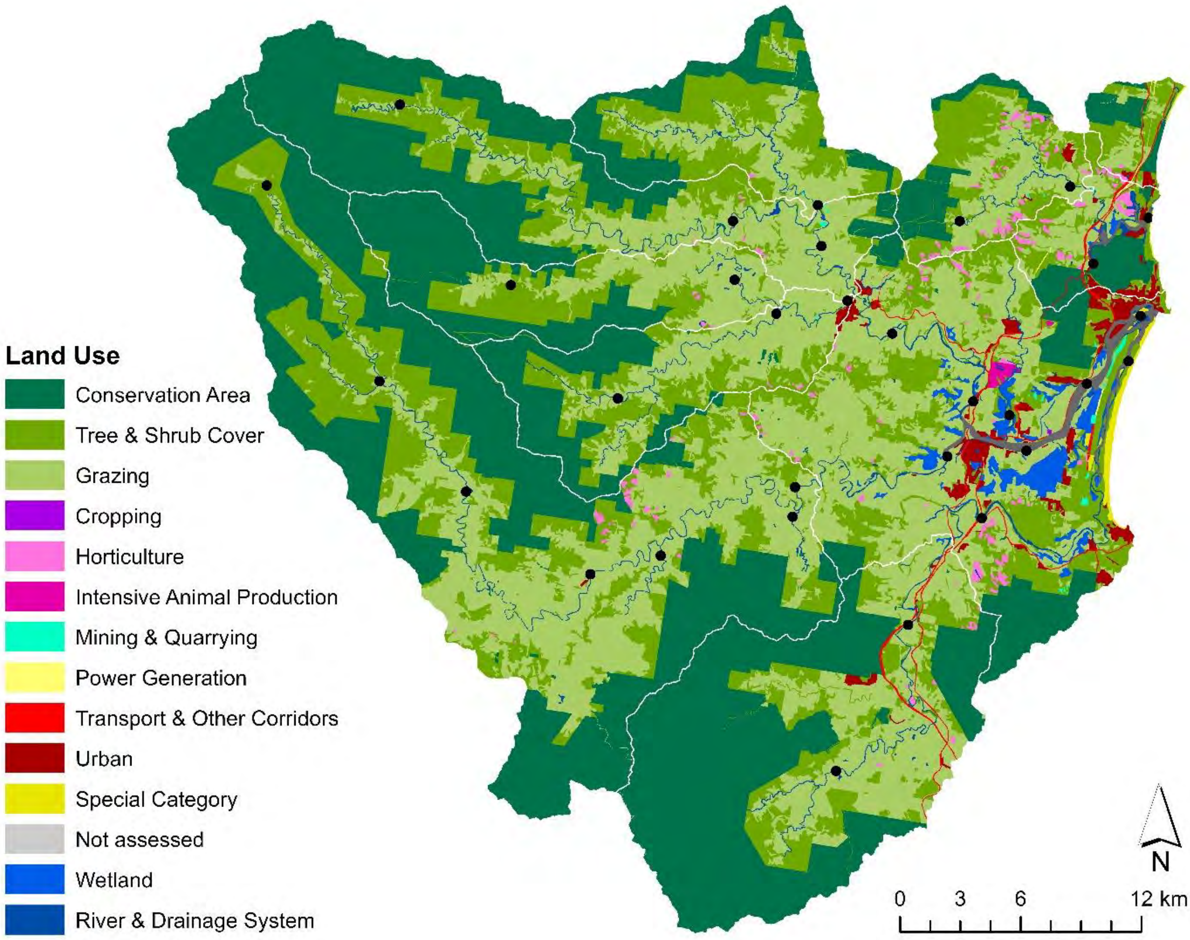


Figure 2.7 *Landuse of the Nambucca catchment.*

2.1.5 River Styles

The dominant river style in the Nambucca catchment is partially confined valley settings (PCVS) comprising 57% of the total stream length (493km); most of this are planform controlled, meandering channels with fine grained sediments (195km or 40%; Alluvium 2012). Confined valley setting (CVS) comprises 34% of the total stream length (290km), and mostly consists of either headwaters (35%) or gravel-bed channels with floodplain pockets (35%). The swampy meadow group (SMG) comprises 6% of the total stream length (50km), with most reaches defined as fine grained valley fill (78%). Finally, tidal laterally unconfined continuous channels (LUVCC) comprise 3% of the total stream length (24km). Highly modified urban streams or water storage comprise 0.5% of the catchment (Figure 2.8).

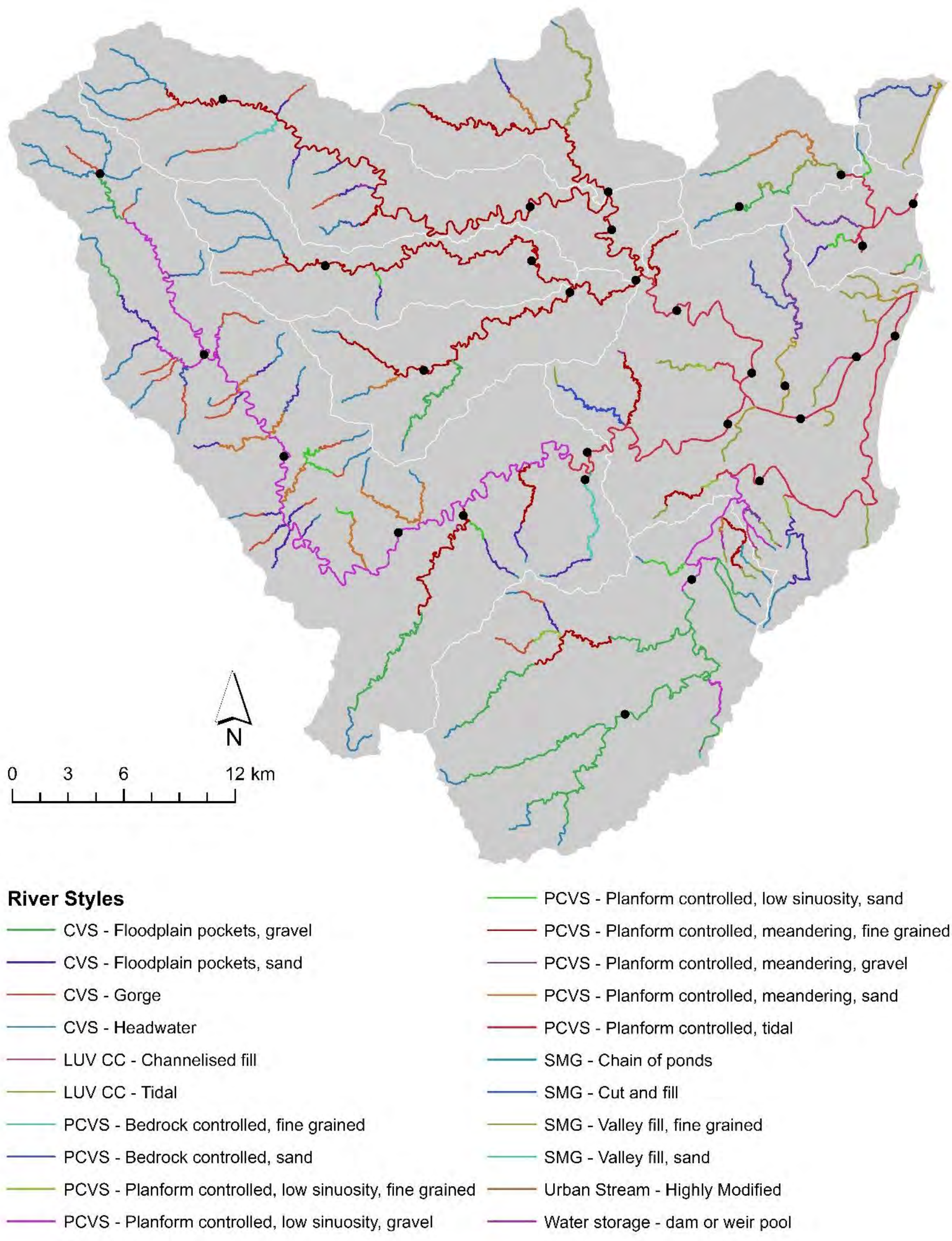


***Figure 2.8** River Styles in the Nambucca catchment.*

2.2 Study design

The design of the Ecohealth freshwater/estuarine monitoring program for catchments in the Nambucca catchment was based on Ecohealth standard methods (Ryder et al. 2016). The number and location of sample sites were designed to assess spatial and temporal variability of subcatchments with statistical robustness.

Locations of 18 freshwater monitoring sites were selected to:

- Assess end-of-system inputs from tributaries; and
- Compare River Styles, Condition and Recovery Potential, and elevation within and across subcatchments.

Locations of the 13 estuarine monitoring sites were selected to:

- Identify longitudinal change and potential point source (tributary) issues within the main stem of each river system and end-of-system flows; and
- Locate ecological changes at the point of the tidal limit.

The design of the Ecohealth program in the Nambucca catchment required prioritization of sites to optimise available resources.

2.2.1 Sampling Schedule

Water chemistry was sampled six times and freshwater macroinvertebrates were sampled bi-annually in spring 2016 and autumn 2017. Riparian condition was assessed primarily in November 2016, with a final assessment in February 2017 that focused on late-flowering grasses. Geomorphic condition was assessed once in November 2016 (Table 2.1).

Sampling events typically comprised five days within a month. Multiple freshwater and estuarine sites were sampled on each sampling day to ensure consistency in freshwater discharge and tidal regime. Estuarine sites were sampled over the full tidal cycle to accurately assess water quality during base flows. OEH supplied the boat and skipper as inkind support to the project. All freshwater sites were sampled via road access. Water quality, aquatic macroinvertebrates, riparian condition and geomorphic condition were assessed by staff from UNE, while freshwater fish were assessed by NSW DPI (Fisheries).

Table 2.1 *Sampling regime for field collection of water chemistry and biota.*

Sampling event	Month	Variables at freshwater sites	Variables at estuary sites
1	July 2016	Water quality	Water quality
2	November 2016*	Water quality, riparian condition, geomorphic condition, aquatic macroinvertebrates	Water quality, riparian condition, geomorphic condition
3	December 2016	Water quality, riparian condition	Water quality, riparian condition
4	February 2017	Water quality	Water quality
5	May 2017	Water quality, aquatic macroinvertebrates	Water quality
6	June 2017	Water quality	Water quality

* Heavy rainfall in late winter meant that spring sampling was delayed to give the macroinvertebrate communities time to recover before sampling.

2.3 Study sites

Thirty-one sites were sampled within the Nambucca catchment with 18 freshwater sites and 13 estuarine sites spread across nine subcatchments (Table 2.2). There were 8 sites located on the Nambucca River, 5 sites on Taylors Arm, 4 sites on Deep Creek, 3 sites on South Creek and Warrell Creek, 2 sites on Buckrabendinni Creek, and single end-of-system sites on Newee, Missabotti, Tom Maras, Bakers, Thumb and Eungai Creeks.

***Table 2.2** Location of field sample sites in the Nambucca catchment.*

Name	Site Code	Easting (m E)	Northing (m S)	Elevation (m)	Salinity Zone
Deep Creek	DEEP4	491413	6613886	50	Lowland freshwater
	DEEP3	496903	6615600	8	Tidal limit, 0-5ppt
	DEEP2	498056	6611768	13	Mid estuary, 15-30ppt
	DEEP1	500794	6614041	1	Marine, >30ppt
Nambucca River	NAMB8	463578	6619677	127	Lowland freshwater
	NAMB7	480140	6613886	38	Lowland freshwater
	NAMB6	484537	6612637	29	Lowland freshwater
	NAMB5	488053	6608286	7	Tidal limit, 0-5ppt
	NAMB4	492085	6604922	4	Mid estuary, 15-30ppt
	NAMB3	494723	6602458	0	Marine, >30ppt
	NAMB2	497731	6605791	0	Marine, >30ppt
	NAMB1	500535	6609314	0	Marine, >30ppt
Missabotti Creek	MISC1	484357	6614679	29	Lowland freshwater
South Creek	SOUC3	474412	6605062	62	Lowland freshwater
	SOUC2	482290	6609266	24	Lowland freshwater
	SOUC1	485839	6609921	17	Lowland freshwater
Buckrabendinni Creek	BUCC2	469094	6610699	94	Lowland freshwater
	BUCC1	480223	6610962	27	Lowland freshwater
Newee Creek	NEWC1	493882	6604228	3	Mid estuary, 15-30ppt
Taylors Arm	TAYL5	456959	6615656	194	Upland freshwater
	TAYL4	466875	6600427	70	Lowland freshwater
	TAYL3	473046	6596322	39	Lowland freshwater
	TAYL2	483221	6600651	13	Tidal limit, 0-5ppt
	TAYL1	490798	6602172	2	Mid estuary, 15-30ppt
Thumb Creek	THUM1	462563	6605914	106	Lowland freshwater
Bakers Creek	BAKE1	476547	6597243	34	Lowland freshwater
Tom Maras Creek	TOMC1	483105	6599176	15	Lowland freshwater
Eungai Creek	EUNC1	485262	6586535	49	Lowland freshwater
Warrell Creek	WARR3	488850	6593801	11	Lowland freshwater
	WARR2	492512	6599105	11	Upper estuary, 5-15ppt
	WARR1	499804	6606912	1	Marine, >30ppt

2.4 Sampling methods and indicators

The indicators chosen focus on the condition of the system to best identify the stressors and pressures that cause change in ecological condition. The selection of indices (and groupings of indicators) represents elements of the structure, function and composition of riverine and estuarine ecosystems.

2.4.1 Water Quality Indicators

Assessing the impacts of land-use change on the ecological health of rivers and streams is an important issue for the management of water resources in Australia. Traditionally, these assessments have been dominated by the measurement of patterns in species distribution and abundance which contribute important information such as the status of threatened species and their habitat requirements. However, many goals of river management refer to concepts of sustainability, viability and resilience that require an implicit knowledge of ecosystem or landscape-level interactions and processes influencing these organisms or populations.

The water chemistry of rivers and estuaries can be an ideal measure of their ecological condition by providing an integrated response to a broad range of catchment disturbances (Table 2.3). Nutrients such as nitrogen, phosphorus, and carbon can play an integral role in regulating rates of primary production in these systems. However, anthropogenic changes to catchment land-use have led to increased supply of nutrients from diffuse or point sources, and altered light and turbidity regimes through increased suspended sediment loads and loss of riparian vegetation. These landscape-level processes define the supply of contaminants to a stream and provide the framework within which other processes operate at smaller spatial scales and shorter temporal scales to regulate their supply and availability.

Table 2.3 *Water chemistry indicators measured at all sites.*

In situ measurements	Water quality samples sent for laboratory analysis
Water depth	
pH	Total nutrients (nitrogen and phosphorus)
Temperature	Dissolved nutrients (nitrate-nitrite, and soluble reactive phosphate)
Salinity/Conductivity	
Dissolved oxygen	Chlorophyll *a*
Turbidity	Total Suspended Solids (TSS)
Secchi depth	

Field and laboratory methods

At each sampling site, *in situ* water quality measurements were measured with the use of a Hydrolab Quanta water quality multi-probe (pH, conductivity, dissolved oxygen (DO), temperature, salinity and turbidity). Secchi depth was measured using a Secchi disc.The following procedural steps are outlined to standardise the collection of these data and to identify quality control.

Water quality probe calibration and use

The water quality probe(s) were calibrated each day prior to use in the field. At each sample site, field measurements for the water column profile was taken at near surface (approx. 0.2m below surface), and at 1m intervals through the water column to a depth of 0.2m from the bottom. Measurements for each water quality parameter using the multi-probe were recorded at each interval. In freshwater sites that were less than 1m in depth, surface and epibenthic measurements were taken and maximum sampling depths noted. Data were recorded on proforma data recording sheets.

Water quality sampling

Water samples were collected at each site for the determination of chlorophyll *a*, total and dissolved nutrients, total suspended solids and Secchi depth. Samples were collected at near surface (<0.2m) and obtained with the use of a hand held sampling device to ensure sample is taken at least 1.5m from the edge of the boat or riverbank. Samples were transferred to acid-washed and rinsed (thrice rinsed with sample water) 125mL containers. Duplicate samples for each parameter were taken from each site, and a third sample of each parameter was collected from a random subset of sites for quality assurance (QA) processing at an independent laboratory. The following procedures for sample collection and treatment are provided for each determination.

Chlorophyll a

Water column chlorophyll *a* is a measure of the photosynthetic biomass of algae/phytoplankton. These organisms are central to important nutrient and biogeochemical processes, and as such may respond to disturbance before effects on higher organisms are detected. This is because the higher organisms depend on processes mediated by algal communities. Consequently, they form the base of food webs supporting zooplankton, grazers such as crustaceans, insects, molluscs and some fish (Burns and Ryder 2001). The short generation time, responsiveness to environmental condition and the availability of sound, quantitative methodologies such as chlorophyll *a* make these measures of phytoplankton ideally suited as indicators of disturbance in aquatic systems. Information can be collected, processed and analysed at time scales relevant to both scientific and management interests.

In the field, a 1L bottle of water from 0.2m depth was collected using the hand held sampling device at each site, labelled, and placed on ice in an esky for transport to the laboratory. Sample processing was carried out within 48 hours of collection using the following steps;

1. Place a Whatman GF/C Glass Microfiber filter paper, using forceps, textured side up onto the filtration apparatus (EYELA Tokyo Rakahikai Coorperation Aspirator A-35) just prior to filtration.
2. Filter a sufficient amount of sample was filtered (100-1,000mL measured with a graduated cylinder), to produce a green colour on the filter paper, or until the flow through the filter paper at ½ atmosphere pressure (approx. 7PSI) is reduced to a trickle. When approximately 10-15mL of the sample remained on the filter, 5-10 drops of the $MgCO_3$ powder were added to preserve the chlorophyll. The filter apparatus and graduated cylinder were then rinsed thoroughly using a squirt bottle with deionised water and the filter drained to remove all signs of moisture.
3. The sample volume filtered was recorded. The amount of water filtered is subject to the level of turbidity at the sampling site.
4. Using forceps, the filter paper was folded and carefully placed into the bottom portion of the prelabled culture tube that was then sealed, wrapped in aluminium foil, placed into a labelled ziplock bag and refrigerated below 4°C.
5. The filter paper was then placed in 10mL of 90% acetone. The solution was refrigerated for 24 hours. The samples were then centrifuged. The absorption spectra were recorded using a UV-1700 Pharmaspec UV-visible spectrometer at 665nm and 750nm.

Total suspended solids

Total suspended solids (TSS) is a direct measure of turbidity of the water. In the field, a pre-labelled 1-L bottle of water from 0.2m depth was collected at each site using the hand held sampling device, and the sample placed into a cool, dark esky.

TSS were measured by filtering a sufficient amount of sample (100-1,000mL measured with a graduated cylinder) through a Whatman GF/C Glass Microfiber filter paper, with a known weight, using an EYELA Tokyo Rakahikai Coorperation Aspirator A-35 at ½ atmosphere pressure (approx. 7PSI). The volume of filtered sample was recorded and used to calculate mg/L of TSS. The filter apparatus and graduated cylinder were thoroughly rinsed using a squirt bottle with deionised water and the filter drained to remove all signs of moisture. The filter paper with retained material was then placed into a foil envelope and dried in an oven at 50°C. They were reweighed after they dried to gain a measure of the weight of the TSS on each sample.

Inorganic nutrients

For inorganic nutrients, two 125mL water samples were collected from 0.2m depth at each site using the hand held sampling device. Samples for total nitrogen and total phosphorus remained unfiltered and were transferred into pre-rinsed, pre-labelled, 125mL PET bottles and immediately placed in a cool, dark esky. Samples remained frozen until time of analysis. Duplicate samples for quality assurance processing at an independent laboratory remained frozen until analyzed. For organic nutrients, two 125mL water samples were collected from 0.2m depth at each site using the hand held sampling device. Approximately 125mL of water was passed through a Whatman GF/C filter paper (effective pore size 0.7µm) in the field and collected into pre-rinsed, pre-labelled, 125mL PET bottles and immediately placed in a cool, dark esky. Samples remained frozen until time of analysis. Duplicate samples for quality assurance processing at an independent laboratory remained frozen until analyzed.

Nitrogen was measured by digesting an unfiltered water sample in a digestion tube with 10mL of digestion mixture. This contained 40g of di-potassium-peroxodisulfate ($K_2S_2O_8$) and 9g of sodium hydroxide (NaOH) in 1000mL of Milli Q water. This sample was then digested in the autoclave for 20 minutes. Five mL of the sample was then placed into a 50mL acid-washed measuring cylinder and diluted to 50mL (Hosomi and Sudo 1986). Five mL of buffer solution was added: 100g of NH_4Cl, 20g sodium tetra borate and 1g EDTA to 1L with Milli Q water. Fifty mL of each sample was measured into a numbered jar. The samples were then filtered. Firstly, the cadmium reduction column was rinsed with 10% buffer solution, making sure the cadmium granules remained covered at all times by either the 10% buffer solution or the sample. The column was drained to 5mm above the cadmium granules, and 25mL of the first sample added. This was collected in a separate beaker as it drained through to rinse the column and was discarded. The column was then filled with the sample and 20mL was collected in the same sample jar. One mL of sulfanilamide solution was added and mixed thoroughly. After 2 minutes, 1mL of dihydrochloride solution was added and mixed. This was repeated for all water samples. After 10 minutes, the absorbance of each sample was measured using a UV-1700 Pharmaspec UV-visible spectrometer at 543nm. This colormetric determination of nitrogen can be used when nitrogen is in the range 0.0125 to 2.25µg/ml. Standards were also be prepared before analyzing the samples to calculate linear regression at 0µg/ml, 0.05µg/ml, 0.2µg/ml, 0.5µg/ml, 1µg/ml, 2µg/ml and 5µg/ml of known nitrogen concentration.

Phosphorus was measured by digesting an unfiltered water sample in a digestion tube with 10mL of digestion mixture. This contained 40g of di-potassium-peroxodisulfate ($K_2S_2O_8$) and 9g of sodium hydroxide (NaOH) in 1000mL of Milli Q water. This sample was then digested in the autoclave for 20 minutes. Twenty mL of sample was then added to a plastic SRP tube with 2mL of colour reagent: 20mL of ascorbic acid solution with 50mL of molybdate antimony solution. This was repeated for all water samples. After 8 minutes, the absorbance of each sample was measured using a UV-1700 Pharmaspec UV-visible spectrometer at 705nm. Standards were also be prepared before analyzing the samples to calculate linear regression at 0µg/ml, 0.05µg/ml, 0.2µg/ml, 0.5µg/ml, 1µg/ml, 2µg/ml and 5µg/ml of known phosphorus concentration.

2.4.2 ANZECC and MER water quality guidelines

The ANZECC Water Quality Guidelines (the guidelines) established in 1992 under the Commonwealth's National Water Quality Management Strategy (NWQMS), provide a scientifically informed framework for the water quality objectives required to maintain current and future water resources and environmental values (ANZECC 2000). The ANZECC guidelines were created in response to growing understanding of the potential for water quality to be a limiting factor to social and economic growth. The guidelines were derived from reviewing water quality guidelines developed overseas. However; Australian guidelines were also incorporated where available (ANZECC 1994).

The ANZECC *Australian Water Quality Guidelines for Fresh and Marine Waters* were released in 1992, and developed using two approaches:

1. An empirical approach which used the Precautionary Principle to create conservative trigger values from all available and acceptable national and international data. This method implemented data from only the most sensitive taxa in order to ensure the protection of these species.
2. The modeling of all available and acceptable national and international data into a statistical distribution with the confidence intervals of 90% and 50%.

Trigger values are conservative thresholds or desired concentration levels for different water quality indicators. When an indicator is below the trigger value there is a low risk present to the protection of that environment. However, when an indicator is above the trigger value, there is a risk that the ecosystem will not be protected. In cases where the trigger value is exceeded, further research and remediation of the risk identified should be conducted. Where a numerical value cannot be derived for a water quality indicator, a target load may be set, for example the salinity guideline; or a descriptive statement, for example for oil there should be no visible surface film; or an index of ecosystem health, for example percentage cover of an algal bloom.

The Australian and New Zealand Environment Conservation Council (ANZECC) Guidelines (2000 and 2006) provide threshold values for freshwater systems for pH, dissolved oxygen (DO), electrical conductivity (EC), salinity and nutrients such as nitrogen (N) and phosphorus (P). For estuarine systems, we used region-based trigger values for estuarine pH, DO, N, P, chlorophyll *a* and turbidity developed by the OEH Estuary and Catchment Science Group as part of the MER program (P. Scanes, pers. comm.). A combination of ANZECC (2000, 2006) and NSW OEH developed trigger values were used to explore water quality across sites and sampling occasions (Table 2.4).

Table 2.4 *ANZECC Guidelines (2000) and NSW OEH minimum and maximum trigger values for freshwater reaches (above and below 150m elevation) and estuarine systems of southeast Australia. Variables with single values only have maximum trigger values. [1] ANZECC guidelines for healthy aquatic ecosystems, [2] OEH guidelines for healthy estuarine ecosystems. * SRP in ANZECC guidelines for freshwater ecosystems, TDP in OEH guidelines for estuarine systems.*

Category	pH	DO (%)	EC (µS/cm)	Turbidity (NTU)	Chla (µg/L)	NOx (µg/L)	SRP* (µg/L)	TN (µg/L)	TP (µg/L)
Upland Freshwater[1] (>150m)	6.5 – 8.0	90-110	30 - 350	25		15	15	250	20
Lowland Freshwater[1] (<150m)	6.5 – 8.5	85-110	125 - 2200	50	3	40	20	350	25
Lower Estuary[2] (>25psu)	7.0 – 8.5	80-110		2.8	2.3	5.1	6.5	205	10.3
Mid Estuary[2] (10-25psu)	7.0 – 8.5	80-110		2.6	4.3	36.6	8.0	380	18.0
Upper Estuary[2] (<10psu)	7.0 – 8.5	80-110		6.0	4.8	46.0	6.4	608	15.0
Estuarine Lagoon[2]	7.0 – 8.5	80-110		5.7	3.9	10.3	6.3	300	13.3
Estuarine Lake[2]	7.0 – 8.5	80-110		6.0	5.0	2.8	9.3	740	22.2

2.4.3 Freshwater macroinvertebrates

Aquatic macroinvertebrates are non-vertebrate aquatic animals (e.g., insects, crustaceans, snails and worms) that are visible to the naked eye and which live at least part of their life within a body of freshwater. Freshwater macroinvertebrates are important members of aquatic foodwebs. They feed on a wide range of food sources such as detritus (dead organic matter), bacteria, algal and plant material, and other animals. They in turn provide food for other animals such as fish and aquatic birds. Macroinvertebrates are useful as bio-indicators as many taxa are sensitive to stress and respond to changes in environmental conditions. Because many macroinvertebrates live in a river reach for an extended period of time, they integrate the impacts on the ecosystem over an extended period of time, rather than just at the time of sampling. In addition, many macroinvertebrates have widespread distributions, they are reasonably easy to collect and their taxonomy is well known.

Macroinvertebrates have been widely used in broad scale assessments of ‘river health’. The most common approach adopted for environmental monitoring has involved the analysis of the taxonomic richness of macroinvertebrates. SIGNAL stands for ‘Stream Invertebrate Grade Number – Average Level’ (Chessman 2003). It is a simple scoring system for macroinvertebrate samples from Australian rivers. A SIGNAL2 score gives an indication of water quality in the river from which the sample was collected. Rivers with high SIGNAL2 scores are likely to have low levels of salinity, turbidity and nutrients such as nitrogen and phosphorus. They are also likely to be high in dissolved oxygen. When considered together with macroinvertebrate richness (the number of types of macroinvertebrates), SIGNAL2 can provide indications of the types of pollution and other physical and chemical factors that are affecting the macroinvertebrate community. SIGNAL2 Scores range from 1 (pollution tolerant) to 10 (pollution intolerant). Another classification system uses the EPT index. This index claims that although different insect taxa vary widely in their sensitivity to sedimentation, the taxa from the orders Ephemeroptera (E), Plecoptera (P), and Trichoptera (T) behave similarly. However, a taxonomic group can exhibit a great deal of heterogeneity, so an assessment method like the EPT may be insensitive to changes in species composition unless composition is altered along with overall taxa richness. Multimetric and multivariate approaches can increase a model’s accuracy. These models evaluate the sampled community by comparing observed conditions to what conditions or taxa are expected to occur in the absence of disturbance.

Field and laboratory methods

Macroinvertebrates were sampled bi-annually (spring 2016 and autumn 2017) at the freshwater sites to align with the MER protocols. Kick net samples (250µm mesh) that comprise 10 linear meters of combined pool, riffle and edge habitats were taken from each of the 18 freshwater sites on each of the two sampling occasions. Only those habitats present at the time were sampled. Invertebrates were immediately preserved in 70% ethanol on site and transported to the laboratory for analysis. Each sample was passed through 2mm, 1mm and 250µm sieves. All taxa from the 2mm and 1mm sieves were recorded, with material retained on the 250µm sieve sorted for a standardized 30-minute period. Macroinvertebrates were identified to Family/genera level, assigned a SIGNAL2 score for pollution tolerance, and the EPT score calculated. Metrics of abundance, richness, and composition were recorded.

2.4.4 Riparian condition

Riparian zones are broadly defined as the interface between terrestrial and aquatic ecosystems (Gregory et al. 1991), and they are found where any body of water directly influences, or is influenced by adjacent land (Boulton et al. 2014). The riparian land is an intermediary semi-terrestrial zone with boundaries that extend outward from the water's edges to the limits of flooding and upward into the canopy of the riverside vegetation (Naiman et al. 2005). Riparian zones are therefore dynamic environmental transition zones that are regularly influenced by freshwater, and characterised by strong energy regimes, considerable habitat diversity, a variety of ecological processes and multidimensional gradients (Naiman et al. 2005).

The ecological functions of a riparian zone can be grouped into four main categories: nutrient flux, geomorphic control, temperature and light regulation, and litter input land (Boulton et al. 2014). Each of the four categories involves different attributes of the riparian zone and may encompass significantly different areas of channel bank. The area within a riparian zone contains valuable water resources, highly fertile soil and supports diverse habitats that contain high levels of biodiversity (Naiman et al. 2005). Riparian zones contribute to numerous ecological functions as well as fulfill many social and economic functions, both directly and indirectly. Given the importance of such systems, riparian health is essential.

Rapid Assessment of Riparian Condition

The Ecohealth Rapid Assessment of Riparian Condition (ERARC) is a multi-metric index of riparian condition, which has been modified from a combination of the Sub-Tropical Rapid Appraisal for Riparian Condition (STRARC) (Southwell 2011), the adapted Tropical Rapid Appraisal of Riparian Condition (TRARC) (Dixon et al. 2006), and the original Rapid Appraisal for Riparian Condition (RARC) (Jansen et al. 2004). The ERARC is comprised of 29 indicators which are grouped into five subindices that when combined with equal weighting, calculate to an overall index of riparian condition. The five subndices help to identify the general components that contribute to the condition of a site (Dixon et al. 2006). For the purposes of Ecohealth grading, the ERARC was modified to separate out geomorphic condition from riparian condition. Riparian condition subindices and their indicators are listed below in Table 2.5.

In summary the five riparian condition subindices describe:

1. Overall extent and condition of vegetation, and provision of habitat in the riparian zone (HABITAT).

2. Originality, weediness and overall quality of the riparian vegetation (NATIVE SPECIES).

3. Extent of the riparian vegetation footprint with regards to structural complexity (COVER).

4. Presence of dead and decaying vegetative material and fringing vegetation (DEBRIS).

5. Current and historic human induced influences on the riparian zone (MANAGEMENT).

HABITAT

Habitats within riparian zones are an important characteristic of riparian condition. Riparian zones play a crucial role in supporting wildlife by providing services such as nesting and roosting habitats, food and shelter from predators and harsh physical conditions, and migratory transport networks. The quality of such services is dependent upon structural complexity, stand age and vegetation continuity and connectivity to larger intact remnant vegetation stands. The HABITAT subindex assesses riparian condition by considering the extent and quality of vegetation, and provision of habitat within the riparian zone. This is achieved by quantifying riparian vegetation continuity and proximity to larger tracts of forest at a landscape scale, channel: riparian width ratio, structural complexity, and the presence of both large and hollow bearing native trees, otherwise known as 'habitat trees', which are known to provide habitat for approximately 15% of all Australian terrestrial vertebrate fauna at any point in time (Gibbons and Lindenmayer 2002). In addition to onsite surveys, spatial data layers from the SIX Maps Vegetation Map Viewer (OEH 2016) are used to assist with the assessment of the Habitat subindex.

NATIVE SPECIES

Invasive exotic plant species have the potential to threaten the ecological integrity and productivity of riparian zone ecosystems, by excluding native species, altering nutrient, light and moisture levels, and can have detrimental effects on natural processes such as terrestrial and aquatic invertebrate food webs. The originality and overall quality of the riparian vegetation is assessed at each structural layer with regards to native plant versus weedy plant species. The layers assessed are canopy, midstory, herbs and forbs, graminoids, and macrophytes or vines, depending on the vegetation community present (closed or open forest systems). The identification of the dominant floristics of each structural layer is a valuable additional measure of stand quality and condition, and allows for the important distinction between native and exotic plant species. In addition to onsite surveys, the Atlas of Living Australia (Atlas of Living Australia [ALA} 2016), is used to assist with the assessment of the Native Species subindex.

COVER

The number of naturally occurring vegetation layers and the percentage cover of each of these layers found in a system can be used as an indicator of the overall presence and extent of the riparian vegetation footprint. The contribution that each layer adds to the system is quantified and provides an overall indication of the presence of riparian vegetation, its structural complexity and its resilience to major flood and other disturbance events. Each of the five riparian structural layers, canopy, midstory, herbs and forbs, graminoids, and macrophytes/vines, is assessed for its completeness and contributes to overall riparian condition.

DEBRIS

Debris refers to the presence of dead and decaying vegetative material and fringing vegetation in the riparian zone. Debris assists with the regeneration of native woody species with the provision of protected habitats, while leaf litter and woody debris are essential for maintaining nutrient cycles and other aquatic and terrestrial ecological processes including food webs. In addition to providing shelter for smaller invertebrates, organic leaf litter is a source of course particulate organic matter, while woody debris in the form of fallen trees and logs provide instream habitat for spawning sites and areas for fish to hide from predators, and to avoid intense sunlight and high current velocities (Crook and Robertson 1999). In addition to the provision of core habitat, debris and fringing vegetation aid river bank stabilisation, and are an important foraging resource for a variety of mammals, birds, reptiles, invertebrates and microorganisms. Debris contributes to riparian condition and is assessed by quantifying woody and non-woody debris - dead standing and fallen trees, logs and branches, and leaf litter from both native and exotic species, along with fringing vegetation.

MANAGEMENT

This considers both current and historic anthropogenic influences on the riparian zone. A particularly important indicator of disturbance or the lack thereof is the presence and abundance of large trees, given the history of logging and land clearing within upper catchments. Vegetation clearing and the presence of livestock continue to accelerate the deterioration of riparian condition. The presence of fencing indicates that there has been an attempt made to exclude livestock from the site. The MANAGEMENT indicators assessed that contribute to riparian condition are tree clearing, fencing, animal impact, noxious weeds, exposed roots and woody regeneration. If left unchecked, human-induced impacts may be detrimental to the health and the complexity of the plant and animal species of the riparian zone, and accelerate the deterioration of riparian condition. The extent and success of site-level measures taken to improve the ecological condition and function of the riparian zone are also considered.

Riparian field methods

All 31 sites in the Nambucca catchment were assessed in both November 2016 and in February 2017 using the ERARC method developed for the Ecohealth project (Ryder et al. 2016). Two sampling periods were required to account for climatic variability, temporal variation in plant species and for collection of flowering plant material for identification (specifically grasses). Data for each of the five subindices were collected at the reach (100m) scale (Table 2.5), and via desktop survey using satellite imagery, vegetation datalayers and species record lists (Atlas of Living Australia [ALA] 2016; Office of Environment and Heritage [OEH] 2016).

Table 2.5 Vegetation condition subindices, their indicators and scores.

Subindices and their indicators	Assessment	Score
HABITAT		**20**
Channel width	Riparian vegetation width ÷ channel width	**4**
Proximity	Distance to closest stand of native vegetation	**4**
Continuity	Longitudinal continuity of riparian vegetation	**4**
Layers	Presence/absence of integral growth forms	**4**
Large native trees	Presence/absence of large trees (>30cm dbh)	**2**
Hollow-bearing trees	Presence/absence of hollow-bearing trees	**2**
NATIVE SPECIES		**20**
Native canopy species	Percentage of woody native species >5m tall	**4**
Native midstory species	Percentage of woody native species <5m tall	**4**
Native herb/forb species	Percentage of non-woody understory plants	**4**
Native graminoid species	Percentage of grass & grass-like plants	**4**
Native macrophyte species	Percentage of in-stream waterplants	**4**
SPECIES COVER		**20**
Canopy species	Percentage cover of woody native species >5m tall	**4**
Midstory species	Percentage cover of woody native species <5m tall	**4**
Herb/forb species	Percentage cover of non-woody understory plants	**4**
Graminoid species	Percentage cover of grass & grass-like plants	**4**
Macrophyte species	Percentage cover of in-stream waterplants	**4**
DEBRIS		**20**
Total leaf litter	Percentage cover of total leaf litter	**3**
Native leaf litter	Percentage cover of native leaf litter	**3**
Dead trees standing	Presence/absence of dead trees standing	**3**
Dead trees fallen	Presence/absence of dead trees fallen	**3**
Lying logs	Presence/absence of lying logs	**4**
Fringing vegetation	Presence/absence of graminoids	**4**
MANAGEMENT		**20**
Tree clearing	Clearing and age of stand assessment	**4**
Fencing	Presence/absence of riparian fencing	**3**
Animal impact	Evidence of livestock grazing	**3**
Canopy health	Physical health of canopy individuals	**2**
Exposed tree roots	Extent of exposed tree roots due to erosion	**4**
Native woody regeneration	Presence/absence of native woody species	**2**
Weedy woody regeneration	**Presence/absence of weedy woody species**	**2**

2.4.5 Mangrove, seagrass and saltmarsh cover in estuarine sites

Riparian and in-stream vegetation in estuaries also perform many functions by providing habitat for a wide range of organisms, preventing erosion of banks from storm surge and tidal action, and acting as a buffer to filter nutrients entering estuaries. In estuaries, mangroves are common in the riparian zone, providing crucial nursery habitat to many aquatic organisms including commercially important fish and prawn species. Seagrasses are also a critical part of estuaries and coastal lagoons. They provide primary production and stability to habitats, and support nurseries and food webs for important species including fish, prawns and invertebrates. One of the most common factors leading to the loss of seagrass is direct human disturbance (hauling nets, boat anchors) or indirect effects from increasing water turbidity and reducing light penetration.

Cover of estuarine macrophytes (mangroves, seagrass and saltmarsh) for both the Nambucca River and Deep Creek estuaries were calculated using the 2011 spatial dataset provided by NSW Department of Industry and Investment – Primary Industries and Energy. The total area of mangrove, seagrass and saltmarsh was calculated for each estuary system.

2.4.6 Geomorphic Condition

Fluvial geomorphology refers to the sediment dynamics of river systems, from the configuration of entire stream networks within catchments to the organisation of sediment particles within a single feature in a stream reach. These complex sediment erosion and transport processes form the physical template that regulates ecological habitat and processes in rivers. Human disturbances can negatively affect the equilibrium of these sediment erosion and transport processes. For example, catchment and riparian clearing can accelerate erosion and delivery of sediment to the stream channel, where it is stored and transported slowly over many floods. However, while the sediment is stored within the channel, it may negatively impact stream ecology by physically smothering habitat, releasing nutrients and contaminants into the streambed or water column, or damaging stream biota.

The condition of the geomorphic template is assessed once for each site during a low-flow period, usually concurrent with the riparian condition assessment. The assessment considers the condition of stream banks (freshwater and estuary sites), stream bed (freshwater sites), and local management that directly impacts reach-scale geomorphic condition. The assessment is conducted within the River Styles framework that classifies stream reaches according to the shape of the surrounding river valley, the shape and mobility of the channel within the valley and the dominant sediment size of the channel.

Geomorphic field methods

Geomorphic condition was assessed at two spatial scales. Subcatchment scores and grades were calaculated using the entire stream network for each subcatchment using the River Styles 2014 data layer supplied by NC LLS. The proportions of total subcatchment stream length in Good, Moderate and Poor Condition were calculated and weighted (3, 2, and 1 for Good, Moderate and Poor, respectively). These were summed to a total score, divided by 3 and converted to proportions. The standard Ecohealth grading structure was applied to each subcatchment proportions.

Site-level geomorphic condition is assessed by field surveys using the geomorphic indicators in Table 2.6. Field assessments are conducted over a 100-m reach for each site. Both bank and bed condition are assessed at freshwater sites, and bank condition is assessed at estuarine sites. Both these site-level geomorphic subindices comprise several indicators. All indicators are assessed on a scale of 1-5 where 1 is poor and 5 is very good, and indicators are equally weighted when calculating subindices.

The representativeness of sites in reporting geomorphic condition is considered at the subcatchment scale and for the site-specific River Style within the subcatchment. In practice, site-level grades are usually consistent with subcatchment grades, but may under-estimate the condition of specific River Styles (e.g. headwaters) due to the logistical constraints of accessing reaches in better condition.

Table 2.6 *Geomorphic condition subindices for bank and bed condition.*

Geomorphic condition subindices and their indicators	
BANK CONDITION	
- Exposed tree roots	Evidence of exposed tree roots
- Bank slumping	Evidence of bank slumping
- Pugging/trampling	Evidence of pugging and trampling
- Active erosion	Evidence of active erosion
BED CONDITION	
- Active erosion	Evidence of active erosion
- Pugging/trampling	Evidence of pugging and trampling
- Smothering fines	Evidence of smothering by fine-grained sediments

2.5 Calculating scores for Ecohealth Indices

2.5.1 Water Quality

A guideline trigger value is formally defined as the value that is commonly used to assess the ecological condition of a waterbody. An exceedance indicates that a variable is outside the expected range. Triggers are likely to be recalculated periodically as additional data from reference systems becomes available. A combination of ANZECC (2000, 2006) and NSW MER (OEH 2013) developed trigger values were used to explore water quality across sites and sampling occasions (Table 2.4).

Calculating non-compliance is the proportion of time that the measured values of the indicator are outside the adopted trigger values (number of samples non-compliant with trigger value divided by the total number of samples (expressed as a value between 0 and 1, with 0 equal to all values being compliant and 1 equal to all values non-compliant)). The result of this process is a score between 0 and 1 for each individual water quality parameter measured as part of Ecohealth monitoring. These scores are simply averaged to determine an overall score between 0 and 1 for Water Quality.

2.5.2 Freshwater macroinvertebrates

Regional trigger values must be developed from literature and past studies for Family Richness (number of families), Total Abundance, SIGNAL2 Score (pollution tolerance index), and EPT taxa (number of Mayflies, Stoneflies and Caddisflies) for each study. In the absence of these, the default threshold values reported in Chessman (2003) can be used for SIGNAL2. Alternatively, it should be determined if one or more sites sampled during the Ecohealth program in a specific catchment can be used as a 'reference condition' for Family Richness and EPT grade. In addition to a trigger value, a Worst Expected Value (WEV) must be calculated for Family Richness, Total Abundance, EPT score and SIGNAL2. The WEV scores are derived from either the 10^{th} and/or the 90^{th} percentile of data for all relevant available data, and represent a site that is the 'unhealthiest'. Calculation of a standardized score involves the comparison of each of the four macroinvertebrate indicators against the corresponding guideline value and WEV scenario. The maximum score for each indicator is 25 and indicators are equally weighted when calculating the Macroinvertebrate Condition Index.

2.5.3 Riparian Condition

The assessment of each site affords each indicator an average site score, where a minimum value of 0 represents a poor state and a maximum value represents pristine condition. These scores assessed both in the field and using a desktop data assessment are combined to produce summary scores for each sub-index, and an overall condition index (Table 2.5). Indicators that are assessed at three points along the transect required averaging to give only one number for each indicator, those recorded at the transect level have only one value for each site. The indicators are then grouped into the five subindices and summary scores for each grouping are calculated through simple averaging to produce a condition score out of 20 for each sub-index (i.e. Habitat, Native Species, Species Cover, Debris, and Management). These scores are then summed to a total score out of 100, standardised to a score ranging from 0 to 1 through simple division and assigned a final Ecohealth Report Card grade for riparian condition.

2.5.4 Mangrove, seagrass and saltmarsh cover in estuaries

As this is the first time mangrove, seagrass and saltmarsh are reported as part of an Ecohealth assessment of the Nambucca catchment, they do not contribute to Ecohealth scores. Area and patch size will be calculated during the next Ecohealth round if the surveys are updated, and these temporal changes will be used to assess system change which will contribute to estuarine riparian condition scores.

2.5.5 Geomorphic Condition

Site-level geomorphic condition is assessed by field surveys using the geomorphic indicators in Table 2.6. The assessment of each site affords each indicator a maximum score out of five, where a score of 1 represented the worst possible condition and a score of 5 represents pristine condition. The scores recorded in the field were combined to produce summary scores for both subindices and an overall condition index. The indicators are grouped into the three subindices and summary scores for each grouping are calculated through simple averaging to produce a condition score out of 5 for each sub-index (i.e. bank condition and bed condition). To calculate the Ecohealth Geomorphic Condition Index, these scores are then summed to a total score out of 10, and are standardised to a score ranging from 0 to 100.

2.6 Spatial Scales

The above process provides the methods for calculating standardized scores for each index used in a particular Ecohealth monitoring program for an individual site. Total scores for a site are simply calculated as an average of the 0 to 1 range of scores across all indices. The scores can then be 'pooled' at spatial scales relevant to reporting requirements such as site, river, sub-catchment, freshwater or estuarine, catchment and region.

2.7 Calculating grades

The condition scores were grouped in ranges and given a corresponding grade (see Table 2.7). This scoring and grading system is based on the traditional format of a school report, with primary ratings ranging from a high of 'A', through intermediate ratings of 'B', 'C' and 'D', to the lowest possible score of an F. Secondary grades of + and – are included to provide greater resolution within a grade, and to better help show improvements over time.

Table 2.7 *Standardised scores from 0-100 and their corresponding Ecohealth grades.*

Score	Grade	Condition	
≥95/100	A	Excellent	Environmental values met (The indicators measured meet all of the benchmark values for almost all of the year).
85/100	B	Good	Most environmental values met (The indicators measured meet all of the benchmark values for most of the year).
70/100	C	Fair	Some of the environmental values met (The indicators measured meet some of the benchmark values for some of the year).
55/100	D	Poor	Few of the environmental values met (The indicators measured meet few of the benchmark values for some of the year).
≤45/100	F	Very Poor	Very few of the environmental values met (The indicators measured meet very few of the benchmark values for almost all of the year).

2.8 Ecohealth report cards

The calculation and reporting of Ecohealth grades involves the synthesis all available indicators each with trigger values six times during the program. Scores are calculated for individual sites, but also must fulfill the broader aims of wider-scale reporting at river, sub-catchment, catchment and regional scales. To produce an Ecohealth grade, the value for each index – Water Quality, Freshwater Macroinvertebrates, Freshwater Fish, Riparian Condition and Geomorphic Condition– must be transformed into standardized scores that account for differing physical conditions and scales of measurement among indices and prevailing climate conditions. The result is a scoring system from 0 to 100, where 0 represents the most ‘unhealthy’ condition and 100 indicates a ‘healthy’ waterway.

PART 3

RESULTS

This section of the report provides detail of the water chemistry and biophysical data collected from July 2016 to June 2017. Results for water chemistry, macroinvertebrates, riparian condition, estuarine macrophytes and geomorphic condition are reported for each subcatchment. *Geomorphic condition* assessed site-scale condition of stream banks and bed at freshwater and estuarine sites, and subcatchment-scale assessment of the stream network. *Riparian condition* assessed freshwater and estuarine sites and included habitat, native species presence, percentage cover, woody and non-woody debris, management issues, as well as identification of local-scale disturbances to riparian zones. *Water quality* identified trends in nutrients (nitrogen (N) and phosphorus (P)), chlorophyll *a* (chl-*a*), suspended solids (TSS), as well as static variables such as pH, salinity, dissolved oxygen (DO) and temperature measured from water column profiles at each site. Attributes that exceed ANZECC or NSW MER guideline thresholds for aquatic ecosystem health are identified. *Aquatic macroinvertebrate* assemblages collected from freshwater sites in spring 2016 and autumn 2017 are used to assess long-term condition of channel habitats and water quality. The taxonomic richness and abundance reported, as well as health indicators using SIGNAL2 scores and EPT richness and abundance. All water chemistry and biophysical data are reported for the Nambucca catchment overall, subcatchments and sites, and organized as:

3.1 Nambucca catchment overall
3.2 Nambucca River
3.3 Missabotti Creek
3.4 South Creek
3.5 Taylors Arm
3.6 Warrell Creek
3.7 Deep Creek.

3.1 Nambucca catchment

The overall grade for the Nambucca catchment was C- (Table 3.1, Figure 3.1), ranging from an F in Tom Maras Creek to C+ in Warrell Creek Estuary and Missabotti Creek (Table 3.1). Overall, Taylors Arm and Missabotti and Thumb Creeks were the freshwater reaches in best condition and Warrell Creek was the estuary in best condition (Figure 3.1).

At most sites, riparian and geomorphic condition were closely related, reiterating that healthy riparian vegetation is critical to maintaining bank stability, and that riparian and geomorphic condition are similarly impacted by degrading landuse practices. Throughout the Nambucca catchment, subcatchment geomorphic condition ranged from D- in South and Buckrabendinni Creeks through to B in Thumb Creek (Figure 3.2a). The Warrell, Deep and Newee Creek estuaries had good riparian condition (Figure 3.2b).

Water quality was poorest in Taylors Arm and Newee Creek estuaries (Figure 3.2c), where nutrient concentrations ranged to several times the OEH trigger threshold for estuarine water quality. Baker Creek had the highest site grade for freshwater sites and the catchment as a whole, with the freshwater reach of Taylors Arm and Warrell Creek estuary also scoring well in comparison to other subcatchments in the Nambucca. The decline in water quality from the freshwater to estuarine reaches of Taylors Arm warrents further investigation.

Aquatic macroinvertebrates were found to be in moderate to poor condition in many subcatchments and overall. In most subcatchments, poor water quality is likely to be the main stressor to aquatic macroinvertebrate communities given geomorphic and riparian conditions (Table 3.1). The exception is Missabotti Creek where aquatic macroinvertebrates were in good condition but geomorphic and riparian condition and water quality were poor. Aquatic macroinvertebrate communities were in good condition in the upper reaches of the Nambucca River (North Arm), Buckrabendinni Creek, Taylors Arm and Thumb Creek (Figure 3.2d).

Freshwater fish communities were good in the Nambucca catchment (Butler et al. 2017), particularly in the upper reaches of the Nambucca River (North Arm) and Taylors Arm (Table 3.1). Fish communities were in moderate condition in the freshwater reaches of Warrell, Eungai and Deep Creeks (Table 3.1, Figure 3.2e).

Table 3.1 *Catchment and subcatchment Ecohealth grades for subcatchments in the Nambucca. Geomorphic condition was assessed at the subcatchment scale. Subcatchments represented by a single site are indicated by italicized grades.*

System	Water quality	Aquatic Macroinvertebrates	Fish	Riparian Condition	Geomorphic Condition	Overall
Nambucca Catchment Overall	D	D+	B-	C-	C	C-
Nambucca River (North Arm)	D-	C-	B	D+	C	C-
Freshwater Nambucca	D	C-	B	C	C	C-
Nambucca estuary	D-			D+	C	D+
Tributaries of the Nambucca River	D-	C-	B	C-	D+	C-
Missabotti Creek	*D-*	*B-*	*B*	*D+*	*C*	*C*
Buckrabendinni Creek	D	C	B-	D-	D-	D+
South Creek	D	F	B	D	D-	D+
Newee Creek	*F*			*D+*	*C*	*D+*
Taylors Arm	D	C	B	C-	C+	C
Freshwater Taylors Arm	D+	C	B	C	C+	C
Taylors Arm estuary	F			D+	C+	D+
Tributaries of Taylors Arm	D+	D	B-	D+	C	C-
Thumb Creek	*D+*	*B-*	*B-*	*D+*	*B*	*C+*
Baker Creek	*C-*	*D*	*B-*	*D+*	*C+*	*C-*
Tom Maras Creek	*D*	*F*		*D+*	*D*	*D-*
Warrell Creek	D	D-	C-	B-	B-	C-
Freshwater Warrell Creek	D-	D-	C-	C+	B-	C-
Warrell Creek estuary	D+			B	B-	C+
Deep Creek	D-	D	C+	C+	C	C-
Freshwater Deep Creek	*D*	*D*	*C+*	*D+*	*C*	*D+*
Deep Creek estuary	D-			B-	C-	C-

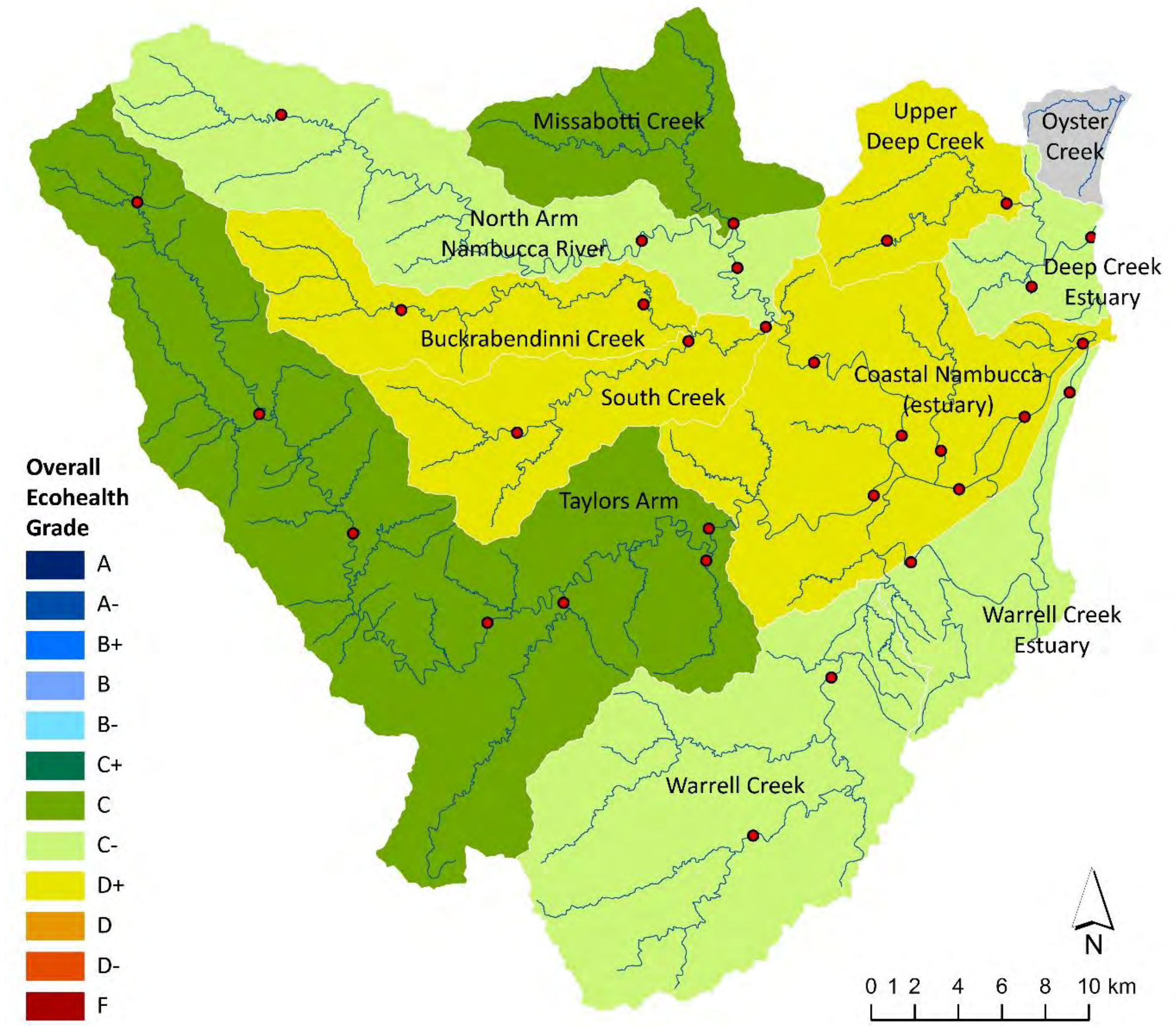
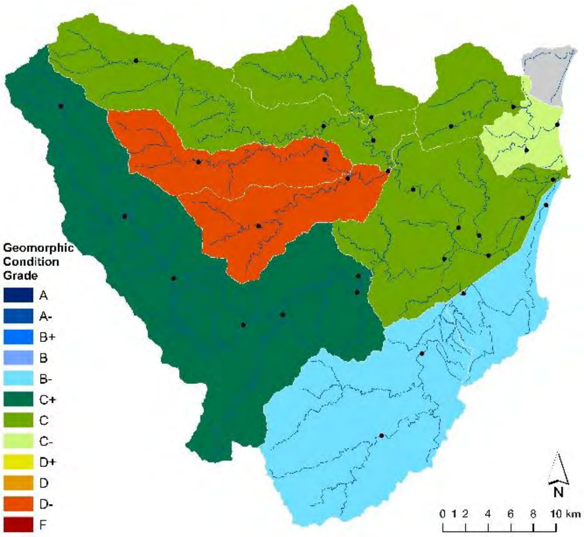
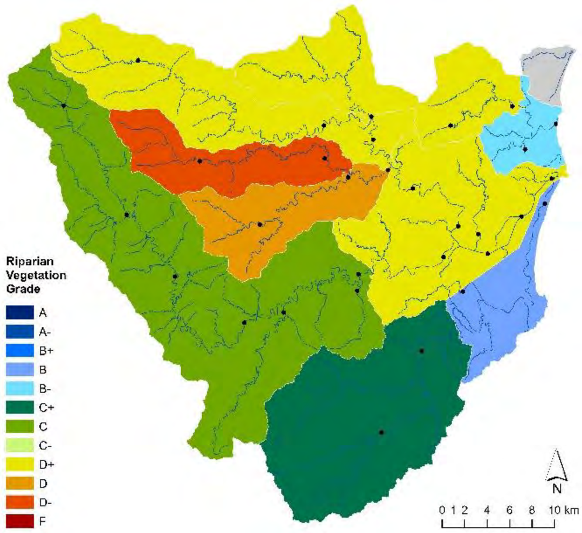


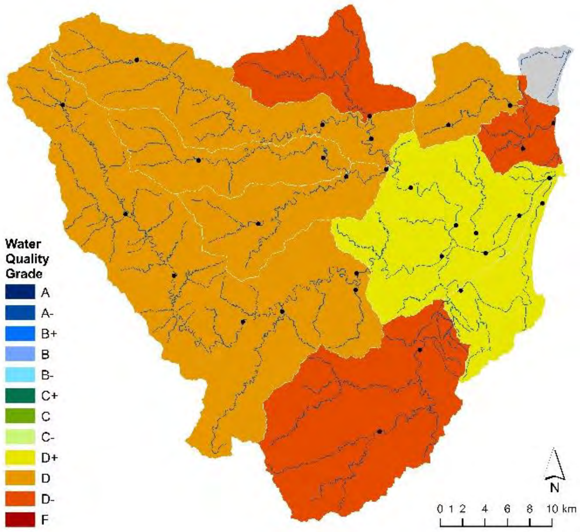
Figure 3.1 *Overall Ecohealth grades for the Nambucca catchment. Grey area represents Not Assessed.*



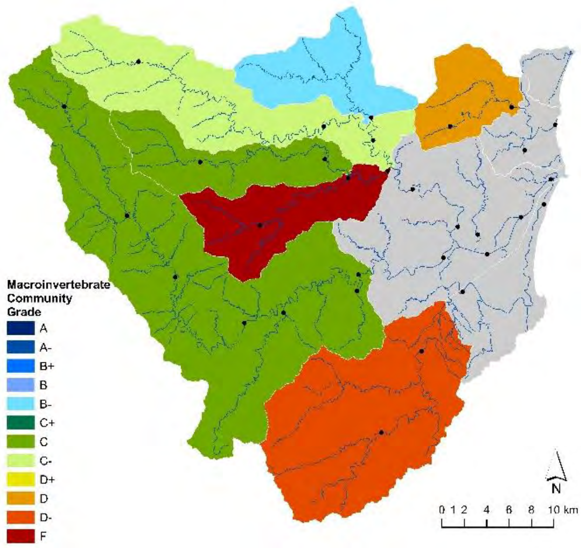
(a) Geomorphic Condition



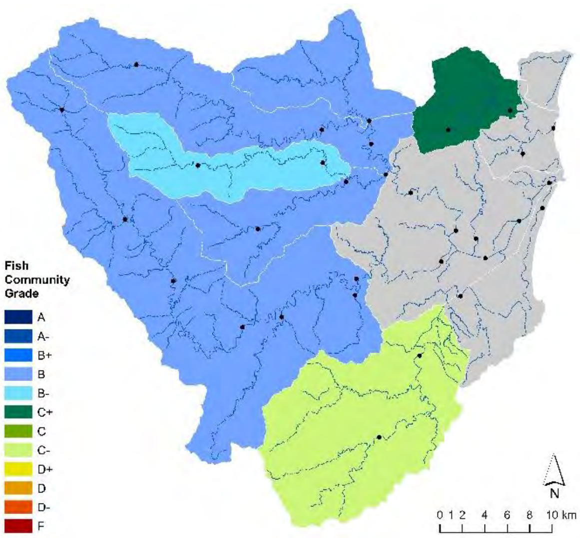
(b) Riparian Condition



(c) Water Quality



(d) Aquatic Macroinvertebrates



(e) Freshwater Fish

Figure 3.2 *Subcatchment Ecohealth grades for (a) geomorphic condition, (b) riparian condition, (c) water quality, (d) aquatic macroinvertebrate communities, and (e) freshwater fish communities. Aquatic macroinvertebrate and fish communities were not assessed for estuarine reaches.*

3.1.1 Geomorphic condition

Assessments of stream condition over the Nambucca subcatchments show that most (76%) of the stream network is in good or moderate condition (Table 3.2, Figure 3.3). Overall, the Nambucca catchment achieved a grade of C for subcatchment-scale geomorphic condition. Three subcatchments have more than 30% of their stream network in good condition (Table 3.2). These include the estuarine Oyster Creek, Warrell Creek and the freshwater Buckrabendinni Creek. Two subcatchments have more than 50% of their stream network in poor geomorphic condition: Missabotti Creek and South Creek (Table 3.2).

Gravel extraction has long been controversial in the Nambucca catchment (Doyle 2003). Gravel extraction was primarily conducted in the Nambucca River (North Arm) and Missabotti Creek. Both of these now have long sections of channel in poor geomorphic condition (Figure 3.3). Doyle (2003) provides a detailed review of the geomorphic and ecological effects of excessive gravel extraction in the Nambucca catchment.

Table 3.2 *Subcatchment scale geomorphic condition calculated over the subcatchments' total stream length using the 2014 River Styles datalayer from NC LLS.*

Subcatchment	% Good Condition	% Moderate Condition	% Poor Condition	Geomorphic Grade
Nambucca catchment overall	27	49	24	C
Missabotti Creek	17	4	79	D-
Nambucca Estuary	20	59	20	C
North Arm (Nabucca trunk)	26	30	45	C-
Buckrabendinni Creek	34	41	26	C
South Creek	8	32	60	D-
Taylors Arm	29	56	15	C+
Warrell Creek	38	54	8	B-
Deep Creek Freshwater	10	79	11	C
Deep Creek Estuary	12	68	20	C-
Oyster Creek	100	0	0	A

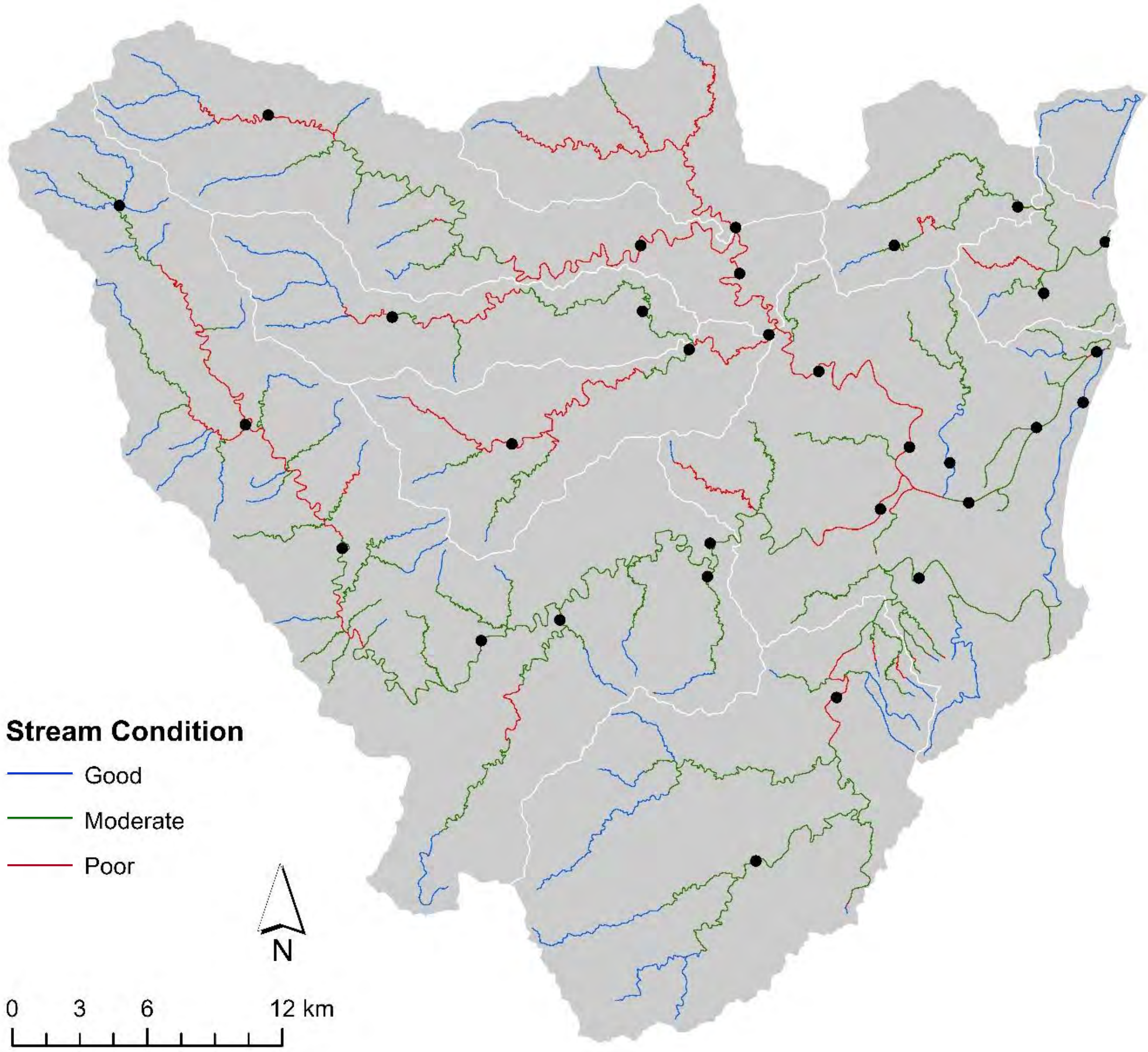


Figure 3.3 *Stream condition of the Nambucca catchment. Black dots represent Ecohealth sites. Data from NC LLS 2014 Riverstyles.*

3.1.2 Riparian condition

The area within a riparian zone can contain valuable water resources, highly fertile soil and supports high levels of biodiversity as well as many social and economic and ecological functions. Averaged across all 31 Ecohealth sites, riparian condition in the Nambucca Catchment was assessed as moderately disturbed and received a score of 63.5, a grade of C-. Breaking down the summary score into hydrological units, riparian condition was best in the Warrell Creek subcatchment. Riparian vegetation throughout this mildly disturbed system ranged from very good riparian condition in the lower estuary through to moderately disturbed in the freshwater reaches of the Warrell Creek coastal floodplain. Similarly to Warrell Creek, the riparian vegetation of the Deep Creek subcatchment was in good condition, with sites ranging from relatively undisturbed in the mid-estuary to highly disturbed in the upper freshwater reaches. Riparian vegetation of the Nambucca Estuary was moderately disturbed but in better condition than freshwater reaches in the Catchment. The Taylors Arm main stem also supported riparian zone systems of moderate disturbance but was found to be in better condition than the main stem of the Nambucca River to the north, which received a high disturbance rating. Tributaries of both Nambucca and Taylors arm were in similar condition to each other and along with the Nambucca River received a high disturbance rating and the lowest summary grades for riparian condition in the Catchment (Table 3.3).

Table 3.3 *Nambucca Catchment summary scores, grades and disturbance types for grouped estuary, freshwater tributary and main stem Ecohealth sites, 2017.*

Hydrological Units	Score	Grade	Disturbance type
Nambucca Catchment	63.5	C-	Moderate
Nambucca Catchment (estuaries)	69.6	C	Moderate
Nambucca Catchment (freshwater)	60.1	C-	Moderate
Nambucca River	57.5	D+	High
Taylors Arm	63.6	C-	Moderate
Nambucca River tributaries	57	D+	High
Taylors Arm tributaries	58.3	D+	High
Warrell Creek	77.3	B-	Mild
Deep Creek	75.2	B-	Mild

The majority of Ecohealth sites contributing to the catchment riparian condition summary grade were representative of the area of the Catchment that has been subjected to broadscale landuse and anthropogenic impact. The overall Nambucca Catchment score, however, may not reflect the riparian condition of intact wilderness/remnant areas which account for approximately 553km^2 of the 1,426km^2, or 38% of the Nambucca Catchment. Wilderness areas and areas of heavily forested remnant stands of vegetation in the Nambucca Catchment include New England, Gumbaynggirr, Dunggir, Baalijin, Yarriabini and Gaagal National Parks, Juugawaarri, Ganay, Jaaningga, Bollanolla, Ngambaa and Jagun Nature Reserves and the Gumbaynggirr State Conservation Area. Riparian vegetation sampled at sites within or adjacent to these intact wilderness/remnant areas reflected a much higher average riparian condition score than that given to the overall Nambucca Catchment.

Low-to-mildly disturbed riparian zones (sites that scored between 80 and 100) that were representative of intact wilderness/remnant areas included four Ecohealth sites: DEEP2, WARR1, TAYL5 and NEWC1. These sites were assessed as being in very good condition with an average score of 86.2, a grade of B+. In these systems, riparian vegetation continuity and vegetation:channel width ratio was high and sites were connected to large remnant patches of native vegetation. Weeds encountered in these sites did not dominate their structural layer and were often only present at disturbed edge areas or occasionally in the midstory. While large native remnant trees were typically common, habitat trees appeared to be reduced in these systems. Fringing vegetation was abundant, tree root exposure was low-to-medium and while woody and non-woody debris were present, large standing and fallen woody debris was reduced, particularly standing dead timber. For each structural layer, native species presence and cover was high and representative of the original vegetation community type, with significant native woody regeneration. Generally, these sites had adequate riparian fencing and no sign of stock impact; however, Newee Creek appeared to be the exception with obvious signs of livestock presence.

Sites that were representative of mild-to-moderately disturbed riparian condition (sites that scored between 60 and 80) were generally in areas that had been partially cleared of vegetation and subjected to long-term landuse yet retained at least some remnant riparian vegetation, such as upland freshwater reaches and estuaries surrounded by low lying floodplains. Nine Ecohealth sites were representative of these conditions: WARR2, DEEP1, EUNC1, NAMB2, DEEP3, WARR3, TAYL2, NAMB3 and NAMB8. The average score for mild-to-moderately disturbed riparian condition was 70.9, a grade of C+. In these systems, riparian vegetation width was poor, vegetation continuity was good and sites were often proximally located or connected to large remnant patches of native vegetation. Large native remnant trees were typically common but habitat trees appeared to be reduced in these systems. While weed species were common throughout these sites, they did not typically dominate any structural layer. Native species presence was typically moderate-to-good throughout the midstory and understory layers and good-to-very good throughout the canopy and macrophyte layers and was representative of the original vegetation community type. Moderate-to-good levels of native non-woody debris and lying woody debris were present, however large woody debris, particularly fallen timber, were often only present in low quantities. Fringing vegetation levels were good-to-very good, tree root exposure was low-to-medium and vegetation cover was generally high at each each structural layer, although often reduced throughout the canopy and midstory and macrophyte layers. Riparian fencing was often present yet incomplete or unutilised and riparian vegetation was occasionally impacted by livestock at these sites. Both woody weed and native woody regeneration was commonly observed at these sites.

Sites that were representative of highly-to-very highly disturbed riparian condition (sites that scored between 40 and 60) were generally areas that had been partially or entirely cleared historically and since subjected to broadscale landuse and long-term anthropogenic impact, such as the floodplains and lowland freshwater reaches of the catchment. The remaining eighteen Ecohealth sites were representative of these conditions. The average score for highly-to-very highly disturbed riparian condition was 54.7, a grade of D. In these systems, riparian vegetation width and continuity were generally moderate and sites were frequently disconnected from, but within 1km of, large remnant patches of native vegetation. Weeds were often encountered throughout these sites and were co-dominant species in two or three structural layers, typically the midstory and understory. While native species presence was typically low-to-poor throughout the midstory and understory layers, it was generally moderate-to-good throughout the canopy and macrophyte layers and representative of the original vegetation community type. Vegetation cover was generally moderate throughout both the canopy and midstory layers and good-to-very good throughout the understory layers. Moderate-to-good levels of non-woody debris and lying woody debris were present, however non-woody debris were frequently dominated by exotic species. Large woody debris were heavily reduced from natural levels and often present in low quantities, with fallen timber being particularly low. Levels of fringing vegetation were typically moderate-to-good, tree root exposure was low-to-medium and although large native trees were still common, habitat trees were further reduced at these sites. Generally, riparian fencing was present but inadequate or missing altogether from at least one side of the bank and livestock presence was frequent in these riparian zones. While both woody weed and native woody regeneration were evident, woody weed regeneration was more common.

There were no Ecohealth sites in the Nambucca Catchment that were considered to be extremely disturbed systems (sites that scored <40) during the time of sampling. While extrememly disturbed areas are likely present in the Nambucca Catchment, they are not representative of the broader subcatchment in which they occur.

Exotic and Noxious Weed Species

Of the 308 dominant riparian vegetation species recorded from the 31 Nambucca Catchment Ecohealth sites, 91 (or 29%) were exotic species while 217 (71%) were native species. When averaged across all sites, weeds accounted for 34% of the dominant species on-site. When separated by growth forms, dominant weed species were most prevalent in the grass layer (58%, of 33 species), followed by the herbs and forbs (43%, of 75 species), vines (31%, of 26 species), shrubs (28%, of 65 species), macrophytes (18% of 44 species), trees (11%, of 38 species) and graminoides (7% of 15 species). No exotic weed species were recorded in the saltmarsh layer (comprising 12 species) during the 2017 sampling period.

The most common dominant weed species were Lantana (*Lantana camara*) in 87% of sites, Broad-leaved Paspalum (*Paspalum mandiocanum*) in 77% of sites, Wild Tobacco (*Solanum mauritianum*) in 65% of sites, Fireweed (*Senecio madagascariensis*) in 55% of sites, Camphor Laurel (*Cinnamomum camphora*) in 48% of sites, Small-leaved Privet (*Ligustrum sinense*) in 45% of sites, and Paspalum (*Paspalum dilatatum*), Pigeon Grass (*Setaria sphacelata*), Blue Billy Goat Weed (*Ageratum houstonianum*), Wandering Jew (*Tradescantia fluminensis*) and Cobbler Pegs (*Bidens pilosa*) in 42% of the 31 Nambucca Catchment Ecohealth sites in 2017 (Appendix 1).

Of the 91 weed species recorded, at the time of reporting, 35 were listed as having a biosecurity risk (formally known as noxious weeds) (NSW DPI 2016). Of these 35 species, Lantana (*Lantana camara*) was the most commonly observed, occurring in 27 of the 31 sites (87%), followed by Fireweed (*Senecio madagascariensis*) in 55% of sites, Camphor Laurel (*Cinnamomum camphora*) in 48% of sites, Small-leaved Privet (*Ligustrum sinense*) in 45% of sites, Wandering Jew (*Tradescantia fluminensis*) in 42% of sites, Mistflower in 29% of sites, Annual Ragweed in 26% of sites and Noogoora Burr in 23% of the 31 Nambucca Catchment Ecohealth sites in 2017 (Appendix 1). Many of the noxious and non-noxious weed species observed during the Ecohealth study are known to be invasive and have the potential to expand in range and out-compete native plant species. Species that are capable of spreading quickly, remaining in the seed bank for many years, outcompeting native grasses and herbaceous species and should be a focus of weed control and weed monitoring programs (see Part 4).

3.1.3 Mangrove, seagrass and saltmarsh cover

Estuarine macrophytes are essential components of estuarine ecology. They improve water quality, contribute to the food chain, stabilise morphology by binding sediments, and provide both habitat and a nursery ground for fish and other marine species (West and Williams 2008, Creese et al. 2009). As with most ecological systems, estuarine macrophyte boundaries are dynamic in nature and may fluctuate over time due to environmental variability (Clough 1982, Leadbitter et al. 1999, West and Williams 2008). However, direct pressures on these systems (natural and anthropogenic) may influence community boundaries and can result in both positive and negative temporal change. Fluctuations in estuarine macrophyte cover can be caused by naturally occurring weather events such as storms, cyclones and floods. Anthropogenic factors that can lead to estuarine macrophyte degradation and decline include global warming and sea-level rise, excessive turbidity, elevated nutrient levels, stormwater discharge, heavy metal and toxin deposition, erosion, increased turbidity and siltation that reduces light intensity, mining and dredging, coastal development, moorings, boat propellers and introduced species (Kirkman 1997, Leadbitter et al. 1999, West and Williams 2008). A temporal comparison of estuarine macrophyte cover could not be undertaken as there has previously only been one assessment of estuarine macrophyte cover in the Nambucca Catchment. The CCA Project data used by Creese et al. (2009) was collected over a four year period between 2000 and 2004 (2000-2003 satellite imagery collection, 2004 ground truthing). However, for the sake of this report, the data collection date is referred to as 2004. Estuarine macrophyte cover data for the Nambucca Catchment in 2004 is given in Table 3.4 and Figure 3.4. In 2004, mangroves were the dominant vegetation community followed by saltmarsh and seagrass in both the Nambucca River and Warrell Creek estuaries, while in the Deep Creek estuary saltmarsh was the dominant vegetation community, followed by mangroves and seagrass (Table 3.4).

For data collection consistency and accuracy in temporal assessment, it is recommended that future cover assessments are done using the methodology of Creese et al. (2009). Satellite imagery should be collected at the same times of year as the original CCA Project dataset used in Creese et al. (2009) to account for natural annual variability attributed to seasonal growth phases and allow for a more accurate comparison with existing data. Management priorities should focus on long-term monitoring and mapping of estuarine macrophyte cover change using consistent and comparative methodologies, and by addressing the direct causes of potential estuarine macrophyte community decline (West and Williams 2008, Crease et al. 2009).

***Table 3.4** Summary of total macrophyte cover differences in the Nambucca River, Warrell Creek and Deep Creek estuaries as assessed in 2004 by Creese et al. (2009).*

Estuary system	Total macrophyte cover in 2004 (km^2)	Total mangrove cover in 2004 (km^2)	Total saltmarsh cover in 2004 (km^2)	Total seagrass cover in 2004 (km^2)
*Nambucca River**	2.41	1.10	0.96	0.35
Warrell Creek	0.95	0.36	0.31	0.28
Deep Creek	0.68	0.04	0.64	0.01
Totals	**4.04**	**1.49**	**1.92**	**0.64**

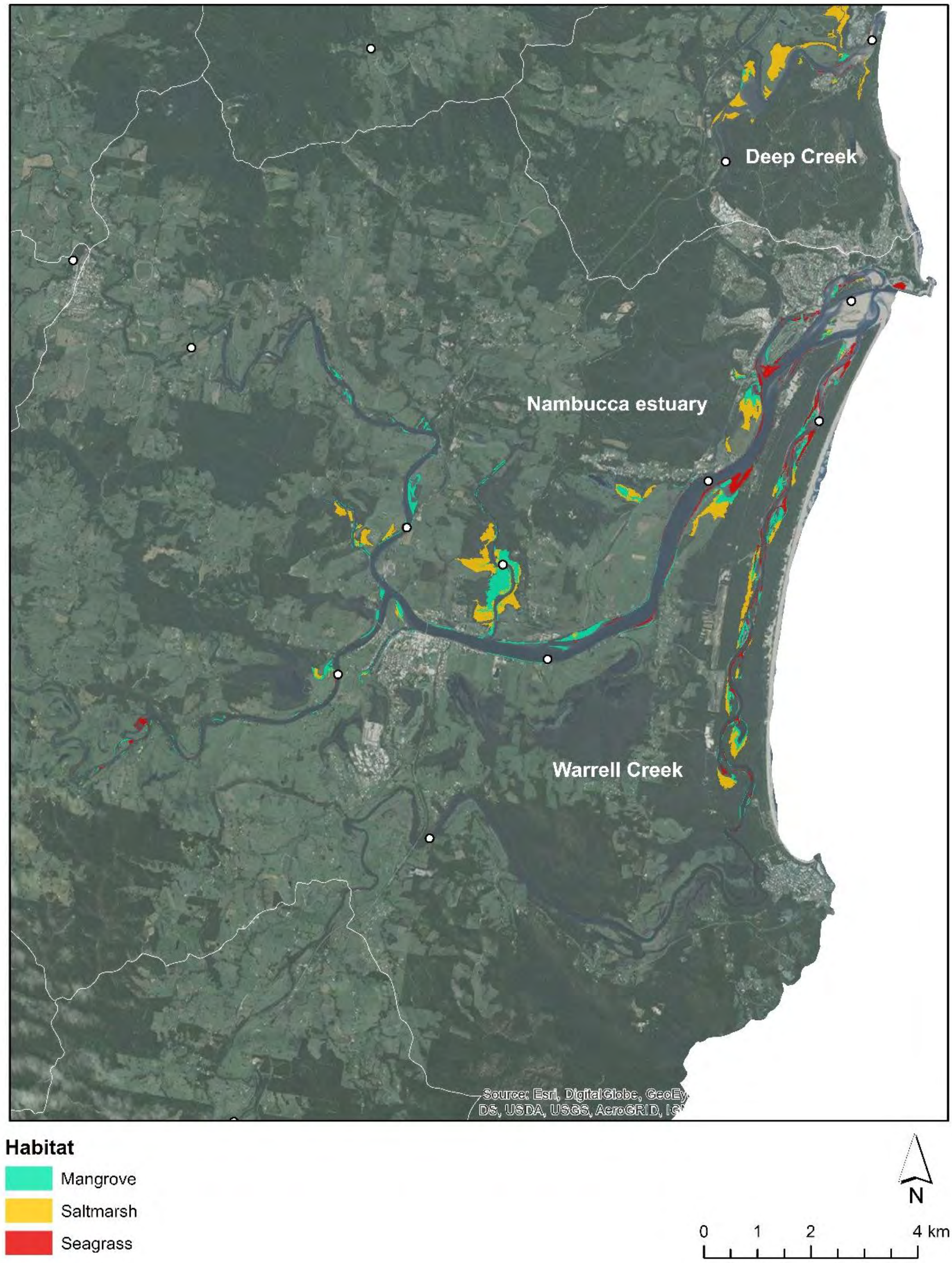


Figure 3.4 *Mangrove, seagrass and saltmarsh habitats in the Nambucca River Catchment estuaries (NSW Department of Industry and Investment – Primary Industries and Energy 2004). The estuaries are divided into three zones for more detailed temporal analysis.*

3.1.4 Water quality

Water quality was poor across the Nambucca and Deep Creek catchments, with an overall grade of D. Water quality was lowest in Newee Creek estuary and Taylors Arm estuary, both receiving grades of F. Given that the freshwater reaches of Taylors Arm were among the highest water quality grades, it is worth investigating the decline in water quality from the lower freshwater reaches of Taylors Arm to the estuary, specifically respecting total and bioavailable phosphorus. It is one of the few subcatchments in the Nambucca catchment where exceedances of phosphorus were a greater issue than exceedances of nitrogen. The freshwater tributaries of Taylors Arm of Baker Creek and Thumb Creek had the best water quality scores in the Nambucca Ecohealth project.

Low levels of dissolved oxygen were frequent in the catchment and likely due to the below average rainfall resulting in smaller stream discharge including the disconnection of pools, during the study period. Many sites in the Nambucca catchment consistently exceeded the ANZECC or NSW OEH nutrient guideline values. This was particularly the case for nitrogen and we suggest a management investment in reducing non-point source inputs of nitrogen in most of the subcatchments would significantly improve water quality across the Nambucca catchment. Yet, even with widespread high nutrient concentrations, algal biomass as measured by chlorophyll *a* rarely exceeded ANZECC or NSW OEH guideline values. Dissolved (bioavailable) nutrient concentrations had fewer exceedences, and may help explain why the elevated nutrients generally did not result in high chlorophyll *a* concentrations or evidence of algal blooms. Additionally, guideline nutrient values may require refining for this region to better predict ecosystem change associated with elevated nutrients.

In contrast to most of the surrounding catchments in the Mid North Coast and Northern Rivers where the tidal limits consistently record the poorest water quality as sites where freshwater and estuarine water quality issues converge, there was no consistent trend of very poor water quality at the tidal limits or upper estuaries in the Nambucca River. This was despite the reduced flushing flows experienced during the study period, which can lead to reduced water quality through the accumulation of nutrients, algal blooms and low dissolved oxygen concentrations. This is a positive finding for the Nambucca catchment as it suggests that nutrients and suspended sediments are not being stored and recycled in the upper estuaries, and indicates that estuarine water quality may respond relatively quickly to improvements to the water quality of inflowing freshwater systems.

Table 3.5 *Subcatchment grades for water quality assessed in 2017.*

System	Water Quality Score	Water Quality Grade
Nambucca Catchment Overall	50	D
Nambucca River Main Stem	49	D-
Freshwater Nambucca (North Arm)	52	D
Nambucca Estuary	47	D-
Tributaries of the Nambucca River	47	D-
Missabotti Creek	49	D-
Buckrabendinni Creek	51	D
South Creek	52	D
Newee Creek	38	F
Taylors Arm	51	D
Freshwater Taylors Arm	59	D+
Taylors Arm Estuary	39	F
Tributaries of Taylors Arm	56	D+
Thumb Creek	57	D+
Baker Creek	61	C-
Tom Maras Creek	51	D
Warrell Creek	53	D
Freshwater Warrell Creek	48	D-
Warrell Creek Estuary	57	D+
Deep Creek	48	D-
Freshwater Deep Creek	54	D
Deep Creek Estuary	45	D-

3.1.5 Aquatic macroinvertebrates

The Nambucca Catchment received an overall score of 56 (D+) for aquatic macroinvertebrate communities (Table 3.6). Of the four macroinvertebrate indicators (scored out of 25), mean family richness scored moderately with 16, SIGNAL2 was also moderate with a score of 15, EPT richness and abundance was poor with a mean of 13, and mean total abundance scored very poorly with 11. In the context of the NSW Northern Rivers Bioregion, the Nambucca Catchment returned a comparable macroinvertebrate score to neighbouring catchments. Of the six catchments previously studied, the Nambucca recorded the second highest maximum richness average behind the Macleay Catchment (2015/16) and the third highest maximum SIGNAL2 score behind the Macleay (2015/16) and Hastings-Camden Haven Catchments (2014/15).

Within the Nambucca Catchment, Thumb Creek and the upper Buckrabendinni Creek (BUCC2) returned the maximum indicator scores for family richness with 38 families across both sampling times. The greatest abundance of macroinvertebrates was observed in Taylors Arm at TAYL3 in autumn 2017 with 746 individuals collected within a 10 linear meter sample. The greatest EPT (Mayflies, Stoneflies and Caddisflies) abundance and diversity were observed in Thumb Creek and Taylors Arm at TAYL3 in autumn 2017, with a maximum of 23 EPT families and 454 EPT individuals, respectively. Across the Nambucca Catchment, Taylors Arm contained the best aquatic macroinvertebrate health and was assisted by TAYL4 which consistently scored above the average for all indicators, particularly for EPT and SIGNAL scores. The Nambucca main stem also returned mean reach indicator scores above the catchment average and scored well for macroinvertebrate health, while the lowest mean subcatchment macroinvertebrate score was observed in Warrell Creek (WARR3 and EUNC1). At a site-scale, Tom Maras Creek (TOMC1) returned the poorest abundance, richness and SIGNAL2 scores throughout the Nambucca Catchment.

There was a weak but positive linear trend between macroinvertebrate indicators and elevation throughout the Nambucca Catchment, suggesting that macroinvertebrate community condition improves as clearing and landuse intensity decreases and the proximity to forested headwaters increases. However, this was not the case for several sites that were both high in the catchment and surrounded by heavily forested headwaters, such as TAYL5 and NAMB8. For these sites, reduced macroinvertebrate scores may be attributed to the unseasonably dry conditions experienced during the sampling period that led to highly reduced in-stream flow and disconnected pools in headwater reaches.

Generally speaking, where increases in water quality and riparian condition occurred across the Nambucca catchment, macroinvertebrate community condition also increased. However, some sites did not follow this general pattern and in these cases macroinvertebrate community composition responded to factors other than water quality or riparian condition, such as habitat quality and quantity. Macroinvertebrate community condition was also strongly influenced by instream flow, indicated by the main stems of both the Nambucca River and Taylors Arm, both of which recorded the highest site scores for macroinvertebrate community condition and naturally receive larger discharges than the small tributaries that experienced disconnection of pools (e.g. Thumb Creek, Table 3.6).

***Table 3.6** Summary of aquatic macroinvertebrate indicator scores and overall macroinvertebrate grade for freshwater sites in the Nambucca Catchment. Each indicator has a maximum score of 25.*

Site	Total Abundance	Family Richness	EPT	SIGNAL2	Macroinvertebrate Score	Macroinvertebrate Grade
Catchment Mean	**11**	**16**	**13**	**15**	**56**	**D+**
Nambucca main stem	**12**	***17***	***14***	***17***	***60***	**C-**
NAMB8	10	16	8	12	46	D-
NAMB7	17	22	21	17	77	B-
NAMB6	10	12	12	22	56	D+
Nambucca FW tribs	***10***	***17***	***14***	***16***	***57***	**D+**
BUCC2	12	25	21	19	77	B-
BUCC1	11	19	14	11	54	D
SOUC3	13	17	12	18	60	C-
SOUC2	4	11	7	10	33	F
SOUC1	7	13	8	11	38	F
MISC1	14	19	21	25	79	B-
Taylors Arm	**16**	**14**	**17**	**18**	**65**	**C**
TAYL5	9	15	12	17	53	D
TAYL4	15	19	21	23	78	B-
TAYL3	25	8	19	13	65	C
Taylors Arm FW tribs	**9**	**17**	**13**	**12**	**52**	**D**
THUM1	14	25	25	15	79	B-
BAKE1	10	15	11	14	51	D
TOMC1	3	12	3	8	26	F
Warrell Creek FW	**13**	**14**	**8**	**12**	**47**	**D-**
EUNC1	8	16	8	14	46	D-
WARR3	18	12	8	10	47	D-
Deep Creek FW	**4**	**16**	**10**	**19**	**50**	**D**
DEEP4	4	16	10	19	50	D

3.1.6 Freshwater fish

Freshwater fish communities were sampled across 21 sites in the Nambucca catchment between 31st October 2016 and 24th November 2016 by Fisheries NSW. In total, 24 species of fish (20 native species) across 13,842 indivdiuals were caught using combinations of electrofishing, seine netting and bait trapping (Bulter et al. 2017). The long-finned eel (*Anguilla reinhardtii*) was the most abundant large fish by abundance and biomass. Australian smelt (*Retropinna semoni*) was the most abundant small fish (Bulter et al. 2017).

Community condition was assessed using three indicators: Expectedness, Nativeness and Recruitment. The Expectedness Indicator assesses the presence of native species 'expected' in the habitats sampled, and was Excellent or Good. The Nativeness Indicator was Excellent across the catchment, with no alien species observed at 10 of the 21 sites. The Recruitment Indicator was generally Good in the upper reaches and Moderate in lowland reaches and the coastal plain.

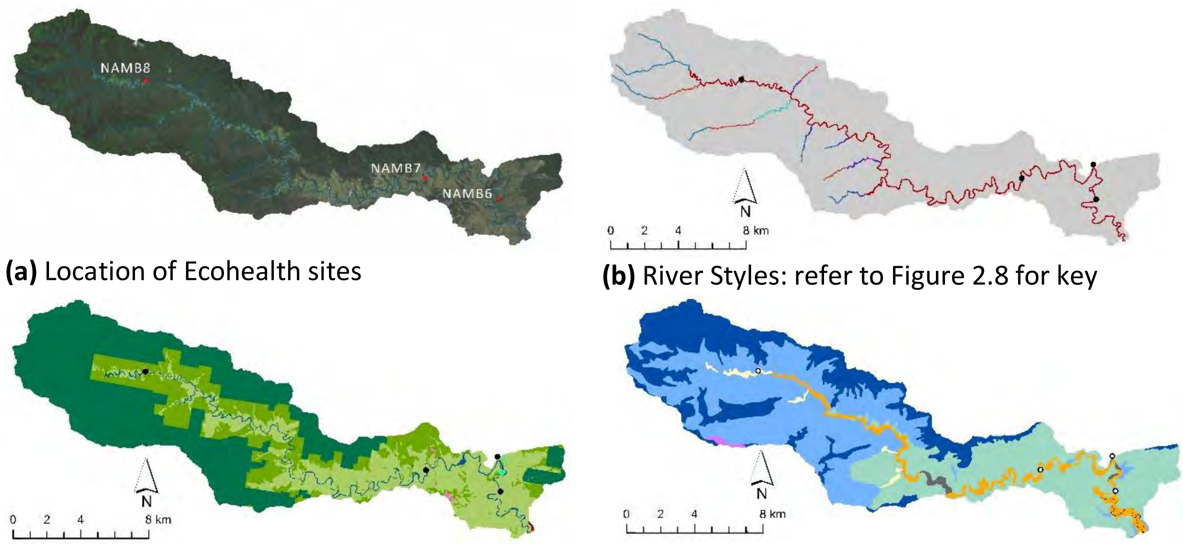
At the catchment-scale, freshwater fish communities were in good condition (a grade of B-, Butler et al. 2017). Fish communities in the Nambucca River (North Arm), Taylors Arm and South and Missabotti Creeks were in good condition (B, Figure 3.2e). The moderate fish community condition in Warrell Creek was the lowest observed condition in the Nambucca catchment, with a score of 64, a grade of C+. This study was the first comprehensive survey of freswahter fish in the Nambucca catchment and the report is available at www.nambucca.nsw.gov.au.

3.2 Nambucca River (North Arm)

3.2.1 Subcatchment and site descriptions

The main stem of the Nambucca River comprises 425.km^2 or 30% of the Nambucca catchment. This is divided into the freshwater reaches (Table 3.7) and the estuary (Table 3.8). The dominant land use in the freshwater reaches of the Nambucca River (North Arm) is conservation (51%), followed by grazing (26%, Table 3.7). Conservation areas are concentrated in the upper reaches. There is a sewerage treatment plant (STP) at Bowraville, but this does not have a license to discharge to the Nambucca River.

There were three sites located in the freshwater reach of the Nambucca River (Figure 3.7). NAMB8 (Plate 3.1) is a planform controlled, meandering, fine-grained channel in a partially confined valley setting located 36.3km upstream of NAMB7. NAMB7 (Plate 3.2) is a planform controlled, meandering, fine-grained channel in a partially confined valley setting located 11.3km upstream of NAMB6. NAMB6 (Plate 3.3) is a planform controlled, meandering, fine-grained channel in a partially confined valley setting located 12.7km upstream of NAMB5.



(a) Location of Ecohealth sites

(b) River Styles: refer to Figure 2.8 for key

(c) Landuse: refer to Figure 2.7 for key

(d) Soils: refer to Figure 2.3 for key

Figure 3.5 *The freshwater Nambucca River (North Arm) showing (a) locations of Ecohealth sites, (b) River Styles, (c) landuse, and (d) soils. Data layers from NC LLS (River Styles) and OEH (landuse and soils).*

Table 3.7 *Subcatchment description of freshwater reaches of the Nambucca River (North Arm). Data from NC LLS and OEH.*

Variable	Subcatchment composition
Area	172.4 km^2
Geology	98.7% slate, phyllite, schist, 0.7% alluvium, 0.6% basalt
Soils	38.4% Dermosols, 30.1% Kurosols, 24.9% Rudosols and Tenosols, 4.8% Tenosols (Alluvial), 0.9% Rudosols (Alluvial), 0.3% Ferrosols
River Styles	63.5% PCVS – Planform controlled, meandering, fine grained, 16.3% CVS – Headwater, 9.4% CVS – Gorge, 5.1% CVS – Floodplain pockets, sand, 3.6% PCVS – Bedrock controlled, fine grained, 1.4% PCVS – Bedrock controlled, 0.7% Water storage – dam or weir pool, 0.1% PCVS – Planform controlled, tidal
Landuse	51.2% Conservation area, 26.2% Grazing, 1.5% River and drainage system, 0.1% Horticulture, 0.1% Mining and quarrying
Major point source discharge	STP at Bowraville
Tree Cover	72%

Plate 3.1 *Site NAMB8 in the upper freshwater Nambucca River (North Arm) upstream of Girralong (looking upstream).*

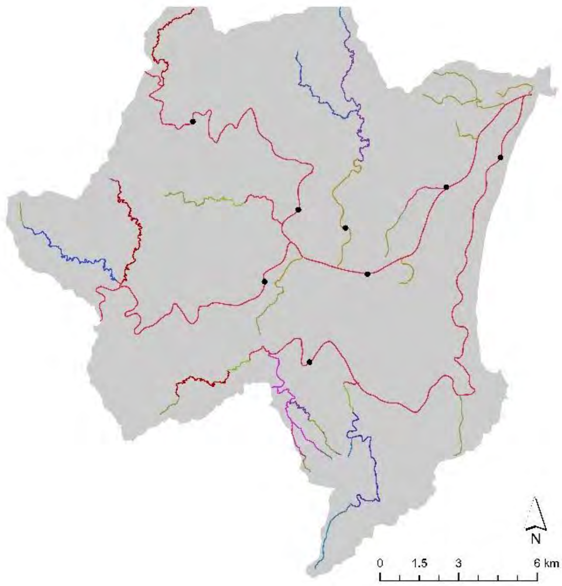
Plate 3.2 *Site NAMB7 in the freshwater Nambucca River (North Arm) upstream of the confluence with Missabotti Creek (looking downstream).*

Plate 3.3 *Site NAMB6 in the lower freshwater Nambucca River (North Arm) upstream of Girralong (looking upstream).*

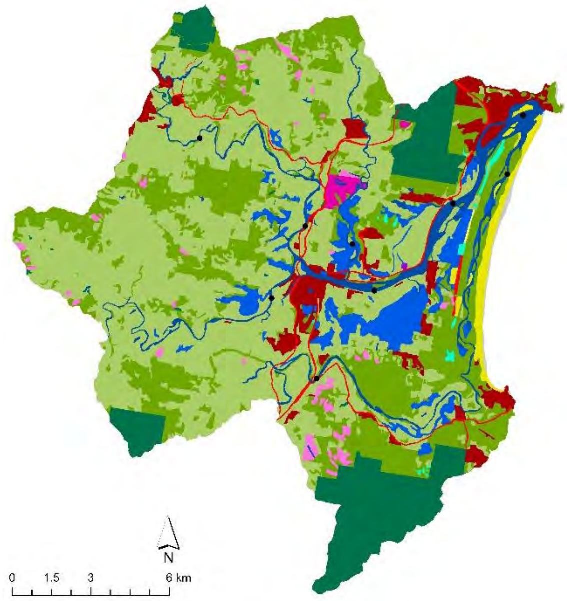
The dominant landuse in the coastal Nambucca subcatchment (that includes the Nambucca Estuary, Newee Creek and Warrell Creek estuary) is grazing (45%) followed by conservation areas (11%, Figure 3.6). The Nambucca Estuary has a small sewerage treatment plant at Macksville and Nambucca Heads, but neither are licensed to discharge to the estuary at any time (Table 3.8).

There were five sites located in the estuarine reach of the Nambucca River (Figure 3.6). NAMB5 (Plate 3.4) is a planform controlled, tidal channel in a partially confined valley setting located at the tidal limit, 10.2km upstream of NAMB4. NAMB4 (Plate 3.5) is a planform controlled, tidal channel in a partially confined valley setting located in the mid estuary 4.9km upstream of NAMB3. NAMB3 (Plate 3.6) is a planform controlled, tidal channel in a partially confined valley setting located in the lower estuary 4.8km upstream of NAMB2. NAMB2 (Plate 3.7) is a planform controlled, tidal channel in a partially confined valley setting located in the lower estuary 4.5km upstream of NAMB1. NAMB1 (Plate 3.8) is a planform controlled, tidal channel in a partially confined valley setting located in the lower estuary 700m upstream of the mouth of the Nambucca River.

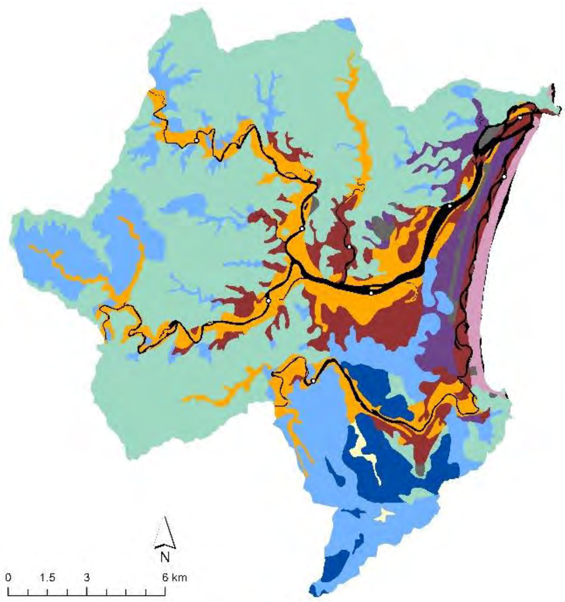
(a) Location of Ecohealth sites



(b) River Styles: refer to Figure 2.8 for key



(c) Landuse: refer to Figure 2.7 for key



(d) Soils: refer to Figure 2.3 for key

Figure 3.6 *The Nambucca Estuary showing (a) locations of Ecohealth sites, (b) River Styles, (c) landuse, and (d) soils. Data layers from NC LLS (River Styles) and OEH (landuse and soils).*

Table 3.8 *Subcatchment description of the Nambucca estuary. Data from NC LLS and OEH.*

Variable	Subcatchment composition
Area	253.2 km^2
Geology	49.7% Slate, phyllite, schist, 26.0% Alluvium, 17.6% slaty siltstone, 6.1% monzogranite, 0.7% sandstone, mudstone
Soils	46.9% Kurosols, 18.5% Dermosols, 11.5% Tenosols (Alluvial), 8.2% Hydrosols, 4.4% Rudosols and Tenosols, 3.6% Podosols, 1.7% Rudosols, 0.3% Rudosols (Alluvial)
River Styles	42.6% PCVS – Planform controlled, tidal, 10.6% SMG – Valley fill, fine grained, 9.7% PCVS – Planform controlled, meandering, fine grained, 8.5% LUV CC – Tidal, 6.1% PCVS – Planform controlled, meandering, gravel, 4.3% SMG – Cut and fill, 4.0% CVS – Floodplain pockets, sand, 3.6% PCVS – Planform controlled, low sinuosity, gravel, 3.0% CVS – Headwater, 2.7% PCVS – Bedrock controlled, sand, 1.8% LUV CC – Channelised fill, 0.7% Dam or weir pool
Landuse	45.1% Grazing, 10.6% Conservation, 5.4% Wetland, 4.8% Urban, 4.3% River and drainage system, 1.4% Transport and other corridors, 1.2% Horticulture
Major point source discharge	STP at Macksville
Tree Cover	36.3%

Plate 3.4 *Site NAMB5 in the upper Nambucca estuary downstream of the confluence with South Creek (looking upstream).*

Plate 3.5 *Site NAMB4 in the mid Nambucca estuary upstream of the confluence with Taylors Arm (looking downstream).*

Plate 3.6 *Site NAMB3 in the lower Nambucca estuary downstream of the confluence with South Creek (looking upstream).*

Plate 3.7 *Site NAMB2 in the mid Nambucca estuary upstream of the confluence with Taylors Arm (looking downstream).*

Plate 3.8 *Site NAMB1 in the lower Nambucca estuary upstream of the confluence with Warrell Creek (looking downstream).*

3.2.2 Geomorphic condition

NAMB 8

The geomorphic River Style at Nambucca River 8 is a planform controlled, meandering, fine-grained channel in a partially confined valley setting. NAMB8 drains 20.3km of stream network, predominantly headwater streams in good geomorphic condition. However, NAMB8 is located midway in an 11km reach assessed as being in poor geomorphic condition overall (Alluvium 2012). The bed sediments at NAMB8 comprised an open framework of subangular cobbles with <5% fine sediments. There were small pockets of active bed erosion due to scour downstream of the causeway. Banks comprised fine sediments with gravel. There was moderate (5-10m) erosion on both banks, minor (<5m) undercutting on the left bank and minor (<5m) slumping on the right bank. There was significant (10-20m) of exposure of tree roots on both banks, but this was evenly distributed along both banks and comprised small proportions of each individual root mass immediately above the low flow channel. NAMB8 scored 84, a B for BANK CONDITION and 87, a B+, for BED CONDITION. The overall geomorphic condition for NAMB8 was 85, a grade of B+.

In summary, NAMB8 was assessed as being in good geomorphic condition, with scour immediately downstream the causeway the most significant issue for site-level geomorphic condition. The desktop GIS assessment of subcatchment geomorphic condition found the freshwater reaches of the Nambucca River (North Arm) to be in moderate condition with a grade of C-. The geomorphic condition at NAMB8 was above the subcatchment average.

NAMB 7

The geomorphic River Style at Nambucca River 7 is also a planform controlled, meandering, fine-grained channel in a partially confined valley setting. NAMB7 drains 81.3km of stream network, with 24.7km of the dominant River Style (planform controlled, meandering, fine-grained channel) assessed as being in poor condition (Alluvium 2012). The bed sediments at NAMB7 comprised a contact framework of rounded pebbles filled with a matrix of 5-32% fine sediments. Pugging from cattle was very significant at NAMB7 (Plate 3.10). Banks comprised fine sediments. There were severe pugging, trampling and slumping (<20m) on both banks from heavy cattle access. NAMB7 scored 58, a D+ for BANK CONDITION and 60, a C-, for BED CONDITION. The overall geomorphic condition for NAMB8 was 59, a grade of D+.

In summary, NAMB7 was assessed as being in poor geomorphic condition, with cattle pugging and compaction of banks and the streambed the most significant current issue for site-level geomorphic condition. The geomorphic condition at NAMB7 (D+) was slightly below the subcatchment average of C-.

NAMB 6

The geomorphic River Style at Nambucca River 6 is a planform controlled, meandering, fine-grained channel in a partially confined valley setting. NAMB6 drains 129.2km of stream network, with 56.9km of the dominant River Style (planform controlled, meandering, fine-grained channel) assessed as being in poor condition (Alluvium 2012). The bed sediments at NAMB6 comprised a dilated framework of rounded pebbles with 32-60% fine sediments. Pugging from cattle was also significant at NAMB6 on the right bank and streambed (Plate 3.11). The reach contained significant quantities of large woody debris, including a cross-spanning trunk that comprises a significant geomorphic control, stabilizing the immediate upstream bed sediments. Scour around these large wood pieces also maintains topographic complexity and pool refugia for aquatic fauna. Banks comprised fine sediments. The right bank had significant (10-20m) slumping and moderate (5-10m) undercutting and active erosion from cattle tracks. NAMB6 scored 64, a C- for BANK CONDITION and 57, a D+, for BED CONDITION. The overall geomorphic condition for NAMB6 was 60, a grade of C-.

In summary, NAMB6 was assessed as being in moderate geomorphic condition, erosion from stock access on the right bank the most significant current issue for site-level geomorphic condition. The geomorphic condition at NAMB6 was equal to the subcatchment average.

NAMB 5

The geomorphic River Style at Nambucca River 5 is a planform controlled, tidal channel in a partially confined valley setting. NAMB5 drains 246.4km of stream network, with 103.1km of the dominant River Style (planform controlled, meandering, fine-grained channel) assessed as being in poor condition (Alluvium 2012). The bed sediments at NAMB5 comprised a framework of rounded pebbles dominated by a matrix of >60% fine sediments. Banks comprised fine sediments. There was severe (20-100m) undercutting and slumping on the left bank, and significant (10-20m) undercutting with severe (20-100m) slumping on the right bank. Both banks were grazed by cattle with erosion from cattle tracks particularly apparent on the left bank. Undercutting of banks was consistently present in the intertidal zone through the reach and likely due to tidal action. NAMB5 scored 48, a D- for BANK CONDITION. The overall geomorphic condition for NAMB5 was 48, a grade of D-.

In summary, NAMB5 was assessed as being in poor geomorphic condition, with cattle pugging and compaction of banks and the streambed the most significant current issue for site-level geomorphic condition. The geomorphic condition at NAMB5 (D-) was below the subcatchment average of C for the Nambucca estuary.

NAMB 4

The geomorphic River Style at Nambucca River 4 is a planform controlled, tidal channel in a partially confined valley setting. NAMB4 drains 256.6km of stream network. As well as the 103.1km of planform controlled, meandering, fine grained channel in poor condition, 14.8km of the upper estuary (planform controlled, tidal channel) upstream of NAMB4 is also considered to be in poor condition (Alluvium 2012). The bed and bank at NAMB4 comprised fine sediments (silty sand). There was severe (20-100m) active erosion in the intertidal zone on the right bank, likely due to historic gravel extraction causing widespread bed lowering and bank incision, the combination of cattle trampling and grazing reducing vegetation cover, and wave wash on the fine bank sediments. The downstream end of the left bank comprised rock revetment. NAMB4 scored 74, a C+ for BANK CONDITION. The overall geomorphic condition for NAMB5 was 74, a grade of C+.

In summary, NAMB4 was assessed as being in moderate geomorphic condition, with cattle trampling and removal of vegetation cover on fine-grained bank sediments the most significant issue for site-level geomorphic condition. The geomorphic condition at NAMB4 (C+) was slightly above the subcatchment average of C for the Nambucca estuary.

NAMB 3

The geomorphic River Style at Nambucca River 3 is a planform controlled, tidal channel in a partially confined valley setting. NAMB3 drains 590.9km of stream network, of which 191.2km is considered to be in poor geomorphic condition (Alluvium 2012). The bed and bank at NAMB3 comprised fine sediments (silty sand). There was minor (<5m) active erosion and minor (<5m) exposed tree roots in the intertidal zone on the right bank, likely due to wave action on the fine bank sediments. NAMB3 scored 88, a B+ for BANK CONDITION. The overall geomorphic condition for NAMB3 was 88, a grade of B+.

In summary, NAMB3 was assessed as being in good geomorphic condition, with minor bank erosion in the intertidal zone from wave action the most significant issue for site-level geomorphic condition. The geomorphic condition at NAMB3 (B+) was above the subcatchment average of C for the Nambucca estuary.

NAMB 2

The geomorphic River Style at Nambucca River 2 is a planform controlled, tidal channel in a partially confined valley setting. NAMB2 drains 604.4km of stream network, of which 191.5km is considered to be in poor geomorphic condition (Alluvium 2012). The bank at NAMB2 comprised fine sediments with the bed consisting of sand. There was moderate (5-10m) active erosion, minor (<5m) slumping and minor (<5m) exposed tree roots in the intertidal zone on the left bank, likely due to trampling and grazing of vegetation cover by cattle and wave action on the fine bank sediments. NAMB2 scored 82, a B for BANK CONDITION. The overall geomorphic condition for NAMB2 was 82, a grade of B.

In summary, NAMB2 was assessed as being in good geomorphic condition, with minor bank erosion in the intertidal zone from cattle trampling and wave action the most significant issue for site-level geomorphic condition. The geomorphic condition at NAMB2 (B) was above the subcatchment average of C for the Nambucca estuary.

NAMB 1

The geomorphic River Style at Nambucca River 1 is a planform controlled, tidal channel in a partially confined valley setting. NAMB1 drains 801.6km of stream network (the entire Nambucca catchment), of which 202.5km is considered to be in poor geomorphic condition (Alluvium 2012). The left bank at NAMB1 comprised rock revetment and the right bank comprised marine sand with the bed consisting of marine sand. NAMB1 scored 88, a B+ for BANK CONDITION. The overall geomorphic condition for NAMB1 was 88, a grade of B+.

In summary, NAMB1 was assessed as being in good geomorphic condition, with rock revetment controlling erosion on the left bank the entire 100m length of the site. The soft sediments that comprise the right bank are constantly reworked but are primarily affected by depositional processes. The geomorphic condition at NAMB1 (B+) was above the subcatchment average of C for the Nambucca estuary.

Nambucca River (North Arm)

Overall, the mid freshwater reaches and upper estuary are in the poorest geomorphic condition. However, both these reaches are considered to have low potential for recovery (Alluvium 2012). Fencing of riparian zones and revegetation to increase root mass and in turn, bank strength, would still improve bank condition in the long term. This is particularly so in the upper estuary (NAMB5) where active erosion occurring on steep banks may also require additional bank protection measures. The 11km reach in poor geomorphic condition surrounding NAMB8 has a moderate potential for recovery. Riparian improvement works in this reach would be beneficial both to this reach and the 17.4km reach in moderate condition immediately downstream.

3.2.3 Riparian condition

NAMB 8

Site: The original riparian vegetation community at Nambucca River 8 (NAMB8, Plate 3.9) was described as 'Riparian subtropical rainforest with River Oak emergents on lowland creek flats' (NAM_RF05), a listed TEC (OEH 2015), grading into 'Flooded Gum moist open forest of sheltered lower slopes and gullies' (NAM_WSF01). NAMB8 received a moderate riparian condition score of 62.9, a grade of C- (Table 3.9).

Dominant Species: The dominant canopy species present were the native species River Oak (*Casuarina cunninghamiana* subsp. *cunninghamiana*), Flooded Gum (*Eucalyptus grandis*), Brush Box (*Lophostemon confertus*), White Cedar (*Melia azedarach*) and Bangalow Palm (*Archontophoenix cunninghamiana*). Dominant native midstory species included Hickory Wattle (*Acacia implexa*), Cheese Tree (*Glochidion fernandi*) and Sandpaper Fig (*Ficus coronata*) and Elderberry (*Cuttsia virburnea*), along with the exotic species Wild Tobacco (*Solanum mauritianum*), Lantana (*Lantana camara*) and Senna (*Senna pendula* var*. glabrata*). The understory was dominated by native species Harsh Ground Fern (*Hypolepis muelleri*), Soft Lomandra (*Lomandra hystrix*), Dusky Coral Pea (*Kennedia rubicunda*), Knotweed species (*Persicaria strigosa*, *P.hydropiper, P.orientalis*), Couch (*Cynodon dactylon*) and Australian Basket Grass (*Oplismenus aemulus*), along with exotic species Mistflower (*Ageratina riparia*), Crofton Weed (*Ageratina adenophora*), Taro (*Calocasia esculenta*), Blue Billy Goat Weed (*Ageratum houstonianum*), Peppermint (*Mentha* x *rotundifolia*), Umbrella Sedge (*Cyperus eragrostis*), Wandering Jew (*Tradescantia fluminensis*), Paspalum species (*Paspalum mandiocanum* and *P.dilatatum*) and Pigeon Grass (*Setaria sphacelata*). Dominant vine species included Cissus species (*Cissus antarctica* and *C.hypoglauca*), Native Raspberry (*Rubus rosifolius*) and the exotic species Common Passionfruit (*Passiflora* sp.). The macrophyte layer included Water Primrose (*Ludwidgia peploides*), Water Couch (*Paspalum distichum*), Pennywort (*Hydrocotyle tripartita*) and the exotic species Salvinia (*Salvinia molesta*).

Noxious weed species: Noxious weed species observed on-site were Lantana (*Lantana camara*), Senna (*Senna pendula* var*. glabrata*), Mistflower (*Ageratina riparia*), Crofton Weed (*Ageratina adenophora*), Green Cestrum (*Cestrum parqui*), Wandering Jew (*Tradescantia fluminensis*) and Salvinia (*Salvinia molesta*).

Summary: Nambucca River 8 was a moderately disturbed closed-forest system with a mixed-aged native canopy and a mix of native and exotic species throughout the midstory and understory structural layers in a partially cleared, predominantly forested rural landscape. The surrounding landuse was a mix of agricultural grazing land, private forested land and state forest, beyond which was National Park. Significant remnant stands of vegetation surround the site on private land, 500m to the north and 1km to the south in Oaky State Forest and 2.5km to the southeast in Gumbaynggirr National Park. Representative elements of the remnant vegetation community were present in all of the structural layers, with NAMB8 scoring well for Habitat and Cover subindices and moderately for Native Species, Debris and Management subindices (Table 3.9). Riparian condition was affected by reduced riparian vegetation width and continuity and the prevalence and regeneration of weed and noxious weed species throughout the midstory and understory structural layers. Reduced levels of cover in the canopy and midstory, reduced levels of fringing vegetation, limited habitat trees and large woody debris and historic land clearing also contributed to the reduction in riparian grade at this site.

Plate 3.9 *Riparian vegetation condition at NAMB8 was considered to be a moderately disturbed system. This was primarily due to reduced riparian width and continuity, the dominance of weed and noxious weed species throughout the midstory and understory structural layers, low levels of large woody debris, historic land clearing and reduced habitat trees.*

Table 3.9 *Site-level assessments of riparian condition in 2016-17 at NAMB8 showing scores for the five subindices and their individual indicators that comprise the Vegetation Condition Index.*

Nambucca River 8	Scores
HABITAT	**15.2/20**
Channel width	2.7
Proximity	3
Continuity	2.5
Layers	4
Large native trees	2
Hollow-bearing trees	1
NATIVE SPECIES	**11.8/20**
Native canopy species	4
Native midstory species	1.8
Native herb/forb species	1.3
Native graminoid species	1.8
Native macrophyte species	3
SPECIES COVER	**15.5/20**
Canopy species	2.5
Midstory species	3
Herb/forb species	4
Graminoid species	4
Macrophyte species	2
DEBRIS	**10/20**
Total leaf litter	3
Native leaf litter	2
Dead trees standing	2
Dead trees fallen	0
Lying logs	1
Fringing vegetation	2
MANAGEMENT	**10.5/20**
Tree clearing	1.5
Fencing	2
Animal impact	1
Canopy Health	2
Exposed tree roots	3
Native woody regeneration	1
Weedy woody regeneration	0
TOTAL	**62.9/100**

NAMB 7

Site: The original riparian vegetation community at Nambucca 7 (NAMB7, Plate 3.10) was described as 'Gallery Silver Weeping Tea-tree shrubland' (an unrecognised Nambucca vegetation community), grading into 'River Oak grassy open forest along larger rivers' (NAM_FW01) and 'Flooded Gum shrubby moist forest of sub-coastal lowlands' (NAM_WSF04) and an invading exotic vegetation community of 'Camphor Laurel, Lantana and Privet' (NAM_EX02-03-04). NAMB7 received a low riparian condition score of 50.8, a grade of D (Table 3.10).

Dominant Species: The dominant canopy species present were the native species River Oak (*Casuarina cunninghamiana* subsp. *cunninghamiana*), Eucalyptus species (*Eucalyptus grandis* and *E.tereticornis*) and the exotic species Camphor Laurel (*Cinnamomum camphora*). Dominant native midstory species included Silver Weeping Tea Tree (*Leptospermum brachyandrum*), Sandpaper Fig (*Ficus coronata*), and Brush Cherry (*Syzygium australe*) along with the exotic species Lantana (*Lantana camara*), Small-leaved Privet (*Ligustrum sinense*) and Wild Tobacco (*Solanum mauritianum*). The understory was dominated by native species Stinging Nettle (*Urtica incisa*), Soft Lomandra (*Lomandra hystrix*), Scurvy Weed (*Commelina cyanea*), Knotweeds (*Persicaria stigosa* and *P.hydropiper*), Couch (*Cynodon dactylon*) and Blady Grass (*Imperata cylindrica*), along with exotic species Purple Top (*Verbena bonariensis*), Blue Billy Goat Weed (*Ageratum houstonianum*), Cleavers (*Galium aparine*), Pigeon Grass (*Setaria sphacelata*), Paspalum species (*Paspalum dilatatum* and *P.mandiocanum*) and Summer Grass (*Digitaria* sp.). Dominant vine species included the two native species Cockspur Thorn (*Maclura cochinchinensis*), Native Raspberry (*Rubus rosifolius*), while the macrophyte layer included Freshwater Eelgrass (*Vallisneria nana*) and Varied Water-milfoil (*Myriophyllum verrucosum*).

Noxious weed species: Noxious weed species observed on-site were Camphor Laurel (*Cinnamomum camphora*), Cockspur Coral Tree (*Erythrina crista-galli*), Lantana (*Lantana camara*), Small-leaved Privet (*Ligustrum sinense*), Fireweed (*Senecio madagascariensis*), Mexican Poppy (*Argemone mexicana*) and Salvinia (*Salvinia molesta*).

Summary: Nambucca River 7 was a highly disturbed closed-forest system with a partially remnant/mixed-aged canopy of native and exotic species throughout all structural layers, in a predominantly cleared, partially forested rural landscape. The surrounding landuse was agricultural grazing land beyond which was forested private land and State Forest. Significant remnant stands of vegetation lie 800m west and 1km south on private land. Representative elements of the remnant vegetation community were retained in all of the structural layers, with NAMB7 scoring moderately for Habitat, Cover and Debris subindices and poorly for Native Species and Management subindices (Table 3.10). Riparian condition was affected by poor habitat connectivity, reduced riparian vegetation width and disrupted continuity and the prevalence and regeneration of weed and noxious weed species throughout all structural layers, particularly in the canopy of both the River Oak and Flooded Gum vegetation communities (NAM_FW01 and NAM_WSF04). Reduced levels of cover in the canopy, exposed tree roots, reduced levels of large woody debris and inadequate riparian fencing and animal impact also contributed to the reduction in riparian grade at this site.

Plate 3.10 *Riparian vegetation condition at NAMB7 was low and considered to be highly disturbed. This was primarily due to poor habitat connectivity, the dominance of weed and noxious weed species throughout all structural layers and the presence of livestock throughout the riparian zone.*

Table 3.10 *Site-level assessments of riparian condition in 2016-17 at NAMB7 showing scores for the five subindices and their individual indicators that comprise the Vegetation Condition Index.*

Nambucca River 7	Scores
HABITAT	**12/20**
Channel width	2
Proximity	1
Continuity	2
Layers	4
Large native trees	2
Hollow-bearing trees	1
NATIVE SPECIES	**7.5/20**
Native canopy species	1.5
Native midstory species	2
Native herb/forb species	1
Native graminoid species	1
Native macrophyte species	2
SPECIES COVER	**14/20**
Canopy species	1
Midstory species	3
Herb/forb species	4
Graminoid species	4
Macrophyte species	2
DEBRIS	**10.8/20**
Total leaf litter	2
Native leaf litter	1.5
Dead trees standing	2
Dead trees fallen	1
Lying logs	1.5
Fringing vegetation	2.5
MANAGEMENT	**6.5/20**
Tree clearing	2
Fencing	1
Animal impact	0
Canopy Health	1.5
Exposed tree roots	1
Native woody regeneration	1
Weedy woody regeneration	0
TOTAL	**50.8/100**

NAMB 6

Site: The original riparian vegetation community at Nambucca River 6 (NAMB6, Plate 3.11) was described as 'River Oak grassy open forest along larger rivers' (NAM_FW01) grading into 'Flooded Gum moist open forest of sheltered lower slopes and gullies' (NAM_WSF01). NAMB5 received a low riparian condition score of 57.3, a grade of D+ (Table 3.11).

Dominant Species: The dominant canopy species present were the native species River Oak (*Casuarina cunninghamiana* subsp. *cunninghamiana*), Flooded Gum (*Eucalyptus grandis*), Watergum (*Tristaniopsis laurina*), White Cedar (*Melia azedarach*) along with the exotic species Camphor Laurel (*Cinnamomum camphora*) and Willow (*Salix* sp.). Dominant native midstory species included Silver Weeping Tea Tree (*Leptospermum brachyandrum*), Brush Kurrajong (*Commersonia fraseri*) and Wattles (*Acacia irrorata* and *A.implexa*.), along with the exotic species Lantana (*Lantana camara*), Small-leaved Privet (*Ligustrum sinense*), Wild Tobacco (*Solanum mauritianum*) and Mickey-mouse Plant (*Ochna serrulata*). The understory was dominated by native species Soft Lomandra (*Lomandra hystrix*), Common Bracken (*Pteridium esculentum*), Knotweeds (*Persicaria stigosa*, *P.hydropiper* and *P.decipiens*), Couch (*Cynodon dactylon*), along with exotic species Sidratusa (*Sida rhombifolia*), Blue Billy Goat Weed (*Ageratum houstonianum*), Coblers Pegs (*Bidens pilosa*), Cleavers (*Galium aparine*), Broadleaf Paspalum (*Paspalum mandiocanum*) and Torpedo Grass (*Panicum repens*). Dominant vine species included the two exotic species Morning Glory (*Ipomoea indica*), Japanese Honeysuckle (*Lonicera japonica*), while a rich macrophyte layer included Potomogeton (*Potomogeton ochtandrus*), Freshwater Eelgrass (*Vallisneria nana*), Water Primrose (*Ludwidgia peploides*) and the exotic species Giant Water Lily (*Nymphaea* sp.).

Noxious weed species: Noxious weed species observed on-site were Camphor Laurel (*Cinnamomum camphora*), Willow (*Salix* sp.), Lantana (*Lantana camara*), Small-leaved Privet (*Ligustrum sinense*), Mickey-mouse Plant (*Ochna serrulata*), Noogoora Burr (*Xanthium occidentale*), Fireweed (*Senecio madagascariensis*), Wandering Jew (*Tradescantia fluminensis*) and Mexican Poppy (*Argemone* sp.).

Summary: Nambucca River 6 was a highly disturbed open-to-closed forest system with a partially remnant/mixed-aged canopy of native and exotic species throughout all structural layers, in a predominantly cleared, partially forested rural landscape. The surrounding landuse was primarily dairy country, beyond which was agricultural grazing country, State Forest and forested private land. Significant remnant stands of vegetation lie 1.5km to the east in Viewmont State Forest. Representative elements of the remnant vegetation community were present in the canopy but sparse in other structural layers, with NAMB6 scoring well for the Cover subindex, moderately for Habitat and Debris and poorly for Native Species and Management subindices (Table 3.11). Riparian condition was affected by poor riparian vegetation width, habitat connectivity and disrupted continuity and the prevalence and regeneration of weed and noxious weed species throughout all structural layers. Reduced levels of cover in the canopy and midstory, particularly in the river Oak vegetation community (NAM_FW01), reduced levels of large woody debris and inadequate riparian fencing and animal impact also contributed to the reduction in riparian grade at this site.

Plate 3.11 *Riparian vegetation condition at NAMB5 was low and considered to be a highly disturbed system. This was primarily due to poor riparian width, continuity and habitat connectivity, the dominance of weed and noxious weed species throughout all structural layers, reduced cover in the canopy and midstory and the presence of livestock throughout the riparian zone.*

Table 3.11 *Site-level assessments of riparian condition in 2016-17 at NAMB6 showing scores for the five subindices and their individual indicators that comprise the Vegetation Condition Index.*

Nambucca River 6	Scores
HABITAT	**10.3/20**
Channel width	1.3
Proximity	0
Continuity	2
Layers	4
Large native trees	2
Hollow-bearing trees	1
NATIVE SPECIES	**8.5/20**
Native canopy species	2
Native midstory species	1.5
Native herb/forb species	2
Native graminoid species	1
Native macrophyte species	2
SPECIES COVER	**17/20**
Canopy species	2.5
Midstory species	2.5
Herb/forb species	4
Graminoid species	4
Macrophyte species	4
DEBRIS	**12.5/20**
Total leaf litter	2.5
Native leaf litter	2
Dead trees standing	0
Dead trees fallen	1
Lying logs	4
Fringing vegetation	3
MANAGEMENT	**9/20**
Tree clearing	2.5
Fencing	1
Animal impact	0
Canopy Health	1.5
Exposed tree roots	3
Native woody regeneration	1
Weedy woody regeneration	0
TOTAL	**57.3/100**

NAMB 5

Site: The original riparian vegetation community at Nambucca River 5 (NAMB5, Plate 3.12) was described as 'Swamp Oak forested wetland of saline areas of coastal estuaries' (NAM_ForW01) grading into 'Riparian subtropical rainforest with River Oak emergents on lowland creek flats' (NAM_RF05), both recognised recognised TEC's (OEH 2015). NAMB5 received a poor riparian condition score of 45.5, a grade of D- (Table 3.12).

Dominant Species: The dominant canopy species present were the native species Swamp Oak (*Casuarina glauca*), Silky Oak and the exotic species Camphor Laurel (*Cinnamomum camphora*). Dominant native midstory species included Sydney Golden Wattle (*Acacia longifolia* subsp. *longifolia*), Sandpaper Fig (*Ficus coronata*), Cheese Tree (*Glochidion fernandi*), along with the exotic species Lantana (*Lantana camara*), Wild Tobacco (*Solanum mauritianum*), Small-leaved Privet (*Ligustrum sinense*), Castor Oil Plant (*Ricinus communis*), Mickey-mouse Plant (*Ochna serrulata*). The understory was dominated by native species Swamp Dock (*Rumex brownii*), Gristle Fern (*Blechnum cartilagenum*), Hairy Knotweed (*Persicaria stigosa*), Pademelon Grass (*Ottochloa gracillima*) and Rice Grass (*Microlaena stipoides*), along with exotic species Fireweed (*Senecio madagascariensis*), Blue Billy Goat Weed (*Ageratum houstonianum*), Wandering Jew (*Tradescantia fluminensis*), Buffalo Grass (*Stenotaphrum secundatum*), Broadleaf Paspalum (*Paspalum mandiocanum*) and Pigeon Grass (*Setaria sphacelata*). Dominant vine species included Silkpod (*Parsonnsia* spp.), Cockspur Thorn (*Maclura cochinchinensis*), and the exotic species Balloon Vine (*Cardiospermum grandiflorum*). A brackish macrophyte layer included Water Couch (*Paspalum distichum*), Blunt Pondweed (*Potomogeton ochreatus*), Broadleaf Cumbungi (*Typha orientalis*), Freshwater Eelgrass (*Vallisneria nana*) and Common Reed (*Phragmites australis*).

Noxious weed species: Noxious weed species observed on-site were Camphor Laurel (*Cinnamomum camphora*), Lantana (*Lantana camara*), Small-leaved Privet (*Ligustrum sinense*), Castor Oil Plant (*Ricinus communis*), Mickey-mouse Plant (*Ochna serrulata*), Fireweed (*Senecio madagascariensis*), Wandering Jew (*Tradescantia fluminensis*) and Balloon Vine (*Cardiospermum grandiflorum*).

Summary: Nambucca River 5 was a very highly disturbed open-to-closed forest system with a partially remnant/mixed-aged canopy and a mix of native and exotic species throughout all structural layers in a predominantly cleared, partially forested rural landscape. The surrounding landuse was agricultural grazing land beyond which was urban settlement and forested private land. Significant remnant stands of vegetation lie in private land 400m, 1km and 1.3km north and 1km south. Representative elements of the remnant vegetation community were present in the canopy structural layer of the Swamp Oak (NAM_ForW01) and in the midstory structural layers of the Riparian Rainforest Community (NAM_RF05) but devoid or sparse in other structural layers of both communities. NAMB5 scored moderately for Cover and Debris subindices and poorly for Habitat, Native Species and Management subindices (Table 3.12). Riparian condition was affected by poor riparian vegetation width, disrupted continuity and habitat connectivity and the dominance and regeneration of weed and noxious weed species, particularly throughout all structural layers of the Riparian Rainforest Community (NAM_RF05). Cover levels were reduced particularly in the midstory of the Swamp Oak vegetation community (NAM_ForW01) and in the understory of the Riparian Rainforest Community (NAM_RF05), while limited native non-woody debris and fringing vegetation, reduced canopy health in the Swamp Oak vegetation community (NAM_ForW01) and inadequate riparian fencing and animal impact also contributed to the reduction in riparian grade at this site.

Plate 3.12 *Riparian vegetation condition at NAMB5 was considered to be a very highly disturbed system. This was primarily due to poor riparian width, continuity and connectivity, the dominance of weed and noxious weed species throughout several structural layers, reduced vegetation cover and the presence of livestock throughout the riparian zone.*

Table 3.12 *Site-level assessments of riparian condition in 2016-17 at NAMB5 showing scores for the five subindices and their individual indicators that comprise the Vegetation Condition Index.*

Nambucca River 5	Scores
HABITAT	**9/20**
Channel width	1
Proximity	1
Continuity	0.5
Layers	3.5
Large native trees	2
Hollow-bearing trees	1
NATIVE SPECIES	**7.3/20**
Native canopy species	1.3
Native midstory species	0.8
Native herb/forb species	0.5
Native graminoid species	0.8
Native macrophyte species	4
SPECIES COVER	**11/20**
Canopy species	3
Midstory species	2.5
Herb/forb species	1
Graminoid species	2.5
Macrophyte species	2
DEBRIS	**10.8/20**
Total leaf litter	2.5
Native leaf litter	1.3
Dead trees standing	2
Dead trees fallen	2
Lying logs	2
Fringing vegetation	1
MANAGEMENT	**7.5/20**
Tree clearing	2.5
Fencing	1
Animal impact	1
Canopy Health	1
Exposed tree roots	2
Native woody regeneration	0
Weedy woody regeneration	0
TOTAL	**45.5/100**

NAMB 4

Site: The original riparian vegetation community at Nambucca River 4 (NAMB4, Plate 3.13) was described as 'Grey Mangrove - River Mangrove low open or closed forest or shrubland of intertidal flats' (NAM_ForW01), grading into 'Prickly Couch – Sea Rush – Saltwater Couch saltmarsh of saline coastal swamps and flats' (NAM_SW01) and 'Swamp Oak forested wetland of saline areas of coastal estuaries' (NAM_ForW01), the latter two communities both recognised as TEC's (OEH 2015). NAMB4 received a low riparian condition score of 57.3, a grade of D (Table 3.13).

Dominant Species: The dominant canopy species present were the native species River Mangrove (*Aegiceras corniculatum*), Grey Mangrove (*Avicennia marina* subsp. *australasica*), Swamp Oak (*Casuarina glauca*) and Broad-leaved Paperbark (*Melaleuca quinquenervia*). Dominant native midstory species included included juvenile mangrove species, Tuckeroo (*Cupaniopsis anacardioides*), Green Bolly Gum (*Neolitsea australiensis*) and Cheese Tree (*Glochidion fernandi*). The understory was dominated by the native grass species Couch (*Cynodon dactylon*), exotic species Fireweed (*Senecio madagascariensis*), Sidratusa (*Sida rhombifolia*), Broadleaf Paspalum (*Paspalum mandiocanum*) and Prairie Grass (*Bromus catharticus*) and an estuarine macrophyte layer which included Sea Rush (*Juncus krausii* subsp. *australiensis*) and Sand Couch (*Sporobolus virginicus* var. *virginicus*). The only vine species present was Silkpod (*Parsonnsia* spp.).

Noxious weed species: One noxious weed species, Fireweed (*Senecio madagascariensis*), was observed on-site.

Summary: Nambucca River 4 was a highly disturbed open-saltmarsh/closed-forest system with a partially remnant canopy, native species throughout the midstory layer and mixed native and exotic species throughout understory layer, in a predominantly cleared, partially forested rural floodplain landscape. The surrounding landuse was agricultural grazing land. Significant remnant stands of vegetation lie between 700-900m east-southeast in Newee Creek Swamp, 400m northeast and 700m west in privately owned wetland parcels, all previously recognised as either 'suitable for environmental protection' or 'unprotected significant habitat' (BMT, 2008). Representative elements of the remnant vegetation community were retained in all of the structural layers, although scarce in the understory, with NAMB4 scoring moderately for the Habitat, Native Species, Cover and Debris subindices and poorly for the Management subindex (Table 3.13). Riparian condition was affected by poor riparian vegetation width, habitat connectivity and disrupted continuity, the presence and regeneration of weed and noxious weed species in the midstory and understory structural layers and reduced levels of cover throughout all structural layers in each of the three vegetation communities. Limited large woody debris, reduced levels of fringing vegetation, the presence of livestock throughout the riparian zone and exposed tree roots due to active bank erosion also contributed to the reduction in riparian grade at this site.

***Plate 3.13** Despite possessing some remnant canopy vegetation riparian vegetation at NAMB4 was highly disturbed. This was primarily due to poor riparian width, continuity and connectivity, reduced vegetation cover and the presence of livestock throughout the riparian zone.*

Table 3.13 *Site-level assessments of riparian condition in 2016-17 at NAMB4 showing scores for the five subindices and their individual indicators that comprise the Vegetation Condition Index.*

Nambucca River 4	Scores
HABITAT	**11.8/20**
Channel width	0.3
Proximity	1
Continuity	2.5
Layers	4
Large native trees	2
Hollow-bearing trees	2
NATIVE SPECIES	**14.5/20**
Native canopy species	4
Native midstory species	4
Native herb/forb species	0.5
Native graminoid species	3
Native macrophyte species	3
SPECIES COVER	**10/20**
Canopy species	1.8
Midstory species	1.3
Herb/forb species	1
Graminoid species	4
Macrophyte species	2
DEBRIS	**11.5/20**
Total leaf litter	1.5
Native leaf litter	3
Dead trees standing	1
Dead trees fallen	1
Lying logs	3
Fringing vegetation	2
MANAGEMENT	**9.5/20**
Tree clearing	3
Fencing	0
Animal impact	0
Canopy Health	1.5
Exposed tree roots	2
Native woody regeneration	1
Weedy woody regeneration	2
TOTAL	**57.3/100**

NAMB 3

Site: The original riparian vegetation community at Nambucca River 3 (NAMB3, Plate 3.14) was described as fringing 'Grey Mangrove - River Mangrove low open or closed forest or shrubland of intertidal flats' (NAM_FOR01), grading rapidly into 'Forest Red Gum – Pink Bloodwood – Grey Ironbark open forest to woodland of near-coastal hills' (NAM_DOF05). NAMB3 received a moderate riparian condition score of 65, a grade of C (Table 3.14).

Dominant species: The dominant canopy species present were the native species River Mangrove (*Aegiceras corniculatum*) and Grey Mangrove (*Avicennia marina* subsp. *australasica*), Forest Red Gum (*Eucalyptus tereticornis*), Swamp Oak (*Casuarina glauca*) and Foam Bark Tree (*Jagera pseudorhus*). Dominant native midstory species included Tuckeroo (*Cupaniopsis anacardioides*), Green Wattle (*Acacia irrorata*), Sweet Pittosporum (*Pittosporum undulatum*), Cheese Tree (*Glochidion fernandi*) and White Dogwood (*Ozothamnus diosmifolius*) along with the exotic species Lantana (*Lantana camara*), Senna (*Senna pendula* var. *glabrata*), Ground Asparagus (*Asparagus aethiopicus*) and Pompom Asparagus (*Asparagus macowanii*). The understory was dominated by native species Blue Flax-lily (*Dianella caerulea*), Spiny-headed Mat-rush (*Lomandra longifolia*), Bird's Nest fern (*Asplenium australasicum*) and Wiry Panic (*Entolasia stricta*) along with the exotic species Broadleaf Paspalum (*Paspalum mandiocanum*). Dominant vine species included the native species Lawyer Vine (*Smilax australis*) and the exotic species Coastal Morning Glory (*Ipomoea cairica*).

Noxious weed species: Noxious weed species observed on-site were Camphor Laurel (*Cinnamomum camphora*), Lantana (*Lantana camara*), Senna (*Senna pendula* var. *glabrata*) and Asparagus Fern Species (*Asparagus aethiopicus* and *A.macowanii*).

Summary: Nambucca River 3 was a moderately disturbed closed-forest system with a partially remnant canopy and a mix of native and exotic species throughout the midstory and structural layers, in a partially forested, predominantly cleared rural coastal floodplain landscape. The immediate surrounding landuse was agricultural grazing country, beyond which was privately owned forested land and urban settlement. A significant remnant stand of vegetation lies 700m to the south in the form of Gumma Swamp, a wetland area previously recognised as suitable vegetation for 'environmental protection' (BMT, 2008). Representative elements of the remnant vegetation communities were present in all of the structural layers present, with NAMB3 scoring well for the Cover subindex and moderately for Habitat, Native Species, Debris and Management subindices (Table 3.14). Riparian condition was affected by poor riparian vegetation width, disrupted continuity and habitat connectivity. The presence and regeneration of weed and noxious weed species, particularly in the understory structural layer further affected the riparian condition score. Reduced levels of cover in the macrophyte layer, poor canopy health in the adjacent Swamp Oak vegetation community (NAM_ForW01) on Goat Island, limited large woody debris and exposed roots of fringing woody vegetation also contributed to the reduction in riparian grade at this site.

***Plate 3.14** Despite possessing good vegetation cover throughout all structural layers NAMB3 was considered to be a moderately disturbed riparian system primarily due to poor riparian width and connectivity and the presence of weed and noxious weed species.*

Table 3.14 *Site-level assessments of riparian condition in 2016-17 at NAMB3 showing scores for the five subindices and their individual indicators that comprise the Vegetation Condition Index.*

Nambucca River 3	Scores
HABITAT	**10/20**
Channel width	0
Proximity	1
Continuity	2
Layers	4
Large native trees	2
Hollow-bearing trees	1
NATIVE SPECIES	**12.5/20**
Native canopy species	4
Native midstory species	3
Native herb/forb species	0.5
Native graminoid species	3
Native macrophyte species	2
SPECIES COVER	**18/20**
Canopy species	4
Midstory species	4
Herb/forb species	4
Graminoid species	4
Macrophyte species	2
DEBRIS	**13.5/20**
Total leaf litter	3
Native leaf litter	2.5
Dead trees standing	3
Dead trees fallen	1
Lying logs	1
Fringing vegetation	3
MANAGEMENT	**12/20**
Tree clearing	3
Fencing	3
Animal impact	3
Canopy Health	0
Exposed tree roots	0
Native woody regeneration	2
Weedy woody regeneration	0
TOTAL	**65/100**

NAMB2

Site: The original riparian vegetation community at Nambucca River 2 (NAMB2, Plate 3.15) was described as 'Grey Mangrove - River Mangrove low open or closed forest or shrubland of intertidal flats' (NAM_FOR01), grading into 'Saltwater Couch - Samphire saltmarsh of low-lying estuarine areas' (NAM_SW04) and 'Swamp Oak forested wetland of saline areas of coastal estuaries' (NAM_ForW01) both listed TEC's (OEH 2015). NAMB2 received a good riparian condition score of 74.2, a grade of C+ (Table 3.15).

Dominant species: The dominant canopy species present were the native species River Mangrove (*Aegiceras corniculatum*) and Grey Mangrove (*Avicennia marina* subsp. *australasica*) and Swamp Oak (*Casuarina glauca*). Dominant native midstory species included juvenile native canopy species along with the exotic species Lantana (*Lantana camara*). The understory was dominated by native species Sea Rush (*Juncus krausii* subsp. *australiensis*), Common Fringe Sedge (*Fimbristylis dichotoma*), Berry Saltbush (*Einadia hastata*), Grey Saltbush (*Atriplex australasica*) and New Zealand Spinach (*Tetragonia tetragonoides*) along with the exotic species Buffalo Grass (*Stenotaphrum secundatum*) and Broadleaf Paspalum (*Paspalum mandiocanum*). One native vine species Cockspur Thorn (*Maclura cochinchinensis*) was present along with the exotic species Coastal Morning Glory (*Ipomoea cairica*). An estuarine macrophyte layer included Marine/Sand Couch (*Sporobolus virginicus* var. *minor* or *virginicus*), Samphire (*Sarcocornia quinqueflora*), Austral Seablite (*Suaeda australis*) and Zostera (*Zostera muelleri* subsp. *capricorni*).

Noxious weed species: Noxious weed species observed on-site were Lantana (*Lantana camara*), Groundsel Bush (*Baccharis halimifolia*) and Coastal Morning Glory (*Ipomoea cairica*).

Summary: Nambucca River 2 was a mildly disturbed open-saltmarsh/closed-forest system with a partially remnant canopy, a native midstory and a mix of native and exotic species throughout the understory structural layer, in a partially forested, predominantly cleared rural coastal landscape. The immediate surrounding landuse was agricultural grazing country, beyond which was Crown and privately owned forested land, sand mining and National Park. Significant remnant stands of vegetation lie adjacent to the site's east and 900m south of the site in the form of neighbouring Crown and privately owned Land with both wetland areas having previously been recognised as 'suitable vegetation for environmental protection' (BMT WBM 2008), and 1.1km to the east in Gaagal Wanggaan (South Beach) National Park. Representative elements of the remnant vegetation communities were present in all of the structural layers present, with NAMB2 scoring well for the Native Species and Cover subindices and moderately for Habitat, Debris and Management subindices (Table 3.15). Riparian condition was affected by poor riparian vegetation width, disrupted continuity and habitat connectivity. The presence and regeneration of weed and noxious weed species, particularly in the understory structural layer further affected the riparian condition score. Reduced levels of cover in the canopy and midstory, particularly in the Swamp Oak vegetation community (NAM_ForW01), limited large woody debris and inadequate riparian fencing and animal impact also contributed to the reduction in riparian grade at this site.

Plate 3.15 *Despite possessing good vegetation cover throughout the canopy and understory structural layers, NAMB2 was considered to be a mildly disturbed riparian system primarily due to poor riparian width and connectivity, the presence of weed and noxious weed species and inadequate riparian fencing.*

Table 3.15 *Site-level assessments of riparian condition in 2016-17 at NAMB2 showing scores for the five subindices and their individual indicators that comprise the Vegetation Condition Index.*

Nambucca River 2	Scores
HABITAT	**12.7/20**
Channel width	0.7
Proximity	2
Continuity	3
Layers	3
Large native trees	2
Hollow-bearing trees	2
NATIVE SPECIES	**18/20**
Native canopy species	4
Native midstory species	4
Native herb/forb species	4
Native graminoid species	2
Native macrophyte species	4
SPECIES COVER	**17/20**
Canopy species	2
Midstory species	3
Herb/forb species	4
Graminoid species	4
Macrophyte species	4
DEBRIS	**12/20**
Total leaf litter	2.5
Native leaf litter	3
Dead trees standing	1
Dead trees fallen	1
Lying logs	1.5
Fringing vegetation	3
MANAGEMENT	**14.5/20**
Tree clearing	3
Fencing	2
Animal impact	1
Canopy Health	1.5
Exposed tree roots	3
Native woody regeneration	2
Weedy woody regeneration	2
TOTAL	**74.2/100**

NAMB 1

Site: High historic disturbance at Nambucca River 1 (NAMB1, Plate 3.16) and the installation of a rock revetment wall has resulted in a highly modified riparian zone and the complete removal of the fringing riparian zone. However, the original fringing riparian vegetation community at NAMB1 could likely have been described as 'Grey Mangrove - River Mangrove low open or closed forest or shrubland of intertidal flats' (NAM_FOR01), grading into the present riparian zone of 'Swamp Oak forested wetland of saline areas of coastal estuaries' (NAM_ForW01), a listed TEC, and 'Coast Banksia woodland and open forest of coastal dunes' (NAM_DOF13) (OEH 2015). NAMB1 received a low riparian condition score of 52, a grade of D (Table 3.16).

Dominant species: The dominant canopy species present were the native species Swamp Oak (*Casuarina glauca*), Coast Banksia (*Banksia integrifolia* subsp. *intergrifolia*) and Fig species (*Ficus macrophylla* and *Ficus* sp.). Dominant native midstory species included Tuckeroo (*Cupaniopsis anacardioides*), Coastal Wattle (*Acacia longifolia* subsp. *sophorae*), Sweet Pittosporum (*Pittosporum undulatum*) and Coast Teatree (*Leptospermum laevigatum*) along with the exotic species Lantana (*Lantana camara*), Bitou Bush (*Chrysanthemoides monilifera* subsp. *rotundata*), Brazillian Pepper Bush (*Schinus terebinthifolius*), Senna (*Senna pendula* var. *glabrata*) and Ground Asparagus (*Asparagus aethiopicus*). The understory was dominated by native species Pigface (*Carpobrotus glaucescens*), Blady Grass (*Imperata cylindrica*), Couch (*Cynodon dactylon*) and Prickly Couch (*Zoysia macrantha*) along with the exotic species Mother of Millions (*Bryophyllum delagoense*). Dominant vine species included Lawyer Vine (*Smilax australis*), Climbing Guinea Flower *(Hibbertia scandens*) and the exotic species Coastal Morning Glory (*Ipomoea cairica*). An estuarine macrophyte layer included the macroalgae Sargossum (*Sargossum* sp.) and scattered Zostera (*Zostera muelleri* subsp. *caprcorni*).

Noxious weed species: Noxious weed species observed on-site were Camphor Laurel (*Cinnamomum camphora*), Lantana (*Lantana camara*), Bitou Bush (*Chrysanthemoides monilifera* subsp. *rotundata*), Brazillian Pepper Bush (*Schinus terebinthifolius*), Senna (*Senna pendula* var. *glabrata*), Asparagus Fern (*Asparagus* spp.) and Mother of Millions (*Bryophyllum delagoense*).

Summary: Nambucca River 1 was a very highly disturbed closed-forest system with a partially remnant/mixed aged canopy and a mix of native and exotic species throughout all structural layers, in a predominantly forested, partially cleared coastal sand island landscape. The immediate surrounding landuse was Crown Reserve beyond which was urban settlement and National Park. Significant remnant stands of vegetation surround the site in the form of Sand Island Crown Reserve, an area previously recognised as 'unprotected significant habitat' (BMT WBM 2008), 700m to the south in Gaagal Wanggaan National Park and 1.2km to the north in Nambucca State Forest. Representative elements of the existing remnant vegetation community were present in all of the structural layers present, with NAMB1 scoring well for the Habitat subindex, moderately for Management and poorly for the Native Species, Cover and Debris subindices (Table 3.16). Riparian condition was affected by the presence and regeneration of weed and noxious weed species throughout all terrestrial structural layers, and reduced levels of vegetation cover due to the removal of the fringing riparian zone. Limited habitat trees, reduced woody and non-woody debris and canopy health also contributed to the reduction in riparian grade at this site.

Plate 3.16 *Despite possessing good vegetation cover in the canopy and midstory layers with the removal of the original fringing riparian vegetation layer NAMB1 was considered to be a very highly disturbed riparian system.*

Table 3.16 *Site-level assessments of riparian condition in 2016-17 at NAMB1 showing scores for the five subindices and their individual indicators that comprise the Vegetation Condition Index.*

Nambucca River 1	Scores
HABITAT	**17/20**
Channel width	4
Proximity	3
Continuity	4
Layers	4
Large native trees	2
Hollow-bearing trees	0
NATIVE SPECIES	**8/20**
Native canopy species	2
Native midstory species	1
Native herb/forb species	1
Native graminoid species	2
Native macrophyte species	2
SPECIES COVER	**8.5/20**
Canopy species	2
Midstory species	2
Herb/forb species	2
Graminoid species	2
Macrophyte species	0.5
DEBRIS	**6.5/20**
Total leaf litter	1.5
Native leaf litter	1.5
Dead trees standing	1
Dead trees fallen	1
Lying logs	1
Fringing vegetation	0.5
MANAGEMENT	**12/20**
Tree clearing	2
Fencing	2
Animal impact	2
Canopy Health	1
Exposed tree roots	3
Native woody regeneration	2
Weedy woody regeneration	0
TOTAL	**52/100**

3.2.4 Water quality

The Nambucca main stem received a poor overall score of 49 (D-) for water quality, slightly below the average score for the Nambucca Catchment. The estuarine reach scored 47 (D-) while the freshwater reach received a slightly higher score of 52 (D) due to fewer exceedances of ANZECC guidelines. In the freshwater reach, NAMB8 received a score of 49 (D-), NAMB7 received the lowest score of the freshwater reach with 47 (D-), while NAMB6 had the best water quality with a score of 59 (D+). In the estuarine reach, NAMB5 received a score of 51 (D), NAMB4 received a score of 48 (D-), NAMB3 received a score of 42 (F), NAMB2 received the lowest score of the estuarine reach with 41 (F) and NAMB1 had the best water quality of the reach with a score of 53 (D). Figure 3.7 shows the ranges and means of key physico-chemical and nutrient variables used in the assessment of water quality for the main stem of the Nambucca River and estuary in comparison with their relevant water quality guidelines. Ranges and means for these variables are given in Tables 3.17, 3.18 and 3.19 and the exceedances are given in Table 3.20.

pH varied longitudinally in the Nambucca main stem with pH increasing with distance downstream. All lowland freshwater sites occasionally breached the ANZECC minimum guideline value of 6.5 for pH with the lowest pH of 5.75 observed at NAMB7. All estuarine sites occasionally breached either the upper OEH exceedance guideline of pH of 8 or the lower OEH exceedance guideline of pH of 7, with the highest pH maximum exceedance recorded at NAMB1 (Table 3.19) and the lowest pH exceedance observed at NAMB5 (Table 3.18). There were no clear longitudinal trends in turbidity throughout the Nambucca main stem, with all three freshwater sites remaining below the ANZECC guideline. Conversely, NAMB1 was the only estuarine site in the Nambucca main stem that did not exceed its relevant OEH turbidity guideline, with exceedance frequencies varying between the upper, middle and lower estuarine sites. Peak turbidity exceedance was observed at NAMB2 with 29.2 NTU, greater than nine times the OEH guideline for lower estuaries (Table 3.19).

While DO% varied among sites, there was a general longitudinal trend from very low DO% values higher in the catchment to high DO% values lower in the catchment. Sites in the upper freshwater reaches fell below the ANZECC guidelines for minimum DO%, while several estuarine sites breached OEH guidelines for both DO% minimums or maximums. DO% concentrations remained below the minimum ANZECC guideline on all six sampling occasions for NAMB8 and on five sampling occasions for NAMB7, with the lowest DO concentration occurring at NAMB8 (3.73mg/L) in July 2017. Low DO concentrations such as those observed at sites in the Nambucca main stem can significantly impact aquatic biota such as fish. All estuarine sites exceeded maximum OEH trigger guidelines on at least one occasion, on five sampling occasions for NAMB5 and NAMB1, and on seven sampling occasions for NAMB4. The highest DO% was observed in May 2017 at NAMB1 (123.7%).

Freshwater sites in the Nambucca main stem regularly exceeded ANZECC nutrient guidelines for lowland freshwater systems. Total nitrogen (TN) guideline values were exceeded regularly in the freshwater sites with the peak concentration of 1451.8µg/L recorded at NAMB7, four times the ANZECC guideline for lowland freshwater streams. Bioavailable nitrogen (NOx) was always exceeded at all three freshwater sites with the peak concentration of 284.6µg/L recorded at NAMB7 in December 2016, seven times the ANZECC guideline for lowland freshwater streams. Total phosphorus (TP) concentrations regularly exceeded ANZECC nutrient guideline values in the two upstream sites in the Nambucca main stem, NAMB7 and NAMB8, and occasionally at NAMB6. Peak TP concentration was observed at NAMB8 (220.7µg/L), almost ten times the ANZECC guideline for lowland freshwater streams. SRP guidelines in lowland freshwater systems were not exceeded at anytime during the sampling period.

Nutrient concentrations in the estuarine reach of the Nambucca main stem varied among sites and displayed no consistent longitudinal pattern (Figure 3.7). Peak exceedances for TN and NOx were observed in the lower estuarine sites of NAMB1 and NAMB3 with readings three and 110 times OEH guidelines, respectively. Peak exceedances for both TP and SRP in the Nambucca estuary were observed at NAMB4 , with measurements more than six and four times OEH guideline vaues for lower estuaries, respectively.

Chl-a exceedances were infrequent to occasional across all sites in the Nambucca main stem except at NAMB1. High levels of variability were recorded at both NAMB8 and NAMB5, with peak Chl-a concentrations at these sites of 19.7 µg/L and 15.4 µg/L, respectively. Chl-a exceedances did not generally follow peaks in nutrient concentrations along the Nambucca main stem, occurred during different sampling periods across the two sites and did not persist past a single sampling occasion. However, TP exceedances corresponded with peak Chl-a concentrations at both NAMB8 and NAMB5.

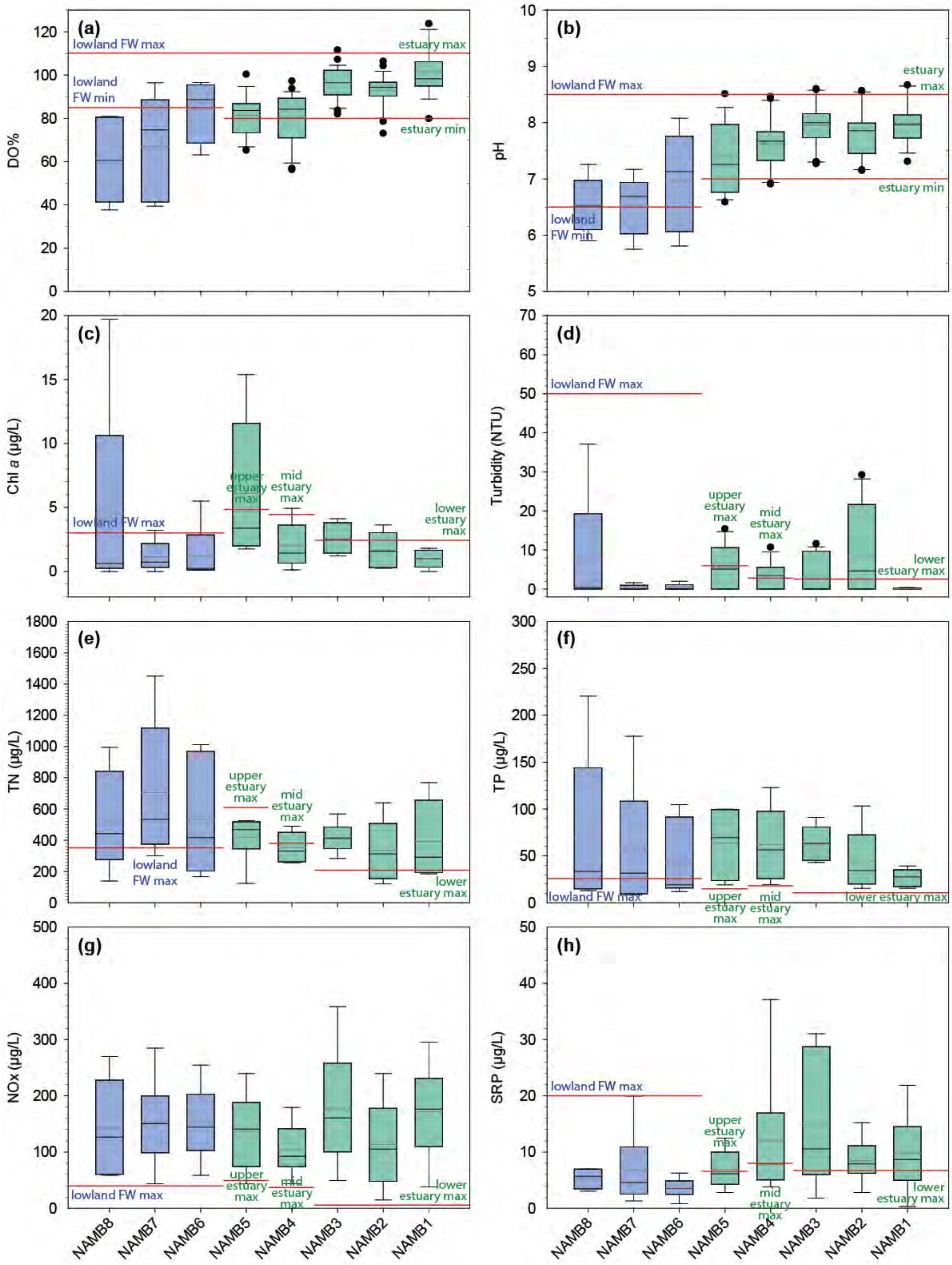


Figure 3.7 *Mean (grey line), median (black line), 25th and 75th percentiles, and range of water quality variables in the main stem of the Nambucca River from 2016-2017. Outliers are represented by black dots. Green and blue boxes represent estuary and freshwater sites, respectively. Red lines represent the relevant maximum or minimum guideline value for each type of system.*

Table 3.17 *Minimums, maximums and means of measured water quality variables for the three freshwater sites NAMB8, NAMB7 and NAMB6 on the Nambucca River.*

	NAMB8			NAMB7			NAMB6		
Variable	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**
Temperature	15.61	25.89	21.01	18.46	24.62	22.01	17.22	27.14	22.94
pH	5.90	7.26	6.53	5.75	7.17	6.52	5.81	8.08	6.96
EC	0.07	0.10	0.08	0.09	0.09	0.09	0.08	0.09	0.08
Salinity (PPT)	0.04	0.05	0.04	0.04	0.05	0.05	0.04	0.05	0.04
DO (mg/L)	3.73	7.66	5.62	3.74	8.42	6.02	6.15	8.50	7.61
DO %	37.70	80.90	60.90	39.40	96.50	66.92	63.20	96.60	84.30
Turbidity	0.00	37.10	7.80	0.00	1.60	0.40	0.00	2.00	0.46
Chla (µg/L)	0.00	19.72	4.47	0.00	3.21	1.14	0.10	5.50	1.23
TSS (mg/L)	0.00	4.47	2.32	0.00	20.83	4.94	1.40	3.08	2.14
TN (µg/L)	139.66	994.92	522.21	300.22	1451.8	704.11	167.77	1011.1	530.27
TP (µg/L)	12.88	220.66	72.38	8.41	177.66	57.35	11.90	104.66	43.10
NOx (µg/L)	58.73	269.58	142.57	43.67	284.64	152.86	58.73	254.52	150.79
SRP (µg/L)	3.04	7.02	5.32	1.30	19.90	6.87	0.80	6.24	3.59

Table 3.18 *Minimums, maximums and means of measured water quality variables for the three upstream sites NAMB5, NAMB4 and NAMB3 in the Nambucca River estuary.*

	NAMB5			NAMB4			NAMB3		
Variable	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**
Temperature	15.67	28.66	22.11	17.03	28.86	22.86	17.07	26.66	21.38
pH	6.59	8.51	7.41	6.91	8.46	7.63	7.27	8.60	7.96
EC	0.24	27.60	9.99	21.90	50.40	42.80	37.00	54.30	49.95
Salinity (PPT)	0.12	16.95	5.93	12.96	32.41	27.56	24.40	35.45	32.58
DO (mg/L)	5.03	13.43	7.80	3.73	10.72	6.34	5.79	9.33	7.27
DO %	65.30	100.40	81.41	56.30	97.20	80.60	82.00	111.50	96.23
Turbidity	0.00	15.40	5.58	0.00	10.70	3.53	0.00	11.60	2.86
Max Depth	2.10	2.70	2.38	3.00	5.60	4.18	2.30	6.80	4.02
Chla (µg/L)	1.76	15.40	6.10	0.12	4.93	1.99	0.74	4.13	2.21
TSS (mg/L)	0.42	884.42	153.36	7.80	17.20	13.40	9.30	26.49	15.56
TN (µg/L)	123.62	525.39	419.93	256.07	490.20	351.51	282.91	567.60	416.01
TP (µg/L)	19.22	99.66	63.65	19.42	122.66	62.02	42.88	91.12	63.87
NOx (µg/L)	43.67	239.46	136.69	43.67	179.22	103.39	49.37	358.65	178.48
SRP (µg/L)	2.80	12.47	6.91	3.79	37.09	12.06	1.80	31.02	14.88

Table 3.19 *Minimums, maximums and means of measured water quality variables for the two downstream sites NAMB2 and NAMB1 in the Nambucca estuary.*

	NAMB2			NAMB1		
Variable	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**
Temperature	17.07	27.95	22.20	18.94	25.10	21.46
pH	7.15	8.57	7.84	7.31	8.67	7.99
EC	31.70	52.80	46.08	51.60	61.20	53.99
Salinity (PPT)	19.51	34.28	29.70	33.62	40.67	35.48
DO (mg/L)	5.08	15.26	7.22	6.11	14.77	7.69
DO %	73.00	106.30	92.95	79.80	123.70	101.62
Turbidity	0.00	29.20	8.81	0.00	0.40	0.13
Max Depth	2.10	4.00	3.24	1.80	3.10	2.54
Chla (µg/L)	0.23	3.63	1.64	0.00	1.80	0.99
TSS (mg/L)	10.30	32.11	19.41	14.95	18.20	16.62
TN (µg/L)	121.04	639.59	336.17	184.68	768.21	392.02
TP (µg/L)	15.32	103.12	45.17	15.25	39.12	26.82
NOx (µg/L)	14.93	239.46	113.42	37.89	295.36	171.57
SRP (µg/L)	2.80	15.20	8.48	0.30	21.86	9.68

Table 3.20 *Exceedances[1] observed in the main stem of the Nambucca River for pH, conductivity (EC), percent saturated dissolved oxygen (DO), turbidity, chlorophyll a (Chl-a), total nitrogen (TN), total phosphorus (TP), bioavailable nitrogen (NOx) and soluble reactive phosphorus (SRP).*

Site	pH	EC	DO %	Turbidity	Chl-a	TN	TP	NOx	SRP
NAMB8	2(40%)2,0	5(100%)5,0	5(100%)5,0	0(0%)	1(20%)	3(50%)	3(50%)	6(100%)	0(0%)
NAMB7	2(40%)2,0	5(100%)5,0	4(80%)4,0	0(0%)	1(20%)	5(83%)	3(50%)	6(100%)	0(0%)
NAMB6	2(40%)2,0	5(100%)5,0	1(25%)1,0	0(0%)	1(20%)	3(50%)	2(33%)	6(100%)	0(0%)
NAMB5	7(35%)6,1	NA	5(36%)5,0	5(42%)	2(40%)	0(0%)	6(100%)	5(83%)	3(50%)
NAMB4	5(17%)5,0	NA	7(28%)7,0	10(53%)	1(20%)	3(50%)	6(100%)	6(100%)	3(50%)
NAMB3	3(12%)0,3	NA	1(4%)0,1	4(27%)	2(40%)	6(100%)	6(100%)	6(100%)	5(83%)
NAMB2	4(17%)0,4	NA	2(8%)2,0	9(56%)	2(40%)	4(67%)	6(100%)	6(100%)	5(83%)
NAMB1	3(16%)0,3	NA	5(21%)1,4	0(0%)	0(0%)	4(67%)	5(83%)	6(100%)	5(83%)

[1] Numbers in black represent the total number and percent of exceedances. Numbers in blue and red represent the numbers of measurements lower than the minimum guideline value and higher than the maximum guideline value, respectively. The number of exceedances includes all depths sampled so may be greater than the number of times sampled. Turbidity, chlorophyll a, and nutrients only have maximum trigger guidelines.

3.2.5 Aquatic macroinvertebrate communities

NAMB 8

NAMB8 recorded 200 and 431 individual macroinvertebrates across 11 and 23 macroinvertebrate families during the spring 2016 and autumn 2017 sampling periods, respectively (Table 3.21). In spring 2016, abundance was dominated by Atyidae shrimp (65 individuals) and richness was dominated by Coleoptera, with five families. Atyidae were again the most abundant family in autumn (205 individuals), while the most diverse order in autumn was Coleoptera with five families. Total abundance, family richness and EPT richness were all higher in autumn 2017.

The mean SIGNAL2 score for NAMB8 was higher in spring (4.6) than autumn (3.8) with the spring score due to the increased presence of key EPT taxa. SIGNAL2 score ranges were consistently large over both seasons.

NAMB8 received a poor overall Ecohealth score of 46 (D-) for aquatic macroinvertebrate community condition, with all indicators except family richness below the catchment average. While the site is capable of supporting a diversity of macroinvertebrate fauna given the wide SIGNAL2 score range, the remaining macroinvertebrate indicators suggest that they were affected by the poor water quality experienced under the low flow conditions of the study period that led to disconnected pools in the reach surrounding NAMB.

NAMB 7

NAMB7 recorded 496 and 446 individual macroinvertebrates across 24 and 23 macroinvertebrate families during the spring 2016 and autumn 2017 sampling periods, respectively (Table 3.21). In spring 2016, abundance was dominated by Atyidae shrimp (65 individuals) and richness was dominated by Trichoptera (Caddisflies), with five families. Elmidae (Riffle beetles) were the most abundant family in autumn (119 individuals) and the most diverse order in autumn was Coleoptera with five families. Total abundance and family richness indicators were consistent across sampling seasons.

The mean SIGNAL2 score for NAMB7 was significantly higher in spring (6.0) than autumn (3.6) with wide SIGNAL2 score ranges occurring over both seasons. The higher score in spring was driven by both higher abundances of Leptophlebiid mayflies and high scoring Trichoptera (Caddisflies).

NAMB7 received a very good overall Ecohealth score of 77 (B-) for aquatic macroinvertebrate community condition and all indicators were generally well above those of the average for the Nambucca Catchment. Good quality and quantity of habitat clearly influenced the high total abundance, family richness and SIGNAL2 scores at NAMB7, as water quality scored poorly with 47 (D-) and riparian condition was also poor with a score of 51 (D).

NAMB 6

NAMB6 recorded 268 and 361 individual macroinvertebrates across 15 and 16 macroinvertebrate families during the spring 2016 and autumn 2017 sampling periods, respectively (Table 3.21). In spring 2016, abundance was dominated by Atyidae shrimp (65 individuals) and richness was dominated by Trichoptera (Caddisflies), with five families. Elmidae (Riffle beetles) were the most abundant family in autumn (119 individuals) and the most diverse order in autumn was Coleoptera with five families. With the exception of EPT richness and abundance, indicator variables were generally consistent across both sampling seasons.

The mean SIGNAL2 score for NAMB6 was marginally higher in spring (5.7) than autumn (5.3). The mean SIGNAL2 score was well above the catchment average with the second highest values in the catchment. SIGNAL2 scores varied across seasons, influenced by high abundances of Atyidae in spring, and Baetid mayflies in autumn.

NAMB6 had a moderate overall Ecohealth score of 56 (D+) for aquatic macroinvertebrate community condition, on par with the catchment average. Of the four macroinvertebrate indicators, only SIGNAL2 scored above the catchment average. While NAMB6 was able to support a diversity of macroinvertebrate fauna given the wide range of SIGNAL2 scores, the remaining macroinvertebrate indicators suggest that the water quality and habitat conditions in the Nambucca Catchment at NAMB6 were in moderate condition. This was reflected in the other Ecohealth indicators with both water quality and riparian condition scoring moderately with 59 (D+) and 57 (D+), respectively.

Table 3.21 *Summary of aquatic macroinvertebrate indicator scores and the overall grade for macroinvertebrate community condition in freshwater sites of the Nambucca River main stem.*

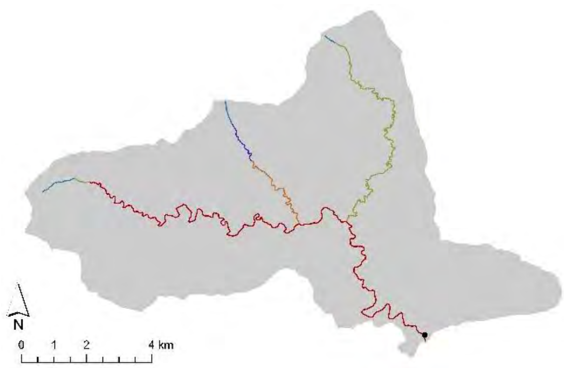
	NAMB6		NAMB7		NAMB8	
Macroinvertebrate indicator	**Spring 2016**	**Autumn 2017**	**Spring 2016**	**Autumn 2017**	**Spring 2016**	**Autumn 2017**
Total abundance	268	361	496	446	200	431
Family richness	15	16	24	23	11	23
EPT abundance	120	101	265	44	51	30
EPT richness	10	5	16	13	5	8
Mean SIGNAL2 score	5.7	5.3	6.0	3.6	4.6	3.8
SIGNAL2 score range	2 - 9	2 - 9	2 - 9	1 - 9	1 - 8	1 - 8
Ecohealth score (grade)	**56 (D+)**		**77 (B-)**		**46 (D-)**	

3.3 Tributaries of the Nambucca River (North Arm)

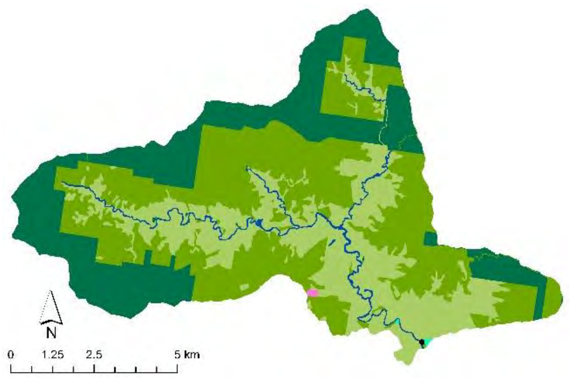
3.3.1 Subcatchment and site descriptions

There are four major tributaries of the North Arm of the Nambucca River: Missabotti Creek, Buckrabendinni Creek which is a tributary of South Creek, and Newee Creek that is joins the Nambucca estuary. The subcatchment of Missabotti Creek is 81.3km^2 (Table 3.22). The dominant landuse in the subcatchment is conservation area (30%), although this is predominantly in the upper subcatchment. Grazing is the second dominant landuse (27%, Figure 3.8c). The dominant River Style is a planform controlled, meandering channel comprised of fine-grained sediment (Table 3.22, Figure 3.8b). There was one site (MISC1) located at the end-of-system in the Missabotti subcatchment (Plate 3.17), 200m upstream of the confluence with the Nambucca River.

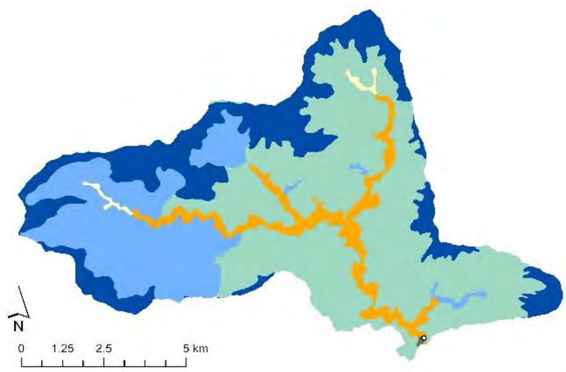
(a) Location of Ecohealth sites



(b) River Styles: refer to Figure 2.8 for key



(c) Landuse: refer to Figure 2.7 for key



(d) Soils: refer to Figure 2.3 for key

Figure 3.8 *Missabotti Creek showing (a) locations of Ecohealth sites, (b) River Styles, (c) landuse, and (d) soils. Data layers from NC LLS (River Styles) and OEH (landuse and soils).*

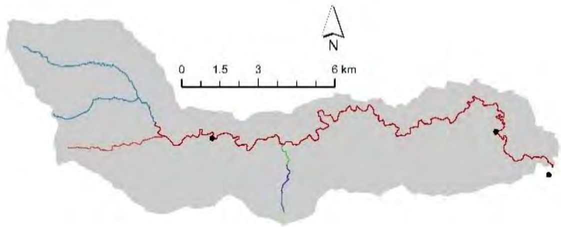
Table 3.22 *Subcatchment description of Missabotti Creek. Data from NC LLS and OEH.*

Variable	Subcatchment composition
Area	81.3 km^2
Geology	100% slate, phyllite, schist
Soils	48.4% Kurosols; 22.3% Rudosols and Tenosols; 21.9% Dermosols; 6.8% Tenosols (Alluvial); 0.5% Rudosols (Alluvial)
River Styles	53.3% PCVS – Planform controlled, meandering, fine grained, 28.2% SMG – Valley fill, fine grained, 8.7% PCVS – Planform controlled, meandering, sand, 6.2% CVS – Headwater, 3.6% CVS – Floodplain pockets, sand
Landuse	29.5% Conservation area, 27.0% Grazing, 1.7% River and drainage system, 0.1% Horticulture, 0.1% Mining and quarrying
Major point source discharge	Nil
Tree Cover	71.1%

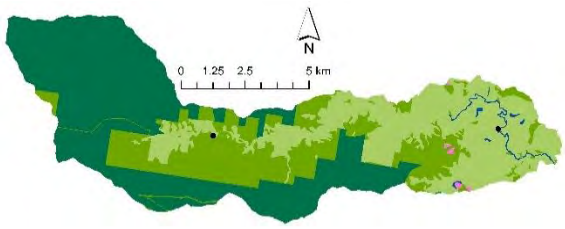
Plate 3.17 *Site MISC1 at the end-of-system of Missabotti Creek, a tributary of the Nambucca River (North Arm).*

The subcatchment of Buckrabendinni Creek is 89km^2, and its landuse is dominated by conservation area (46%) and grazing (30%, Table 3.23, Figure 9c). The dominant River Style is a planform controlled, meandering channel comprised of fine-grained sediment (Figure 3.9b). There were two sites in Buckrabendinni subcatchment. BUCC2 (Plate 3.18) is located 21.8km upstream of BUCC1. BUCC1 is located at the end-of-system in the Bucrabendinni Creek subcatchment (Plate 3.19), 4.2km upstream of the confluence with South Creek.

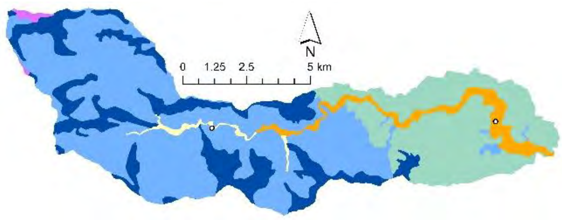
(a) Location of Ecohealth sites



(b) River Styles: refer to Figure 2.8 for key



(c) Landuse: refer to Figure 2.7 for key



(d) Soils: refer to Figure 2.3 for key

***Figure 3.9** Buckrabendinni Creek showing (a) locations of Ecohealth sites, (b) River Styles, (c) landuse, and (d) soils. Data layers from NC LLS (River Styles) and OEH (landuse and soils).*

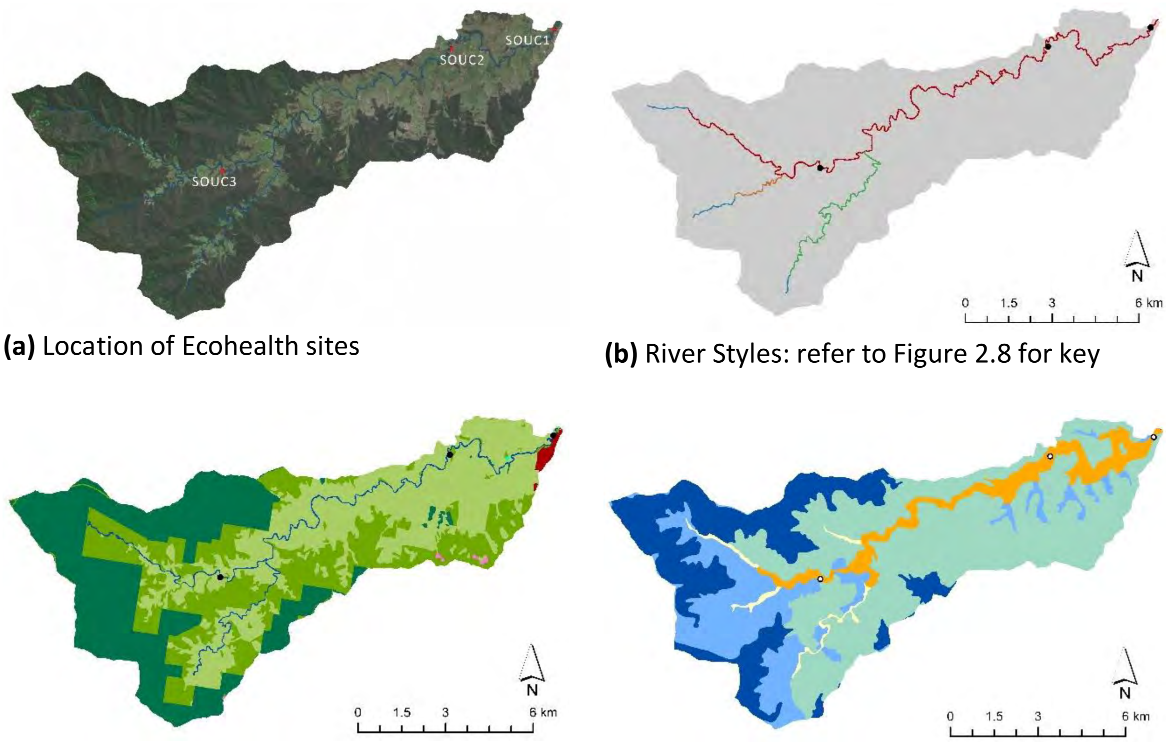
***Table 3.23** Subcatchment description of Buckrabendinni Creek. Data from NC LLS and OEH.*

Variable	Subcatchment composition
Area	88.6 km^2
Geology	97.5% slate, phyllite, schist; 1.9% alluvium; 0.6% basalt
Soils	49.9% Dermosols, 24.7% Kurosols, 19.0 Rudosols and Tenosols, 4.9% Tenosols (Alluvial), 1.0% Rudosols (Alluvial), 0.5% Ferrosols
River Styles	61.8% PCVS – Planform controlled, meandering, fine grained, 24.7% CVS – Headwater, 8.8% CVS – Gorge, 2.7% CVS – Floodplain pockets, sand, 2.0% PCVS – Planform controlled, low sinuosity, sand
Landuse	45.9% Conservation area, 29.4% Grazing, 0.6% River and drainage, 0.2% Horticulture
Major point source discharge	Nil
Tree Cover	69.9%

Plate 3.18 *Site BUCC2 in the upper subcatchment of Buckrabendinni Creek, a tributary of South Creek (looking upstream).*

Plate 3.19 *Site BUCC1 at the end-of-system of Buckrabendinni Creek, looking upstream.*

The subcatchment of South Creek is 89km^2 and its dominant landuse is grazing (37%), closely followed by conservation areas (34%) in the upper subcatchment (Figure 3.10c). The dominant River Style is a planform controlled, meandering channel comprised of fine-grained sediment (Figure 3.10b). There were three sites in South Creek subcatchment. SOUC3 (Plate 3.20) is located in the upper subcatchment, 16.6km upstream of SOUC2. SOUC2 (Plate 3.21) is 700m upstream of the confluence with Buckrabendinni Creek and 6.8km upstream of SOUC1. SOUC1 (Plate 3.22) is located at the end-of-system in the South Creek subcatchment, 400m upstream of the confluence with the Nambucca River.



(a) Location of Ecohealth sites

(b) River Styles: refer to Figure 2.8 for key

(c) Landuse: refer to Figure 2.7 for key

(d) Soils: refer to Figure 2.3 for key

Figure 3.10 *South Creek showing (a) locations of Ecohealth sites, (b) River Styles, (c) landuse, and (d) soils. Data layers from NC LLS (River Styles) and OEH (landuse and soils).*

Table 3.24 *Subcatchment description of South Creek. Data from NC LLS and OEH.*

Variable	Subcatchment composition
Area	88.9 km^2
Geology	97.6% slate, phyllite, schist; 2.4% alluvium
Soils	49.9% Kurosols; 22.8% Rudosols and Tenosols; 17.8% Dermosols; 8.1% Tenosols (Alluvial); 1.3% Rudosols (Alluvial)
River Styles	66.0% PCVS – Planform controlled, meandering, fine grained, 19.9% CVS – Floodplain pockets, gravel, 8.6% CVS – Headwater, 5.5% PCVS – Planform controlled, meandering, sand
Landuse	36.7% Grazing, 33.6% Conservation area, 1.7% River and drainage system, 0.5% Urban, 0.1% Horticulture
Major point source discharge	Nil
Tree Cover	60.9%

Plate 3.20 *Site SOUC3 in the upper subcatchment of South Creek, looking upstream.*

Plate 3.21 *Site SOUC2 in South Creek upstream of the confluence with Buckrabendinni Creek, looking downstream.*

Plate 3.22 *Site SOUC1 at the end-of-system of South Creek, looking downstream.*

There was one site at the end-of-system of Newee Creek (NEWC1, Plate 3.23). NEWC1 was located in the estuary, 1.9km upstream of the confluence with the Nambucca River (Figure 3.6a). The channel at NEWC1 is laterally unconfined and tidal.

Plate 3.23 *Site NEWC1 at the end-of-system of Newee Creek.*

3.3.2 Geomorphic condition

MISC 1

The geomorphic River Style at Missabotti Creek 1 is a planform controlled, meandering, fine-grained channel in a partially confined valley setting. MISC1 drains 40.5km of stream network (the Missabotti Creek subcatchment), with half of the stream network (20.6km) comprising the dominant River Style of planform controlled, meandering, fine grained channel assessed as being in poor geomorphic condition (Alluvium 2012), largely due to historic gravel extraction (Doyle 2003).

The bed sediments at MISC1 comprised a contact framework of rounded pebbles filled with a matrix of 5-32% fine sediments. There were significant deposits of the bed sediments (rounded pebbles) on gravel bars in and adjacent to the channel and these sediments are regularly reworked during freshes. Missabotti Creek likely contributes significant bedload to the Nambucca River.

Banks comprised fine sediments. There was minor (<5m) undercutting and moderate (5-10m) slumping on the left bank, and minor (<5m) active erosion on the right bank. MISC1 scored 58, a D+ for BANK CONDITION and 73, a C+, for BED CONDITION. The overall geomorphic condition for MISC1 was 66, a grade of C.

In summary, MISC1 was assessed as being in moderate geomorphic condition, with high bedload movement through the reach the most significant issue for site-level geomorphic condition. This is primarily due to the small size and mobility of the bedload but is likely to affect pool depth and habitat availability for instream macrophytes and fauna. The desktop GIS assessment of subcatchment geomorphic condition found the Missabotti Creek subcatchment to be in a poor condition with a grade of D-. The geomorphic condition at MISC1 was above the subcatchment average.

BUCC 2

The geomorphic River Style at Buckrabendinni Creek 2 is a planform controlled, meandering, fine-grained channel in a partially confined valley setting. BUCC2 drains 21.2km of stream network, with half of the stream network (11.2km) comprising headwaters in good geomorphic condition (Alluvium 2012). The site was located at the upstream end of a 1.8km reach in moderate geomorphic condition, upstream of which was a 3.9km reach in poor geomorphic condition.

The bed sediments at BUCC2 comprised a mixed load of angular cobbles and subanglular pebbles with a matrix of 5-32% fine sediments. There was no active erosion of the stream bed and the reach comprised pool-riffle sequences. Banks comprised fine sediments. There was moderate (5-10m) undercutting on the left bank and significant (10-20m) undercutting on the right bank. BUCC2 scored 68, a C for BANK CONDITION and 83, a B, for BED CONDITION. The overall geomorphic condition for BUCC2 was 76, a grade of B-.

In summary, BUCC2 was assessed as being in good geomorphic condition, with undercutting of both banks immediately above the low flow channel the most significant issue for site-level geomorphic condition. The desktop GIS assessment of subcatchment geomorphic condition found the Buckrabendinni Creek subcatchment to be in moderate condition with a grade of C. The geomorphic condition at BUCC2 was above the subcatchment average.

BUCC 1

The geomorphic River Style at Buckrabendinni Creek 1 is a planform controlled, meandering, fine-grained channel in a partially confined valley setting. BUCC1 drains 45.9km of stream network (the Buckrabendinni subcatchment), with 27% of the stream network (11.2km) comprising the dominant River Style of planform controlled, meandering, fine grained channels in poor geomorphic condition (Alluvium 2012).

The bed sediments at BUCC1 comprised gravel with a matrix of >60% fine sediments. There was significant cattle pugging of bed sediments (Plate 3.26). Banks comprised fine sediments. There was severe (20-100m) slumping on both banks and moderate (5-10m) active erosion on the left bank. BUCC1 scored 20, an F for BANK CONDITION and 33, an F, for BED CONDITION. The overall geomorphic condition for BUCC1 was 27, a grade of F.

In summary, BUCC1 was assessed as being in very poor geomorphic condition, with trampling and compaction from cattle access the most significant issue for site-level geomorphic condition. The desktop GIS assessment of subcatchment geomorphic condition found the Buckrabendinni Creek subcatchment to be in moderate condition with a grade of C. The geomorphic condition at BUCC1 was significantly below the subcatchment average.

SOUC 3

The geomorphic River Style at South Creek 3 is a planform controlled, meandering, fine-grained channel in a partially confined valley setting. SOUC3 drains 13.1km of stream network, with 80% of the stream network (10.6km) assessed to be in poor geomorphic condition (Alluvium 2012). The site was located midway through a 19.6km reach in poor geomorphic condition.

The bed sediments at SOUC3 comprised subangular cobbles with a matrix of 32-60% fine sediments. There was no active erosion of the stream bed and the reach comprised a run and pool-riffle sequence. Banks comprised fine sediments with 20% of the length of the right bank comprising a bedrock outcrop. There was minor (<5m) undercutting on the left bank immediately downstream of the bridge and no erosion observed on the right bank. SOUC3 scored 88, a B+ for BANK CONDITION and 87, a B+, for BED CONDITION. The overall geomorphic condition for SOUC3 was 87, a grade of B+.

In summary, SOUC3 was assessed as being in good geomorphic condition, with minor scour on the left bank immediately downstream of the bridge the most significant issue for site-level geomorphic condition. The desktop GIS assessment of subcatchment geomorphic condition found the South Creek subcatchment to be in a poor condition with a grade of D-. The geomorphic condition at SOUC3 was significantly above the subcatchment average.

SOUC 2

The geomorphic River Style at South Creek 2 is a planform controlled, meandering, fine-grained channel in a partially confined valley setting. SOUC2 drains 40.1km of stream network, with half of the stream network (21.4km) assessed to be in poor geomorphic condition (Alluvium 2012). The site was located at the downstream end of a 4.3km reach in moderate geomorphic condition.

The bed sediments at SOUC2 comprised well rounded pebbles with a matrix of >60% fine sediments. There was no active erosion of the stream bed with deposits of bed sediments on bars adjacent to the banks. Banks comprised fine sediments. There was severe (20-100m) undercutting on the left bank and significant (10-20m) undercutting on the right bank. SOUC2 scored 60, a C- for BANK CONDITION and 70, a C+, for BED CONDITION. The overall geomorphic condition for SOUC2 was 65, a grade of C.

In summary, SOUC2 was assessed as being in moderate geomorphic condition, with undercutting of both banks but particularly the left bank the most significant issue for site-level geomorphic condition. The desktop GIS assessment of subcatchment geomorphic condition found the South Creek subcatchment to be in a poor condition with a grade of D-. The geomorphic condition at SOUC2 was above the subcatchment average.

SOUC 1

The geomorphic River Style at South Creek 1 is a planform controlled, meandering, fine-grained channel in a partially confined valley setting. SOUC1 drains 94.9km of stream network (the South Creek and Buckrabendinni subcatchments), with 42% of the stream network (40.1km) assessed to be in poor geomorphic condition (Alluvium 2012). The site was located at the downstream end of a 6.4km reach in poor geomorphic condition.

The bed sediments at SOUC1 comprised well rounded pebbles with a matrix of >60% fine sediments. There was no active erosion of the stream bed and the reach predominantly comprised pools and a run with a riffle at the downstream end of the site. Banks comprised fine sediments. There was minor (<5m) undercutting and minor (<5m) slumping on the left and moderate (5-10m) undercutting and slumping on the right bank. Bank erosion was associated with heavy human trails, particularly on the right bank. SOUC1 scored 68, a C for BANK CONDITION and 53, a D, for BED CONDITION. The overall geomorphic condition for SOUC1 was 61, a grade of C-.

In summary, SOUC1 was assessed as being in moderate geomorphic condition, with bank erosion on the right bank the most significant issue for site-level geomorphic condition. The desktop GIS assessment of subcatchment geomorphic condition found the South Creek subcatchment to be in a poor condition with a grade of D-. The geomorphic condition at SOUC3 was above the subcatchment average.

NEWC 1

The geomorphic River Style at Newee Creek 1 is a laterally unconfined tidal channel. NEWC1 drains 18.9km of stream network (the Newee Creek subcatchment), with only 300m of the stream network assessed to be in poor geomorphic condition and that reach is classified as a weir pool or dam (Alluvium 2012). The site was located midway in a 4.0km reach in good geomorphic condition.

The bed sediments at NEWC1 comprised soft sediments (silty sands). Banks comprised fine sediments. There was moderate (5-10m) undercutting in the intertidal zone of the right bank due to wave action which resulted in moderate exposure of tree roots. NEWC1 scored 68, a C for BANK CONDITION. The overall geomorphic condition for NEWC1 was 68, a grade of C.

In summary, NEWC1 was assessed as being in moderate geomorphic condition, with bank erosion on the right bank the most significant issue for site-level geomorphic condition. The desktop GIS assessment of subcatchment geomorphic condition grouped Newee Creek in with the Nambucca Estuary, which had a subcatchment geomorphic condition grade of C. The geomorphic condition at NEWC1was equal to the subcatchment average.

3.3.3 Riparian Condition

MISC 1

Site: The original riparian vegetation community at Missabotti Creek 1 (MISC1, Plate 3.24) was described as 'River Oak grassy open forest along larger rivers' (NAM_FW01) grading into 'Turpentine – Brush Box – Flooded Gum – Blackbutt shrubby moist forest of sub-coastal lowlands' (NAM_WSF04). MISC1 received a low riparian condition score of 55.2, a grade of D+ (Table 3.25).

Dominant Species: The dominant canopy species present were the native species River Oak (*Casuarina cunninghamiana* subsp. *cunninghamiana*), White Cedar (*Melia azedarach*), Flooded Gum (*Eucalyptus grandis*) and the exotic species Camphor Laurel (*Cinnamomum camphora*). Dominant native midstory species included Silver Weeping Tea Tree (*Leptospermum brachyandrum*), Sandpaper Fig (*Ficus coronata*), Cheese Tree (*Glochidion fernandi*) and Wattles (*Acacia irrorata* and *A.implexa*.), along with the exotic species Lantana (*Lantana camara*), Small-leaved Privet (*Ligustrum sinense*) and Wild Tobacco (*Solanum mauritianum*). The understory was dominated by native species Common Bracken (*Pteridium esculentum*), Soft Lomandra (*Lomandra hystrix*), Scurvy Weed (*Commelina cyanea*), Knotweeds (*Persicaria stigosa*, *P.hydropiper* and *P.decipiens*) and the exotic species along with exotic species Ink Weed (*Phytolacca octandra*), Silver-leaved Desmodium (*Desmodium uncinatum*), Blue Billy Goat Weed (*Ageratum houstonianum*), Sidratusa (*Sida rhombifolia*), Paspalum species (*Paspalum dilatatum* and *P.mandiocanum*) and Pigeon Grass (*Setaria* sp.). Dominant vine species included Native Raspberry (Rubus rosifolius) and Japanese Honeysuckle (*Lonicera japonica*), while the macrophyte layer included Water Primrose (*Ludwigia peploides*), Triangular Club Rush (*Schoenoplectiella mucronata*) and Swamp Lily (*Ottelia ovalifolia*).

Noxious weed species: Noxious weed species observed on-site were Camphor Laurel (*Cinnamomum camphora*), Lantana (*Lantana camara*), Small-leaved Privet (*Ligustrum sinense*), Fireweed (*Senecio madagascariensis*) and Japanese Honeysuckle (*Lonicera japonica*).

Summary: Missabotti Creek 1 was a highly disturbed open-to-closed forest system with a partially remnant/mixed-aged canopy of native and exotic species throughout all structural layers, in a predominantly cleared, partially forested rural landscape. The surrounding landuse was primarily agricultural grazing land beyond which was dairy country, State Forest and forested private land. Significant remnant stands of vegetation lie 1.7km north and east in private land and 2.2km west in Crown Reserve. Representative elements of the remnant vegetation community were present in the canopy but sparse in other structural layers, with MISC1 scoring moderately for Habitat, Cover and Debris subindices and poorly for Native Species and Management subindices (Table 3.25). Riparian condition was affected by poor habitat connectivity, contracted vegetation width, disrupted continuity and the prevalence and regeneration of weed and noxious weed species throughout all structural layers, particularly in the midstory and understory structural layers. Reduced levels of cover in the canopy and midstory particularly in the 'River Oak' vegetation community (NAM_FW01), reduced levels of woody and non-woody debris and inadequate riparian fencing and animal impact also contributed to the reduction in riparian grade at this site.

Plate 3.24 *Riparian vegetation condition at MISC1 was considered to be highly disturbed. This was primarily due to reduced riparian width and poor continuity and connectivity, the dominance of weed and noxious weed species throughout all structural layers, reduced cover in the canopy and midstory and the presence of livestock throughout the riparian zone.*

Table 3.25 *Site-level assessments of riparian condition in 2016-17 at MISC1 showing scores for the five subindices and their individual indicators that comprise the Vegetation Condition Index.*

Missabotti Creek 1	Scores
HABITAT	**11.7/20**
Channel width	2.7
Proximity	0
Continuity	2
Layers	4
Large native trees	2
Hollow-bearing trees	1
NATIVE SPECIES	**9.8/20**
Native canopy species	3
Native midstory species	1
Native herb/forb species	0.75
Native graminoid species	1
Native macrophyte species	4
SPECIES COVER	**14.8/20**
Canopy species	2.5
Midstory species	2.25
Herb/forb species	3
Graminoid species	4
Macrophyte species	3
DEBRIS	**11/20**
Total leaf litter	3
Native leaf litter	1.5
Dead trees standing	2
Dead trees fallen	0
Lying logs	1.5
Fringing vegetation	3
MANAGEMENT	**8/20**
Tree clearing	2.5
Fencing	0
Animal impact	0
Canopy Health	1.5
Exposed tree roots	2
Native woody regeneration	2
Weedy woody regeneration	0
TOTAL	**55.2/100**

BUCC 2

Site: The original riparian vegetation community at Bucrabendinni Creek 2 (BUCC2, Plate 3.25) was described as 'Riparian subtropical rainforest with River Oak emergents on lowland creek flats' (NAM_RF05), a listed TEC (OEH 2015), grading into 'Flooded Gum moist open forest of sheltered lower slopes and gullies' (NAM_WSF01). BUCC2 received a low riparian condition score of 57.8, a grade of D+ (Table 3.26).

Dominant Species: The dominant canopy species present were the native species River Oak (*Casuarina cunninghamiana* subsp. *cunninghamiana*), Flooded Gum (*Eucalyptus grandis*), White Cedar (*Melia azedarach*) and Watergum (*Tristaniopsis laurina*). Dominant native midstory species included Sweet Pittosporum (*Pittosporum undulatum*), Maidens Wattle (*Acacia maidenii*), Cheese Tree (*Glochidion fernandi*) and Sandpaper Fig (*Ficus coronata*), along with the exotic species Wild Tobacco (*Solanum mauritianum*), Lantana (*Lantana camara*), Arsenic Bush (*Senna septemtrionalis*). The understory was dominated by native species Soft Lomandra (*Lomandra hystrix*), Knotweeds (*Persicaria stigosa* and *P.hydropiper*), Scurvy Weed (*Commelina cyanea*), along with exotic species Peppermint (*Mentha* x *rotundifolia*), Silver-leaved Desmodium (*Desmodium uncinatum*), Taro (*Calocasia esculenta*), Pigeon Grass (*Setaria Sphacelata*) and Barnyard Grass (*Echinochloa crus-gali*). Dominant vine species included Cissus species (*Cissus antarctica* and *C.hypoglauca*), Native Raspberry (*Rubus rosifolius*), Sweet Sarsaparilla (*Smilax glyciphylla*) and the exotic species Balloon Vine (*Cardiospermum grandiflorum*), while a rich macrophyte layer included Water Primrose (*Ludwidgia peploides*), Potomogeton (*Potomogeton octandrus*), Triangular Club Rush (*Schoenoplectiella mucronata*) and Water Couch (*Paspalum distichum*).

Noxious weed species: Noxious weed species observed on-site were Lantana (*Lantana camara*), Privet species (*Ligustrum lucidum* and *L.sinense*), Arsenic Bush (*Senna septemtrionalis*), Crofton Weed (*Ageratina adenophora*) and Balloon Vine (*Cardiospermum grandiflorum*).

Summary: Bucrabendinni Creek 2 was a highly disturbed closed-forest system with a mixed-aged native canopy and a mix of native and exotic species throughout the midstory and understory structural layers in a partially cleared, predominantly forested rural landscape. The surrounding landuse was primarily agricultural grazing land and forestry, beyond which was forested private land and State Conservation Area. Significant remnant stands of vegetation surrounded the site on private land, 500m to the north and 2.5km to the southeast in Buckrabeninni State Forest and 900m to the northwest and 1.8km to the south in Gumbaynggirr State Conservation Area. While representative elements of the remnant vegetation communities were present in all of the structural layers present they were sometimes scarce, with BUCC2 scoring well for the Cover subindex, moderately for Habitat and poorly for Native Species, Debris and Management subindices (Table 3.26). Riparian condition was affected by reduced riparian vegetation width and poor continuity and the prevalence and regeneration of weed and noxious weed species throughout the midstory and understory structural layers. Reduced levels of cover in the canopy and midstory layers, limited large woody debris, inadequate riparian fencing and occasional animal impact also contributed to the reduction in riparian grade at this site.

***Plate 3.25** Despite possessing good native vegetation cover in the forested areas adjacent to the riparian zone, riparian condition at BUCC2 was considered to be a highly disturbed system. This was primarily due to reduced riparian width and poor continuity, the dominance of weed and noxious weed species in the midstory and understory structural layers, reduced cover in the canopy and midstory structural layers and low levels of large woody debris.*

Table 3.26 *Site-level assessments of riparian condition in 2016-17 at BUCC2 showing scores for the five subindices and their individual indicators that comprise the Vegetation Condition Index.*

Bucrabendinni Creek 2	Scores
HABITAT	**14.3/20**
Channel width	2.3
Proximity	4
Continuity	1
Layers	4
Large native trees	2
Hollow-bearing trees	1
NATIVE SPECIES	**9/20**
Native canopy species	4
Native midstory species	1
Native herb/forb species	0.5
Native graminoid species	0.5
Native macrophyte species	3
SPECIES COVER	**16.5/20**
Canopy species	1.5
Midstory species	3
Herb/forb species	4
Graminoid species	4
Macrophyte species	4
DEBRIS	**8.5/20**
Total leaf litter	2.5
Native leaf litter	1.5
Dead trees standing	0
Dead trees fallen	0
Lying logs	1.5
Fringing vegetation	3
MANAGEMENT	**9.5/20**
Tree clearing	1
Fencing	1
Animal impact	2
Canopy Health	1.5
Exposed tree roots	3
Native woody regeneration	1
Weedy woody regeneration	0
TOTAL	**57.8/100**

BUCC 1

Site: The original riparian vegetation community at Bucrabendinni Creek 1 (BUCC1, Plate3.26) was described as 'Riparian subtropical rainforest with River Oak emergents on lowland creek flats' (NAM_RF05), a listed TEC (OEH 2015) and an invading exotic vegetation community of 'Camphor Laurel, Lantana and Privet' (NAM_EX02-03-04). BUCC1 received a poor riparian condition score of 49.7, a grade of D- (Table 3.27).

Dominant Species: The dominant canopy species present were the native species River Oak (*Casuarina cunninghamiana* subsp. *cunninghamiana*), Watergum (*Tristaniopsis laurina*) and Hard Quandong (*Elaeocarpus obovatus*) along with the exotic species Camphor Laurel (*Cinnamomum camphora*). Dominant native midstory species included Sandpaper Fig (*Ficus coronata*), Brush Cherry (*Syzygium australe*) and Ironwood (*Backhousia myrtifolia*), along with the exotic species Lantana (*Lantana camara*), Wild Tobacco (*Solanum mauritianum*) and Broad-leaved Privet (*Ligustrum lucidum*). The understory was dominated by native species Soft Lomandra (*Lomandra hystrix*), Common Rush (*Juncus ursitatus*), Knotweeds (*Persicaria stigosa* and *P.hydropiper*), Harsh Ground Fern (*Hypolepis muelleri*) and Couch (*Cynodon dactylon*), along with exotic species Purple Top (*Verbena bonariensis*), Turnip Weed (*Rapistrum rugosum*), Blue Billy Goat Weed (*Ageratum houstonianum*), Sidratusa (*Sida rhombifolia*), Wandering Jew (*Tradescantia fluminensis*), Umbrella Sedge (*Cyperus eragrostis*), Cobblers Pegs (*Bidens pilosa*), Rhodes Grass (*Chloris gayana*) and Paspalum species (*Paspalum dilatatum* and *P.mandiocanum*). Dominant vine species included Cockspur Thorn (*Maclura cochinchinensis*) and the exotic species Balloon Vine (*Cardiospermum grandiflorum*), while the macrophyte layer included Potomogeton (*Potomogeton ochtandrus*), Water Primrose (*Ludwidgia peploides*) and the exotic species Giant Water Lily (*Nymphaea* sp.).

Noxious weed species: Noxious weed species observed on-site were Camphor Laurel (*Cinnamomum camphora*), Lantana (*Lantana camara*), Broad-leaved Privet (*Ligustrum lucidum*), Mistflower (*Ageratina riparia*), Noogoora Burr (*Xanthium occidentale*), Fireweed (*Senecio madagascariensis*), Wandering Jew (*Tradescantia fluminensis*) and Balloon Vine (*Cardiospermum grandiflorum*).

Summary: Bucrabendinni Creek 1 was a very highly disturbed closed-forest system with a partially remnant, predominantly exotic, mixed-aged canopy and a mix of native and exotic species throughout all structural layers, in a predominantly cleared, partially forested rural landscape. The surrounding landuse was primarily agricultural grazing land and dairy country, beyond which was forested private land and State Forest. Significant remnant stands of vegetation lie 1.6km to the west and 1.2km north on private land. While representative elements of the remnant vegetation communities were present in all of the structural layers present they were sometimes scarce, with BUCC1 scoring moderately for Habitat, Cover and debris subindices, poorly for Management and very poorly for the Native Species subindex (Table 3.27). Riparian condition was affected by poor habitat connectivity, reduced connectivity and riparian vegetation width and the prevalence and regeneration of weed and noxious weed species throughout all structural layers. Reduced levels of cover in the canopy and midstory, a reduction in native leaf litter and standing woody debris and inadequate riparian fencing and animal impact also contributed to the reduction in riparian grade at this site.

Plate 3.26 *Riparian vegetation condition at BUCC1 was poor and considered to be a very highly disturbed system. This was primarily due to poor habitat connectivity and reduced vegetation width and continuity, the dominance of weed and noxious weed species throughout all structural layers and the presence of livestock throughout the riparian zone.*

Table 3.27 *Site-level assessments of riparian condition in 2016-17 at BUCC1 showing scores for the five subindices and their individual indicators that comprise the Vegetation Condition Index.*

Bucrabendinni Creek 1	**Scores**
HABITAT	**10.7/20**
Channel width	1.7
Proximity	0
Continuity	2
Layers	4
Large native trees	2
Hollow-bearing trees	1
NATIVE SPECIES	**4.5/20**
Native canopy species	1
Native midstory species	0.5
Native herb/forb species	0.5
Native graminoid species	0.5
Native macrophyte species	2
SPECIES COVER	**14/20**
Canopy species	1.5
Midstory species	1.5
Herb/forb species	4
Graminoid species	4
Macrophyte species	3
DEBRIS	**13/20**
Total leaf litter	3
Native leaf litter	1
Dead trees standing	2
Dead trees fallen	1
Lying logs	4
Fringing vegetation	2
MANAGEMENT	**7.5/20**
Tree clearing	2
Fencing	1
Animal impact	0
Canopy Health	0.5
Exposed tree roots	3
Native woody regeneration	1
Weedy woody regeneration	0
TOTAL	**49.7/100**

SOUC 3

Site: The original riparian vegetation community at South Creek 3 (SOUC3, Plate 3.27) was described as 'Riparian subtropical rainforest with River Oak emergents on lowland creek flats' (NAM_RF05), a recognised TEC) (OEH 2015), with the current midstory dominated by the exotic vegetation community 'Lantana' (NAM_EX04). SOUC3 received a low riparian condition score of 57.8, a grade of D+ (Table 3.28).

Dominant Species: The dominant canopy species present were the native species River Oak (*Casuarina cunninghamiana* subsp. *cunninghamiana*) and White Cedar (*Melia azedarach*). Dominant native midstory species included Sandpaper Fig (*Ficus coronata*), Maiden's Wattle (*Acacia madenii*), Cheese Tree (*Glochidion fernandi*) and the exotic species Lantana (*Lantana camara*), Wild Tobacco (*Solanum mauritianum*) and Castor Oil Plant (*Ricinus communis*). The understory was dominated by native species Soft Lomandra (*Lomandra hystrix*), Gristle Fern (*Blechnum cartilagineum*), Knotweed (*Persicaria hydropiper*), Couch (*Cynodon dactylon*), along with exotic species Spear Thistle (*Cirsium vulgare*), Blue Billy Goat Weed (*Ageratum houstonianum*), Fireweed (*Senecio madagascariensis*), Polka Dot Plant (*Hypoestes phyllostachya*), Wandering Jew (*Tradescantia fluminensis*) and Paspalum species (*Paspalum dilatatum* and *P.mandiocanum*). Dominant vine species included Cockspur Thorn (*Maclura cochinchinensis*) and the exotic species Common Passionfruit (*Passiflora* sp.) and Glory Lily (*Gloriosa superba*). While the macrophyte layer included Potomogeton (*Potomogeton ochtandrus*) and Freshwater Eelgrass (*Vallisneria nana*).

Noxious weed species: Noxious weed species observed on-site were Lantana (*Lantana camara*), Castor Oil Plant (*Ricinus communis*), Crofton Weed (*Ageratina adenophora*), Annual Ragweed (*Ambrosia artemisiifolia*), Mistflower (*Ageratina riparia*), Fireweed (*Senecio madagascariensis*), Polka Dot Plant (*Hypoestes phyllostachya*), Wandering Jew (*Tradescantia fluminensis*) and Glory Lily (*Gloriosa superba*).

Summary: South Creek 3 was a highly disturbed closed-forest system with a mixed-aged canopy and a mix of native and exotic species throughout the midstory and understory structural layers, in a predominantly cleared/forested rural landscape. The surrounding landuse was primarily agricultural grazing land, beyond which was State Forest, National Park and forested private land. Significant remnant stands of vegetation surround the site on private land 300m to the south and 500m to the north and beyond in Mistake State Forest and Dunggir National Park. While representative elements of the remnant vegetation communities were present in all of the structural layers present they were sometimes scarce, particularly in the midstory. SOUC3 scored well for Habitat and Cover subindices, moderately for Native Species, Management and poorly for the Debris subindex (Table 3.28). Riparian condition was affected by reduced riparian width and the presence and regeneration of weed and noxious weed species, particularly in the midstory and understory structural layers. Reduced levels of cover, particularly in the canopy, reduced levels of fringing vegetation, woody and non-woody debris, limited habitat trees and inadequate riparian fencing and animal impact also contributed to the reduction in riparian grade at this site.

***Plate 3.27** Despite possessing good vegetation cover in the canopy layer riparian veetation at SOUC3 was low and considered to be a highly disturbed system. This was primarily due to reduced riparian vegetation width, the dominance of weed and noxious weed species, particularly in the midstory, reduced woody and non-woody debris and the presence of livestock throughout the riparian zone.*

Table 3.28 *Site-level assessments of riparian condition in 2016-17 at SOUC3 showing scores for the five subindices and their individual indicators that comprise the Vegetation Condition Index.*

South Creek 3	Scores
HABITAT	**15/20**
Channel width	2
Proximity	3
Continuity	3
Layers	4
Large native trees	2
Hollow-bearing trees	1
NATIVE SPECIES	**11/20**
Native canopy species	4
Native midstory species	1
Native herb/forb species	1
Native graminoid species	1
Native macrophyte species	4
SPECIES COVER	**15/20**
Canopy species	2
Midstory species	3
Herb/forb species	4
Graminoid species	4
Macrophyte species	2
DEBRIS	**6.8/20**
Total leaf litter	1.8
Native leaf litter	2
Dead trees standing	0
Dead trees fallen	0
Lying logs	1
Fringing vegetation	2
MANAGEMENT	**10/20**
Tree clearing	2
Fencing	1
Animal impact	1
Canopy Health	2
Exposed tree roots	3
Native woody regeneration	1
Weedy woody regeneration	0
TOTAL	**57.8/100**

SOUC 2

Site: The original riparian vegetation community at South Creek 2 (SOUC2, Plate 3.28) was described as 'Weeping Lilly Pilly dry riparian rainforest' (NAM_RF09), a recognised TEC (OEH 2015) and 'Riparian subtropical rainforest with River Oak emergents on lowland creek flats' (NAM_RF05) with the current vegetation dominated by the exotic vegetation community 'Camphor Laurel, Lantana and Privet' (NAM_EX02-03-04). SOUC2 received a poor riparian condition score of 47, a grade of D- (Table 3.29).

Dominant Species: The dominant canopy species present were the native species Weeping Lilly Pilly (*Waterhousea floribunda*), Watergum (*Tristaniopsis laurina*) and River Oak (*Casuarina cunninghamiana* subsp. *cunninghamiana*), along with the exotic species Camphor Laurel (*Cinnamomum camphora*) and Willow (*Salix* sp.). Dominant native midstory species included Silver Weeping Tea Tree (*Leptospermum brachyandrum*), Sandpaper Fig (*Ficus coronata*) and Hickory Wattle (*Acacia implexa*), along with the exotic species Lantana (*Lantana camara*) and Privet species (*Ligustrum lucidum* and *L.sinense*). The understory was dominated by native species Soft Lomandra (*Lomandra hystrix*), Common Bracken (*Pteridium esculentum*), Common Rush (*Juncus ursitatus*), Knotweeds (*Persicaria hydropiper* and *P.strigosa*) and Couch (*Cynodon dactylon*), along with exotic species Purple Top (*Verbena bonariensis*), Mistflower (*Ageratina riparia*), Blue Billy Goat Weed (*Ageratum houstonianum*), Pigeon Grass (*Setaria sphacelata*), Paspalum species (*Paspalum dilatatum* and *P.mandiocanum*) and Prarie Grass (*Bromus catharticus*). The only vine species present was the native species Cockspur Thorn (*Maclura cochinchinensis*) while the macrophyte layer included Water Primrose (*Ludwgia peploides*), Duck Weed (*Azola pinata*), Potomogeton (*Potomogeton ochtandrus*) and the exotic species Giant Water Lily (*Nymphaea* sp.).

Noxious weed species: Noxious weed species observed on-site were Camphor Laurel (*Cinnamomum camphora*), Willow (*Salix* sp.), Lantana (*Lantana camara*), Broad-leaf Privet (*Ligustrum lucidum*), Small-leaved Privet (*Ligustrum sinense*), Mistflower (*Ageratina riparia*), Crofton Weed (*Ageratina adenophora*), Narrow-leaved Rattlepod (*Crotalaria lanceolata*) and Fireweed (*Senecio madagascariensis*).

Summary: South Creek 2 was a very highly disturbed closed-forest system with a partially remnant, predominantly exotic, mixed-aged canopy and a mix of native and exotic species throughout all structural layers, in a predominantly cleared, partially forested rural landscape. The surrounding landuse was primarily agricultural grazing land and horticulture, beyond which was urban settlement and forested private land. Significant remnant stands of vegetation lie 1.2km west and 1.6km south on private land. While representative elements of the remnant vegetation communities were present in all of the structural layers present they were sometimes scarce, with SOUC2 scoring moderately for Habitat, Cover and Debris subindices and poorly for Native Species and Management subindices (Table 3.29). Riparian condition was affected by poor habitat connectivity, reduced riparian vegetation width and the prevalence and regeneration of weed and noxious weed species throughout all structural layers, particularly in the canopy and midstory structural layers of the Weeping Lilly Pilly vegetation community (NAM_RF09). The absence of habitat trees, reduced macrophyte cover and large woody debris, exposed tree roots and inadequate riparian fencing and animal impact also contributed to the reduction in riparian grade at this site.

Plate 3.28 *Despite possessing good vegetation cover in the canopy and midstory layers riparian vegetation at SOUC2 was poor and considered to be a very highly disturbed system. This was primarily due to poor habitat connectivity, the dominance of weed and noxious weed species throughout all structural layers and the presence of livestock throughout the riparian zone.*

Table 3.29 *Site-level assessments of riparian condition in 2016-17 at SOUC2 showing scores for the five subindices and their individual indicators that comprise the Vegetation Condition Index.*

South Creek 2	Scores
HABITAT	**10/20**
Channel width	3
Proximity	0
Continuity	2.5
Layers	4
Large native trees	0.5
Hollow-bearing trees	0
NATIVE SPECIES	**5/20**
Native canopy species	0.5
Native midstory species	0.5
Native herb/forb species	0.5
Native graminoid species	0.5
Native macrophyte species	3
SPECIES COVER	**14/20**
Canopy species	3
Midstory species	4
Herb/forb species	3
Graminoid species	2
Macrophyte species	2
DEBRIS	**12.5/20**
Total leaf litter	3
Native leaf litter	0..5
Dead trees standing	0
Dead trees fallen	2
Lying logs	4
Fringing vegetation	3
MANAGEMENT	**5.5/20**
Tree clearing	2
Fencing	0
Animal impact	0
Canopy Health	1.5
Exposed tree roots	1
Native woody regeneration	1
Weedy woody regeneration	0
TOTAL	**47/100**

SOUC 1

Site: The original riparian vegetation community at South Creek 1 (SOUC1, Plate 3.29) was described as 'Weeping Lilly Pilly dry riparian rainforest' (NAM_RF09), a recognised TEC (OEH 2015) and the exotic vegetation community 'Camphor Laurel, Lantana and Privet' (NAM_EX02-03-04). SOUC1 received a low riparian condition score of 58.8, a grade of D+ (Table 3.30).

Dominant Species: The dominant canopy species present were the native species Weeping Lilly Pilly (*Waterhousea floribunda*), Watergum (*Tristaniopsis laurina*) and River Oak (*Casuarina cunninghamiana* subsp. *cunninghamiana*), along with the exotic species Camphor Laurel (*Cinnamomum camphora*) and Cockspur Coral tree (*Erythrina crista-galli*). Dominant native midstory species included Sandpaper Fig (*Ficus coronata*) and Hickory Wattle (*Acacia implexa*), along with the exotic species Lantana (*Lantana camara*), Broad-leaf Privet (*Ligustrum lucidum*) and Small-leaved Privet (*Ligustrum sinense*). The understory was dominated by native species Soft Lomandra (*Lomandra hystrix*), Knotweed (*Persicaria hydropiper*), Common Bracken (*Pteridium esculentum*), Common Rush (*Juncus ursitatus*), Slender Rat's Tail Grass (*Sporobolus crebra*) and Couch (*Cynodon dactylon*), along with exotic species Wandering Jew (*Tradescantia fluminensis*), Blue Billy Goat Weed (*Ageratum houstonianum*), Sidratusa (*Sida rhombifolia*), Paspalum species (*Paspalum mandiocanum* and *P.dilatatum*), Pigeon Grass (*Setaria sphacelata*) and Rhodes Grass (*Chloris gayana*). Dominant vine species included the two exotic species Morning Glory (*Ipomoea indica*) and Balloon Vine (*Cardiospermum grandiflorum*). The macrophyte layer included Blunt Pondweed (*Potomogeton ochreatus*), Duck Weed (*Azolla pinata*) and the exotic species Salvinia (*Salvinia molesta*).

Noxious weed species: Noxious weed species observed on-site were Camphor Laurel (*Cinnamomum camphora*), Cockspur Coral tree (*Erythrina crista-galli*), Lantana (*Lantana camara*), Broad-leaf Privet (*Ligustrum lucidum*) and Small-leaved Privet (*Ligustrum sinense*), Mistflower (*Ageratina riparia*), Noogoora Burr (*Xanthium occidentale*), Wandering Jew (*Tradescantia fluminensis*), Morning Glory (*Ipomoea indica*), Balloon Vine (*Cardiospermum grandiflorum*) and Salvinia (*Salvinia molesta*).

Summary: South Creek 1 was a highly disturbed closed-forest system with a partially remnant/mixed-aged canopy and a mix of native and exotic species throughout all structural layers in a predominantly cleared, partially forested rural/urban landscape. The surrounding landuse was both agricultural grazing land and urban settlement, beyond which were dairies, forested country on private land and a water storage facility. Significant remnant stands of vegetation lie in private land 1.3km south and 3.3km north of the site in Viewmont State Forest and adjacent lands. Representative elements of the remnant vegetation community were present in the canopy but sparse in other structural layers, with SOUC1 scoring well for the Cover subindex, moderately for Habitat and Debris, and poorly for Native Species and Management subindices (Table 3.30). Riparian condition was affected by poor habitat connectivity and the prevalence and regeneration of weed and noxious weed species throughout all structural layers. Reduced levels of native non-woody debris and inadequate riparian fencing and subsequent animal impact also contributed to the reduction in riparian grade at this site.

Plate 3.29 *Despite possessing good vegetation cover in the canopy and midstory layers riparian vegetation at SOUC1 was a highly disturbed system. This was primarily due to the dominance of weed and noxious weed species throughout all structural layers, poor habitat connectivity and the presence of livestock throughout the riparian zone.*

Table 3.30 *Site-level assessments of riparian condition in 2016-17 at SOUC1 showing scores for the five subindices and their individual indicators that comprise the Vegetation Condition Index.*

South Creek 1	Scores
HABITAT	**13.3/20**
Channel width	3.3
Proximity	0
Continuity	3
Layers	4
Large native trees	2
Hollow-bearing trees	1
NATIVE SPECIES	**5.5/20**
Native canopy species	1
Native midstory species	1
Native herb/forb species	0.5
Native graminoid species	1
Native macrophyte species	2
SPECIES COVER	**18/20**
Canopy species	3
Midstory species	4
Herb/forb species	4
Graminoid species	4
Macrophyte species	3
DEBRIS	**14/20**
Total leaf litter	3
Native leaf litter	1
Dead trees standing	2
Dead trees fallen	1
Lying logs	4
Fringing vegetation	3
MANAGEMENT	**8/20**
Tree clearing	2.5
Fencing	1
Animal impact	0
Canopy Health	1.5
Exposed tree roots	2
Native woody regeneration	1
Weedy woody regeneration	0
TOTAL	**58.8/100**

NEWC1

Site: The original riparian vegetation community at Newee Creek 1 (NEWC1, Plate 3.30) was described as 'Grey Mangrove - River Mangrove low open or closed forest or shrubland of intertidal flats' (NAM_FOR01), grading into 'Saltwater Couch - Samphire saltmarsh of low-lying estuarine areas' (NAM_SW04) and 'Swamp Oak forested wetland of saline areas of coastal estuaries' (NAM_ForW01) both listed TEC's (OEH 2015). NEWC1 received a very good riparian condition score of 80.7, a grade of B (Table 3.31).

Dominant species: The dominant canopy species present were the native species River Mangrove (*Aegiceras corniculatum*) and Grey Mangrove (*Avicennia marina* subsp. *australasica*) and Swamp Oak (*Casuarina glauca*). Dominant native midstory species included juvenile canopy species, while the understory consisted of estuarine saltmarsh and macrophyte species including Sea Rush (*Juncus krausii* subsp. *australiensis*), Sand Couch (*Sporobolus* spp.), Samphire (*Sarcocornia quinqueflora*) and Common Reed (*Phragmites australis*).

Noxious weed species: No weed or noxious weed species were observed on-site.

Summary: Newee Creek 1 was a low disturbance open-saltmarsh/closed-forest system with a partially remnant canopy and all structural layers dominated by native species in a predominantly forested/cleared rural-coastal landscape. The immediate surrounding landuse was Crown Reserve and private land, beyond which was agricultural grazing country, transport networks and urban settlement. Significant remnant stands of vegetation surround the site in the form of Newee Creek Swamp located on both Crown Reserve and private land and an area of vegetation which has previously been recognised as both 'suitable for environmental protection' and 'unprotected significant habitat' (BMT WBM 2008). Representative elements of the remnant vegetation communities were retained in all structural layers, with NEWC1 scoring full marks for the Native Species subindex, well for Habitat, Cover subindices and moderately for Debris and Management subindices (Table 3.31). Riparian condition was affected by reduced levels of cover in the midstory and macrophyte structural layers and by a reduction in both woody and non-woody debris. Limited habitat trees, root exposure of fringing woody vegetation, inadequate riparian fencing and animal impact also contributed to the reduction in riparian grade at this site.

Plate 3.30 *Riparian vegetation condition at NEWC1 was very good and considered to be of low disturbance. This was mainly attributed to the dominance of native species throughout all structural layers and the presence of livestock in the riparian zone.*

Table 3.31 *Site-level assessments of riparian condition in 2016-17 at NEWC1 showing scores for the five subindices and their individual indicators that comprise the Vegetation Condition Index.*

Newee Creek 1	Scores
HABITAT	**18.7/20**
Channel width	3.7
Proximity	4
Continuity	4
Layers	4
Large native trees	2
Hollow-bearing trees	1
NATIVE SPECIES	**20/20**
Native canopy species	4
Native midstory species	4
Native herb/forb species	4
Native graminoid species	4
Native macrophyte species	4
SPECIES COVER	**18/20**
Canopy species	4
Midstory species	3
Herb/forb species	4
Graminoid species	4
Macrophyte species	3
DEBRIS	**13/20**
Total leaf litter	2
Native leaf litter	3
Dead trees standing	1
Dead trees fallen	1
Lying logs	2
Fringing vegetation	4
MANAGEMENT	**11/20**
Tree clearing	3
Fencing	0
Animal impact	0
Canopy Health	1.5
Exposed tree roots	2.5
Native woody regeneration	2
Weedy woody regeneration	2
TOTAL	**80.7/100**

3.3.4 Water quality

Nambucca River tributaries received a low overall score of 49 (D-) for water quality, a slightly below average score for the Nambucca Catchment. Together the Nambucca River tributaries included three freshwater tributaries made up of six sites (MISC1, BUCC2, BUCC1, SOUC3, SOUC2 and SOUC1) and one site on the single estuarine tributary (NEWC1). Of the freshwater tributaries, Missabotti Creek received a score 49 (D-), Buckrabendinni Creek received a mean score of 51 (D), South Creek received a mean score of 52 (D), while the estuarine tributary of Newee Creek received a score of 38 (F). Figure 3.11 shows the key physico-chemical and nutrient variables used in the assessment of water quality for the Nambucca River tributaries. Ranges and means for these variables are given in Tables 3.32 to 3.35 and the exceedances are given in Table 3.36.

pH generally remained towards the lower end of the neutral range, occasionally falling below minimum ANZECC and OEH exceedances at all sites. No tributary site exceeded the maximum pH exceedance at any time during the sampling period. The lowest pH was observed at SOUC3 with a value of 6.07. Two of the seven tributary sites exceeded turbidity guidelines, with OEH guidelines consistently exceeded at NEWC1 and on one single occassion at SOUC1, with the latter a significant exceedance of the ANZECC lowland freshwater guideline at 66NTU.

All Nambucca River tributaries frequently exceeded the ANZECC and OEH minimum guidelines for DO%, with the three South Creek sites and Buckrabendinni at BUCC1 below the minimum ANZECC guidelines for DO% on all sampling occassions. Lowest observed DO% of 34.3% were observed at both BUCC1 and SOUC3. Low concentrations of DO% like these can significantly impact aquatic biota such as fish.

Nitrogen was high (both total and bioavailable) across all Nambucca River tributaries during the study period. Both freshwater and estuarine nitrogen guideline values were frequently exceeded with a peak TN concentration exceedance of 1654.8µg/L observed at NEWC1, eight times greater than the OEH guidelines for lower estuaries. The highest NOx concentration of of 464.1µg/L was observed at SOUC1, a value 11 times greater than the ANZECC guideline for lowland freshwater systems.

Total phosphorus concentrations were highly variable across the tributary sites. However, all sample sites in the tributaries exceeded ANZECC and OEH nutrient trigger values for TP on at least two sampling occasions and on five of six sampling occasions at BUCC1, SOUC1 and NEWC1. The highest TP concentration of 542µg/L was observed at BUCC1, 21 times greater than the ANZECC guideline for lowland streams. Bioavailable phosphorus (SRP) was generally low thoughout the tributaries; however, guideline values were occasionally exceeded in Newee Creek, Buckrabendinni and in Missabotti Creek. Similarly to TN and TP, the highest concentration of SRP was again observed at BUCC1, with a reading of 34.3µg/L (Table 3.33). It is worth investigating sources of phosphorus to Buckrabendinni Creek, for example the use of dairy effluent to fertigate improved pasture or green fodder crops close drainage lines.

Concentrations of Chl-a and exceedances of guideline values varied among tributaries. BUCC1 recorded the highest concentration of chl-a, with a very high concentration of 93.6µg/L or 31 times greater than the ANZECC guideline for lowland freshwater systems (Table 3.33). At the time of the February sampling period, this particularly high Chl-a concentration coincided with exceedances in TN, TP and NOX and followed the peak TP concentration (542.1µg/L) observed in December 2016. However, high Chl-a concentrations did not persist through following sampling occasions. Exceedances of Chl-a guideline values were occasional to frequent in South Creek, frequent in Newee Creek, occasional in BUCC1 and absent in BUCC2 and MISC1 (Table 3.36) . WQ stress variables (pH, DO, EC, turbidity, and nutrients) in the Nambucca River Tributaries suggest that these systems are strongly influenced by surrounding landuse practices. However, generally low concentrations in the response variable (Chl-a) suggest that these systems possess some resilience to high nutrient concentrations. This resilience may be in part due to the filtering effect of the gravels that comprise the streambeds (that is, hyporheic exchange), and to the extensive macrophyte beds observed at many sites.

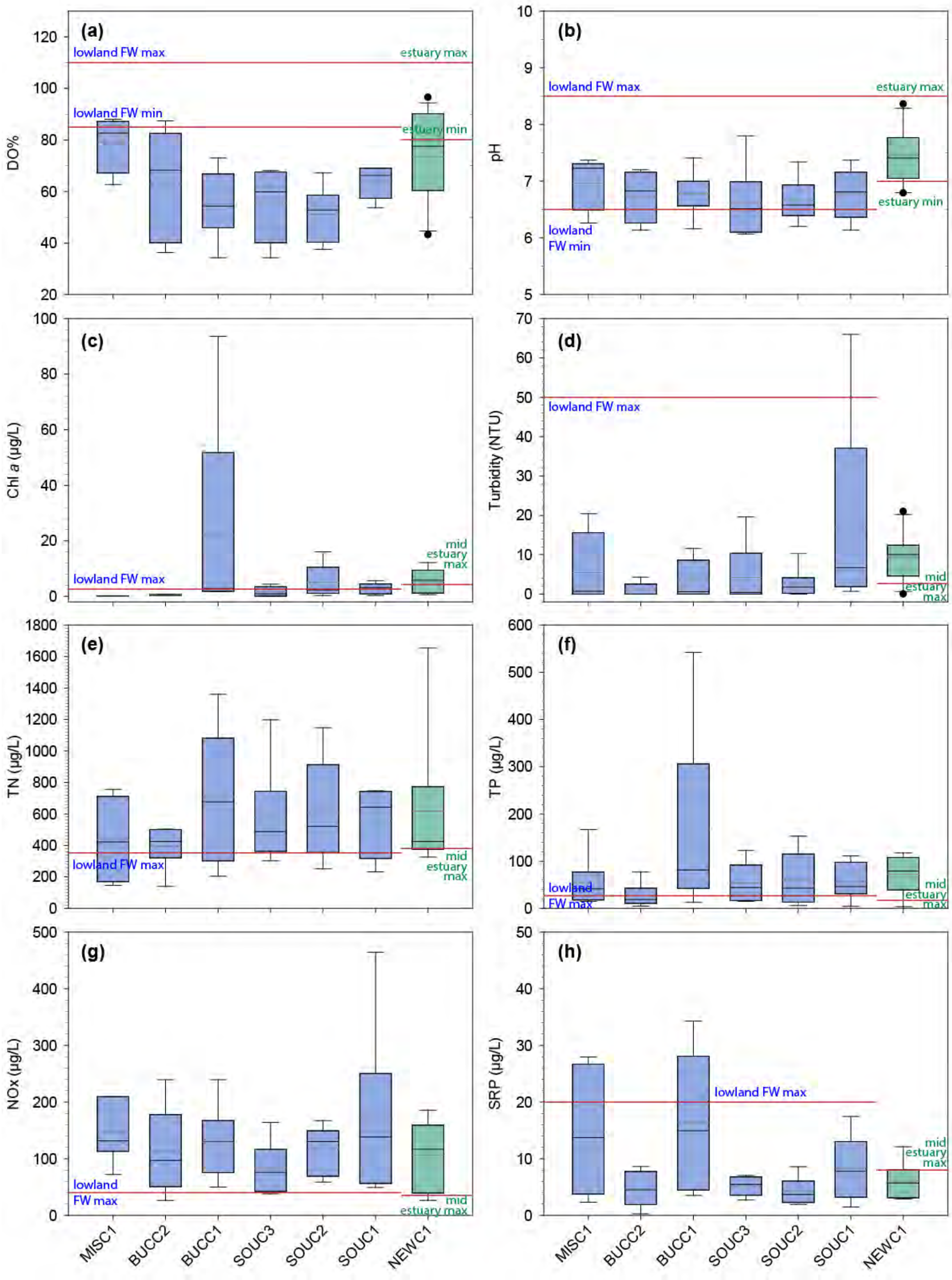


Figure 3.11 *Mean (grey line), median (black line), 25th and 75th percentiles, and range of water quality variables in the tributaries of the Nambucca River (North Arm) from 2016-2017. Outliers are represented by black dots. Green and blue boxes represent estuary and freshwater sites, respectively. Red lines represent the relevant maximum or minimum guideline value for each type of system.*

Table 3.32 *Minimums, maximums and means of measured water quality variables for the one site MISC1 on Missabotti Creek.*

	MISC1		
Variable	**Min**	**Max**	**Mean**
Temperature	17.45	26.32	21.98
pH	6.26	7.37	6.97
EC	0.07	0.09	0.08
Salinity (PPT)	0.04	0.05	0.04
DO (mg/L)	6.13	7.77	7.28
DO %	62.70	88.00	79.05
Turbidity	0.00	20.40	5.45
Chla (µg/L)	0.00	0.22	0.09
TSS (mg/L)	0.30	4.06	2.01
TN (µg/L)	145.70	754.42	436.43
TP (µg/L)	15.13	166.66	55.08
NOx (µg/L)	72.24	209.34	146.84
SRP (µg/L)	2.32	27.94	14.70

Table 3.33 *Minimums, maximums and means of measured water quality variables for the two sites BUCC2 and BUCC1 in Buckrabendinni Creek.*

	BUCC2			BUCC1		
Variable	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**
Temperature	15.61	26.61	21.75	14.11	28.02	20.96
pH	6.14	7.20	6.73	6.16	7.41	6.78
EC	0.09	0.12	0.10	0.15	0.21	0.18
Salinity (PPT)	0.05	0.06	0.05	0.07	0.10	0.09
DO (mg/L)	3.60	7.56	5.73	3.46	6.45	5.01
DO %	36.30	87.40	62.74	34.30	73.00	55.10
Turbidity	0.00	4.30	1.02	0.00	11.60	3.40
Chla (µg/L)	0.26	0.79	0.52	1.79	93.60	22.01
TSS (mg/L)	0.67	3.40	1.76	1.49	8.36	5.14
TN (µg/L)	139.66	503.31	395.39	204.32	1359.82	706.66
TP (µg/L)	4.66	77.12	27.08	12.66	542.12	166.10
NOx (µg/L)	26.41	239.46	112.55	50.17	239.46	129.52
SRP (µg/L)	0.30	8.64	4.64	3.51	34.31	16.41

Table 3.34 *Minimums, maximums and means of measured water quality variables for the three sites SOUC3, SOUC2 and SOUC1 on South Creek.*

	SOUC3			SOUC2			SOUC1		
Variable	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**
Temperature	13.40	27.63	20.56	12.11	28.34	20.15	12.51	27.71	20.64
pH	6.07	7.80	6.62	6.20	7.34	6.66	6.14	7.37	6.78
EC	0.10	0.17	0.13	0.21	0.48	0.34	0.20	0.32	0.28
Salinity (PPT)	0.05	0.08	0.06	0.10	0.23	0.16	0.09	0.15	0.13
DO (mg/L)	3.41	6.74	5.07	3.35	6.97	5.14	4.51	6.82	6.07
DO %	34.30	68.10	55.27	37.50	67.20	51.22	53.70	69.10	63.82
Turbidity	0.00	19.60	4.24	0.00	10.30	2.70	0.70	66.00	16.92
Chla (µg/L)	0.11	4.45	1.61	0.34	16.06	5.12	0.33	5.64	2.80
TSS (mg/L)	0.61	6.00	3.88	1.63	10.43	5.51	3.40	15.20	7.79
TN (µg/L)	302.55	1197.97	574.68	251.40	1147.21	610.40	232.20	746.14	558.18
TP (µg/L)	14.90	122.66	53.89	5.74	153.12	60.40	4.24	111.13	56.82
NOx (µg/L)	37.89	164.16	82.93	58.73	167.22	116.99	49.37	464.14	171.38
SRP (µg/L)	2.74	7.03	5.20	1.93	8.59	4.25	1.46	17.47	8.30

Table 3.35 *Minimums, maximums and means of measured water quality variables for the one site NEWC1 on Newee Creek.*

	NEWC1		
Variable	**Min**	**Max**	**Mean**
Temperature	15.30	27.07	22.20
pH	6.79	8.36	7.46
EC	24.60	49.60	41.41
Salinity (PPT)	14.55	32.52	25.91
DO (mg/L)	2.95	8.54	5.88
DO %	43.20	96.50	73.57
Turbidity	0.00	21.00	9.36
Max Depth	1.40	1.80	1.62
Chla (µg/L)	0.58	12.14	5.45
TSS (mg/L)	9.70	38.92	22.39
TN (µg/L)	325.88	1654.82	616.41
TP (µg/L)	3.15	117.66	72.30
NOx (µg/L)	26.41	185.55	106.60
SRP (µg/L)	2.88	12.10	6.04

Table 3.36 *Exceedances[1] observed in tributaries of the Nambucca River for pH, conductivity (EC), percent saturated dissolved oxygen (DO), turbidity, chlorophyll a (Chl-a), total nitrogen (TN), total phosphorus (TP), bioavailable nitrogen (NOx) and soluble reactive phosphorus (SRP).*

Site	pH	EC	DO %	Turbidity	Chl-a	TN	TP	NOx	SRP
BUCC2	2(40%)2,0	5(100%)	4(80%)4,0	0(0%)	0(0%)	5(83%)	2(33%)	5(83%)	0(0%)
BUCC1	1(17%)1,0	0(0%)	6(100%)6,0	0(0%)	2(40%)	4(67%)	5(83%)	6(100%)	3(50%)
SOUC3	3(50%)3,0	2(33%)	6(100%)6,0	0(0%)	1(20%)	5(83%)	3(50%)	5(83%)	0(0%)
SOUC2	2(33%)2,0	0(0%)	6(100%)6,0	0(0%)	2(40%)	5(83%)	4(67%)	6(100%)	0(0%)
SOUC1	2(33%)2,0	0(0%)	5(100%)5,0	1(20%)	3(60%)	4(67%)	5(83%)	6(100%)	0(0%)
MISC1	1(20%)1,0	5(100%)	3(75%)3,0	0(0%)	0(0%)	4(67%)	4(67%)	6(100%)	2(33%)
NEWC1	3(20%)3,0	NA	9(60%)9,0	10(91%)	3(60%)	5(83%)	5(83%)	5(83%)	1(17%)

[1] Numbers in black represent the total number and percent of exceedances. Numbers in blue and red represent the numbers of measurements lower than the minimum guideline value and higher than the maximum guideline value, respectively. The number of exceedances includes all depths sampled so may be greater than the number of times sampled. Turbidity, chlorophyll a, and nutrients only have maximum trigger guidelines.

3.3.5 Aquatic macroinvertebrates

Missabotti Creek

MISC1 recorded total abundances of 456 and 372 across 19 and 22 macroinvertebrate families during the 2016 spring and 2017 autumn sampling periods, respectively (Table 3.37). In spring 2016, several families were represented in high numbers, with Leptophlebiidae mayflies the most abundant with 132 individuals. Spring richness was dominated by Trichoptera with six families present. Autumn abundance was highest in the Elmidae family (Riffle Beetles) with 100 individuals present. Richness in autumn was largely partitioned among three orders, with Coleoptera and Diptera each represented by five families and Trichoptera represented by four families.

The mean SIGNAL2 score for MISC1 was significantly higher in spring 2016 (6.6) than autumn 2017 (4.9). MISC1 achieved the highest mean SIGNAL2 score recorded in the Nambucca Catchment, with the spring SIGNAL2 score eclipsing that of the autumn sample through the presence of high scoring Trichoptera and the high abundance of Leptophlebiidae mayflies. The SIGNAL2 score range was relatively large across both seasons.

MISC1 received a very good overall Ecohealth score of 79 (B) for aquatic macroinvertebrate community condition, the equal highest site score achieved in the Nambucca Catchment. The macroinvertebrate indicators all scored well above the average for the Nambucca Catchment. The macroinvertebrate community at MISC1 contained both highly sensitive taxa and high abundances of pollution sensitive taxa. The site experienced good streamflow during the study period and this maintained both habitat quality and quanity for macroinvertebrates.

Table 3.37 *Summary of aquatic macroinvertebrate indicator scores and the overall macroinvertebrate grade for the freshwater site in the Missabotti Creek subcatchment.*

	MISC1	
Macroinvertebrate indicator	**Spring 2016**	**Autumn 2017**
Total abundance	456	372
Family richness	19	22
EPT abundance	297	79
EPT richness	14	12
Mean SIGNAL2 score	6.6	4.9
SIGNAL2 score range	2 - 10	2 - 8
Ecohealth score (grade)	**79 (B-)**	

Buckrabendinni Creek

BUCC2 recorded 360 and 342 individual macroinvertebrates across 28 and 23 macroinvertebrate families over the spring 2016 and autumn 2017 sampling periods, respectively (Table 3.38). In spring 2016, the highest family abundance was recorded within the Chironomidae family (non-biting midges) with 51 individuals identified, 33 belonging to the Chironominae subfamily. Spring richness was dominated by Trichoptera (Caddisflies) with 10 families present. In autumn 2017, abundance was dominated by Chironomidae, with 71 individuals in five subfamilies. Autumn richness was dominated by Coleoptera with eight families represented. Along with THUMB1, BUCC2 recorded the equal highest score in the Nambucca Catchment for the family richness indicator.

Mean SIGNAL2 scores for BUCC2 were consistently above average for the Nambucca Catchment and likely a result of high richness scores and wide SIGNAL2 score ranges. The higher SIGNAL2 score recorded in spring was largely owing to increased numbers of high-scoring Coleoptera (Elmidae), Ephemeroptera (Leptophlebiidae), and Trichoptera families (namely Calocidae and Helicophidae).

BUCC2 received a very good overall Ecohealth score of 77 (B-) for aquatic macroinvertebrate community condition with all indicators generally scoring well above the average for the Nambucca Catchment. BUCC2 has the potential to support a high diversity of macroinvertebrate fauna in high abundances which was indicated by both high scores in richness and abundances of pollution-intolerant fauna. The macroinvertebrate indicators suggest that the habitat conditions at BUCC2 were in good condition. While BUCC2 had similar riparian condition and slightly improved water quality scores compared with BUCC1, the resulting very good macroinvertebrate score is likely attributed to both proximity to heavily forested catchment headwaters and reduced landuse pressures, i.e. reduced agricultural grazing.

BUCC1 recorded 378 and 296 individual macroinvertebrates across 30 and 13 macroinvertebrate families over the spring 2016 and autumn 2017 sampling periods, respectively (Table 3.38). In spring 2016, the highest family abundance was recorded within the Atyidae family (shrimp) with 64 individuals from the Paratya genus. Spring richness was dominated by Trichoptera (Caddisflies) with 11 families present. In autumn 2017, abundance was dominated by Corixidae, with 147 individuals belonging to the Micronecta genus. Autumn richness was dominated by Diptera with five families represented, owing to a large number of Chironomid larvae.

Mean SIGNAL2 scores for BUCC1 were significantly higher in spring 2016 (5.3) than autumn 2017 (2.7). While SIGNAL2 score ranges were consistent across the sampling times, all other indicators were higher in spring 2016 than autumn 2017.

BUCC1 received a score of 54 (D) for aquatic macroinvertebrate community condition which was slightly below the average for the Nambucca Catchment. Most indicators were equal to or above the Nambucca Catchment average apart from the SIGNAL2 score which was affected by the low richness and abundance of taxa with high SIGNAL2 values in autumn 2017. BUCC1 had the potential to support both high diversity and high abundance of macroinvertebrate fauna and the macroinvertebrate indicators suggest that the water quality and habitat conditions at BUCC1 were in moderate condition. This was supported by both the Ecohealth water quality and riparian condition assessments which each returned a low-to-moderate score of 49 (D-) for this site.

Table 3.38 *Summary of aquatic macroinvertebrate indicator scores and the overall macroinvertebrate grade for freshwater sites of the Bucrabendinni Creek sub-catchment.*

	BUCC1		BUCC2	
Macroinvertebrate indicator	**Spring 2016**	**Autumn 2017**	**Spring 2016**	**Autumn 2017**
Total abundance	378	296	360	342
Family richness	30	13	28	23
EPT abundance	176	15	180	125
EPT richness	16	4	16	13
Mean SIGNAL2 score	5.3	2.7	5.5	4.8
SIGNAL2 score range	2 - 8	2 - 8	2 - 10	2 - 9
Ecohealth score (grade)	**54 (D)**		**77 (B-)**	

South Creek

SOUC3 recorded 217 and 545 individual macroinvertebrates across 15 and 22 macroinvertebrate families over the spring 2016 and autumn 2017 sampling periods, respectively (Table 3.39). In spring 2016, the highest family abundance was recorded within the Leptophlebiidae family (Mayflies) with 68 individuals identified, 51 of which belonged to the *Nousia* genus. Both spring and autumn richness was dominated by Coleoptera (Aquatic Beetles) with six and nine families respectively. Family abundance in autumn 2017 was again highest in the Leptophlebiid mayflies with 130 individuals. The most diverse orders were Trichoptera (Caddisflies) and Diptera with five families present in each. Family richness, EPT abundance and EPT richness were significantly higher in autumn and driven by increases in Trichoptera larvae.

Mean SIGNAL2 scores for SOUC3 were marginally higher in autumn (5.1) than in spring (4.8) and driven by the consistent presence of high scoring Leptophlebiid mayflies and the high abundance of low scoring Atyid (Shrimp) and Chironomid larvae recorded in the autumn sample.

SOUC3 received a slightly-above-average overall Ecohealth score of 60 (C) for aquatic macroinvertebrate community condition with all macroinvertebrate indicators scoring above the average for the Nambucca Catchment, with the exception of EPT abundance. SOUC3 supported a high diversity of macroinvertebrate fauna in moderate-to-high abundances and the macroinvertebrate indicators and SIGNAL2 range, particularly in autumn, suggest that the water quality and habitat conditions in the Nambucca Catchment at SOUC3 were in moderate condition. This was supported by both the Ecohealth water quality and riparian condition assessments which returned moderate scores of 53 (D) and 58 (D+), respectively. While SOUC3 had similar riparian condition and slightly improved water quality scores compared with SOUC1, the macroinvertebrate score at SOUC3 was likely improved by the proximity to heavily forested catchment headwaters and lower landuse pressures in the surrounding catchment.

SOUC2 recorded 227 and 114 individual macroinvertebrates across 14 macroinvertebrate families over both the spring 2016 and autumn 2017 sampling periods, respectively (Table 3.39). In spring 2016, the highest family abundance was recorded within the Chironomidae family (Non-biting midges) with 89 individuals identified, 57 of which belonged to the Chironominae subfamily. Spring richness was dominated by Diptera (Flies) with seven families. In autumn 2017, Chironomid midges were the most abundant family with 36 individuals. The most diverse order was Ephemeroptera with six families present. Family richness was constant in spring and autumn, yet EPT abundance and richness increased significantly and was driven by increases in Leptophlebiid and Baetid mayflies.

Mean SIGNAL2 scores for SOUC2 were higher in autumn (4.3) than in spring (3.7), although the range of SIGNAL2 scores was similar between seasons. Although family richness was constant between seasons, EPT abundance and EPT richness in autumn were higher than spring. The increase in EPT richness and abundance, particularly in high-scoring Mayflies contributed to the higher SIGNAL2 score in autumn.

SOUC2 received a very poor overall Ecohealth score of 33 (F) for aquatic macroinvertebrate community condition with all macroinvertebrate indicators scoring below the average for the Nambucca Catchment. While SOUC2 was able to support a diversity of macroinvertebrate fauna, these were in low abundances. The macroinvertebrate indicators and SIGNAL2 range suggest that the water quality and habitat conditions at SOUC2 were in poor condition. This was supported by the Ecohealth water quality and riparian condition assessments which both recorded low scores of 53 (D) and 47 (D-), respectively.

SOUC1 recorded 307 and 147 individual macroinvertebrates across 15 and 16 macroinvertebrate families over the spring 2016 and autumn 2017 sampling periods, respectively (Table 3.39). In spring 2016, the highest family abundance was recorded within the Chironomidae family (Non-biting midges) with 82 individuals identified, 50 of which belonged to the Orthocladiinae subfamily. Spring richness was dominated by Ephemeroptera (Mayflies) and Diptera (Flies) with five families each. In autumn 2017, abundance was again highest in the Chironomid midges with 33 individuals. The most diverse order was Coleoptera (Aquatic Beetles) with five families present. Family richness was similar in spring and autumn, however between the two sampling seasons the prevalence of aquatic beetle larvae increased from three to five families with the most abundant Coleopteran family being Hydrophilidae on both occasions.

Mean SIGNAL2 scores for SOUC1 were significantly higher in spring (4.8) than autumn (3.3), although the range of SIGNAL2 scores was similar between seasons. Although family richness was slightly higher in autumn, total abundance, EPT abundance and EPT richness in spring were higher than in autumn. The increase in the mean SIGNAL2 at SOUC1 in spring was primarily due to higher abundances of high-scoring Ephemeroptera (Mayflies).

SOUC1 received a very poor overall Ecohealth score of 38 (F) for aquatic macroinvertebrate community condition with all macroinvertebrate indicators scoring below the average for the Nambucca Catchment While SOUC1 was able to support a diversity of macroinvertebrate fauna, these were in low abundances and the macroinvertebrate indicators and SIGNAL2 range suggest that the water quality and habitat conditions at SOUC1 were in poor condition. This was only partially supported by Ecohealth water quality and riparian condition assessments which returned low and moderate scores of 49 (D-) and 59 (D+), respectively. The presence of weedy species at SOUC1 was very high and dominated by Camphor Laurel which is known to be detrimental to native macroinvertebrate species. This likely contributed to the low macroinvertebrate score for SOUC1.

Table 3.39 *Summary of aquatic macroinvertebrate indicator scores and the overall macroinvertebrate grade for freshwater sites of the South Creek subcatchment.*

	SOUC1		SOUC2		SOUC3	
Macroinvertebrate indicator	**Spring 2016**	**Autumn 2017**	**Spring 2016**	**Autumn 2017**	**Spring 2016**	**Autumn 2017**
Total abundance	307	149	227	114	217	545
Family richness	15	16	14	14	15	22
EPT abundance	121	11	20	41	68	199
EPT richness	8	4	5	8	4	10
Mean SIGNAL2 score	4.8	3.3	3.7	4.3	4.8	5.1
SIGNAL2 score range	2 - 9	2 - 8	2 - 9	2 - 8	1 - 8	1 - 10
Ecohealth score (grade)	**38 (F)**		**33 (F)**		**60 (C-)**	

3.4 Taylors Arm

3.4.1 Subcatchment and site descriptions

Taylors Arm comprises 403km^2 (Table 3.40). Almost half (46%) of the entire Taylors Arm subcatchment (including both the freshwater and estuarine reaches) is protected in conservation areas (Figure 3.12c), with grazing at 29%, the second dominant landuse by area (Table 3.40). The headwaters of Taylors Arm and its tributaries are predominantly in the high-elevation areas under national parks and other conservation areas. Except for the upland reach, Taylors Arm itself is a planform controlled, gravel-bed channel with low sinuosity, although its tributary channels comprise other River Styles (Figure 3.12b).

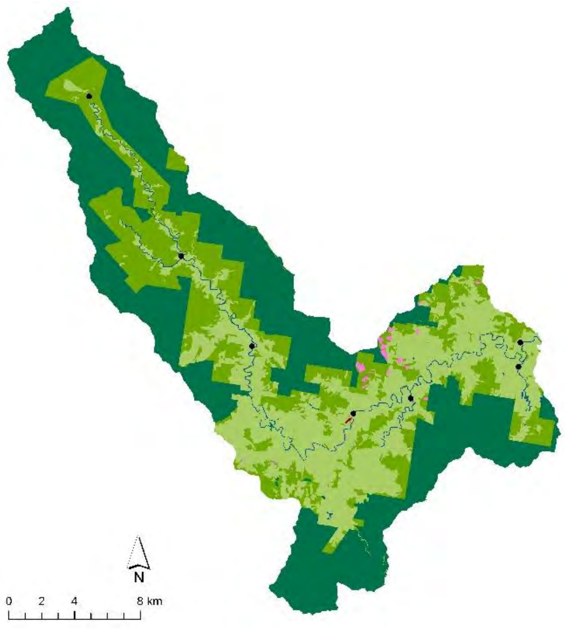
There were three sites located in the freshwater reach of Taylors Arm (Figure 3.12a). TAYL5 (Plate 3.31) is located immediately downstream of the convergence of four headwaters into the Taylors Arm main channel (Figure 3.12b). TAYL5 is an upland gravel-bed channel with floodplain pockets in a constrained valley setting. TAYL5 is 30 km upstream of TAYL4.

TAYL4 (Plate 3.32) is a lowland gravel-bed channel in a partially constrained valley setting. The channel is planform controlled and has low sinuosity. TAYL4 is 22km upstream of TAYL3. TAYL3 (Plate 3.33) is a planform controlled, low sinuosity gravel-bed channel in a partially constrained valley setting. TAYL3 is 25.9km upstream of TAYL2.

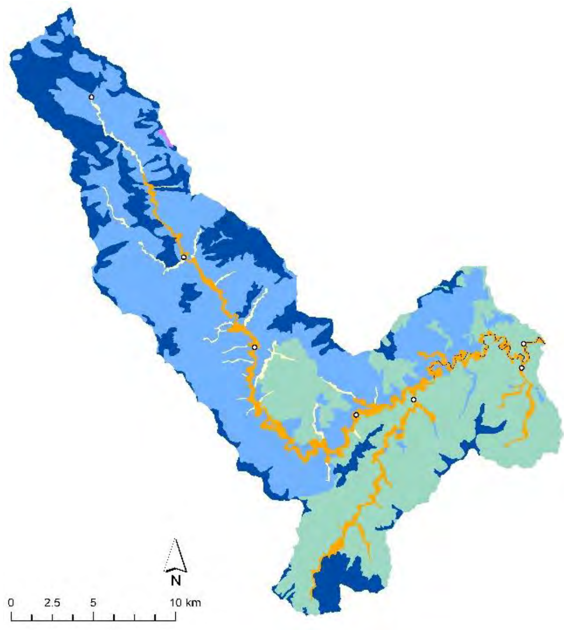
TAYL2 (Plate 3.34) is in the upper estuary. The channel is planform controlled and tidal within a partially constrained valley setting. TAYL2 is 14.3km upstream of TAYL1. TAYL1 (Plate 3.35) is in the mid estuary. TAYL1 is also a planform controlled, tidal channel in a partially constrained valley setting. TAYL1 is 1.9km upstream of the confluence with the Nambucca River estuary.

(a) Location of Ecohealth sites

(b) River Styles: refer to Figure 2.8 for key



(c) Landuse: refer to Figure 2.7 for key



(d) Soils: refer to Figure 2.3 for key

Figure 3.12 *Taylors Arm showing (a) locations of Ecohealth sites, (b) River Styles, (c) landuse, and (d) soils. Data layers from NC LLS (River Styles) and OEH (landuse and soils).*

Table 3.40 *Subcatchment description of Taylors Arm. Data from NC LLS and OEH.*

Variable	Subcatchment composition
Area	403.1 km^2
Geology	63.1% slate, phyllite, schist; 34.4% slaty siltstone; 2.4% sandstone, mudstone; 0.1% basalt
Soils	42.1% Dermosols, 31.2% Kurosols, 19.9% Rudosols and Tenosols, 5.4% Tenosols (Alluvial), 1.2% Rudosols (Alluvial), 0.1% Ferrosols
River Styles	29.6% PCVS – Planform controlled, low sinuosity, sand, 17.5% CVS – Headwater, 10.5% PCVS – Planform controlled, meandering, sand, 10.3% CVS – Floodplain pockets, sand, 8.7% CVS – Gorge, 6.9% CVS – Floodplain pockets, gravel, 6.9% PCVS – Planform controlled, meandering, fine grained, 3.1% PCVS – Planform controlled, low sinuosity, sand, 2.7% PCVS – Bedrock controlled, fine grained, 2.3% PCVS – Planform controlled, tidal, 1.5% PCVS – Bedrock controlled, sand
Landuse	45.6% Conservation area, 28.7% Grazing, 1% River and drainage system, 0.3% Horticulture
Major point source discharge	Nil
Tree Cover	70%

Plate 3.31 *Site TAYL5 in the upland freshwater reach of Taylors Arm (looking downstream).*

Plate 3.32 *Site TAYL4 in the lowland freshwater reach of Taylors Arm (looking downstream).*

Plate 3.33 *Site TAYL3 at the end of the freshwater reach of Taylors Arm (looking upstream).*

Plate 3.34 *Site TAYL2 in the upper estuary of Taylors Arm (looking downstream).*

Plate 3.35 *Site TAYL1 is a mid estuary zone at the end-of-system for Taylors Arm.*

3.4.2 Geomorphic condition

TAYL 5

The geomorphic River Style at Taylors Arm 5 is a gravel-bed channel with floodplain pockets in a confined valley setting. TAYL5 drains 19.3km of stream network, predominantly headwater streams in good geomorphic condition (Alluvium 2012). The bed sediments at TAYL5 comprised an open framework of subangular cobbles with <5% fine sediments in the upstream riffle and subangular pebbles with a matrix of 32-60% fine sediments in the downstream pool. No erosion of the streambed was observed at TAYL5. Banks comprised fine sediments with gravel. There was moderate (5-10m) erosion on the left bank with moderate (5-10m) exposure of tree roots on the same bank. However, the exposure of tree roots only comprised small proportions of each individual root mass immediately above the low flow channel. TAYL5 scored 88, a B+ for BANK CONDITION and 90, an A-, for BED CONDITION. The overall geomorphic condition for TAYL5 was 89, a grade of B+.

In summary, TAYL5 was assessed as being in good geomorphic condition, with a small amout of bank erosion on the outside bend (left bank) the most significant issue for site-level geomorphic condition. The desktop GIS assessment of subcatchment geomorphic condition found Taylors Arm to be in moderate condition with a grade of C+. The geomorphic condition at TAYL5 was significantly above the subcatchment average.

TAYL 4

The geomorphic River Style at Taylors Arm 5 is a planform controlled, low sinuosity gravel-bed channel in a partially confined valley setting. TAYL4 drains 114.4km of stream network (including the Thumb Creek subcatchment), predominantly headwater streams in good geomorphic condition. However, TAYL4 is located at the upstream end of a 4.6km reach in moderate geomorphic condition with 24km of channel in poor geomorphic condition immediately upstream (Alluvium 2012). The bed sediments at TAYL4 comprised gravel with >60% fine sediments. There was significant pugging and trampling by cattle throughout the stream bed (Plate 3.32), and the streambed contained significant fine sediments. Banks comprised fine sediments. There was moderate (5-10m) erosion on the right bank, with moderate (5-10m) undercutting on the right bank due to minor bridge scour. There was significant (10-20m) slumping on the left bank. TAYL4 scored 56, a D+ for BANK CONDITION and 47, a D-, for BED CONDITION. The overall geomorphic condition for TAYL4 was 51, a grade of D.

In summary, TAYL4 was assessed as being in poor geomorphic condition, with erosion, slumping and pugging due to cattle traffic the most significant issue for site-level geomorphic condition. The desktop GIS assessment of subcatchment geomorphic condition found Taylors Arm to be in moderate condition with a grade of C+. The geomorphic condition at TAYL4 was significantly below the subcatchment average.

TAYL 3

The geomorphic River Style at Taylors Arm 3 is a planform controlled, low sinuosity gravel-bed channel in a partially confined valley setting. TAYL3 drains 136.6km of stream network, with 24% of the dominant River Style (planform controlled, low sinuosity, gravel) in poor geomorphic condition. TAYL3 is located midway in a 36km reach assessed as being in moderate geomorphic condition overall (Alluvium 2012). The bed sediments at TAYL3 comprised gravel with >60% fine sediments. The streambed had moderate pugging from cattle and severe smothering by fine sediments. Banks comprised fine sediments. There was significant (10-20m) trampling and pugging of banks from cattle access, and moderate (5-10m) active erosion and exposed tree roots. There was significant (10-20m) active erosion and exposure of tree roots on the right bank, an outside bend also accessed by cattle. TAYL3 scored 62, a C- for BANK CONDITION and 57, a D+, for BED CONDITION. The overall geomorphic condition for TAYL3 was 59, a grade of D+.

In summary, TAYL3 was assessed as being in poor geomorphic condition, with cattle trampling and pugging on banks the most significant issue for site-level geomorphic condition. The desktop GIS assessment of subcatchment geomorphic condition found Taylors Arm to be in moderate condition with a grade of C+. The geomorphic condition at NAMB8 was below the subcatchment average.

TAYL 2

The geomorphic River Style at Taylors Arm 2 is a planform controlled, tidal channel in a partially confined valley setting. TAYL2 drains 260.7km of stream network, with 85% of the stream network in good to moderate geomorphic condition (Alluvium 2012). TAYL3 is located in the upper estuary. The bed sediments at TAYL2 comprised gravel with 32-60% fine sediments. Banks comprised consolidated fine sediments. There was significant (10-20m) undercutting in the intertidal zone of the left bank, with significant (10-20m) slumping as well; the left bank was the outside bend. The right bank (inside bend) had moderate (5-10m) undercutting in the intertidal zone and moderate (5-10m) slumping. TAYL2 scored 54, a D for BANK CONDITION. The overall geomorphic condition for TAYL2 was 54, a grade of D.

In summary, TAYL2 was assessed as being in poor geomorphic condition, with high loads of fine sediment and bank slumping the most significant issue for site-level geomorphic condition. The desktop GIS assessment of subcatchment geomorphic condition found Taylors Arm to be in moderate condition with a grade of C+. The geomorphic condition at TAYL2 was significantly below the subcatchment average.

TAYL 1

The geomorphic River Style at Taylors Arm 1 is a planform controlled, tidal channel in a partially confined valley setting. TAYL1 drains 275km of stream network (Taylors Arm subcatchment). TAYL2 is located in the mid estuary. The bed and banks at TAYL1 comprised fine sediments. There was significant (10-20m) undercutting in the intertidal zone of the left bank, with severe (20-100m) slumping as well. The right bank had severe (20-100m) slumping. TAYL1 scored 40, an F for BANK CONDITION. The overall geomorphic condition for TAYL1 was 40, a grade of F.

In summary, TAYL1 was assessed as being in poor geomorphic condition, with high loads of fine sediment and bank slumping the most significant issue for site-level geomorphic condition. The desktop GIS assessment of subcatchment geomorphic condition found Taylors Arm to be in moderate condition with a grade of C+. The geomorphic condition at TAYL1 was significantly below the subcatchment average.

3.4.3 Riparian condition

TAYL 5

Site: The original riparian vegetation community at Taylors Arm 5 (TAYL5, Plate 3.36) was described by existing vegetation mapping as 'Green-leaved Rose-walnut – Sassafras – Black Booyong – Yellow Carabeen tall closed forest on sediments and metasediments of near coastal hills and escarpments' (NAM_RF08), a listed TEC (OEH 2015), but maybe better described as 'Riparian subtropical rainforest with on lowland creek flats with Crabapple, Coachwood and Yellow Carabeen' (an unrecognised Nambucca vegetation community), a listed TEC under 'Lowland Rainforests of Subtropical Australia (OEH 2015), 'Grading into Brushbox and Turpentine shrubby moist forest of sub-coastal lowlands' (also an un unrecognised Nambucca vegetation community). TAYL5 received a very good riparian condition score of 84, a grade of B (Table 3.41).

Dominant Species: The dominant canopy species present were the native species Crabapple (*Schizomeria ovata*), Coachwood (*Cerratopetalum apetalum*), Yellow Carabeen (*Sloanea woollsii*), Bangalow Palm (*Archontophoenix cunninghamiana*), Hairy Acronychia (*Acronychia pubescens*), Brush Box (*Lophostemon confertus*), Turpentine (*Syncarpia glomulifera*) and Strangler Fig species (*Ficus* sp.). Dominant native midstory species included Brush Pepperbush (*Tasmannia insipida*), Brush Cherry (*Syzygium australe*), Elderberry (*Cuttsia viburnea*) and Black Wattle (*Callicoma serratifolia*), along with the exotic species Lantana (*Lantana camara*) and Wild Tobacco (*Solanum mauritianum*). The understory was dominated by native species Soft Lomandra (*Lomandra hystrix*), Rainforest Spinach (*Elatostema stipitatum*), Binung (*Cristella dentata*), Gristle Fern (*Blechnum cartilagenum*), Knotweed (*Persicaria stigosa*), Common Bracken (*Pteridium esculentum*), Australian Basket Grass (*Oplismenus imbecillis*) and Pademelon Grass (*Ottochloa gracillima*), along with exotic species Taro (*Colocasia esculenta*), Crofton Weed (*Ageratina adenophora*), Wandering Jew (*Tradescantia fluminensis*), Common Bittercress (*Cardamine hirsuta*) and Broadleaf Paspalum (*Paspalum mandiocanum*). A rich vine layer included dominant species Prickly Supplejack (*Ripogonum discolour*), Kangaroo Vine (*Cissus antartica*), Native Raspberry (*Rubus rosifolius*), Smilax species (*Smilax glyciphylla* and *S.australis*) and the exotic species Common Passionfruit (*Passiflora* sp.), while the macrophyte layer included Pennywort (*Hydrocotyle tripartita*) and the exotic species Watercress (*Rorippa nasturtium-aquaticum*) and Common Starwort (*Callitriche stagnalis*).

Noxious weed species: Noxious weed species observed on-site were Lantana (*Lantana camara*), Crofton Weed (*Ageratina adenophora*) and Wandering Jew (*Tradescantia fluminensis*).

Summary: Taylors Arm 5 was a low disturbance, closed-forest system with a partially remnant, partially regrowth canopy and native species prevalence throughout all structural layers in a predominantly forested rural landscape. The site itself was located in a small reserve with surrounding landuse appearing to be both historically logged and grazed and is now forested private land, beyond which was National Park and State Forest. Significant remnant stands of vegetation surround the site in all directions on forested private land, 650m east in Gumbaynggirr National Park and 800m west in Nulla-Five Day State Forest. Representative elements of the remnant vegetation community were retained in all of the structural layers with TAYL5 scoring full marks for the Cover subindex, well for Habitat, Native Species and Management and moderately for the Debris subindex (Table 3.41).

Riparian condition was affected by the presence and regeneration of weed and noxious weed species, particularly in the midstory and understory structural layers and reduced levels of large woody debris at this site.

Plate 3.36 *Riparian vegetation condition at TAYL5 was very good and of low disturbance. This was mainly attributed to the presence of a remnant canopy and the dominance of native species throughout all structural layers, however the presence of weed and noxious weed species and low levels of large woody debris reduced riparian condition.*

Table3.41 *Site-level assessments of riparian condition in 2016-17 at TAYL5 showing scores for the five subindices and their individual indicators that comprise the Vegetation Condition Index.*

Taylors Arm 5	Scores
HABITAT	**19.5/20**
Channel width	4
Proximity	4
Continuity	3.5
Layers	4
Large native trees	2
Hollow-bearing trees	2
NATIVE SPECIES	**15/20**
Native canopy species	4
Native midstory species	3
Native herb/forb species	3
Native graminoid species	3
Native macrophyte species	2
SPECIES COVER	**20/20**
Canopy species	4
Midstory species	4
Herb/forb species	4
Graminoid species	4
Macrophyte species	4
DEBRIS	**13/20**
Total leaf litter	3
Native leaf litter	2
Dead trees standing	0
Dead trees fallen	1
Lying logs	3
Fringing vegetation	4
MANAGEMENT	**16.5/20**
Tree clearing	2.5
Fencing	3
Animal impact	3
Canopy Health	2
Exposed tree roots	3
Native woody regeneration	2
Weedy woody regeneration	1
TOTAL	**84/100**

TAYL 4

Site: The original riparian vegetation community at Taylors Arm 4 (TAYL4, Plate 3.37) was described as 'Gallery Watergum and Weeping Bottlebrush Shrubland and forest' (an unrecognised Nambucca vegetation community) grading into 'River Oak grassy open forest along larger rivers' (NAM_FW01) and 'Flooded Gum moist open forest of sheltered lower slopes and gullies' (NAM_WSF01). TAYL4 received a low riparian condition score of 56, a grade of D+ (Table 3.42).

Dominant Species: The dominant canopy species present were the native species River Oak (*Casuarina cunninghamiana* subsp. *cunninghamiana*), Flooded Gum (*Eucalyptus grandis*), White Cedar (*Melia azedarach*) and Watergum (*Tristaniopsis laurina*), along with the exotic species Willow (*Salix* sp.). Dominant native midstory species included Weeping Bottlebrush (*Callistemon viminalis*), Sandpaper Fig (*Ficus coronata*) and the exotic species Wild Tobacco (*Solanum mauritianum*), Lantana (*Lantana camara*), Small-leaved Privet (*Ligustrum sinense*) and Arsenic Bush (*Senna septemtrionalis*). The understory was dominated by native species Stinging Nettle (*Urtica incisa*), Soft Lomandra (*Lomandra hystrix*), Knotweeds (*Persicaria hydropiper* and *P.strigosa*), Gristle Fern (*Blechnum cartilagenum*), Common Rush (*Juncus ursitatus*) and Couch (*Cynodon dactylon*), along with exotic species Blue Billy Goat Weed (*Ageratum houstonianum*), Taro (*Colocasia esculenta*), Silver-leaved Desmodium (*Desmodium uncinatum*), Wandering Jew (*Tradescantia fluminensis*), Sidratusa (*Sida rhombifolia*), Umbrella Sedge (*Cyperus eragrostis*), Fireweed (*Senecio madagascariensis*), Paspalum species (*Paspalum mandiocanum* and *P.dilatatum*) and Prairie Grass (*Bromus catharticus*). Dominant vine species included Silkpod (*Parsonsia* spp.), Native Raspberry (*Rubus rosifolius*) and an exotic Rose cultivar species (*Rosa* sp.), while the macrophyte layer included Freshwater Eelgrass (*Vallisneria nana*), Potomogeton (*Potomogeton ochtandrus*), Water Couch (*Paspalum distichum*), Water Primrose (*Ludwigia peploides*) and the exotic species Watercress (*Rorippa nasturtium-aquaticum*).

Noxious weed species: Noxious weed species observed on-site were Willow (*Salix* sp.), Lantana (*Lantana camara*), Small-leaved Privet (*Ligustrum sinense*), Arsenic Bush (*Senna septemtrionalis*), Noogoora Burr (*Xanthium occidentale*), Wandering Jew (*Tradescantia fluminensis*) and Fireweed (*Senecio madagascariensis*).

Summary: Taylors Arm 4 was a highly disturbed open-to-closed forest system with a mixed-aged canopy of native and exotic species throughout all structural layers, in a predominantly cleared, partially forested rural landscape. The surrounding landuse was primarily agricultural grazing land beyond which was forested private land, state forest and national park. Significant remnant stands of vegetation surround the site and lie 500m south, 500m west and 1km east on private land, 1.2km east and 1.7km south east in Mistake State Forest and 2.5km west in Thumb Creek State Forest, beyond which lies New England National Park. Representative elements of the remnant vegetation community were present in all of the structural layers with TAYL4 scoring moderately for the Habitat, Native Species, Cover and Debris subindices and poorly for the Management subindex (Table 3.42). Riparian condition was affected by reduced riparian vegetation width, disrupted continuity, poor habitat connectivity and the presence and regeneration of weed and noxious weed species, particularly in the midstory and understory structural layers. Reduced levels of cover, particularly in the canopy and midstory, limited woody debris, reduced fringing vegetation, inadequate riparian fencing and subsequent animal impact also contributed to the reduction in riparian grade at this site.

Plate 3.37 *Riparian vegetation condition at TAYL4 was considered to be highly disturbed. This was primarily due to reduced riparian vegetation width, disrupted continuity, poor habitat connectivity, the presence of weed and noxious weed species, reduced canopy and midstory cover, low levels of large woody debris, inadequate riparian fencing and the presence of livestock throughout the riparian zone.*

Table 3.42 *Site-level assessments of riparian condition in 2016-17 at TAYL4 showing scores for the five subindices and their individual indicators that comprise the Vegetation Condition Index.*

Taylors Arm 4	Scores
HABITAT	**11.5/20**
Channel width	2
Proximity	1
Continuity	1.5
Layers	4
Large native trees	2
Hollow-bearing trees	1
NATIVE SPECIES	**10/20**
Native canopy species	3
Native midstory species	1
Native herb/forb species	1
Native graminoid species	2
Native macrophyte species	3
SPECIES COVER	**14/20**
Canopy species	2
Midstory species	1
Herb/forb species	4
Graminoid species	4
Macrophyte species	3
DEBRIS	**11/20**
Total leaf litter	3
Native leaf litter	2
Dead trees standing	1
Dead trees fallen	1
Lying logs	2
Fringing vegetation	2
MANAGEMENT	**9.5/20**
Tree clearing	2
Fencing	1
Animal impact	0
Canopy Health	1.5
Exposed tree roots	3
Native woody regeneration	2
Weedy woody regeneration	0
TOTAL	**56/100**

TAYL 3

Site: The original riparian vegetation community at Taylors Arm 3 (TAYL3, Plate 3.38) was described as 'Gallery Silver Weeping Tea-tree and Weeping Bottlebrush Shrubland' (an unrecognised Nambucca vegetation community) grading into 'River Oak grassy open forest along larger rivers' (NAM_FW01). TAYL3 received a low riparian condition score of 58.8, a grade of D+ (Table 3.43).

Dominant Species: The dominant native canopy species present was River Oak (*Casuarina cunninghamiana* subsp. *cunninghamiana*) along with the exotic species Camphor Laurel (*Cinnamomum camphora*) and Willow (*Salix* sp.). Dominant native midstory species included Weeping Bottlebrush (*Callistemon viminalis*), Silver Weeping Tea Tree (*Leptospermum brachyandrum*), Sandpaper Fig (*Ficus coronata*), along with the exotic species Wild Tobacco (*Solanum mauritianum*), Castor Oil Plant (*Ricinus communis*), Lantana (*Lantana camara*). The understory was dominated by native species Soft Lomandra (*Lomandra hystrix*), Common Rush (*Juncus ursitatus*), Stinging Nettle (*Urtica incisa*), Knotweed (*Persicaria hydropiper*), Gristle Fern (*Blechnum cartilagenum*), Couch (*Cynodon dactylon*) and Rice Grass (*Microlaena stipoides*), along with exotic species White Clover (*Trifolium repens*), Blue Billy Goat Weed (*Ageratum houstonianum*), Wandering Jew (*Tradescantia fluminensis*), Sidratusa (*Sida rhombifolia*), Umbrella Sedge (*Cyperus eragrostis*), Prairie Grass (*Bromus catharticus*), Broadleaf Paspalum (*Paspalum mandiocanum*) and Pigeon Grass (*Setaria sphacelata*). Dominant vine species included Kangaroo Vine (*Cissus antartica*), and the exotic species Japanese Honeysuckle (*Lonicera japonica*), while a rich macrophyte layer included Potomogeton (*Potomogeton ochtandrus*), Freshwater Eelgrass (*Vallisneria nana*), Water Primrose (*Ludwidgia peploides*), Water Couch (*Paspalum distichum*) and the exotic species Watercress (*Rorippa nasturtium-aquaticum*).

Noxious weed species: Noxious weed species observed on-site were Camphor Laurel (*Cinnamomum camphora*), Castor Oil Plant (*Ricinus communis*), Lantana (*Lantana camara*), Noogoora Burr (*Xanthium occidentale*), Fireweed (*Senecio madagascariensis*), Wandering Jew (*Tradescantia fluminensis*) and Japanese Honeysuckle (*Lonicera japonica*).

Summary: Taylors Arm 3 was a highly disturbed open-to-closed forest system with a mixed-aged canopy of native and exotic species throughout all structural layers, in a predominantly cleared, partially forested rural landscape. The surrounding landuse was primarily agricultural grazing land and urban settlement beyond which was forested private land, State Forest and Nature Reserve. Significant remnant stands of vegetation lie 650m west, 1km south and 1km east on private land, 1.6km north and 2.5km west in Mistake State Forest and 3.9km east in Ngambaa Nature Reserve. While representative elements of the remnant vegetation communities were present in all of the structural layers present they were sometimes scarce with TAYL3 scoring well for the Cover subindex, moderately for Habitat, Native Species, Debris and poorly for the Management subindex (Table 3.43). Riparian condition was affected by reduced riparian vegetation width, disrupted continuity, poor habitat connectivity and the presence and regeneration of weed and noxious weed species, particularly in the understory structural layer. Reduced levels of cover, particularly in the canopy of the River Oak grassy open forest (NAM_ForW01), the removal of habitat trees, limited woody debris, inadequate riparian fencing and subsequent animal impact also contributed to the reduction in riparian grade at this site.

Plate 3.38 *Despite possessing good vegetation cover in the midstory layer, riparian vegetation at TAYL3 was highly disturbed. This was primarily due to reduced riparian vegetation width, disrupted continuity, poor habitat connectivity, the presence of weed and noxious weed species, reduced canopy cover, low levels of large woody debris, inadequate riparian fencing and the presence of livestock throughout the riparian zone.*

Table 3.43 *Site-level assessments of riparian condition in 2016-17 at TAYL3 showing scores for the five subindices and their individual indicators that comprise the Vegetation Condition Index.*

Taylors Arm 3	Scores
HABITAT	**10.3/20**
Channel width	1.3
Proximity	1
Continuity	2
Layers	4
Large native trees	2
Hollow-bearing trees	0
NATIVE SPECIES	**12/20**
Native canopy species	3
Native midstory species	3
Native herb/forb species	1
Native graminoid species	1
Native macrophyte species	4
SPECIES COVER	**16/20**
Canopy species	1
Midstory species	3
Herb/forb species	4
Graminoid species	4
Macrophyte species	4
DEBRIS	**11/20**
Total leaf litter	2
Native leaf litter	2
Dead trees standing	0
Dead trees fallen	0
Lying logs	4
Fringing vegetation	3
MANAGEMENT	**9.5/20**
Tree clearing	2
Fencing	1
Animal impact	0
Canopy Health	1.5
Exposed tree roots	3
Native woody regeneration	1
Weedy woody regeneration	1
TOTAL	**58.8/100**

TAYL 2

Site: The original riparian vegetation community at Taylors Arm 2 (TAYL2, Plate 3.39) was described as 'Brush Box – Grey Myrtle – Water Gum dry rainforests of poorer soils of gorges and river valleys' (NAM_RF11) and 'Riparian subtropical rainforest with River Oak emergents on lowland creek flats' (NAM_RF05), both listed TEC's (OEH 2015), grading into 'Flooded Gum moist open forest of sheltered lower slopes and gullies' (NAM_WSF01). TAYL2 received a moderate riparian condition score of 65.4, a grade of C (Table 3.44).

Dominant Species: The dominant canopy species present were the native species Watergum (*Tristaniopsis laurina*), River Oak (*Casuarina cunninghamiana* subsp. *cunninghamiana*), Flooded Gum (*Eucalyptus grandis*) and Rough-leaved Elm (*Aphananthe philippinensis*). Dominant native midstory species included Weeping Bottlebrush (*Callistemon viminalis*), Brush Cherry (*Syzygium australe*), Silver Weeping Teatree (*Leptospermum brachyandrum*), Sandpaper Fig (*Ficus coronata*) and Orange Thorn (*Pittosporum multiflorum*), along with the exotic species Lantana (*Lantana camara*), Castor Oil Plant (*Ricinus communis*) and Privet species (*Ligustrum sinense* and *L.lucidum*). The understory was dominated by native species Soft Lomandra (*Lomandra hystrix*), Knotweeds (*Persicaria stigosa* and *P.hydropiper*), Scurvy Weed (*Commelina cyanea*), Wild Violet (*Viola banksii*), Pademelon Grass (*Oplismenus gracillima*) and Rice Grass (*Microlaena stipoides*), along with exotic species Wandering Jew (*Tradescantia fluminensis*), Mistflower (*Ageratina riparia*), Fleabane (*Conyza bonariensis*) and Broadleaf Paspalum (*Paspalum mandiocanum*). Dominant vine species included the native species Cockspur Thorn (*Maclura cochinchinensis*), Native Raspberry (*Rubus rosifolius*) and Whip Vine (*Flagellaria indica*), while the macrophyte layer included Freshwater Eelgrass (*Vallisneria nana*).

Noxious weed species: Noxious weed species observed on-site were Lantana (*Lantana camara*), Castor Oil Plant (*Ricinus communis*), Privet species (*Ligustrum sinense* and *L.lucidum*), Annual Ragweed (*Ambrosia artemisiifolia*), Mistflower (*Ageratina riparia*) and Wandering Jew (*Tradescantia fluminensis*).

Summary: Taylors Arm 2 was a moderately disturbed closed-forest system with a partially remnant canopy and a mix of native and exotic species throughout all structural layers, in a predominantly cleared, partially forested rural landscape. The surrounding landuse was primarily agricultural grazing land and private forested land, beyond which was State Forest and Nature Reserve. Significant remnant stands of vegetation lie immediately north of the site, 2km southwest and southeast on private land, 3.5km southwest in Ngambaa Nature Reserve, and 3km south and 5.5km northwest in Mistake State Forest and Ingalba State Forest respectively. Representative elements of the remnant vegetation community were retained in all of the structural layers, with TAYL2 scoring moderately for all subindices; Habitat, Native Species, Cover, Debris and Management (Table 3.44). Riparian condition was affected by reduced riparian vegetation width and disrupted continuity and the presence and regeneration of weed and noxious weed species, particularly in the midstory and understory structural layers. Reduced levels of cover, particularly in the canopy, limited large woody debris, inadequate riparian fencing and animal impact also contributed to the reduction in riparian grade at this site.

Plate 3.39 *Despite possessing relatively good vegetation cover in the canopy and midstory layers, riparian vegetation at TAYL2 was considered to be a moderately disturbed system. This was primarily due to reduced riparian width and continuity and cover, the presence of weed and noxious weed species, particularly in the midstory structural layer, low levels of large woody debris and inadequate riparian fencing and livestock presence.*

Table 3.44 *Site-level assessments of riparian condition in 2016-17 at TAYL2 showing scores for the five subindices and their individual indicators that comprise the Vegetation Condition Index.*

Taylors Arm 2	Scores
HABITAT	**14.7/20**
Channel width	1.7
Proximity	3
Continuity	2
Layers	4
Large native trees	2
Hollow-bearing trees	2
NATIVE SPECIES	**11.5/20**
Native canopy species	4
Native midstory species	2.5
Native herb/forb species	2
Native graminoid species	2
Native macrophyte species	1
SPECIES COVER	**14.8/20**
Canopy species	2.8
Midstory species	3
Herb/forb species	3
Graminoid species	4
Macrophyte species	2
DEBRIS	**13/20**
Total leaf litter	3
Native leaf litter	3
Dead trees standing	1
Dead trees fallen	0
Lying logs	3
Fringing vegetation	3
MANAGEMENT	**11.5/20**
Tree clearing	2.5
Fencing	1
Animal impact	0
Canopy Health	1.5
Exposed tree roots	4
Native woody regeneration	2
Weedy woody regeneration	0
TOTAL	**65.4/100**

TAYL 1

Site: The original riparian vegetation community at Taylors Arm 1 (TAYL1, Plate 3.40) was described as 'Grey Mangrove - River Mangrove low open or closed forest or shrubland of intertidal flats' (NAM_FOR01), grading into 'Prickly Couch – Sea Rush – Saltwater Couch saltmarsh of saline coastal swamps and flats' (NAM_SW01) and 'Swamp Oak forested wetland of saline areas of coastal estuaries' (NAM_ForW01) both listed TEC's (OEH 2015). TAYL1 received a low riparian condition score of 54.3, a grade of D (Table 3.45).

Dominant species: The dominant canopy species present were the native species River Mangrove (*Aegiceras corniculatum*) and Grey Mangrove (*Avicennia marina* subsp. *australasica*) and Swamp Oak (*Casuarina glauca*). Dominant native midstory species included juvenile canopy species, Cheese Tree (*Glochidion fernandi*) and the exotic species Lantana (*Lantana camara*), Small-leaved Privet (*Ligustrum sinense*) and Wild Tobacco (*Solanum mauritianum*). The understory was dominated by native species Couch (*Cynodon dactylon*) and estuarine saltmarsh and macrophyte species including Sand Couch (*Sporobolus* spp.), Sea Rush (*Juncus krausii* subsp. *australiensis*) and Tall Sedge (*Carex appressa*) along with the exotic species Watter Buttons (*Cotula coronopifolia*), Fireweed (*Senecio madagascariensis*), Buffalo Grass (*Stenotaphrum secundatum*) and Paspalum (*Paspalum mandiocanum*). One native vine species was present, Cockspur Thorn (*Maclura cochinchinensis*) while Zostera (*Zostera muelleri* subsp. *caprcorni*) was the dominant instream macrophyte species.

Noxious weed species: Noxious weed species observed on-site were Lantana (*Lantana camara*), Small-leaved Privet (*Ligustrum sinense*), Wild Tobacco (*Solanum mauritianum*) and Fireweed (*Senecio madagascariensis*).

Summary: Taylors Arm 1 was a highly disturbed open-saltmarsh/closed-forest system with a partially remnant/mixed aged canopy where present, and a mix of native and exotic species throughout all structural layers, in a predominantly forested/cleared rural-coastal landscape. The immediate surrounding landuse was agricultural grazing country beyond which was privately owned forested wetland habitat and urban settlement. Significant remnant stands of vegetation lie directly to the west of the site in private land in the form of the 100 Acre Swamp, an area of recognised cultural and Ramsar significance (VOM 2016), and in estuarine wetland habitat 1.2km to the north and 800m to the east. All three areas have previously been recognised as either 'suitable for environmental protection' or 'unprotected significant habitat' (BMT WBM 2008). While representative elements of the remnant vegetation communities were present in all of the structural layers present they were sometimes scarce, with TAYL1 scoring moderately for the Habitat, Native Species, Cover and Debris subindices, and poorly for the Management subindex (Table 3.45). Riparian condition was affected by poor riparian vegetation width and disrupted continuity and the presence and regeneration of weed and noxious weed species, particularly in the midstory and understory structural layers. Reduced levels of cover in the canopy and midstory, particularly in the Swamp Oak vegetation community (NAM_ForW01), limited woody and non-woody debris and inadequate riparian fencing and animal impact also contributed to the reduction in riparian grade at this site.

Plate 3.40 *Riparian vegetation condition at TAYL1 was low and considered to be a very highly disturbed system. This was primarily due to poor riparian width and continuity, the presence of weed and noxious weed species and livestock impacts throughout the riparian zone.*

Table 3.45 *Site-level assessments of riparian condition in 2016-17 at TAYL1 showing scores for the five subindices and their individual indicators that comprise the Vegetation Condition Index.*

Taylors Arm 1	Scores
HABITAT	**11/20**
Channel width	0
Proximity	3
Continuity	1.5
Layers	3.5
Large native trees	2
Hollow-bearing trees	1
NATIVE SPECIES	**12.8/20**
Native canopy species	4
Native midstory species	2
Native herb/forb species	1
Native graminoid species	2.8
Native macrophyte species	3
SPECIES COVER	**11.5/20**
Canopy species	1.5
Midstory species	1
Herb/forb species	2
Graminoid species	4
Macrophyte species	3
DEBRIS	**10.5/20**
Total leaf litter	1.5
Native leaf litter	2.5
Dead trees standing	2
Dead trees fallen	1
Lying logs	1
Fringing vegetation	2.5
MANAGEMENT	**8.5/20**
Tree clearing	1
Fencing	0
Animal impact	0
Canopy Health	1.5
Exposed tree roots	3
Native woody regeneration	2
Weedy woody regeneration	1
TOTAL	**54.3/100**

3.4.4 Water quality

Taylors Arm main stem received a low overall score of 51 (D-) for water quality, which was slightly above the average score for the Nambucca Catchment. The estuarine reach scored 39 (F), while the freshwater reach received a higher score of 59 (D+) due to fewer exceedances of ANZECC guidelines. In the freshwater reach, TAYL5 received a score of 67 (C), the highest water quality score of the Nambucca Catchment, TAYL4 received a score of 52 (D), and TAYL3 received a score of 59 (D+). In the estuarine reach, TAYL2 received a score of 41 (F) and TAYL1 received a score of 37 (F), the lowest score of the Taylors Arm reach. Figure 3.13 shows the key physico-chemical and nutrient variables used in the assessment of water quality for the main stem of Taylors Arm. Ranges and means for these variables are given in Tables 3.46 and 3.47and the exceedances are given in Table 3.48.

There were no clear longitudinal trends in pH in the Taylors Arm main stem with pH remaining relatively stable and close to neutral across all sites. While the majority of pH values fell within the ANZECC and OEH guidelines, several pH exceedances did occur in all sites except TAYL5. The majority of the exceedances were for values below the minimum guidelines with TAYL4 recording the lowest pH of 6.04 in the freshwater reach and TAYL2 recording the lowest pH of 6.02 in the estuarine reach. TAYL2 also recorded the only exceedance of the OEH maximum guideline value with a peak pH of 8.6. There were no strong trends in turbidity measures throughout Taylors Arm, with all three freshwater sites remaining below the ANZECC guideline thorughout the study period. Sites in the upper and lower estuarine reaches occasionally exceeded their respective OEH guidlines with the highest turbidity of 19.0NTU recorded at TAYL1 at 6.7 times the OEH guideline for lower estuaries.

All the sites on Taylors Arm regularly fell below the ANZECC and OEH minimum guidelines for DO%. Minimum DO% were more frequently exceeded in freshwater sites than estuarine sites and were likely due to the low flows experienced during the study period. DO% was below the minimum ANZECC lowland guideline value on all occassions at TAYL4 and on all but one occasion at TAYL3. The lowest DO% of 31.7% was recorded at TAYL3. This equated to a DO concentration of 2.73mg/L which is likely to significantly impact aquatic biota such as fish.

While concentrations of Total Nitrogen (TN) fluctuated both spatially and temporally throughout Taylors Arm, mean TN concentrations were similar across all sites. ANZECC and OEH guideline values were exceeded frequently in most sites with the highest TN concentration of 1033.11µg/L recorded at TAYL5; this was greater than four times the ANZECC guideline for upland freshwater streams. Concentrations of bioavailable nitrogen (NOx) consistently exceeded ANZECC guidelines in the freshwater sites with the highest concentration of 222.4µg/L recorded at TAYL4, more than five times the ANZECC guideline for lowland freshwater systems. The highest NOx concentration observed in the Taylors Arm estuary was 316.5µg/L recorded at TAYL1. These values exceeded the OEH guideline for mid estuaries by greater than eight times.

There was no strong longitudinal pattern for total phosphorus concentrations(TP) in Taylors Arm. However, TP concentrations frequently exceeded maximum ANZECC and OEH guideline values at most sites. The highest TP concentration of 200.1µg/L was observed at in the estuarine site of TAYL2, 19 times the OEH guideline for mid estuarine systems, while the highest concentration of TP observed in freshwater reaches was 148.1µg/L at TAYL3, close to six times the guideline value.

Bioavailable phosphorus concentrations (SRP) varied throughout Taylors Arm, but only exceeded guideline values in the estuarine reach. SRP concentrations were consistently high at TAYL1, with the highest SRP concentration observed six times greater than the OEH guideline vaues for mid estuaries.

Chl-a mean concentrations varied among sites and did not follow trends in nutrient concentrations. However, there was a longitudinal trend of lower Chl-a values high in Taylors Arm increasing to higher Chl-a values lower in the subatchment. Guideline exceedance values occurred on a single sampling occasion in February 2017 at the three estuarine sites, TAYL1, TAYL2 and TAYL3 although these exceedances did not persist past the single sampling occasion. The highest Chl-a concentration of 5.5µg/L was observed at TAYL1. A combination of elevated nutrient levels and extended periods of below average rainfall and above average maximum temperatures across the Nambucca Catchment are the likely drivers of the temporarily elevated response variable, Chl-a. WQ stress variables (pH, DO, EC, turbidity and nutrients) in the main stem of Taylors Arm point to the potential influence of surrounding landuse on this particular reach. However, the response variable (Chl-a) did not follow similar temporal or spatial patterns, suggesting that Taylors Arm has a degree of resilience to high nutrient concentrations. This resilience may be in part due to the filtering effect of the gravels that comprise the streambeds (that is, hyporheic exchange), and to the extensive macrophyte beds observed at many sites.

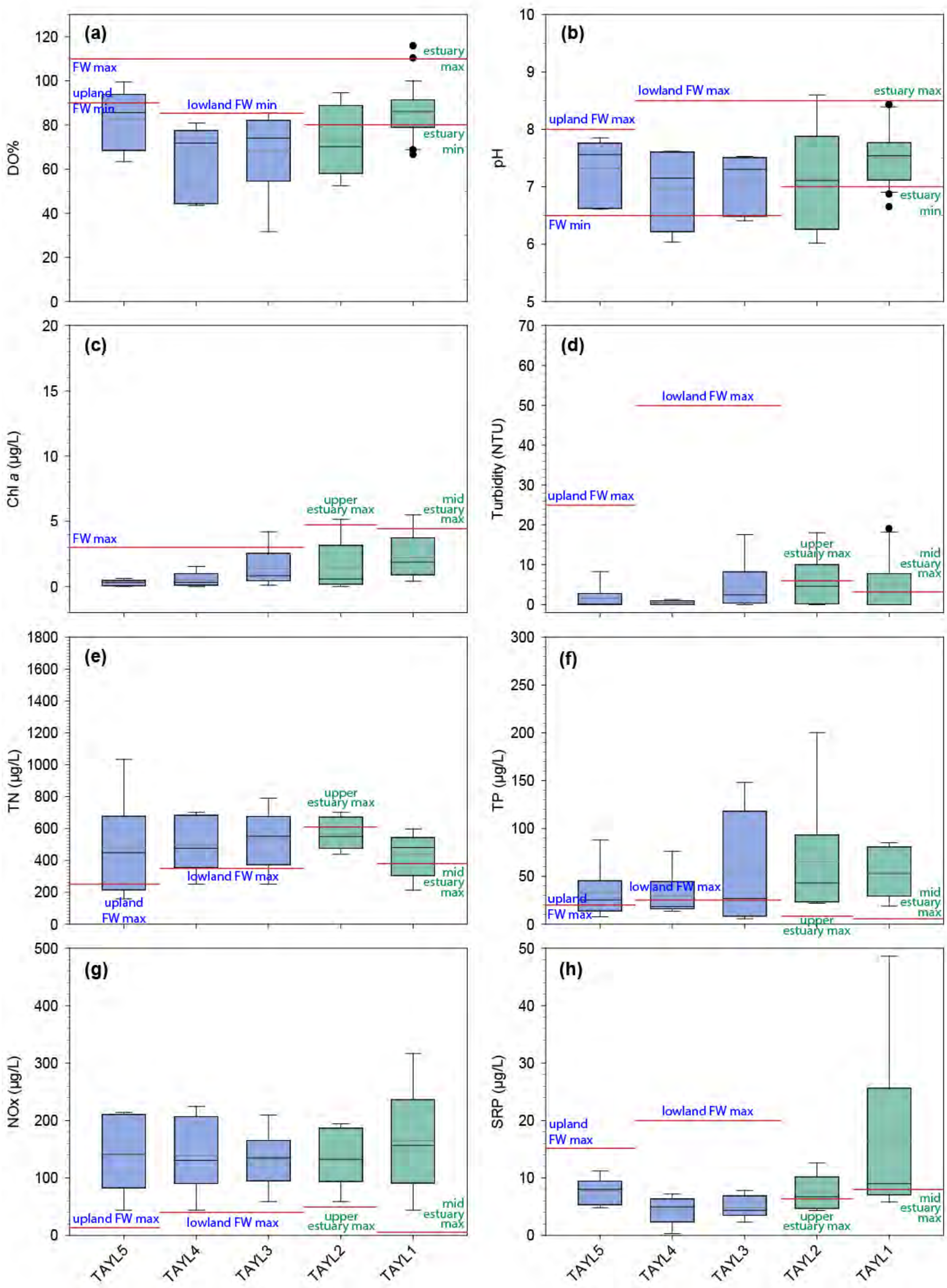


Figure 3.13 *Mean (grey line), median (black line), 25th and 75th percentiles, and range of water quality variables in Taylors Arm from 2016-2017. Outliers are represented by black dots. Green and blue boxes represent estuary and freshwater sites, respectively. Red lines represent the relevant maximum or minimum guideline value for each type of system.*

Table 3.46 *Minimums, maximums and means of measured water quality variables for the three freshwater sites TAYL5, TAYL4 and TAYL3 on Taylors Arm.*

	TAYL5			TAYL4			TAYL3		
Variable	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**
Temperature	10.60	27.88	18.42	14.17	24.47	20.35	14.48	24.82	20.16
pH	6.61	7.85	7.32	6.04	7.62	6.97	6.41	7.53	7.09
EC	0.05	0.14	0.10	0.10	0.23	0.12	0.11	0.21	0.16
Salinity (PPT)	0.04	0.07	0.05	0.04	0.60	0.15	0.05	0.10	0.08
DO (mg/L)	5.34	12.54	8.82	3.75	7.54	6.14	2.73	8.19	6.27
DO %	63.40	99.50	82.73	43.60	80.90	64.83	31.70	85.40	68.07
Turbidity	0.00	8.30	1.60	0.00	1.30	0.52	0.00	17.60	4.70
Chla (µg/L)	0.00	0.63	0.28	0.00	1.54	0.50	0.12	4.20	1.36
TSS (mg/L)	0.20	2.64	1.52	0.93	2.00	1.43	2.10	9.18	4.59
TN (µg/L)	158.29	1033.11	479.99	251.40	701.99	494.91	251.40	790.29	532.37
TP (µg/L)	7.66	88.12	32.18	13.66	76.12	29.60	5.66	148.13	54.14
NOx (µg/L)	43.67	213.88	140.61	43.67	224.40	139.26	58.73	209.34	132.50
SRP (µg/L)	4.79	11.21	7.73	0.30	7.18	4.41	2.30	7.81	4.87

Table 3.47 *Minimums, maximums and means of measured water quality variables for the two estuarine sites TAYL2 and TAYL1 on Taylors Arm.*

	TAYL2			TAYL1		
Variable	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**
Temperature	14.51	28.51	21.13	17.18	28.36	24.40
pH	6.02	8.60	7.14	6.91	8.43	7.61
EC	0.17	20.00	3.81	41.60	49.80	44.73
Salinity (PPT)	0.08	11.94	2.23	26.77	31.33	28.83
DO (mg/L)	4.10	8.98	6.74	4.61	8.60	6.35
DO %	52.50	94.60	72.38	66.60	115.80	87.28
Turbidity	0.00	18.00	5.83	0.00	19.00	7.25
Max Depth	NA	NA	NA	3.30	4.30	3.87
Chla (µg/L)	0.00	5.16	1.45	0.42	5.50	2.63
TSS (mg/L)	1.34	11.26	5.02	16.35	21.16	18.30
TN (µg/L)	438.60	701.99	564.59	335.03	597.25	473.89
TP (µg/L)	21.88	200.12	64.92	18.94	85.13	62.71
NOx (µg/L)	58.73	194.28	134.41	43.67	316.46	174.59
SRP (µg/L)	4.29	12.59	7.42	5.79	48.64	20.53

Table 3.48 *Exceedances[1] observed in Taylors Arm for pH, conductivity (EC), percent saturated dissolved oxygen (DO), turbidity, chlorophyll a (Chl-a), total nitrogen (TN), total phosphorus (TP), bioavailable nitrogen (NOx) and soluble reactive phosphorus (SRP).*

Site	pH	EC	DO %	Turbidity	Chl-a	TN	TP	NOx	SRP
TAYL5	0(0%)0,0	0(0%)	4(67%)4,0	0(0%)	0(0%)	4(67%)	4(67%)	6(100%)	0(0%)
TAYL4	2(33%)2,0	5(83%)5,0	6(100%)6,0	0(0%)	0(0%)	5(83%)	2(33%)	6(100%)	0(0%)
TAYL3	1(17%)1,0	1(17%)1,0	5(83%)5,0	0(0%)	1(20%)	5(83%)	3(50%)	6(100%)	0(0%)
TAYL2	4(67%)3,1	NA	4(67%)4,0	2(33%)	1(20%)	2(33%)	6(100%)	6(100%)	3(50%)
TAYL1	6(33%)6,0	NA	10(56%)8,2	8(62%)	1(20%)	4(67%)	6(100%)	6(100%)	4(67%)

[1] Numbers in black represent the total number and percent of exceedances. Numbers in blue and red represent the numbers of measurements lower than the minimum guideline value and higher than the maximum guideline value, respectively. The number of exceedances includes all depths sampled so may be greater than the number of times sampled. Turbidity, chlorophyll a, and nutrients only have maximum trigger guidelines.

3.4.5 Aquatic macroinvertebrates

TAYL5 recorded 305 and 285 individual macroinvertebrates across 29 and 19 macroinvertebrate families during the spring 2016 and autumn 2017 sampling periods, respectively (Table 3.49). In spring 2016, abundance was dominated by Psephenidae (Water Pennies), with 68 individuals identified, while richness was highest in Trichoptera with seven families represented. Autumn abundance was dominated by Atyidae shrimp (96 individuals). Autumn richness was co-dominated by Trichoptera and Coleoptera, each represented by five families.

The mean SIGNAL2 score for TAYL5 was significantly higher in spring (6.1) than autumn (3.6) and likely driven by abundances of high scoring Trichoptera, Ephemeroptera, and Coleoptera in spring. SIGNAL2 score ranges were relatively wide, particularly in the spring sample.

TAYL5 received a low overall Ecohealth score of 53 (D) for aquatic macroinvertebrate community condition with all macroinvertebrate indicators, aside from SIGNAL2, scoring below the average for the Nambucca Catchment. While TAYL5 was capable of sustaining a wide diversity of macroinvertebrate fauna, it did so at reduced abundances. Ecohealth indicator assessments returned a good score for water quality with 67 (C) and a very good score for riparian condition of 84 (B). This suggests that despite the close proximity to heavily forested headwaters and good water quality at this site, the low macroinvertebrate score at TAYL5 was likely a response to the reduced streamflow due to drier than average climatic conditions during the sampling period.

TAYL4 recorded 470 and 392 individual macroinvertebrates across 25 and nine macroinvertebrate families during the spring 2016 and autumn 2017 sampling periods, respectively (Table 3.49). In spring 2016, total abundance was dominated by Leptophlebiid mayflies (139 individuals) and family richness was dominated by Trichoptera (Caddisflies) with eight families present. Autumn abundance was co-dominated by Atyidae shrimp (111 individuals) and Hydrophilidae (Water Scavenger Beetles) with 99 individuals present. Autumn richness was co-dominated by Trichoptera and Coleoptera, each represented by three families.

The mean SIGNAL2 score for TAYL4 was higher in spring (6.0) than in autumn (5.0), while SIGNAL2 score ranges were relatively wide, particularly the autumn sample.

TAYL4 received a very good overall Ecohealth score of 78 (B-) for aquatic macroinvertebrate community condition. As such, macroinvertebrate indicators were consistently above or well above the average for the Nambucca Catchment. With relatively high total abundance, family richness and SIGNAL2 scores, macroinvertebrate indicators suggest that the water quality, food and habitat conditions in the Nambucca Catchment at TAYL4 are capable of sustaining a diverse range of macroinvertebrate fauna. This was only partially supported by Ecohealth water quality and riparian condition assessments which each returned moderate scores of 52 (D) and 56 (D+), respectively. The good macrophyte cover, streamflow and proximity to heavily forested catchment headwaters at TAYL4 were likely important drivers of macroinvertebrate community condition at TAYL4.

TAYL3 recorded 568 and 746 individual macroinvertebrates across 16 and 7 macroinvertebrate families during the spring 2016 and autumn 2017 sampling periods, respectively (Table 3.49). In spring 2016, abundance was dominated by Atyidae shrimp (287 individuals) and richness was dominated by Trichoptera (Caddisflies), with four families. Autumn abundance was comprehensively dominated by Baetid mayflies, with 412 individuals. The most diverse order in autumn was Trichoptera with three families represented. TAYL3 recorded the highest score in the Nambucca catchment for total abundance, yet the lowest score in the Nambucca catchment for family richness.

The mean SIGNAL2 score for TAYL3 was higher in autumn (4.7) than spring (4.0) with a wider SIGNAL2 score range occurring in spring.

TAYL3 received a moderate overall Ecohealth score of 65 (C-) for aquatic macroinvertebrate community condition. Macroinvertebrate indicators fluctuated from well above to well below the average for the Nambucca Catchment. The macroinvertebrate indicators suggest that the water quality, food and habitat conditions at TAYL3 are in good condition and despite comparatively lower autumn richness scores, are capable of sustaining macroinvertebrate fauna in high abundances. This was partially supported by Ecohealth water quality and riparian condition assessments which each returned moderate scores of 59 (D+). The macroinvertebrate community at TAYL3 was likely assisted by the high proportion of native plant species in the immediate riparian overstory, very good macrophyte cover and reasonable streamflow.

Table 3.49 *Summary of aquatic macroinvertebrate indicator scores and the overall macroinvertebrate grade for freshwater sites of the Taylors Arm main-stem.*

	TAYL3		TAYL4		TAYL5	
Macroinvertebrate indicator	**Spring 2016**	**Autumn 2017**	**Spring 2016**	**Autumn 2017**	**Spring 2016**	**Autumn 2017**
Total abundance	568	746	470	392	305	285
Family richness	16	7	25	9	29	19
EPT abundance	163	454	267	83	89	46
EPT richness	10	5	17	11	15	4
Mean SIGNAL2 score	4.0	4.7	6.0	5.0	6.1	3.6
SIGNAL2 score range	2 - 9	2 - 7	2 - 9	3 - 10	2 - 10	2 - 8
Ecohealth score (grade)	**65 (C-)**		**78 (B-)**		**53 (D)**	

3.5 Tributaries of Taylors Arm

3.5.1 Subcatchment and site descriptions

There are three major freshwater tributaries of Taylors Arm: Thumb Creek, Baker Creek and Tom Maras Creek. The subcatchments of these small systems are included within the Taylors Arm subcatchment for estimations of area, landuse and soils (Figure 3.12, Table 3.40). End-of-system sites were located on each major tributary.

THUM1 was located 200m upstream of the confluence with Taylors Arm (approximately 11.6km upstream of TAYL4). The lower reach of Thumb Creek where THUM1 (Plate 3.41) was located is a planform controlled, low sinuosity gravel-bed channel in a partially constrained valley setting.

BAKE1 was located 680m upstream of the confluence with Taylors Arm (approximately 19.2km upstream of TAYL2). The lower reach of Baker Creek where BAKE1 (Plate 3.42) was located is a planform controlled, meandering channel comprsing fine-grained sediment in a partially constrained valley setting.

TOMC1 was located 600m upstream of the confluence with Taylors Arm (approximately 1.7km upstream of TAYL2). The majority of the stream network in the Tom Maras Creek subcatchment is represented by TOMC1 (Plate 3.43) which is a bedrock controlled channel comprising fine-grained sediment in a partially constrained valley setting.

Plate 3.41 *Site THUM1 at the end-of-system site on Thumb Creek, a tributary of Taylors Arm.*

Plate 3.42 *Site BAKE1 at the end-of-system site on Baker Creek, a tributary of Taylors Arm.*

Plate 3.43 *Site TOMC1 at the end-of-system site on Tom Maras Creek, a tributary of Taylors Arm.*

3.5.2 Geomorphic condition

THUM 1

The geomorphic River Style at Thumb Creek 1 is a planform controlled, low sinuosity gravel-bed channel in a partially confined valley setting. THUM1 drains 29.2km of stream network, predominantly headwaters and gorges in good geomorphic condition. However, THUM1 is located at the downstream end of a 5.1km reach in poor geomorphic condition (Alluvium 2012). The bed sediments at THUM1 comprised a mixed bedload of subangular cobbles and pebbles with >60% fine sediments. There was minor (<5m) erosion on the downstream end of instream gravel bars. Banks comprised fine sediments with gravels. There was significant (10-20m) active erosion on the right bank immediately upstream of the bridge at the confluence with Taylors Arm, with minor (<5m) slumping on the left bank upstream of the bridge. THUM1 scored 78, a B- for BANK CONDITION and 83, a B, for BED CONDITION. The overall geomorphic condition for THUM1 was 81, a grade of B.

In summary, THUM1 was assessed as being in good geomorphic condition, with bank erosion upstream of the bridge the most significant issue for site-level geomorphic condition. Thumb Creek was included in the Taylors Arm subcatchment in the desktop GIS assessment of subcatchment geomorphic condition with a moderate condition with a grade of C+. The geomorphic condition at THUM1 was above the subcatchment average.

BAKE 1

The geomorphic River Style at Baker Creek 1 is a planform controlled, meandering, fine-grained channel in a partially confined valley setting. BAKE1 drains 31.6km of stream network, predominantly in moderate geomorphic condition (Alluvium, 2012). BAKE1 is located in a reach assessed as being in moderate geomorphic condition, but downstream of a 4.3km reach in poor geomorphic condition (Alluvium 2012). The bed sediments at BAKE1 comprised gravel with >60% fine sediments. There was moderate (5-10m) active erosion and smothering by fine sediments in the site, which was located downstream of a bridge that was replaced during the study period. Banks comprised fine sediments. There was moderate (5-10m) active erosion and moderate (5-10m) undercutting on both banks. There was moderate (5-10m) slumping on the left bank. BAKE1 scored 68, a C for BANK CONDITION and 73 a C+, for BED CONDITION. The overall geomorphic condition for BAKE was 71, a grade of C+.

In summary, BAKE1 was assessed as being in moderate geomorphic condition, with localized bank erosion and the deposition of significant fine sediments on the streambed the most significant issue for site-level geomorphic condition. Baker Creek was included in the Taylors Arm subcatchment in the desktop GIS assessment of subcatchment geomorphic condition with a moderate condition with a grade of C+. The geomorphic condition at BAKE1 was equal to the subcatchment average.

TOMC 1

The geomorphic River Style at Tom Maras Creek 1 is a bedrock controlled, fine-grained channel in a partially confined valley setting. TOMC1 drains 9.9km of stream network, predominantly in moderate (6.6km) geomorphic condition (Alluvium 2012). The bed and bank sediments at TOMC1 comprised fine sediments. There was significant pugging and trampling by cattle on both banks. There was significant (10-20m) slumping of the right bank and moderate (5-10m) of undercutting and bank erosion on the right bank immediately upstream of the bridge. TOMC1 scored 60, a C- for BANK CONDITION and 47, a D-, for BED CONDITION. The overall geomorphic condition for TOMC1 was 53, a grade of D.

In summary, TOMC1 was assessed as being in poor geomorphic condition, with slumping and pugging due to cattle traffic the most significant issue for site-level geomorphic condition. Baker Creek was included in the Taylors Arm subcatchment in the desktop GIS assessment of subcatchment geomorphic condition with a moderate condition with a grade of C+. The geomorphic condition at TOMC1 was significantly below to the subcatchment average.

3.5.3 Riparian condition

THUM 1

Site: The original riparian vegetation community at Thumb Creek 1 (THUM1, Plate 3.44) was described as ‘Riparian subtropical rainforest with River Oak emergents on lowland creek flats’ (NAM_RF05), a listed TEC (OEH 2015), grading into ‘River Oak grassy open forest along larger rivers’ (NAM_FW01). THUMB1 received a low riparian condition score of 58, a grade of D+ (Table 3.50).

Dominant Species: The dominant canopy species present were the native species River Oak (*Casuarina cunninghamiana* subsp. *cunninghamiana*), Morton Bay Fig (*Ficus macrophylla*) and the exotic species Cockspur Coral tree (*Erythrina crista-galli*). Dominant native midstory species included Silver Weeping Tea Tree (*Leptospermum brachyandrum*), Elderberry (*Cuttsia virburnea*) and Black Wattle (*Callicoma serratifolia*), along with the exotic species Wild Tobacco (*Solanum mauritianum*), Small-leaved Privet (*Ligustrum sinense*), Lantana (*Lantana camara*), Senna (*Senna septemtrionalis*) and Taro (*Colocasia esculenta*). The understory was dominated by native species Soft Lomandra (*Lomandra hystrix*), Binung (*Christella dentata*), Knotweeds (*Persicaria decipiens* and *P.hydropiper*), Scurvy Weed (*Commelina cyanea*), Lesser Joyweed (*Alternanthera denticulata*), Couch (*Cynodon dactylon*) and Creeping Beard Grass (*Oplismenus imbecillis*), along with exotic species Ink Weed (*Phytolacca octandra*), Blue Billy Goat Weed (*Ageratum houstonianum*), Mistflower (*Ageratina riparia*), Wandering Jew (*Tradescantia fluminensis*), Peppermint (*Mentha* x *rotundifolia*), Pigeon Grass (*Setaria* sp. *sphacelata*) and Paspalum species (*Paspalum dilatatum* and *P. mandiocanum*). Dominant vine species included Kangaroo Vine (*Cissus antartica*), Snake Vine (*Stephania japonica*), Native Raspberry (*Rubus rosifolius*), while the macrophyte layer included Water Couch (*Paspalum distichum*), Pennywort (*Hydrocotyle tripartita*) and the exotic species Watercress (*Rorippa nasturtium-aquaticum*).

Noxious weed species: Noxious weed species observed on-site were Cockspur Coral tree (*Erythrina crista-galli*), Small-leaved Privet (*Ligustrum sinense*), Lantana (*Lantana camara*), Green Cestrum (*Cestrum parqui*), Angel's Trumpet (*Brugmansia suaveolens*), Arsenic Bush (*Senna septemtrionalis*), Mistflower (*Ageratina riparia*), Noogoora Burr (*Xanthium occidentale*), Annual Ragweed (*Ambrosia artemisiifolia*), Wandering Jew (*Tradescantia fluminensis*) and Fireweed (*Senecio madagascariensis*).

Summary: Thumb Creek 1 was a highly disturbed closed forest system with a mixed-aged canopy of native and exotic species throughout all structural layers, in a predominantly forested, partially cleared rural landscape. The surrounding landuse was primarily agricultural grazing land and forested private land, beyond which was state forest and national park. Significant remnant stands of vegetation surround the site in the form of forested private land, 1.3km east in Dunggir National Park and 1.2km south in Thumb Creek State Forest. Representative elements of the remnant vegetation community were present in all of the structural layers, with THUM1 scoring moderately for the Habitat, Cover and management subindices and poorly for the Native Species and Debris subindices (Table 3.50).

Riparian condition was affected by disrupted riparian continuity and the presence and regeneration of weed and noxious weed species, particularly in the midstory and understory structural layers.

Reduced levels of cover in the canopy and midstory, a reduction in fringing vegetation and large woody debris, limited habitat trees, inadequate riparian fencing and animal impact also contributed to the reduction in riparian grade at this site.

Plate 3.44 *Riparian vegetation condition at THUM1 was considered to be highly disturbed. This was primarily due to disrupted continuity, the presence of weed and noxious weed species, reduced canopy and midstory cover, low levels of large woody debris, inadequate riparian fencing and the presence of livestock throughout the riparian zone.*

Table 3.50 *Site-level assessments of riparian condition in 2016-17 at THUM1 showing scores for the five subindices and their individual indicators that comprise the Vegetation Condition Index.*

Thumb Creek 1	Scores
HABITAT	**14/20**
Channel width	3
Proximity	3
Continuity	1
Layers	4
Large native trees	2
Hollow-bearing trees	1
NATIVE SPECIES	**9.5/20**
Native canopy species	3
Native midstory species	1
Native herb/forb species	2
Native graminoid species	1.5
Native macrophyte species	2
SPECIES COVER	**14/20**
Canopy species	2
Midstory species	2
Herb/forb species	4
Graminoid species	4
Macrophyte species	2
DEBRIS	**8/20**
Total leaf litter	3
Native leaf litter	2
Dead trees standing	0
Dead trees fallen	0
Lying logs	1
Fringing vegetation	2
MANAGEMENT	**12.5/20**
Tree clearing	2
Fencing	2
Animal impact	1
Canopy Health	1.5
Exposed tree roots	3
Native woody regeneration	2
Weedy woody regeneration	1
TOTAL	**58/100**

BAKE 1

Site: The original riparian vegetation community at Baker Creek 1 (BAKE1, Plate 3.45) was a Lowland Rainforest formation, likely to be 'Shatterwood – Whalebone Tree dry rainforests on metasediments' (NAM_RF10), a listed TEC (OEH 2015) and invading exotic vegetation community of 'Camphor Laurel, Lantana and Privet' (NAM_EX02-03-04) grading into 'Flooded Gum moist open forest of sheltered lower slopes and gullies' (NAM_WSF01). BAKE1 received a low riparian condition score of 59.7, a grade of D+ (Table 3.51).

Dominant Species: The dominant canopy species present were the native species Flooded Gum (*Eucalyptus grandis*), Grey Possumwood (*Quintinia verdonii*) and the exotic species Camphor Laurel (*Cinnamomum camphora*). Dominant native midstory species included Brush Cherry (*Syzigium australe*), Weeping Bottlebrush (*Callistemon viminalis*), Sandpaper Fig (*Ficus coronata*), Silver Weeping Tea Tree (*Leptospermum brachyandrum*) along with the exotic species Wild Tobacco (*Solanum mauritianum*), Privet species (*Ligustrum sinense* and *L.lucidum*), Lantana (*Lantana camara*). The understory was dominated by native species Scurvy Weed (*Commelina cyanea*), Soft Lomandra (*Lomandra hystrix*), Common Rush (*Juncus ursitatus*), Knotweeds (*Persicaria stigosa* and *P.hydropiper*), Common Bracken (*Pteridium esculentum*), Pademelon Grass (*Oplismenus gracillima*), along with exotic species Wandering Jew (*Tradescantia fluminensis*), Sidratusa (*Sida rhombifolia*), Rhodes Grass (*Chloris gayana*), Pigeon Grass (*Setaria sphacelata*) and Paspalum species (*Paspalum mandiocanum* and *P.dilatatum*). A rich vine layer included the dominant native species Lawyer Vine (*Smilax australis*), Native Raspberry (*Rubus rosifolius*), Silkpod (*Parsonnsia* spp.), Cockspur Thorn (*Maclura cochinchinensis*) and Kangaroo Vine (*Cissus antarctica*), while the macrophyte layer included Water Primrose (*Ludwidgia peploides*), Potomogeton (*Potomogeton ochtandrus*), Triangular Club Rush (*Schoenoplectiella mucronata*), Duck Weed (*Azolla pinata*) and the exotic species Parrot's Feather (*Myriophyllum aquaticum*).

Noxious weed species: Noxious weed species observed on-site were species Camphor Laurel (*Cinnamomum camphora*), Privet species (*Ligustrum sinense* and *L.lucidum*), Lantana (*Lantana camara*), Noogoora Burr (*Xanthium occidentale*), species Wandering Jew (*Tradescantia fluminensis*) and Parrot's Feather (*Myriophyllum aquaticum*).

Summary: Baker Creek 1 was a highly disturbed closed-forest system with a mixed-aged canopy and a mix of native and exotic species throughout the all structural layers, with a prevalence of exotic species throughout the midstory, in a predominantly cleared, partially forested rural landscape. The surrounding landuse was primarily agricultural grazing land beyond which was forested private land, State Forest and Nature Reserve. Significant remnant stands of vegetation lie 550m east, 800m west and 1km north on private land, 1km east in Ingalba State Forest and 1.2km south in Ngambaa Nature Reserve. While representative elements of the remnant vegetation communities were present in all of the structural layers present they were sometimes scarce, with BAKE1 scoring well for the Cover subindex, moderately for Habitat and Debris and poorly for Native Species and Management subindices (Table 3.51). Riparian condition was affected by reduced riparian vegetation width, disrupted continuity, poor habitat connectivity and the prevalence and regeneration of weed and noxious weed species throughout all structural layers. Reduced levels of cover in the canopy, limited large woody debris inadequate riparian fencing and animal impact also contributed to the reduction in riparian grade at this site.

Plate 3.45 *Despite possessing good vegetation cover, particularly in the midstory, riparian vegetation at BAKE1 was highly disturbed. This was primarily due to poor riparian habitat connectivity, the dominance of weed and noxious weed species throughout all structural layers, and inadequate riparian fencing and the presence of livestock throughout the riparian zone.*

Table 3.51 *Site-level assessments of riparian condition in 2016-17 at BAKE1 showing scores for the five subindices and their individual indicators that comprise the Vegetation Condition Index.*

Baker Creek 1	Scores
HABITAT	**12.7/20**
Channel width	2.7
Proximity	1
Continuity	2
Layers	4
Large native trees	2
Hollow-bearing trees	1
NATIVE SPECIES	**6.5/20**
Native canopy species	2
Native midstory species	0.5
Native herb/forb species	1
Native graminoid species	1
Native macrophyte species	2
SPECIES COVER	**18/20**
Canopy species	2
Midstory species	4
Herb/forb species	4
Graminoid species	4
Macrophyte species	4
DEBRIS	**13.5/20**
Total leaf litter	3
Native leaf litter	1.5
Dead trees standing	1
Dead trees fallen	0
Lying logs	4
Fringing vegetation	4
MANAGEMENT	**9/20**
Tree clearing	1.5
Fencing	1
Animal impact	0
Canopy Health	1.5
Exposed tree roots	4
Native woody regeneration	1
Weedy woody regeneration	0
TOTAL	**59.7/100**

TOMC 1

Site: The original riparian vegetation community at Tom Maras Creek 1 (TOMC1, Plate 3.46) was described as 'Shatterwood – Whalebone Tree dry rainforests on metasediments' (NAM_RF10), a listed TEC (OEH 2015) and 'Flooded Gum moist open forest of sheltered lower slopes and gullies' (NAM_WSF01). TOMC1 received a low riparian condition score of 57.3, a grade of D+ (Table 3.52).

Dominant Species: The dominant canopy species present were the native species Flooded Gum (*Eucalyptus grandis*), Watergum (*Tristaniopsis laurina*) and the exotic species Camphor Laurel (*Cinnamomum camphora*). Dominant native midstory species included Brush Kurrajong (*Commersonia fraseri*), Weeping Bottlebrush (*Callistemon viminalis*), Green Native Cascarilla (*Croton verreauxii*), Sandpaper Fig (*Ficus coronata*) and Silver Weeping Tea Tree (*Leptospermum brachyandrum*), along with the exotic species Wild Tobacco (*Solanum mauritianum*), Lantana (*Lantana camara*) and Green Cestrum (*Cestrum parqui*). The understory was dominated by native species Common Bracken (*Pteridium esculentum*), Soft Lomandra (*Lomandra hystrix*), Knotweeds (*Persicaria stigosa* and *P.hydropiper*), Scurvy Weed (*Commelina cyanea*), Australian Basket Grass (*Oplismenus aemulus*) and Pademelon Grass (*Ottochloa gracillima*), along with exotic species Fireweed (*Senecio madagascariensis*), Sidratusa (*Sida rhombifolia*), Paspalum species (*Paspalum mandiocanum* and *P.urvillei*) and Pigeon Grass (*Setaria sphacelata*). Dominant vine species included Cockspur Thorn (*Maclura cochinchinensis*), while the macrophyte layer included Water Primrose (*Ludwidgia peploides*), Potomogeton (*Potomogeton ochtandrus*) and the exotic species Salvinia (*Salvinia molesta*).

Noxious weed species: Noxious weed species observed on-site were Camphor Laurel (*Cinnamomum camphora*), Lantana (*Lantana camara*) and Green Cestrum (*Cestrum parqui*), Annual Ragweed (*Ambrosia artemisiifolia*), Fireweed (*Senecio madagascariensis*) and Salvinia (*Salvinia molesta*).

Summary: Tom Maras Creek was a highly disturbed closed-forest system with a mixed-aged canopy and native and exotic species throughout all structural layers in a predominantly cleared, partially forested rural landscape. The surrounding landuse was primarily agricultural grazing land beyond which was private forested land, beyond which was State Forest and Nature Reserve. Significant remnant stands of vegetation lie 1.3km west, 1.5km north and 2km east and of the site on private land, 2km south in Ingalba State Forest and 2.3km southwest in Ngambaa Nature Reserve. Representative elements of the remnant vegetation community were present in all of the structural layers with TOMC1 scoring moderately for Native Species, Cover, Debris and Management subindices and poorly for the Habitat subindex (Table 3.52). Riparian condition was affected by poor riparian vegetation width and habitat connectivity, disrupted continuity and the presence and regeneration of weed and noxious weed species, particularly in the understory structural layer. Reduced levels of cover in the canopy and midstory, limited large woody debris, historic clearing and inadequate riparian fencing and animal impact also contributed to the reduction in riparian grade at this site.

Plate 3.46 *Riparian vegetation condition at TOMC1 was highly disturbed. This was primarily due to poor riparian width and habitat connectivity, reduced connectivity, the presence of weed and noxious weed species, inadequate riparian fencing and the presence of livestock throughout the riparian zone.*

***Table 3.52** Site-level assessments of riparian condition in 2016-17 at TOMC1 showing scores for the five subindices and their individual indicators that comprise the Vegetation Condition Index.*

Tom Maras Creek 1	Scores
HABITAT	**9.3/20**
Channel width	1.3
Proximity	0
Continuity	2
Layers	4
Large native trees	2
Hollow-bearing trees	0
NATIVE SPECIES	**10.5/20**
Native canopy species	3
Native midstory species	3
Native herb/forb species	2
Native graminoid species	1.5
Native macrophyte species	1
SPECIES COVER	**14/20**
Canopy species	1.5
Midstory species	2.5
Herb/forb species	4
Graminoid species	4
Macrophyte species	2
DEBRIS	**13/20**
Total leaf litter	3
Native leaf litter	3
Dead trees standing	2
Dead trees fallen	0
Lying logs	2
Fringing vegetation	3
MANAGEMENT	**10.5/20**
Tree clearing	1.5
Fencing	1
Animal impact	1
Canopy Health	2
Exposed tree roots	3
Native woody regeneration	1
Weedy woody regeneration	1
TOTAL	**57.3/100**

3.5.4 Water quality

Together the freshwater tributaries of Taylors Arm received a moderate overall score of 56 (D+) for water quality, an above average score for the Nambucca Catchment. Thumb Creek received a score of 57 (D+), Baker Creek received the highest score of 61 (C-), while Tom Maras Creek received the lowest tributary score of Taylors Arm with 51 (D). Figure 3.14 shows the key physico-chemical and nutrient variables used in the assessment of water quality for Taylors Arm tributaries. Ranges and means for these variables are given in Table 3.53 and the exceedances are given in Table 3.54.

Mean pH concentrations generally remained consistent throughout the freshwater tributaries of Taylors Arm. All sites breached the ANZECC minimum exceedance of 6.5 for pH in lowland streams on one or two occasions only, with the lowest pH of 6.06 observed at THUM1. The tributaries of Taylors Arm did not exceed the maximum pH guideline at any site during the sampling period. Turbidity did not exceed ANZECC guidelines at any site during the study period.

DO% exceeded the ANZECC minimum guideline for lowland freshwater systems at all three sites on all sampling occassions. The lowest DO% were observed at both BAKE1 and TOMC1 with DO% values of less than 15%. The corresponding DO concentrations of 1.19mg/L and 0.76mg/L at BAKE1 and TOMC1 respectively are low enough to significantly impact aquatic biota such as fish. These minimum DO observations occurred in February, 2017 following extended periods of below average rainfall and above average maximum temperatures for the Nambucca catchment.

Total nitrogen (TN) concentrations varied both spatially and temporally throughout the three Taylors Arm tributaries. ANZECC trigger values were exceeded on all sampling occassions at TOMC1 and exceeded frequently at both THUM1 and BAKE1. Peak TN exceedances were observed at both TOMC1 and THUM1 with each recording concentrations greater than three times the ANZECC guidelines for lowland freshwater systems. With the exception of a single sampling occasion at BAKE1, all three tributaries of Taylors Arm exceeded bioavailable nitrogen (NOx) guideline values on all sampling occassions, with all three sites performing similarly and generally following the same trend. The highest NOx concentration was observed at BAKE1 at 254.5µg/L, greater than 8 times the ANZECC guideline.

Mean total phosphorus (TP) concentrations varied between the three tributaries. However, all three sites regularly exceeded the ANZECC maximum TP trigger value of 25µg/L, with 83% of samples at Tom Maras Creek exceeding the ANZECC TP guideline. Peak exceedances for TP were observed at both TOMC1 and BAKE1, with concentrations greater than six times the ANZECC guideline for lowland streams. In contrast, bioavailable phosphorus (SRP) concentrations did not exceed ANZECC guidelines at any site during the sampling period.

Mean Chl-a concentrations in the system varied between tributaries and while ANZECC guidelines were at times exceeded, they did not persist beyond single sampling occasions at any one site. However, where ANZECC guidelines for Chl-a were exceeded, the general pattern appeared to follow similar exceedance patterns observed for both TN and TP for the same sites. A combination of elevated nutrient levels and extended periods of below average rainfall and above average maximum temperatures across the Nambucca Catchment are the likely drivers of the periodically elevated response variable, Chl-a. However, despite the persistence of high nutrient loads throughout the sampling period, particularly TN, several low concentrations in the response variable (Chl-a) suggests that the Taylors Arm tributaries have some degree of resilience to high nutrient concentrations. The peak Chl-a exceedance was observed at TOMC1 in July 2016 with a concentration of 56.03µg/L, over 18 times the ANZECC guideline for lowland streams. Slightly lower Chl-a exceedances were also observed in TOMC1 and in BAKE1 in February 2017, at nine and ten times the guideline value, respectively.

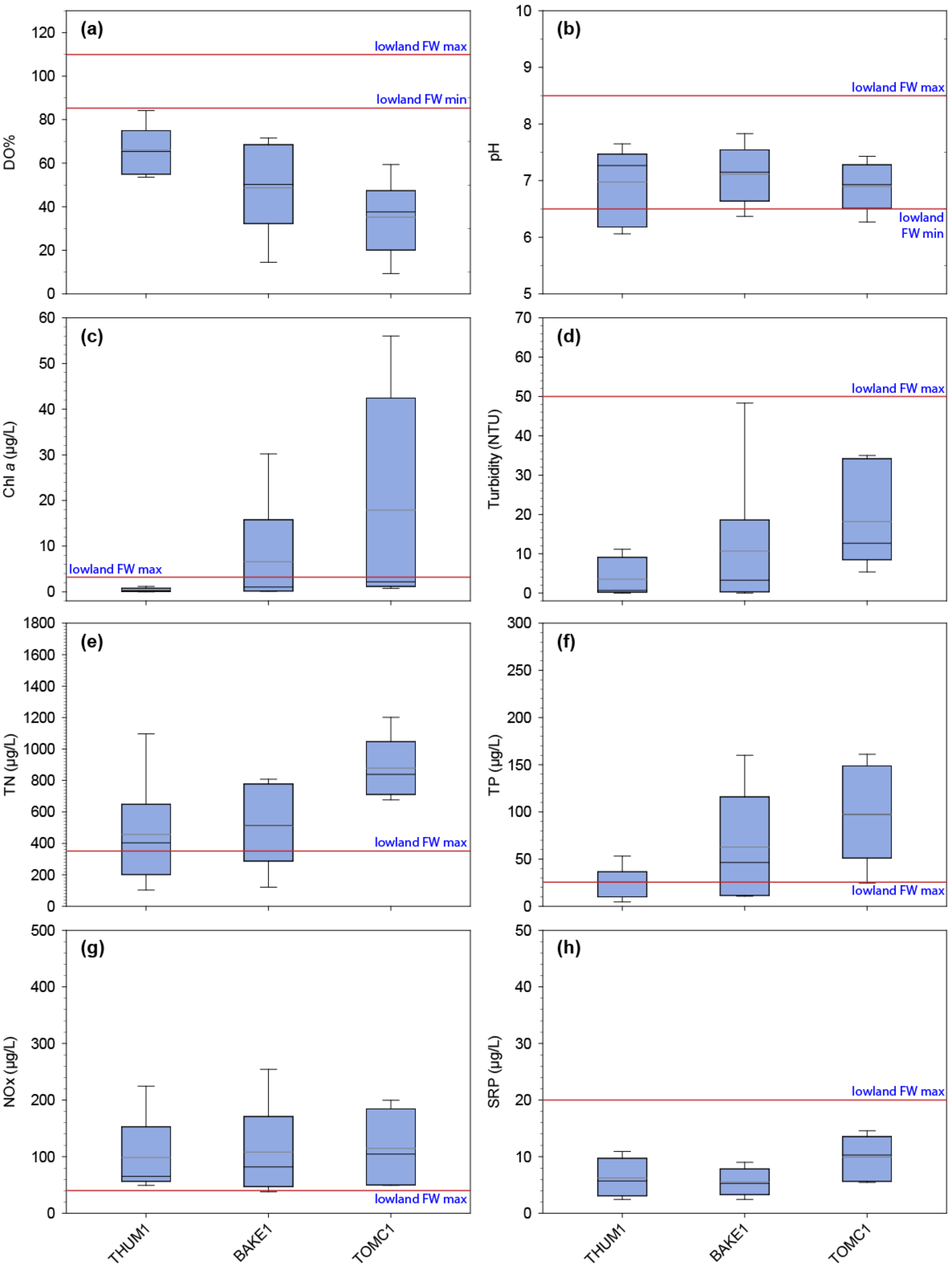


Figure 3.14 *Mean (grey line), median (black line), 25th and 75th percentiles, and range of water quality variables in freshwater tributaries of Taylors Arm from 2016-2017. Outliers are represented by black dots. Green and blue boxes represent estuary and freshwater sites, respectively. Red lines represent the relevant maximum or minimum guideline value for each type of system.*

Table 3.53 *Minimums, maximums and means of measured water quality variables for the three sites TOMC1, BAKE1 and THUM1 on the tributaries Tom Maras, Baker, and Thumb Creeks.*

	THUM1			BAKE1			TOMC1		
Variable	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**
Temperature	14.10	23.68	19.20	11.8	24.8	18.9	11.45	25.11	19.57
pH	6.06	7.65	6.98	6.37	7.83	7.11	6.27	7.43	6.90
EC	0.10	0.14	0.13	0.025	0.333	0.245	0.30	1.52	0.58
Salinity (PPT)	0.06	0.07	0.07	0.11	0.16	0.14	0.14	0.77	0.29
DO (mg/L)	4.58	8.44	6.61	1.19	7.80	4.93	0.76	6.22	3.48
DO %	53.60	84.20	66.00	14.5	71.5	48.7	9.30	59.40	35.17
Turbidity	0.00	11.10	3.53	0.0	48.3	10.7	5.40	35.00	18.20
Chla (µg/L)	0.00	1.17	0.39	0.122	30.196	6.594	0.73	56.03	17.88
TSS (mg/L)	0.21	4.72	2.30	2.2	36.0	10.5	2.63	14.29	8.04
TN (µg/L)	102.42	1096.5	456.27	121.0	807.9	511.4	675.50	1201.12	878.55
TP (µg/L)	4.66	53.12	25.24	10.7	160.1	62.8	24.62	161.13	97.55
NOx (µg/L)	49.37	224.40	98.60	37.9	254.5	108.3	49.37	199.72	114.65
SRP (µg/L)	2.43	10.93	6.23	2.4	9.0	5.5	5.46	14.59	9.92

Table 3.54 *Exceedances[1] observed in tributaries of Taylors Arm for pH, conductivity (EC), percent saturated dissolved oxygen (DO), turbidity, chlorophyll a (Chl-a), total nitrogen (TN), total phosphorus (TP), bioavailable nitrogen (NOx) and soluble reactive phosphorus (SRP).*

Site	pH	EC	DO %	Turbidity	Chl-a	TN	TP	NOx	SRP
THUM1	2(33%)2,0	2(33%)2,0	6(100%)6,0	0(0%)	0(0%)	4(67%)	3(50%)	6(100%)	0(0%)
BAKE1	1(17%)1,0	1(17%)2,0	6(100%)6,0	0(0%)	1(20%)	4(67%)	3(50%)	5(83%)	0(0%)
TOMC1	1(17%)1,0	0(0%)	6(100%)6,0	0(0%)	2(40%)	6(100%)	5(83%)	6(100%)	0(0%)

[1] Numbers in black represent the total number and percent of exceedances. Numbers in blue and red represent the numbers of measurements lower than the minimum guideline value and higher than the maximum guideline value, respectively. The number of exceedances includes all depths sampled so may be greater than the number of times sampled. Turbidity, chlorophyll a, and nutrients only have maximum trigger guidelines.

3.5.5 Aquatic macroinvertebrates

Thumb Creek

THUM1 recorded total abundances of 281 and 536 across 25 and 23 macroinvertebrate families during the 2016 spring and 2017 autumn sampling periods, respectively (Table 3.55). In spring 2016, abundance was dominated by Chironomid midges with 85 individuals recorded. Spring richness was dominated by Trichoptera with seven families. Autumn abundance was again highest in the Chironomid family with 123 individuals. Autumn richness was dominated by Trichoptera with nine families. Thumb Creek scored the equal highest score for family richness throughout the Catchment.

The mean SIGNAL2 score for THUMB1 was higher in autumn 2017 (5.1) when compared to spring 2016 (4.2). However, the SIGNAL2 score range was wider in spring 2016. The greater autumn SIGNAL2 score was increased by higher numbers of high-scoring Trichoptera and Ephemeroptera. This factor contributed to THUMB1 achieving the highest EPT score in the Nambucca catchment.

THUM1 received a very good overall Ecohealth score of 79 (B-) for aquatic macroinvertebrate community condition, the equal highest site score achieved in the Nambucca catchment. All macroinvertebrate indicators scored well above the average for the Nambucca Catchment, except for the SIGNAL2 score which equalled the catchment average. These results, combined with the presence of taxa that were highly sensitive to pollution, suggest that the water quality and habitat conditions in Thumb Creek were in good condition overall. However, the macroinvertebrate result was only partially reflected in the other Ecohealth indicators with both water quality and riparian vegetation returning moderate scores of 57 (D+) and 58 (D+) respectively. The very good macroinvertebrate score at THUM1 is likely driven by proximity to heavily forested catchment headwaters, little landuse pressures and good habitat quality, but was also negatively affected by the below average streamflow which led to disconnection of pools during the study period.

Table 3.55 *Summary of aquatic macroinvertebrate indicator scores and the overall macroinvertebrate grade for the freshwater site in the Thumb Creek subcatchment.*

	THUM1	
Macroinvertebrate indicator	**Spring 2016**	**Autumn 2017**
Total abundance	281	536
Family richness	25	23
EPT abundance	66	277
EPT richness	11	23
Mean SIGNAL2 score	4.2	5.1
SIGNAL2 score range	1 - 10	2 - 8
Ecohealth score (grade)	**79 (B-)**	

Baker Creek

BAKE1 recorded abundances of 286 and 345 individuals across 17 and 16 families over the spring 2016 and autumn 2017 sampling periods, respectively (Table 3.56). Spring family abundance was dominated by Chironomidae larvae and pupa, with 106 individuals. The highest spring richness was recorded within the Trichoptera order, with five families represented. Autumn abundance was dominated by Simuliidae (Black Flies) with 137 larvae and pupa. Autumn richness was highest within the Coleopterans, represented by four families. Despite BAKE1 having similar total richness to the average for the Nambucca catchment, a large proportion of the families present were represented by relatively few individuals.

The mean SIGNAL2 score for BAKE1 was marginally higher in spring 2016 (4.7) than in autumn 2017 (4.3). While abundance was higher in autumn, all other variables including SIGNAL2 range were higher in spring. The increase in the mean SIGNAL2 at BAKE1 in spring was primarily due to high abundances of high-scoring Trichoptera (Caddisflies).

BAKE1 received a low overall Ecohealth score of 51 (D) for aquatic macroinvertebrate community condition with all macroinvertebrate indicators scoring marginally lower than the average for the Nambucca Catchment While the site is capable of supporting a range of macroinvertebrate fauna given the wide SIGNAL2 score range and average richness score, the remaining macroinvertebrate indicators suggest poor water quality, food and/or habitat conditions at Bakers Creek. The water quality and riparian condition assessments returned moderate scores of 61 (C-) and 59 (D+) respectively. The presence of weedy species at BAKE1 was very high and dominated by Small-leaved Privet which may detrimental to native macroinvertebrate species.

Table 3.56 *Summary of aquatic macroinvertebrate indicator scores and the overall macroinvertebrate grade for the freshwater site in the Baker Creek subcatchment.*

	BAKE1	
Macroinvertebrate indicator	**Spring 2016**	**Autumn 2017**
Total abundance	286	345
Family richness	17	16
EPT abundance	89	36
EPT richness	9	8
Mean SIGNAL2 score	4.7	4.3
SIGNAL2 score range	1 - 9	2 - 8
Ecohealth score (grade)	**51 (D)**	

Tom Maras Creek

TOMC1 recorded 147 and 136 individual macroinvertebrates across 12 and 16 macroinvertebrate families during the 2016 spring and 2017 autumn sampling periods, respectively (Table 3.57). Spring abundance was dominated by Chironomidae with 88 individuals. Spring richness was highest in the Dipterans with three families represented. In autumn, the highest abundance recorded was again in the Chironomid family with 82 individuals. Aquatic beetles (Coleopterans) were the most represented order in autumn with four families present. The TOMC1 site recorded the lowest total abundance, EPT and SIGNAL2 scores across the Nambucca catchment.

The mean SIGNAL2 score for TOMC1 was higher in spring 2016 (3.9) than autumn 2017 (3.5). TOMC1 had the lowest mean SIGNAL2 score recorded in the Nambucca catchment. The SIGNAL2 score range was relatively wide across both seasons, though the abundances present in both samples were dominated by low scoring taxa, for example Chironominae, Orthocladiinae, and Tanypodinae.

TOMC1 received a very poor overall Ecohealth score of 26 (F) for aquatic macroinvertebrate community condition, the lowest score recorded throughout the Nambucca catchment. While pollution intolerant taxa were present, they were far outnumbered by pollution-tolerant taxa with low SIGNAL2 scores. The macroinvertebrate indicators, which were all well below the average for Nambuca catchment, suggest that water quality, food and habitat conditions in Tom Maras Creek were in poor condition. This was supported by the other Ecohealth indicators with a poor water quality score of 51 (D) and a poor riparian condition score of 57 (D+). The very poor macroinvertebrate score at TOMC1 was also likely a response to the reduced streamflow experienced during the study period. Additionally, large pockets of Camphor laurel were recorded upstream of the site and this tree species is known to be detrimental to native macroinvertebrate species.

Table 3.57 *Summary of aquatic macroinvertebrate indicator scores and the overall macroinvertebrate grade for the freshwater site in the Tom Maras Creek subcatchment.*

	TOMC1	
Macroinvertebrate indicator	**Spring 2016**	**Autumn 2017**
Total abundance	147	136
Family richness	12	16
EPT abundance	12	14
EPT richness	3	3
Mean SIGNAL2 score	3.5	3.9
SIGNAL2 score range	1 - 9	2 - 8
Ecohealth score (grade)	**26 (F)**	

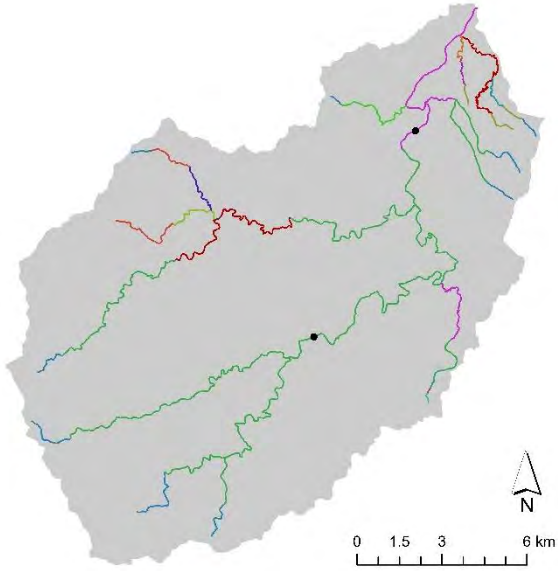
3.6 Warrell Creek

3.6.1 Subcatchment and site descriptions

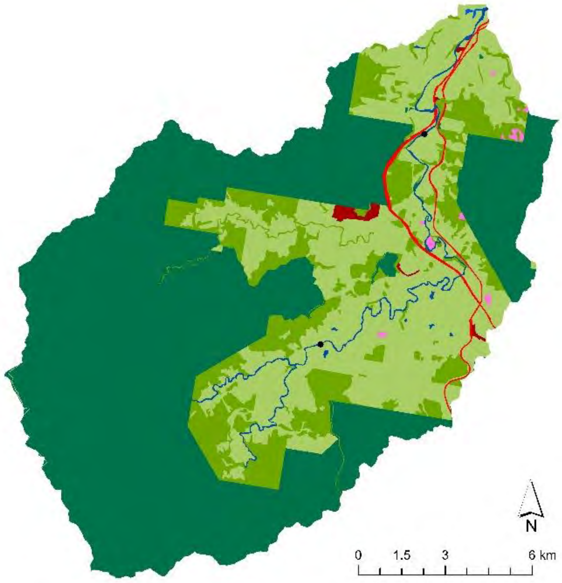
Warrell Creek covers an area of 227km^2 (Table 3.58). Over half of the subcatchment (58%) is conservation area, with grazing (27%) the second-most dominant landuse (Figure 3.15c). The dominant River Style is gravel-bed channel with floodplain pockets in a constrained valley setting (Figure 3.15b). There is a small sewerage treatment plant at Scotts Head, but this does not have a license to discharge into Warrell Creek.

There were four sites in the Warrell Creek subcatchment (Figure 3.15a). EUNC1 (Plate 3.47) is an end-of-system site on Eungai Creek. The channel at EUNC1 is a gravel-bed with floodplain pockets in a constrained valley setting. EUNC1 is 18km upstream of WARR3. WARR3 (Plate 3.48) is the end-of-system freshwater site for Warrell Creek. The channel at WARR3 is a planform controlled, low sinuosity, gravel-bed stream in a partially constrained valley setting, located 11.6km upstream of WARR2. WARR2 (Plate 3.49) is a planform controlled tidal channel in the upper estuary of Warrell Creek. WARR2 is 20km upstream of WARR1. WARR1 (Plate 3.50) is the end-of-system estuary site for Warrell Creek. WARR1 is located in the mid estuary, in a planform controlled channel 2.7km upstream of the confluence with the Nambucca River.

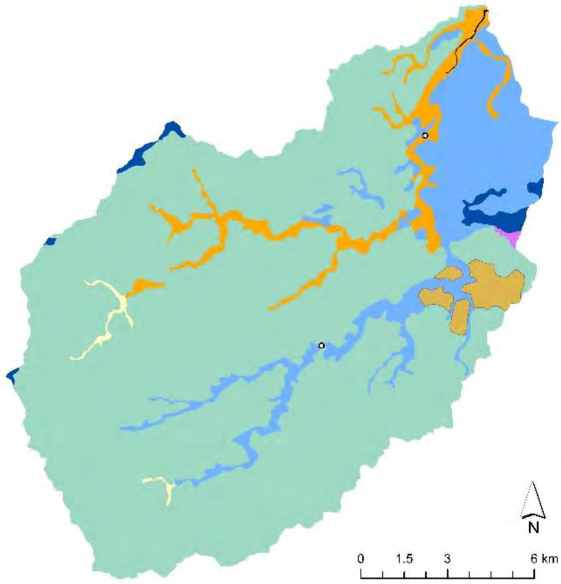
(a) Location of Ecohealth sites.



(b) River Styles: refer to Figure 2.8 for key



(c) Landuse: refer to Figure 2.7 for key



(d) Soils: refer to Figure 2.3 for key

Figure 3.15 *Warrell Creek showing (a) locations of Ecohealth sites, (b) River Styles, (c) landuse, and (d) soils. Data layers from NC LLS (River Styles) and OEH (landuse and soils).*

Table 3.58 *Subcatchment description of Warrell Creek. Data from NC LLS and OEH.*

Variable	Subcatchment composition
Area	226.6 km^2
Geology	53.8% slaty siltstone, 45.1% sandstone, mudstone, 0.7% alluvium, 0.3% monzogranite
Soils	78.9% Kurosols, 13.3% Dermosols, 4.4% Tenosols (Alluvial), 1.8% Kurosols, Natric; 1.1% Rudosols and Tenosols, 0.3% Rudosols (Alluvial), 0.1% Ferrosols
River Styles	53.1% CVS – Floodplain pockets, gravel, 11.3% PCVS – Planform controlled, meandering, fine grained, 10.0% PCVS – Planform controlled, low sinuosity, gravel, 9.8% CVS – Headwater, 3.7% CVS – Gorge, 2.8% PCVS – Planform controlled, low sinuosity, sand, 2.1% SMG – valley fill, sand, 1.8% PCVS – Planform controlled, low sinuosity, fine grained, 1.7% CVS – Floodplain pockets, sand, 1.1% PCVS – Planform controlled, meandering, sand, 1.1% SMG – Chain of ponds, 0.3% SMG – Valley fill, sand, 1.0% Water storage – dam or weir pool
Landuse	57.9% Conservation area, 26.7% Grazing, 0.9% River and drainage system, 0.8% Transport and other corridors, 0.4% Urban, 0.2% Horticulture
Major point source discharge	STP at Scotts Head
Tree Cover	71.1%

Plate 3.47 *Site EUNC1 on Eungai Creek (looking downstream).*

Plate 3.48 *Site WARR3 on the lower freshwater reach of Warrell Creek (looking upstream).*

Plate 3.49 *Site WARR2 in the upper estuary of Warrell Creek.*

Plate 3.50 *Site WARR1 in the lower estuary of Warrell Creek.*

3.6.2 Geomorphic condition

EUNC 1

The geomorphic River Style at Eungai Creek 1 is a gravel-bed channel with floodplain pockets in a confined valley setting. EUNC1 drains 30.5km of stream network, predominantly in good geomorphic condition (Alluvium 2012). EUNC1 is located in a reach assessed as being in moderate geomorphic condition (Alluvium 2012). The bed sediments at EUNC1 comprised gravel with >60% fine sediments. There was moderate (5-10m) active erosion and smothering by fine sediments in the streambed. Banks comprised fine sediments. There was moderate (5-10m) slumping on the right bank, and minor (<5m combined width) of active gully erosion from road runoff on the left bank immediately upstream of the bridge. EUNC1 scored 78, a B- for BANK CONDITION and 70 a C+, for BED CONDITION. The overall geomorphic condition for EUNC1 was 74, a grade of C+.

In summary, EUNC1 was assessed as being in moderate geomorphic condition, with localized bank erosion and the deposition of significant fine sediments on the streambed the most significant issue for site-level geomorphic condition. Eungai Creek was included in the Warrell Creek subcatchment in the desktop GIS assessment of subcatchment geomorphic condition with a good condition with a grade of B-. The geomorphic condition at EUNC1 was slightly below the subcatchment average.

WARR 3

The geomorphic River Style at Warrell Creek 3 is planform controlled, low sinuosity, gravel-bed channel in a partially confined valley setting. WARR3 drains 88.4km of stream network, predominantly in moderate geomorphic condition (Alluvium 2012). However, WARR3 is located midway in a 6.6km reach assessed as being in poor geomorphic condition (Alluvium 2012). The bed sediments at WARR3 comprised gravel with >60% fine sediments. There was moderate (5-10m) active erosion and smothering by fine sediments in the streambed. Banks comprised fine sediments. There was moderate (5-10m) slumping on the right bank. WARR3 scored 72, a C+ for BANK CONDITION and 70 a C+, for BED CONDITION. The overall geomorphic condition for WARR3 was 71, a grade of C+.

In summary, WARR3 was assessed as being in moderate geomorphic condition, with localized bank slumping and the deposition of significant fine sediments on the streambed the most significant issue for site-level geomorphic condition. The desktop GIS assessment of subcatchment geomorphic condition found the Warrell Creek subcatchment to be in good condition with a grade of B-. The geomorphic condition at WARR3 was slightly below the subcatchment average.

WARR 2

The geomorphic River Style at Warrell Creek 2 is planform controlled, tidal channel in a partially confined valley setting. WARR2 drains 143km of stream network, predominantly in moderate geomorphic condition (Alluvium 2012). WARR2 is located midway in a 4km reach assessed as being in moderate geomorphic condition (Alluvium 2012). The bed sediments at WARR2 comprised fine sediments (silty sand). There was minor (5-10m) active erosion and undercutting in the intertidal zones of both banks. WARR2 scored 80, a B for BANK CONDITION. The overall geomorphic condition for WARR2 was 80, a grade of B.

In summary, WARR2 was assessed as being in good geomorphic condition, with minor undercutting in the intertidal zone due to tidal action the most significant issue for site-level geomorphic condition. The desktop GIS assessment of subcatchment geomorphic condition found the Warrell Creek subcatchment to be in good condition with a grade of B-. The geomorphic condition at WARR2 was slightly above the subcatchment average.

WARR 1

The geomorphic River Style at Warrell Creek 1 is planform controlled, tidal channel in a partially confined valley setting. WARR1 drains 180.4km of stream network (the Eungai and Warrell Creek subcatchments), predominantly in good geomorphic condition (Alluvium 2012). WARR1 is located towards the downstream end of a 10.7km reach assessed as being in good geomorphic condition (Alluvium 2012). The bed sediments at WARR1 comprised marine sand. There was moderate (10-20m) active erosion, slumping and exposure of tree roots on both banks, naturally driven by the sandy bank material. WARR1 scored 72, a C+ for BANK CONDITION. The overall geomorphic condition for WARR1 was 72, a grade of C+.

In summary, WARR1 was assessed as being in moderate geomorphic condition, with moderate bank slumping and exposure of tree roots the most significant issue for site-level geomorphic condition. The desktop GIS assessment of subcatchment geomorphic condition found the Warrell Creek subcatchment to be in good condition with a grade of B-. The geomorphic condition at WARR2 was slightly below the subcatchment average.

3.6.3 Riparian condition

EUNC 1

Site: The original riparian vegetation community at Eungai Creek 1 (EUNC1, Plate 3.51) was described as 'Gallery Watergum forest' (an unrecognised Nambucca vegetation community) grading into 'Flooded Gum moist open forest of sheltered lower slopes and gullies' (NAM_WSF01). EUNC1 received a good riparian condition score of 75.3, a grade of B- (Table 3.59).

Dominant Species: The dominant canopy species present were the native species Flooded Gum (*Eucalyptus grandis*), Thick-leaved Laurel (*Cryptocarya meisneriana*) and Watergum (*Tristaniopsis laurina*). Dominant native midstory species included Brush Cherry (*Syzygium australe*), Guioa (*Guioa semiglauca*), Brush Kurrajong (*Commersonia fraseri*), Black Wattle (*Callicoma serratifolia*) and Sandpaper Fig (*Ficus coronata*), along with the exotic species Lantana (*Lantana camara*), Privet species (*Ligustrum sinense* and *L.lucidum*) and Wild Tobacco (*Solanum mauritianum*). The understory was dominated by native species Soft Lomandra (*Lomandra hystrix*), Common Bracken (*Pteridium esculentum*), Harsh Ground Fern (*Hypolepis muelleri*), Scurvy Weed (*Commelina cyanea*), Wild Violet (*Viola banksii*), Creeping Beard Grass (*Oplismenus imbecillis*), Pademelon Grass (*Ottochloa gracillima*), along with exotic species Annual Ragweed (*Ambrosia artemisiifolia*), Taro (*Colocasia esculenta*) and Broadleaf Paspalum (*Paspalum mandiocanum*). A rich vine layer included dominant species, Native Raspberry (*Rubus rosifolius*), Smilax species (*Smilax glyciphylla* and *S.australis*), Silkpod (*Parsonnsia* spp.), Water Vine (*Cissus hypoglauca*), Round-leaf Vine (*Legnephora moorei*) and the exotic species Common Passionfruit (*Passiflora* sp.), while the macrophyte layer included Streaked Arrowgrass (*Triglochin striata*) and Pennywort (*Hydrocotyle tripartita*).

Noxious weed species: Noxious weed species observed on-site were Lantana (*Lantana camara*), Privet species (*Ligustrum sinense* and *L.lucidum*) and Annual Ragweed (*Ambrosia artemisiifolia*).

Summary: Eungai Creek 1 was a mildly disturbed closed-forest system with a mixed-aged canopy of native and exotic species throughout all structural layers, in a predominantly cleared, partially forested rural landscape. The surrounding landuse was primarily agricultural grazing land, State Forest corridor and private land with environmental plantings and private forestry, beyond which was State Forest. Significant remnant stands of vegetation lie 500m north and 900m south on forested private land and 1.2km north and 2km south in Tamban State Forest. Representative elements of the remnant vegetation community were present in all of the structural layers, with EUNC1 scoring well for the Habitat and Cover subindices, moderately for the Native Species, Debris and Management subindices (Table 3.59). Riparian condition was affected by the presence and regeneration of weed and noxious weed species, particularly in the midstory and understory structural layers and reduced levels of cover in the canopy. Reduced levels of woody debris and native non-woody debris and historic clearing also contributed to the reduction in riparian grade at this site.

Plate 3.51 *Despite possessing good vegetation cover in the canopy and midstory layers, riparian vegetation at EUNC1 was considered to be mildly disturbed. This was primarily due to presence and regeneration of weed and noxious weed species, particularly in the midstory and understory structural layers, reduced levels of cover in the canopy and a reduction in levels of woody debris and native non-woody debris.*

Table 3.59 *Site-level assessments of riparian condition in 2016-17 at EUNC1 showing scores for the five subindices and their individual indicators that comprise the Vegetation Condition Index.*

Eungai Creek 1	Scores
HABITAT	**18.3/20**
Channel width	3.3
Proximity	3
Continuity	4
Layers	4
Large native trees	2
Hollow-bearing trees	2
NATIVE SPECIES	**13.5/20**
Native canopy species	4
Native midstory species	1.5
Native herb/forb species	3
Native graminoid species	2
Native macrophyte species	3
SPECIES COVER	**16/20**
Canopy species	3
Midstory species	4
Herb/forb species	4
Graminoid species	4
Macrophyte species	1
DEBRIS	**13.5/20**
Total leaf litter	3
Native leaf litter	1.5
Dead trees standing	1
Dead trees fallen	0
Lying logs	4
Fringing vegetation	4
MANAGEMENT	**14/20**
Tree clearing	2
Fencing	3
Animal impact	2
Canopy Health	2
Exposed tree roots	3
Native woody regeneration	2
Weedy woody regeneration	0
TOTAL	**75.3/100**

WARR 3

Site: The original riparian vegetation community at Warrell Creek 3 (WARR3, Plate 3.52a,b) was described as 'Knotweed wet meadow forbland on alluvial soils of coastal floodplains' (NAM_FW02), a listed TEC (OEH 2015) and 'Gallery Watergum forest' (an unrecognised Nambucca vegetation community) grading into 'Flooded Gum moist open forest of sheltered lower slopes and gullies' (NAM_WSF01). WARR3 received a moderate riparian condition score of 66.2, a grade of C (Table3.60).

Dominant Species: The dominant canopy species present were the native species Flooded Gum (*Eucalyptus grandis*), Watergum (*Tristaniopsis laurina*), Rose Walnut (*Endiandra discolor*) and the exotic species Camphor Laurel (*Cinnamomum camphora*). Dominant native midstory species included Brush Cherry (*Syzygium australe*), Sandpaper Fig (*Ficus coronata*) and Brush Kurrajong (*Commersonia fraseri*), along with the exotic species Lantana (*Lantana camara*), Small-leaved Privet (*Ligustrum sinense*), Wild Tobacco (*Solanum mauritianum*) and Arsenic Bush (*Senna septemtrionalis*). The understory was dominated by native species Hairy Knotweed (*Persicaria strigosa*), Soft Lomandra (*Lomandra hystrix*), Tall Saw-sedge (*Gahnia clarkei*), Scurvy Weed (*Commelina cyanea*), Wild Violet (*Viola banksii*), Australian Basket Grass (*Oplismenus aemulus*), Forest Hedgehog Grass (*Echinopogon ovatus*) and Couch (*Cynodon dactylon*), along with exotic species Mistflower (*Ageratina riparia*), Fireweed (*Senecio madagascariensis*), Wandering Jew (*Tradescantia fluminensis*), Broadleaf Paspalum (*Paspalum mandiocanum*), Prairie Grass (*Bromus catharticus*), Rhodes Grass (*Chloris gayana*) and Pigeon Grass (*Setaria sphacelata*). Dominant vine species included Silkpod (*Parsonnsia* spp.), Cockspur Thorn (*Maclura cochinchinensis*) and Arrow Vine (*Calystegia marginata*) while a rich macrophyte layer included Marsh Club-rush (*Bolboschoenus fluviatilis*), Freshwater Eelgrass (*Vallisneria nana*), Ribbonweed (*Vallisneria australis*), Potomogeton (*Potomogeton ochtandrus*), Water Primrose (*Ludwidgia peploides*) and the exotic species Giant Water Lily (*Nymphaea* sp.).

Noxious weed species: Noxious weed species observed on-site were Camphor Laurel (*Cinnamomum camphora*), Arsenic Bush (*Senna septemtrionalis*), Small-leaved Privet (*Ligustrum sinense*), Lantana (*Lantana camara*), Mistflower (*Ageratina riparia*), Noogoora Burr (*Xanthium occidentale*), Annual Ragweed (*Ambrosia artemisiifolia*), Fireweed (*Senecio madagascariensis*) and Wandering Jew (*Tradescantia fluminensis*).

Summary: Warrell Creek 3 was a moderately disturbed open-to-closed-forest system with a partially remnant canopy and a mix of native and exotic species throughout all structural layers in a predominantly cleared, partially forested rural coastal landscape. The surrounding landuse was primarily agricultural grazing land, dairy farming and transport networks (and associated construction sites), beyond which was forested private land, State Forest and National Park. Significant remnant stands of vegetation lie 850m northeast and 1.1km southwest in forested private land, 400m west in Ingalba State Forest, 1.5km east in Way Way State Forest, beyond which lies Yarriabini National Park. Representative elements of the remnant vegetation community were retained in all of the structural layers, with WARR3 scoring well for the Cover subindex and moderately for Habitat, Native Species, Debris and Management subindices (Table 3.60).

Riparian condition was affected by poor riparian vegetation width and habitat connectivity and disrupted continuity, as well as the presence and regeneration of weed and noxious weed species, particularly in the midstory and understory structural layers. Reduced levels of cover in the canopy, midstory, particularly in the Watergum and Flooded Gum forests (unrecognised and NAM_WSF01, respectively), a reduction in large woody debris and animal impact also contributed to the reduction in riparian grade at this site.

Plate 3.52a *Riparian vegetation condition at WARR3 was considered to be moderately disturbed. This was primarily due to poor riparian vegetation width, habitat connectivity and disrupted continuity, the presence of weed and noxious weed species in the midstory and understory, reduced canopy and midstory cover, low levels of large woody debris and the presence of livestock throughout the riparian zone.*

***Plate 3.52b** WARR3 also comprised a Knotweed wet meadow at the upstream part of the site.*

Table 3.60 *Site-level assessments of riparian condition in 2016-17 at WARR3 showing scores for the five subindices and their individual indicators that comprise the Vegetation Condition Index.*

Warrell Creek 3	Scores
HABITAT	**11.7/20**
Channel width	1.7
Proximity	1
Continuity	2
Layers	4
Large native trees	2
Hollow-bearing trees	1
NATIVE SPECIES	**11.5/20**
Native canopy species	3
Native midstory species	2.5
Native herb/forb species	2
Native graminoid species	1
Native macrophyte species	3
SPECIES COVER	**15.5/20**
Canopy species	1.5
Midstory species	2
Herb/forb species	4
Graminoid species	4
Macrophyte species	4
DEBRIS	**13/20**
Total leaf litter	3
Native leaf litter	2
Dead trees standing	1
Dead trees fallen	1
Lying logs	3
Fringing vegetation	3
MANAGEMENT	**14.5/20**
Tree clearing	2
Fencing	3
Animal impact	1
Canopy Health	1.5
Exposed tree roots	3
Native woody regeneration	2
Weedy woody regeneration	2
TOTAL	**66.2/100**

WARR 2

Site: The original riparian vegetation community at Warrell Creek 2 (WARR2) (Plate 3.53) was described as 'Broad-leaved Paperbark – Swamp Oak – Tall Sedge swamp forest on alluvial soils' (NAM_ForW04) grading into 'Swamp Oak – Broad-leaved Paperbark – Willow Bottlebrush floodplain forested wetland' (NAM_ForW02), both recognised TEC's (OEH 2015). WARR2 received a good riparian condition score of 79, a grade of B- (Table 3.61).

Dominant Species: The dominant canopy species present were the native species Broad-leaved Paperbark (*Melaleuca quinquenervia*), Swamp Oak (*Casuarina glauca*), Willow Bottlebrush (*Callistemon salignus*) and Flooded Gum (*Eucalyptus grandis*). Dominant native midstory species included Prickly-leaved Teatree (*Melaleuca stypheloides*), Sandpaper Fig (*Ficus coronata*), Cabbage Tree Palm (*Livistonia australis*), Orange Thorn (*Pittosporum multiflorum*), Narrow-leaved Palm Lily (*Cordyline stricta*), along with the exotic species Lantana (*Lantana camara*). The understory was dominated by native species Tall Saw-sedge (*Ghania clarkei*), Common Rush (*Juncus ursitatus*), Forest Buttercup (*Ranunculus inundatus*), Wild Violet (*Viola banksii*), Angled Lobelia (*Lobelia anceps*), Pademelon Grass (*Ottochloa gracillima*), Couch (*Cynodon dactylon*), along with exotic species Broadleaf Paspalum (*Paspalum mandiocanum*). Dominant vine species included Silkpod (*Parsonnsia* spp.), Snake Vine (Stephania japonica), and the exotic species Coastal Morning Glory (*Ipomoea cairica*), while a rich estuarine macrophyte layer included Bare Twig-rush (*Baumea juncea*), Leafy Twig-rush (*Cladium procerum*), Bacopa (*Bacopa monnieri*), Common Reed (*Phragmites australis*), River Lily (*Crinum pedunculatum*), Streaked Arrowgrass (*Triglochin striata*), and the exotic species Giant Water Lily (*Nymphaea* sp.).

Noxious weed species: One noxious weed species was observed on-site, Lantana (*Lantana camara*).

Summary: Warrell Creek 2 was a mildly disturbed closed-forest system with a partially remnant canopy and native species prevalence throughout all structural layers, in a predominantly cleared, partially forested rural-coastal landscape. The surrounding landuse was rural lifestyle blocks and agricultural grazing land beyond which was transport networks and urban settlement. Warrell Creek 2 is surrounded by significant remnant vegetation fringing the creek and has previously been recognised as 'unprotected significant habitat' (BMT WBM 2008). Additional significant remnant stands of vegetation lie in private and Crown Reserve Land 900m to the north and northeast on Bald Hill and its surrounds and on private land 600m south on the flanks of the Way Way State Forest. Representative elements of the remnant vegetation community were retained in all of the structural layers with WARR2 scoring full marks for the Cover subindex, well for the Native Species and Debris subindices and moderately for the Habitat and Management subindices (Table 3.61).

Riparian condition was affected by reduced riparian vegetation width and habitat connectivity and the presence and regeneration of weed and noxious weed species, particularly in the understory structural layer. Reduced levels of woody debris and inadequate riparian fencing to delineate a riparian zone and protect riparian vegetation also contributed to the reduction in riparian grade at this site.

Plate 3.53 *Riparian vegetation condition at WARR2 was good yet mildly disturbed. This was primarily due to reduced riparian width and habitat connectivity, the presence of weed and noxious weed species, low levels of large woody debris and inadequate riparian fencing.*

Table 3.61 *Site-level assessments of riparian condition in 2016-17 at WARR2 showing scores for the five subindices and their individual indicators that comprise the Vegetation Condition Index.*

Warrell Creek 2	Scores
HABITAT	**13/20**
Channel width	1
Proximity	1
Continuity	4
Layers	4
Large native trees	2
Hollow-bearing trees	1
NATIVE SPECIES	**17.5/20**
Native canopy species	4
Native midstory species	4
Native herb/forb species	4
Native graminoid species	2.5
Native macrophyte species	3
SPECIES COVER	**20/20**
Canopy species	4
Midstory species	4
Herb/forb species	4
Graminoid species	4
Macrophyte species	4
DEBRIS	**15/20**
Total leaf litter	3
Native leaf litter	3
Dead trees standing	1
Dead trees fallen	1
Lying logs	3
Fringing vegetation	4
MANAGEMENT	**13.5/20**
Tree clearing	3
Fencing	0
Animal impact	3
Canopy Health	1.5
Exposed tree roots	3
Native woody regeneration	2
Weedy woody regeneration	1
TOTAL	**79/100**

WARR 1

Site: The original riparian vegetation community at Warrell Creek 1 (WARR1) (Plate 3.54) was described as 'Grey Mangrove - River Mangrove low open or closed forest or shrubland of intertidal flats' (NAM_ForW01) and 'Sea Rush saltmarsh of saline coastal swamps and flats' (NAM_SW02), a listed TEC, grading into 'Saltwater Couch - Samphire saltmarsh of low-lying estuarine areas' (NAM_SW04) and 'Swamp Oak forested wetland of saline areas of coastal estuaries' (NAM_ForW01) both listed TEC's (OEH 2015). WARR1 received a very good riparian condition score of 88.8, a grade of B+ (Table 3.62).

Dominant species: The dominant canopy species present were the native species River Mangrove (*Aegiceras corniculatum*) and Grey Mangrove (*Avicennia marina* subsp. *australasica*), Swamp Oak (*Casuarina glauca*), Coast Banksia (*Banksia integrifolia* subsp. *intergrifolia*) and Willow Bottlebrush (*Calistemon salignus*). Dominant native midstory species included Coastal Wattle (*Acacia longifolia* subsp. *sophorae*), Coast Teatree (*Leptospermum laevigatum*), Tuckeroo (*Cupaniopsis anacardioides*) and Coffee Bush (*Breynia oblongifolia*) along with the exotic species Bitou Bush (*Chrysanthemoides monilifera* subsp. *rotundata*), Lantana (*Lantana camara*). The understory was dominated by native species Sea Rush (*Juncus krausii* subsp. *australiensis*), Knobby club-rush (*Ficinia nodosa*), Blady Grass (*Imperata cylindrica*), Thigh-socket grass (*Ischaemum triticeum*), Spiny-headed Mat-rush (*Lomandra longifolia*), New Zealand Spinach (*Tetragonia tetragonoides*), Scurvy Weed (*Commelina cyanea*) and Pigface (*Carpobrotus glaucescens*) along with exotic species Rhodes Grass (*Chloris gayana*) and Paspalum (*Paspalum* spp.). Dominant vine species included Silkpod (*Parsonnsia* spp.), Mangrove Vine (*Cynanchum carnosum*), Lawyer Vine (*Smilax australis*) and the exotic species Morning Glory (*Ipomoea cairica*). An estuarine saltmarsh and macrophyte layer included Sea Rush (*Juncus krausii* subsp. *australiensis*), Sand Couch (*Sporobolus* spp.), Zostera (*Zostera muelleri* subsp. *caprcorni*) and Paddle Weed (*Halophila ovalis*).

Noxious weed species: observed on-site were Bitou Bush (*Chrysanthemoides monilifera* subsp. *rotundata*), Lantana (*Lantana camara*) and Coastal Morning Glory (*Ipomoea cairica*).

Summary: Warrell Creek 1 was a low disturbance open-saltmarsh/closed-forest system with a mixed-aged native canopy and a mix of native and exotic species throughout the midstory and understory structural layers in a forested coastal landscape. The immediate surrounding landuse was National Park, beyond which was Crown Reserve and privately owned forested land, sand mining and agricultural grazing country. Significant remnant stands of vegetation surround the site in the form of Gaagal Wanggaan (South Beach) National Park and on neighbouring Crown and privately owned Land. Representative elements of the remnant vegetation communities were retained in all structural layers, with WARR1 scoring full marks for the Cover subindex, well for Habitat, Native Species and Debris subindices and moderately for the Management subindex (Table 3.62). Riparian condition was affected by the presence and regeneration of weed and noxious weed species, particularly in the midstory structural layer. Reduced habitat trees and standing woody debris and exposed tree roots due to bank erosion also contributed to the reduction in riparian grade at this site.

Plate 3.54 *Riparian vegetation condition at WARR1 was very good and considered to be of low disturbance. This was mainly attributed to the presence of a remnant canopy and the dominance of native species throughout all structural layers. Improvements could be made through the control and removal of weed and noxious weed species.*

Table 3.62 *Site-level assessments of riparian condition in 2016-17 at WARR1 showing scores for the five subindices and their individual indicators that comprise the Vegetation Condition Index.*

Warrell Creek 1	Scores
HABITAT	**19/20**
Channel width	4
Proximity	4
Continuity	4
Layers	4
Large native trees	2
Hollow-bearing trees	1
NATIVE SPECIES	**18/20**
Native canopy species	4
Native midstory species	2
Native herb/forb species	4
Native graminoid species	4
Native macrophyte species	4
SPECIES COVER	**20/20**
Canopy species	4
Midstory species	4
Herb/forb species	4
Graminoid species	4
Macrophyte species	4
DEBRIS	**17/20**
Total leaf litter	3
Native leaf litter	3
Dead trees standing	0
Dead trees fallen	3
Lying logs	4
Fringing vegetation	4
MANAGEMENT	**14.8/20**
Tree clearing	3
Fencing	3
Animal impact	3
Canopy Health	1.75
Exposed tree roots	2
Native woody regeneration	2
Weedy woody regeneration	0
TOTAL	**88.8/100**

3.6.4 Water quality

Warrell Creek received a low overall score of 53 (D+) for water quality, a score slightly above the average for the Nambucca catchment. The estuarine reach scored 57 (D+), while the freshwater reach received a score of 47 (D-) due to greater frequenices of guideline exceedances. In the freshwater reach, EUNC1 received a score of 49 (D-) and WARR3 received a score of 47 (D-); the latter was lowest score of the subcatchment. In the estuarine reach, WARR2 received a score of 48 (D-) and the downstream site of WARR1 received a score of 67 (C), the highest WQ score of the Nambucca catchment. Figure 3.16 shows the key physico-chemical and nutrient variables used in the assessment of water quality for Warrell Creek. Ranges and means for these variables are given in Tables 3.63 and 3.64 and the exceedances are given in Table 3.65.

pH varied longitudinally in Warrell Creek with pH generally increasing with distance downstream. Three of the four sites infrequently breached relevant OEH and ANZECC minimum exceedances for pH. The lowest pH minimum exceedance of 6.14 was observed in the freshwater reach at WARR3 while the maximum pH guideline was not exceeded at any site. Turbidity measures followed clear logitudinal trends throughout Warrell Creek, with mean turbidity values decreasing with distance downstream. Only one site, WARR2 in the estuarine reach of the subcatchment, exceeded OEH mid estuary guidelines for turbidity with all exceedance values observed in December following a four-month period of below-average rainfall. Maximum turbidity at this site was recorded at twice the upper guideline limit for mid estuaries.

A longitudinal pattern of increasing mean DO% with distance downstream was observed in Warrell Creek. Readings consistently fell below the relevant ANZECC and OEH minimum guidelines in both freshwater sites (EUNC1, WARR3) and in all but one sampling event at the WARR2 estuarine site. Similar site minimums were observed at WARR3 and EUNC1 of 10.50% and 14.6% DO, respectively. Such low DO% are eight and five times below the ANZECC guideline for lowand freshwater streams, respectively, and will most certainly have negative impacts on aquatic faunal assemblages including fish.

Nitrogen trigger values were exceeded frequently in the subcatchment particularly in the freshwater reaches at WARR3 and EUNC1 which almost always exceeded the maximum trigger values of 350 µg/L and 40 µg/L for both TN and NOx respectively. The highest TN concentration of 962.5µg/L was observed at EUNC1, more than two and a half times the ANZECC guideline of 350µg/L for lowland freshwater systems. Overall, TN concentrations decreased with distance downstream. Bioavailable nitrogen (NOx) concentrations varied spatially and temporally throughout Warrell Creek. The highest NOx concentration of 299.7µg/L was recorded at WARR3, greater than seven times the ANZECC guideline for lowland freshwater streams.

Similarly to TN, mean total phosphorus (TP) concentrations generally decreased with distance downstream. However, sites almost always exceeded ANZECC and OEH nutrient trigger values for TP, with the highest concentrations observed in the freshwater reach at WARR3 and EUNC1 with readings greater than six times the ANZECC guideline for lowland freshwater streams. In the estuarine reach, the highest concentration of TP was recorded at WARR1 at over eight times the OEH guideline for lower estuaries. Mean bioavailable phosphorus (SRP) was generally consistent thoughout the reach. However, the frequency of exceedances increased with distance downstream as guidelines values became smaller. In the freshwater reach, the highest concentration of SRP of 31.2µg/L was recorded at EUNC1 while the highest SRP concentration in the estuarine reach was observed at WARR2, with a reading 6.4 times the OEH guideline values for upper estuaries.

Occasional Chl-a guideline exceedances occurred throughout the freshwater reaches and in the upper estuarine reaches of the Warrell Creek system with the highest concentration of Chl-a of 30.64µg/L observed at EUNC1, over 10 times the ANZECC guideline for lowland streams. While Chl-a occasionally exceeded guideline values in Warrell Creek, these exceedances coincided with maximum nutrient concentrations at three of the four sites. In both the freshwater and estuarine sites, peak Chl-a exceedances coincided with multiple nutrient exceedances in the February sampling period, again highlighting the potential subcatchment response to adjacent landuse inputs in combination with six months of below-average rainfall and above-average maximum temperatures. Despite the persistence of high nutrient loads throughout the sampling period, particularly TN, several low concentrations in the response variable (Chl-a) suggests that Warrell Creek has some degree of resilience to high nutrient concentrations.

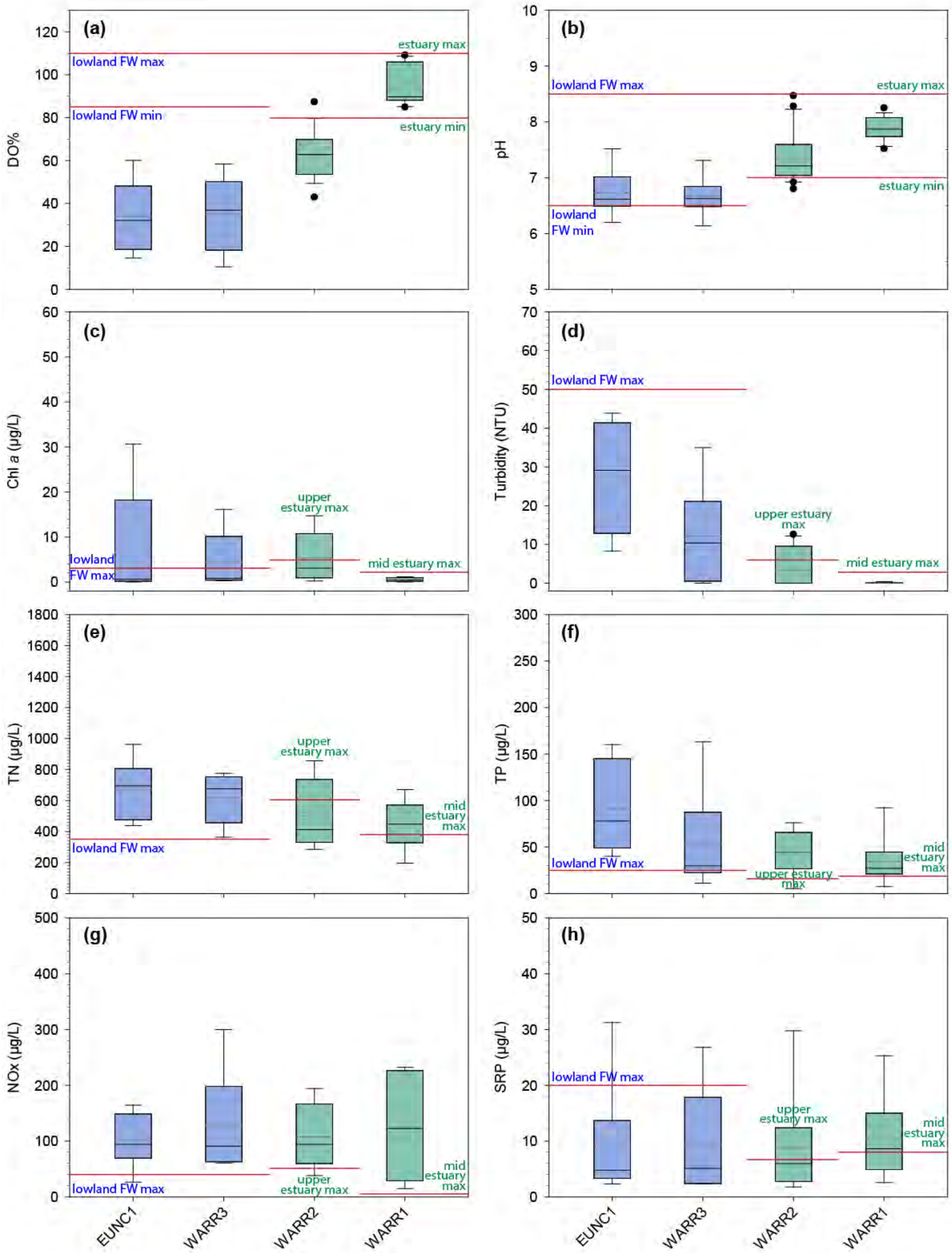


Figure 3.16 *Mean (grey line), median (black line), 25th and 75th percentiles, and range of water quality variables in Eungai and Warrell Creeks from 2016-2017. Outliers are represented by black dots. Green and blue boxes represent estuary and freshwater sites, respectively. Red lines represent the relevant maximum or minimum guideline value for each type of system.*

Table 3.63 *Minimums, maximums and means of measured water quality variables for the site EUNC1 on Eungai Creek.*

	EUNC1		
Variable	**Min**	**Max**	**Mean**
Temperature	12.13	23.91	18.05
pH	6.20	7.52	6.73
EC	0.27	0.44	0.36
Salinity (PPT)	0.13	0.21	0.17
DO (mg/L)	1.55	6.39	3.52
DO %	14.60	60.10	33.83
Turbidity	8.30	43.90	27.57
Chla (µg/L)	0.00	30.64	7.48
TSS (mg/L)	4.91	20.63	11.99
TN (µg/L)	438.60	962.47	672.13
TP (µg/L)	39.88	160.13	91.29
NOx (µg/L)	26.41	164.16	100.92
SRP (µg/L)	2.32	31.22	9.09

Table 3.64 *Minimums, maximums and means of measured water quality variables for three sites WARC3, WARR2 and WARR1 on Warrell Creek.*

	WARR3			WARR2			WARR1		
Variable	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**
Temperature	13.19	25.04	19.21	14.80	29.54	22.81	16.41	25.59	20.80
pH	6.14	7.31	6.67	6.80	8.47	7.36	7.52	8.25	7.89
EC	0.03	0.32	0.24	0.53	29.90	11.66	39.30	55.30	48.28
Salinity (PPT)	0.12	0.15	0.13	0.25	18.46	6.89	24.67	36.32	31.29
DO (mg/L)	0.92	6.48	3.59	4.36	10.95	5.89	6.35	10.10	7.47
DO %	10.50	58.40	35.17	42.90	87.30	62.49	84.90	109.10	94.47
Turbidity	0.00	35.00	12.17	0.00	12.60	3.43	0.00	0.40	0.10
Max Depth	-	-	-	2.70	4.60	3.34	1.70	2.20	1.94
Chla (µg/L)	0.24	16.13	4.35	0.23	14.70	5.30	0.00	1.16	0.56
TSS (mg/L)	3.40	13.21	7.81	1.15	12.68	5.97	6.20	24.32	16.06
TN (µg/L)	363.13	774.07	620.11	284.26	856.51	501.34	195.53	670.79	445.57
TP (µg/L)	11.08	163.13	53.63	5.20	76.12	44.31	7.39	92.12	34.68
NOx (µg/L)	60.85	299.70	128.27	37.89	194.28	107.43	14.93	232.07	125.00
SRP (µg/L)	2.32	26.76	9.41	1.78	29.76	8.84	2.57	25.26	10.38

***Table 3.65** Exceedances[1] observed in Warrell Creek for pH, conductivity (EC), percent saturated dissolved oxygen (DO), turbidity, chlorophyll a (Chl-a), total nitrogen (TN), total phosphorus (TP), bioavailable nitrogen (NOx) and soluble reactive phosphorus (SRP).*

Site	pH	EC	DO %	Turbidity	Chl-a	TN	TP	NOx	SRP
EUNC1	1(17%)1,0	0(0%)	6(100%)6,0	0(0%)	2(40%)	6(100%)	6(100%)	5(83%)	1(17%)
WARR3	1(17%)1,0	1(17%)1,0	6(100%)6,0	0(0%)	2(40%)	6(100%)	5(83%)	6(100%)	1(17%)
WARR2	4(18%)4,0	NA	17(94%)17,0	4(31%)	2(40%)	2(33%)	5(83%)	5(83%)	2(33%)
WARR1	0(0%)0,0	NA	0(0%)0,0	0(0%)	0(0%)	4(67%)	5(83%)	4(67%)	3(50%)

[1] Numbers in black represent the total number and percent of exceedances. Numbers in blue and red represent the numbers of measurements lower than the minimum guideline value and higher than the maximum guideline value, respectively. The number of exceedances includes all depths sampled so may be greater than the number of times sampled. Turbidity, chlorophyll a, and nutrients only have maximum trigger guidelines.

3.6.5 Aquatic macroinvertebrates

Eungai Creek

EUNC1 recorded abundances of 218 and 307 individuals across 15 and 18 families over the spring 2016 and autumn 2017 sampling periods, respectively (Table 3.66). The highest family abundance in spring was recorded in the Chironomidae and Leptophlebiidae families, each represented by 86 individuals. Spring richness was dominated by Hemiptera (True Bugs), represented by four families. Autumn abundance was dominated by Leptophlebiidae mayflies (78 individuals) and the most diverse order in autumn was Coleoptera (Aquatic Beetles) with six families present.

The mean SIGNAL2 score for EUNC1 was higher in autumn 2017 (4.7) than in spring 2016 (4.1) and a wider SIGNAL2 score range was also observed in autumn 2017. While healthy abundances of high scoring Leptophlebiid mayflies were present in both samples, higher numbers of low scoring Dipterans and Hemipterans reduced the final score in spring 2016.

EUNC1 received a poor overall Ecohealth score of 46 (D-) for aquatic macroinvertebrate community condition with all indicators apart from family richness scoring below the average for the Nambucca catchment. While EUNC1 is capable of supporting a range of macroinvertebrate fauna given the wide SIGNAL2 range, the macroinvertebrate indicators suggest that the water quality, food and habitat conditions EUNC1 were in poor condition. Ecohealth assessments of other indicators suggest that poor availability and quality of habitat and poor water quality likely impacted the macroinvertebrate community during the study period: the low streamflow experienced during the study period led to the disconnection of pools during sampling.

Table 3.66 *Summary of aquatic macroinvertebrate indicator scores and the overall macroinvertebrate grade for the freshwater site in the Eungai Creek subcatchment.*

	EUNC1	
Macroinvertebrate indicator	**Spring 2016**	**Autumn 2017**
Total abundance	218	307
Family richness	15	18
EPT abundance	70	95
EPT richness	5	6
Mean SIGNAL2 score	4.1	4.7
SIGNAL2 score range	1 - 8	1 – 9
Ecohealth score (grade)	**46 (D-)**	

Warrell Creek

WARR3 recorded total abundances of 420 and 566 across eight and 20 macroinvertebrate families during the 2016 spring and 2017 autumn sampling periods, respectively (Table 3.67). In spring 2016, abundance was dominated by Atyidae (Shrimp) with 382 individuals recorded from the Paratya genus. Spring richness was low across all taxa with the highest order richness recorded within Diptera, being represented by two families. Autumn abundance was dominated by Simuliidae (Black flies) with 298 individuals identified. Autumn richness was highest within the Coleoptera order, being represented by five families. WARR3 achieved the second highest indicator score for total abundance in the Nambucca catchment.

The mean SIGNAL2 score for WARR3 was significantly higher in autumn 2017 (4.7) when compared to spring 2016 (3.1). A low total SIGNAL2 score for WARR3 was due to very high numbers of low scoring taxa occurring over the sampling seasons, a very low richness score and a narrow SIGNAL2 range in spring 2016.

WARR3 received a poor overall Ecohealth score of 47 (D-) for aquatic macroinvertebrate community condition, with all indicators apart from total abundance scoring below the average for the Nambucca catchment. The macroinvertebrate indicators suggest that the water quality and habitat conditions at Warrell Creek were in poor condition. While high abundances were recorded, the community was dominated by pollution-tolerant taxa.

Table 3.67 *Summary of aquatic macroinvertebrate indicator scores and the overall macroinvertebrate grade for the freshwater site in the Warrell Creek subcatchment.*

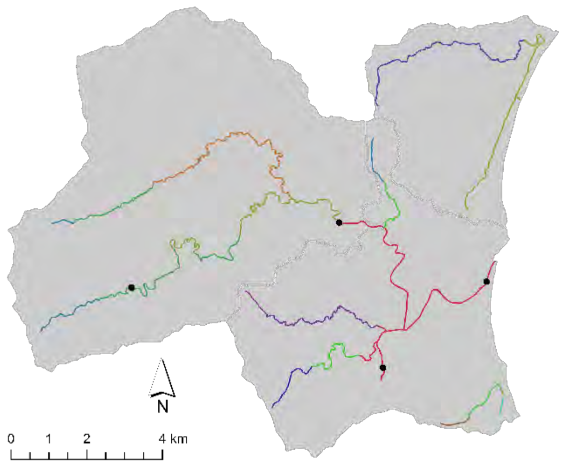
	WARR3	
Macroinvertebrate indicator	**Spring 2016**	**Autumn 2017**
Total abundance	420	566
Family richness	8	20
EPT abundance	2	102
EPT richness	1	12
Mean SIGNAL2 score	3.1	4.7
SIGNAL2 score range	1 - 6	2 - 8
Ecohealth score (grade)	**47 (D-)**	

3.7 Deep Creek

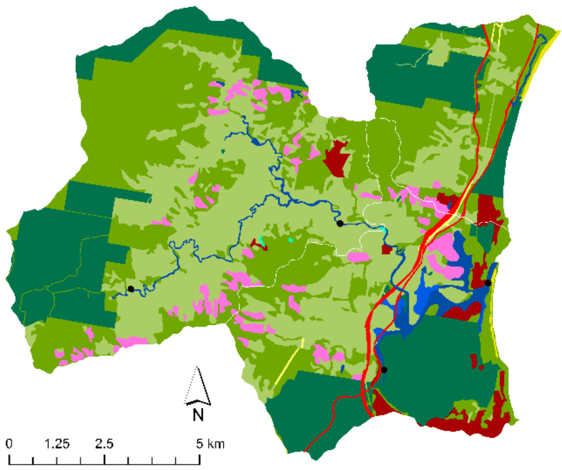
3.7.1 Subcatchment and site descriptions

Deep Creek covers a subcatchment area of 94.2km^2. The freshwater reach drains 57.6km2, predominantly grazing areas (34.4%), followed by patchy conservation areas (20.4%, Table 3.68). Deep Creek contains the highest percentage of horticulture (4.2%) of the Nambucca LGA. Gravel-bed channels with floodplain pockets dominate and are set in constrained valleys (Figure 3.17b). There is one site located in the freshwater reach of Deep Creek: DEEP4 (Plate 3.55). DEEP 4 is a gravel-bed channel with floodplain pockets in a constrained valley setting located 12.3km upstream of DEEP3.

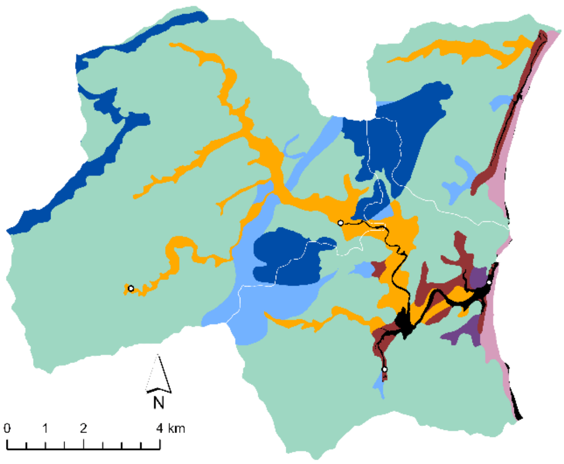
(a) Location of Ecohealth sites.



(b) River Styles: refer to Figure 2.8 for key



(c) Landuse: refer to Figure 2.7 for key



(d) Soils: refer to Figure 2.3 for key

Figure 3.17 *Deep Creek showing (a) locations of Ecohealth sites, (b) River Styles, (c) landuse, and (d) soils. Data layers from NC LLS (River Styles) and OEH (landuse and soils).*

Table 3.68 *Subcatchment description of the freshwater Deep Creek. Data from NC LLS and OEH.*

Variable	Subcatchment composition
Area	57.6 km^2
Geology	86.6% slate, phyllite, schist, 9.3% monzogranite, 4.1% alluvium
Soils	78.1% Kurosols, 9.0% Rudosols and Tenosols, 8.0% Tenosols, 4.8% Dermosols
River Styles	31.8% CVS – Floodplain pockets, gravel, 27.4% PCVS – Planform controlled, meandering, sand, 26.7% SMG – Valley fill, fine grained, 9.9% CVS – Headwater, 4.1% PCVS – Planform controlled, tidal
Landuse	34.4% Grazing, 20.4% Conservation area, 4.2% Horticulture, 1.4% River and drainage system, 0.7% Urban, 0.1% Mining and quarrying
Major point source discharge	Nil
Tree Cover	59.2%

Plate 3.55 *Site DEEP4 in the freshwater reach of Deep Creek (looking upstream).*

The estuarine reaches of Deep Creek drain an area of 36.6km2 (Table 3.69). This is predominantly conservation areas (30%), followed by grazing (25%) and urban areas (6%). Planform controlled tidal channels (41%) are the dominant River Style, followed by low sinuosity sand-bed channels in the small freshwater tributaries (Figure 3.17b). There were three sites located in the estuarine reaches. DEEP3 (Plate 3.56) was located at the tidal limit (upper estuary) at the division of a fine-grained valley fill and planform controlled tidal channel. DEEP3 was located 7.9km upstream of DEEP1. DEEP2 (Plate 3.57) was at the upstream extent of the estuarine lagoon, 5.4km upstream of DEEP1. DEEP1 (Plate 3.58) was the downstream extent of the estuarine lagoon, 500m upstream of the mouth of Deep Creek.

Table 3.69 *Subcatchment description of Deep Creek estuary. Data from NC LLS and OEH.*

Variable	Subcatchment composition
Area	36.6 km^2
Geology	76.4% slate, phyllite, schist, 16.9% alluvium, 6.7% monzogranite
Soils	66.3% Kurosols, 7.9% Tenosols (Alluvial), 7.4% Dermosols, 6.7% Rudosols and Tenosols, 4.7% Hydrosols, 2.4% Rudosols, 1.6% Podosols
River Styles	40.5% PCVS – Planform controlled, tidal, 21.6% PCVS – Planform controlled, low sinuosity, sand, 16.9% PCVS - 7.0% CVS – Floodplain pockets, sand, 4.9% CVS – Headwater, 3.3% Urban Stream – Highly modified, 3.3% Water storage – dam or weir pool, 1.7% SMG – Valley fill, sand, 0.8% LUV CC –Tidal
Landuse	29.7% Conservation area, 25.3% Grazing, 5.6% Urban, 5.1% Horticulure, 4.7% River and drainage, 2.5% Transport and other corridors, 1.4% Wetland, 0.4% Power generation
Major point source discharge	STP at Nambucca Heads
Tree Cover	54.7%

Plate 3.56 *Site DEEP3 at the tidal limit of Deep Creek (looking downstream).*

Plate 3.57 *Site DEEP2 at the upper extent of the estuarine lagoon (looking upstream).*

Plate 3.58 *Site DEEP1 near the mouth of Deep Creek (looking upstream).*

3.7.2 Geomorphic condition

DEEP 4

The geomorphic River Style at Deep Creek 4 is a gravel-bed channel with floodplain pockets in a confined valley setting. DEEP4 drains 3.3km of stream network, predominantly in good geomorphic condition (Alluvium 2012). DEEP4 is located midway in a 3.5km reach assessed as being in moderate geomorphic condition (Alluvium 2012). The bed sediments at DEEP4 comprised gravel with >60% fine sediments. There was severe (20-100m) pugging and trampling of the streambed (Plate 3.59) from cattle access, with significant smothering of bed sediments by fine sediments. Banks comprised fine sediments. There was severe (20-100m) pugging and trampling of the stream bank by cattle access, with severe (20-100m) bank slumping on both banks. There was significant (10-20m) undercutting on the upstream end of the right bank which was the outside of a bend. This led to moderate (5-10m) exposure of tree roots. DEEP4 scored 38, an F for BANK CONDITION and 40 an F for BED CONDITION. The overall geomorphic condition for DEEP4 was 39, a grade of F.

In summary, DEEP4 was assessed as being in very poor geomorphic condition, with severe pugging and trampling by cattle access leading to severe bank slumping the most significant issue for site-level geomorphic condition. The desktop GIS assessment of subcatchment geomorphic condition found the freshwater reach of the Deep Creek subcatchment to be in moderate condition with a grade of C. The geomorphic condition at DEEP4 was significantly below the subcatchment average.

DEEP 3

The geomorphic River Style at Deep Creek 3 is fine-grained valley fill in the upstream half of the site and planform controlled, tidal channel in a partially confined valley setting in the downstream half of the site. The tidal limit is very distinct due to a large a rock weir halfway through the site. DEEP3 drains 26.7km of stream network, predominantly in moderate geomorphic condition (Alluvium 2012). The bed sediments at DEEP3 comprised fine sediments (silty sand with gravel). There was moderate (5-10m) active erosion and undercutting on both banks and trampling from heavy human traffic on the right bank at the downstream end of the site. DEEP3 scored 64, a C- for BANK CONDITION. The overall geomorphic condition for DEEP3 was 64, a grade of C-.

In summary, DEEP3 was assessed as being in moderate geomorphic condition, with heavy trampling on the downstream end of the right bank. The desktop GIS assessment of subcatchment geomorphic condition found the estuarine reach of the Deep Creek subcatchment to be in moderate condition with a grade of C-. The geomorphic condition at DEEP3 was equal to the subcatchment average.

DEEP 2

The geomorphic River Style at Deep Creek 2 is a planform controlled, tidal channel in a partially confined valley setting. DEEP2 is located in the upstream end of an estuarine lagoon and drains 240m of stream network, all in a moderate geomorphic condition (Alluvium 2012). The bed sediments at DEEP2 comprised fine sediments (silty sand). There was minor (<5m) undercutting and slumping on the left bank, slightly due to the wetting and drying of fine bank sediments in the intertidal zone and some human traffic. DEEP2 scored 92, an A- for BANK CONDITION. The overall geomorphic condition for DEEP2 was 92 a grade of A-.

In summary, DEEP2 was assessed as being in very good geomorphic condition, with minor trampling from human traffic the most significant issue for site-level geomorphic condition. The desktop GIS assessment of subcatchment geomorphic condition found the estuarine reach of the Deep Creek subcatchment to be in moderate condition with a grade of C-. The geomorphic condition at DEEP2 was significantly higher than the subcatchment average.

DEEP 1

The geomorphic River Style at Deep Creek 1 is a planform controlled, tidal channel in a partially confined valley setting. DEEP1 is located in the downstream end of an estuarine lagoon and drains 63.4km of stream network (including the freshwater reaches of Deep Creek), predominantly in a moderate geomorphic condition (Alluvium 2012). The bed sediments at DEEP1 comprised marine sand with some finer sediments (silts). Bank sediments comprised silty sands on the left bank and less cohesive sand on the right bank. There was moderate (5-10m) slumping on the left bank, exacerbated by heavy human traffic on the left bank, and fragile bank materials with moderate human traffic on the right bank. There was also moderate (5-10m) of undercutting in the intertidal zone of the left bank in the upstream reaches. DEEP1 scored 74, a C+ for BANK CONDITION. The overall geomorphic condition for DEEP1 was 74, a grade of C+.

In summary, DEEP1 was assessed as being in moderate geomorphic condition, with heavy trampling from human traffic the most significant issue for site-level geomorphic condition. The desktop GIS assessment of subcatchment geomorphic condition found the estuarine reach of the Deep Creek subcatchment to be in moderate condition with a grade of C-. The geomorphic condition at DEEP1 was slightly higher than the subcatchment average.

3.7.3 Riparian condition

DEEP 4

Site: The original riparian vegetation community at Deep Creek 4 (DEEP4, Plate 3.59) was described as 'Weeping Lilly Pilly dry riparian rainforest' (NAM_RF09), a listed TEC (OEH 2015) grading into 'Flooded Gum moist open forest of sheltered lower slopes and gullies' (NAM_WSF01) and the exotic vegetation community 'Camphor Laurel' (NAM_EX02). DEEP4 received a low riparian condition score of 59, a grade of D+ (Table 3.70).

Dominant Species: The dominant canopy species present were the native species Flooded Gum (*Eucalyptus grandis*), Brush Box (*Lophostemon confertus*), Weeping Lilly Pilly (*Waterhousea floribunda*), Watergum (*Tristaniopsis laurina*) along with the exotic species Camphor Laurel (*Cinnamomum camphora*). Dominant native midstory species included Black Wattle (*Callicoma serratifolia*), Cheese Tree (*Glochidion fernandi*), Brush Cherry (*Syzygium australe*) Sandpaper Fig (*Ficus coronata*) and Narrow-leaved Palm Lily (*Cordyline stricta*) and the exotic species Lantana (*Lantana camara*) and Small-leaved Privet (*Ligustrum sinense*). The understory was dominated by native species Red-fruit Saw-sedge (*Ghania siebriana*), Soft Lomandra (*Lomandra hystrix*), Gristle Fern (*Blechnum cartilagenum*), Knotweeds (*Persicaria strigose* and *P.hydropiper*), Scurvy Weed (*Commelina cyanea*), Wild Violet (*Viola banksii*), Australian Basket Grass (*Oplismenus aemulus*) and Pademelon Grass (*Ottochloa gracillima*) and the exotic species Mistflower (*Ageratina riparia*), Fireweed (*Senecio madagascariensis*), Cobblers Pegs (*Bidens pilosa*), Liverseed Grass (*Urochloa panicoides*), Paspalum (*Paspalum mandiocanum*), Rhodes Grass (*Chloris gayana*). Dominant vine species included Silkpod (*Parsonnsia* spp.), Kangaroo Vine (*Cissus antartica*), Wombat Berry (*Eustrephus latifolius*) and the exotic species Morning Glory (*Ipomoea indica*), while the macrophyte layer included Triangular Club Rush (*Schoenoplectiella mucronata*), Swamp Lily (*Ottelia ovalifolia*) and Water-milfoil (*Myriophyllum variifolium*).

Noxious weed species: Noxious weed species observed on-site were Camphor Laurel (*Cinnamomum camphora*), Lantana (*Lantana camara*), Small-leaved Privet (*Ligustrum sinense*), Mistflower (*Ageratina riparia*), Fireweed (*Senecio madagascariensis*) and Morning Glory (*Ipomoea indica*).

Summary: Deep Creek 4 was a highly disturbed closed-forest with a mixed-aged canopy of native and exotic species throughout all structural layers, in a predominantly cleared, predominantly forested rural coastal landscape. The surrounding landuse was primarily agricultural grazing land and forested private land, beyond which was State Forest and National Park. Significant remnant stands of vegetation surround the site 350m to the north, 430m to the west and 1km to the south on forested private land, 800m west in Viewmont State Forest and 700m north in Bollanolla Nature Reserve. Representative elements of the remnant vegetation community were present in all of the structural layers, with DEEP1 scoring well for the Habitat and Cover subindices and poorly for the Native Species, Debris and Management subindices (Table 3.70). Riparian condition was affected by poor riparian vegetation width and the prevalence and regeneration of weed and noxious weed species throughout all structural layers (excluding macrophytes). Reduced levels of cover in the canopy, midstory and understory, limited habitat trees, a reduction in large woody and native non-woody debris and inadequate riparian fencing and animal impact also contributed to the reduction in riparian grade at this site.

Plate 3.59 *Riparian vegetation condition at DEEP4 was considered to be highly disturbed. This was primarily due to the prevalence and regeneration of weed and noxious weed species, reduced cover, limited habitat trees, a reduction in large woody and native non-woody debris and inadequate riparian fencing and subsequent animal impact.*

Table 3.70 *Site-level assessments of riparian condition in 2016-17 at DEEP4 showing scores for the five subindices and their individual indicators that comprise the Vegetation Condition Index.*

Deep Creek 4	Scores
HABITAT	**15/20**
Channel width	2
Proximity	3
Continuity	4
Layers	4
Large native trees	2
Hollow-bearing trees	0
NATIVE SPECIES	**9.5/20**
Native canopy species	1.5
Native midstory species	1.3
Native herb/forb species	1.5
Native graminoid species	1.3
Native macrophyte species	4
SPECIES COVER	**15.5/20**
Canopy species	3
Midstory species	3
Herb/forb species	3
Graminoid species	4
Macrophyte species	2.5
DEBRIS	**9.5/20**
Total leaf litter	3
Native leaf litter	1.5
Dead trees standing	0
Dead trees fallen	0
Lying logs	2
Fringing vegetation	3
MANAGEMENT	**9.5/20**
Tree clearing	2
Fencing	1
Animal impact	0
Canopy Health	1.5
Exposed tree roots	3
Native woody regeneration	2
Weedy woody regeneration	0
TOTAL	**59/100**

DEEP 3

Site: The original riparian vegetation community at Deep Creek 3 (DEEP3, Plate 3.60) was described as 'Weeping Lilly Pilly dry riparian rainforest' (NAM_RF09), a listed TEC (OEH 2015) grading into 'Flooded Gum moist open forest of sheltered lower slopes and gullies' (NAM_WSF01) and the exotic vegetation community 'Camphor Laurel and Lantana' (NAM_EX02-03). DEEP3 received a good riparian condition score of 73.2, a grade of C+ (Table 3.71).

Dominant Species: The dominant canopy species present were the native species Flooded Gum (*Eucalyptus grandis*), Brush Box (*Lophostemon confertus*), Bangalow Palm (*Archontophoenix cunninghamiana*), Weeping Lilly Pilly (*Waterhousea floribunda*), Watergum (*Tristaniopsis laurina*), along with the exotic species Camphor Laurel (*Cinnamomum camphora*). Dominant native midstory species included Black Wattle (*Callicoma serratifolia*), Weeping Bottlebrush (*Callistemon viminalis*), Cheese Tree (*Glochidion fernandi*), Sandpaper Fig (*Ficus coronata*), Silver Weeping Tea Tree (*Leptospermum brachyandrum*), Narrow-leaved Palm Lily (*Cordyline stricta*), and the exotic species Wild Tobacco (*Solanum mauritianum*), Lantana (*Lantana camara*) and Castor Oil Plant (*Ricinus communis*). The understory was dominated by native species Soft Lomandra (*Lomandra hystrix*), Common Rush (*Juncus ursitatus*), Common Bracken (*Pteridium esculentum*), Hairy Knotweed (*Persicaria strigosa*), Gristle Fern (*Blechnum cartilagenum*), Scurvy Weed (*Commelina cyanea*), Creeping Beard Grass (*Oplismenus aemulus*) and Pademelon Grass (*Ottochloa gracillima*), along with exotic species Crofton Weed (*Ageratina adenophora*), Blue Billy Goat Weed (*Ageratum houstonianum*), Annual Ragweed (*Ambrosia artemisiifolia*), Silver-leaved Desmodium (*Desmodium uncinatum*), Fireweed (*Senecio madagascariensis*), Pigeon Grass (*Setaria sphacelata*), Paspalum species (*Paspalum mandiocanum* and *P. dilatatum*) and Tall fescue (*Festuca arundinaceae*). Dominant vine species included Smilax species (*Smilax glyciphylla* and *S.australis*), Silkpod (*Parsonnsia* spp.) and Water Vine (*Cissus hypoglauca*), while a rich macrophyte layer included Water Couch (*Paspalum distichum*), River Club Rush (*Schoenoplectus validus*), Water Primrose (*Ludwidgia peploides*), Tall Sedge (*Carex appressa*) and the exotic species Egeria (*Egeria densa*).

Noxious weed species: Noxious weed species observed on-site were Camphor Laurel (*Cinnamomum camphora*), Lantana (*Lantana camara*), Castor Oil Plant (*Ricinus communis*), Crofton Weed (*Ageratina adenophora*), Annual Ragweed (*Ambrosia artemisiifolia*), Fireweed (*Senecio madagascariensis*) and Egeria (*Egeria densa*).

Summary: Deep Creek 3 was a mildly disturbed closed-forest system with a partially remnant canopy and a mix of native and exotic species throughout all structural layers, in a predominantly cleared, partially forested rural coastal landscape. The surrounding landuse was agricultural grazing land, beyond which was horticultural land, quarry, forested private land, State Forest and Nature Reserve. Significant remnant stands of vegetation lie 700m south and 1km north on private land, 2.6km southest in Nambucca State Forest, 3.2km north in Little Newry State Forest, 3.4km east in Valla Nature Reserve and 5.5km west in Bollanolla Nature Reserve. Representative elements of the remnant vegetation community were retained in all of the structural layers, with DEEP3 scoring well in the Cover and Management subindices and moderately in Habitat, Native Species and Debris subindices (Table 3.71). Riparian condition was affected by reduced riparian vegetation width, disrupted continuity, poor habitat connectivity and the presence and regeneration of weed and noxious weed species, particularly in the midstory and understory structural layers. Reduced levels of cover in the canopy and a reduction in large woody debris and native non-woody debris also contributed to the reduction in riparian grade at this site.

Plate 3.60 *Riparian vegetation condition at DEEP3 was considered to be a mild disturbance system. This was primarily due to reduced riparian vegetation width, disrupted continuity, poor habitat connectivity and the presence and regeneration of weed and noxious weed species, reduced cover and a reduction in large woody debris and native non-woody debris.*

Table 3.71 *Site-level assessments of riparian condition in 2016-17 at DEEP3 showing scores for the five subindices and their individual indicators that comprise the Vegetation Condition Index.*

Deep Creek 3	Scores
HABITAT	**14.2/20**
Channel width	2.7
Proximity	1
Continuity	2.5
Layers	4
Large native trees	2
Hollow-bearing trees	2
NATIVE SPECIES	**11.5/20**
Native canopy species	3
Native midstory species	2
Native herb/forb species	1.8
Native graminoid species	1.8
Native macrophyte species	3
SPECIES COVER	**18/20**
Canopy species	3
Midstory species	4
Herb/forb species	4
Graminoid species	4
Macrophyte species	3
DEBRIS	**14.5/20**
Total leaf litter	3
Native leaf litter	1.5
Dead trees standing	1
Dead trees fallen	1
Lying logs	4
Fringing vegetation	4
MANAGEMENT	**15/20**
Tree clearing	2.5
Fencing	3
Animal impact	3
Canopy Health	1.5
Exposed tree roots	3
Native woody regeneration	2
Weedy woody regeneration	0
TOTAL	**73.2/100**

DEEP 2

Site: The original riparian vegetation community at Deep Creek 2 (DEEP2, Plate 3.61) was described as 'Broad-leaved Paperbark – Bare Twig Rush swamp sclerophyll open forest of coastal swamps' (NAM_ForW06) and 'Swamp Oak – Broad-leaved Paperbark – Willow Bottlebrush floodplain forested wetland' (NAM_ForW02), both listed TEC's, grading into 'Blackbutt – Red Mahogany – Bloodwood dry open forest on infertile sandy soils of low coastal rises and hills' (NAM_DOF04) (OEH 2015). DEEP2 received an excellent riparian condition score of 91.5 a grade of A- (Table 3.72).

Dominant species: The dominant canopy species present were the native species River Mangrove (*Aegiceras corniculatum*), Broad-leaved Paperbark (*Melaleuca quinquenervia*), Swamp Oak (*Casuarina glauca*), Blackbutt (*E.pilularis*) and Tallowwood (*E.microcorys*). Dominant native midstory species included Willow Bottlebrush (*Callistemon salignus*), Sydney Golden Wattle (*Acacia longifolia* subsp. *longifolia*), Large-leaf Hop-bush (*Dodonaea triquetra*) and Geebung (*Persoonia* sp.). The understory was dominated by native species Tall Saw-sedge (*Ghania clarkei*), Blue Flax Lily (*Dianella caerula*), Prickly Couch (*Zoysia macrantha*), Blady Grass (*Imperata cylindrica*) and Wild Violet (*Viola banksii*). Native vine species included Hairy Apple Berry (*Billardia scandens*) while the estuarine macrophyte layer included Sea Rush (*Juncus krausii* subsp. *australiensis*), Estuarine Twig Rush (*Baumea juncea*), Fringe-sedge (*Fimbristylis ferruginea*) and Sand Couch (*Sporobolus virginicus* sp.).

Noxious weed species: No weed or noxious weed species were observed on-site.

Summary: Deep Creek 2 was a relatively undisturbed open-swamp/closed-forest system with an intact remnant canopy and all structural layers dominated by native species in a predominantly forested/partially cleared rural-coastal landscape. The immediate surrounding landuse was state forest, beyond which was agricultural grazing country, transport networks and urban settlement. Significant remnant stands of vegetation surround the site in the form of Nambucca State Forest and wetland areas that have previously been recognised as 'suitable vegetation for environmental protection' (BMT WBM 2008). Representative elements of the remnant vegetation communities were retained in all structural layers, with DEEP2 scoring full marks for the Native Species subindex and well for Habitat, Cover, Debris and Management subindices (Table 3.72). Riparian condition was affected by a small disruption to vegetation continuity and reduced levels of woody debris.

Plate 3.61 *Riparian vegetation condition at DEEP2 was exemplary and considered to be relatively undisturbed. This was mainly attributed to the presence of a remnant canopy and the dominance of native species throughout all structural layers.*

Table 3.72 *Site-level assessments of riparian condition in 2016-17 at DEEP2 showing scores for the five subindices and their individual indicators that comprise the Vegetation Condition Index.*

Deep Creek 2	Scores
HABITAT	**18.5/20**
Channel width	3
Proximity	4
Continuity	3.5
Layers	4
Large native trees	2
Hollow-bearing trees	2
NATIVE SPECIES	**20/20**
Native canopy species	4
Native midstory species	4
Native herb/forb species	4
Native graminoid species	4
Native macrophyte species	4
SPECIES COVER	**19/20**
Canopy species	4
Midstory species	4
Herb/forb species	4
Graminoid species	4
Macrophyte species	3
DEBRIS	**15/20**
Total leaf litter	3
Native leaf litter	3.
Dead trees standing	0
Dead trees fallen	3
Lying logs	2
Fringing vegetation	4
MANAGEMENT	**18/20**
Tree clearing	4
Fencing	3
Animal impact	3
Canopy Health	2
Exposed tree roots	3
Native woody regeneration	2
Weedy woody regeneration	2
TOTAL	**93.5/100**

DEEP 1

Site: The original riparian vegetation community at Deep Creek 1 (DEEP1, Plate 3.62) was described as 'Saltwater Couch - Samphire saltmarsh of low-lying estuarine areas' (NAM_SW04) and 'Swamp Oak forested wetland of saline areas of coastal estuaries' (NAM_ForW01), both listed TEC's, grading into 'Tuckeroo - Bird's Eye Alectryon - Beach Acronychia littoral rainforests' (NAM_RF02), a listed TEC, and 'Coast Banksia woodland and open forest of coastal dunes' (NAM_DOF13) (OEH 2015). DEEP1 received a good riparian condition score of 77, a grade of B- (Table 3.73).

Dominant species: The dominant canopy species present were the native species River Mangrove (*Aegiceras corniculatum*) and Grey Mangrove (*Avicennia marina* subsp. *australasica*), Broad-leaved Paperbark (*Melaleuca quinquenervia*), Swamp Oak (*Casuarina glauca*), Coast Banksia (*Banksia integrifolia* subsp. *intergrifolia*), Tuckeroo (*Cupaniopsis anacardioides*) and Three-veined Cryptocarya (*Cryptocarya triplinervis*). Dominant native midstory species included Coastal Wattle (*Acacia longifolia* subsp. *sophorae*), Orange Thorn (*Pittosporum multiflorum*), Lilly Pilly (*Acmena smithii*) along with the exotic species Wild Tobacco (*Solanum mauritianum*), Bitou Bush (*Chrysanthemoides monilifera* subsp. *rotundata*) and Senna (*Senna pendula* var. *glabrata*). The understory was dominated by native species Spiny-headed Mat-rush (*Lomandra longifolia*), New Zealand Spinach (*Tetragonia tetragonoides*), Scurvy Weed (*Commelina cyanea*) and Wild Violet (*Viola banksii*) along with exotic species Fireweed (*Senecio madagascariensis*), Asparagus Ferns (*Asparagus* spp.), Broadleaf Paspalum (*Paspalum mandiocanum*) and Buffalo Grass (*Stenotaphrum secundatum*). Dominant vine species included Dodder (*Cuscuta* sp.), Silkpod (*Parsonnsia* spp.), Mangrove Vine (*Cynanchum carnosum*) and the exotic species Coastal Morning Glory (*Ipomoea cairica*). An estuarine macrophyte layer included Sea Rush (*Juncus krausii* subsp. *australiensis*), Rusty Sedge (*Fimbristylis ferruginea*), Sand Couch (*Sporobolus virginicus* var. *virginicus*) and Zostera (*Zostera muelleri* subsp. *caprcorni*).

Noxious weed species: Noxious weed species observed on-site were Bitou Bush (*Chrysanthemoides monilifera* subsp. *rotundata*), Senna (*Senna pendula* var. *glabrata*), Asparagus Ferns (*Asparagus* spp.) and Coastal Morning Glory (*Ipomoea cairica*).

Summary: Deep Creek 1 was a mildly disturbed closed-forest system with a mixed-aged canopy and a mix of native and exotic species throughout all structural layers, in a predominantly forested, partially cleared urban-coastal landscape. The immediate surrounding landuse was Crown Land, forestry and Nature Reserve beyond which was urban settlement. Significant remnant stands of vegetation surround the site in the form of Crown Land and Nambucca State Forest to the south and Valla Nature Reserve to the North. Representative elements of the remnant vegetation communities were retained in all structural layers, with DEEP1 scoring well for subindices Habitat, Native Species and Cover and moderately for Debris and Management subindices (Table 3.73). Riparian condition was affected by contracted riparian vegetation width and the presence and regeneration of weed and noxious weed species, particularly in the midstory and understory structural layers. A reduction in seagrass cover, limited habitat trees and large woody debris and exposed tree roots due to bank erosion also contributed to the reduction in riparian grade at this site.

***Plate 3.62** Despite possessing good vegetation cover throughout all structural layers, DEEP1 was considered to be a mildly disturbed riparian system primarily due to the presence of weed and noxious weed species, reduced riparian width and low levels of large woody debris.*

Table 3.73 *Site-level assessments of riparian condition in 2016-17 at Deep Creek 1 showing scores for the five subindices and their individual indicators that comprise the Vegetation Condition Index.*

Deep Creek 1	Scores
HABITAT	**15/20**
Channel width	1
Proximity	4
Continuity	4
Layers	4
Large native trees	2
Hollow-bearing trees	0
NATIVE SPECIES	**18/20**
Native canopy species	4
Native midstory species	3
Native herb/forb species	3
Native graminoid species	4
Native macrophyte species	4
SPECIES COVER	**18/20**
Canopy species	4
Midstory species	4
Herb/forb species	4
Graminoid species	4
Macrophyte species	2
DEBRIS	**12/20**
Total leaf litter	3
Native leaf litter	3
Dead trees standing	1
Dead trees fallen	0
Lying logs	2
Fringing vegetation	3
MANAGEMENT	**14/20**
Tree clearing	2
Fencing	3
Animal impact	3
Canopy Health	2
Exposed tree roots	2
Native woody regeneration	2
Weedy woody regeneration	0
TOTAL	**77/100**

3.7.4 Water quality

Deep Creek received a poor overall score of 48 (D-) for water quality, a below average score for the Nambucca Catchment. The estuarine reach scored 45 (D-), while the freshwater reach received a higher score of 54 (D) due to fewer guideline exceedances in the single freshwater site at DEEP4. In the estuarine reach, DEEP3 received a score of 45 (D-), DEEP2 received a score of 31 (F), the lowest WQ score of the Nambucca Catchment, and DEEP1 received a score of 53 (D+), the highest score of the Deep Creek estuarine reach. Figure 3.18 shows the key physicochemical and nutrient variables used in the assessment of water quality for the Deep Creek subcatchment. Ranges and means for these variables are given in Tables 3.74 and 3.75, and the exceedances are given in Table 3.76.

All Deep Creek sites, freshwater and estuarine, exceeded either minimum or maximum guidelines for pH with a clear longitudinal pattern of increasing pH with distance downstream. The lowest pH of 5.58 was observed at DEEP4, while the highest pH of 8.62 was recorded at DEEP1.While there were no clear longitudinal patterns for turbidity, all sites except DEEP1 exceeded upper guideline trigger values. The freshwater site DEEP4 exceeded ANZECC guidelines on one occasion with the site maximum turbidity value of 81.9NTU. DEEP2 exceeded OEH turbididty guidelines for estuarine lagoons on all six sampling occasions with a site maximum turbidity value of 136NTU (22 times the guideline) observed in July 2017. Turbidity exceedances observed in DEEP2 are likely due to a combination of reduced flushing events due to natural temporal closures of the intermitently closed/open lake or lagoon (ICOLL) in Deep Creek and above-average rainfall events. This is supported by the site maximum turbidity being observed at the July 2017 sampling event which coincided with above-average rainfall for the same month.

A clear longitudinal pattern of increasing mean DO% with distance downstream was observed in Deep Creek. While all Deep Creek sites (freshwater and estuarine) exceeded minimum guidelineson occasion, both DEEP4 and DEEP3 consistently fell below their respective minimum guidelines. The lowest DO% of 9.7% was recorded at DEEP4 and was nine times below the ANZECC trigger value for lowland freshwater systems. This corresponded to a DO concentration of 0.90mg/L, which is low enough to result in fish kills.

Total nitrogen (TN) guideline values were exceeded frequently in all Deep Creek sites except at DEEP3 where exceedance was infrequent. Peak maximum TN were observed in the freshwater reach in July at DEEP4 (828µg/L) and in the estuarine reach in December at DEEP1 (2162µg/L), two and seven times greater than the relevant ANZECC and OEH guidelines, respectively. Bioavailable nitrogen (NOx) was frequently exceeded in all Deep Creek sites except on one sampling occasion at DEEP3, with the peak concentration of 224.4µg/L NOx recorded at DEEP3, greater than four times the OEH guideline for upper estuaries.

Total phosphorus concentrations in Deep Creek regularly-to-very frequently exceeded freshwater ANZECC and estuarine OEH guideline values. Peak exceedance for TP was observed at DEEP2 (241µg/L), ten times the OEH guideline for estuarine lagoons. In contrast, SRP only occasionally exceeded guideline values in two of the four sites.

Chl-a measures did not follow trends in nutrient concentrations in Deep Creek and only occasional exceedances occurred in the Deep Creek estuary. Chl-a concentrations at these sites (DEEP2 and DEEP3) were variable, with the highest exceedance (13.5µg/L) recorded at DEEP3 in February, 2017.

Table 3.74 *Minimums, maximums and means of measured water quality variables for two sites DEEP4 and DEEP3 on Deep Creek.*

	DEEP4			DEEP3		
Variable	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**
Temperature	14.86	24.29	19.63	15.52	28.91	21.75
pH	5.58	7.31	6.58	5.68	7.41	6.58
EC	0.13	0.15	0.14	0.14	21.50	6.35
Salinity (PPT)	0.06	0.08	0.07	0.07	12.94	3.68
DO (mg/L)	0.90	7.37	4.91	2.81	6.99	5.39
DO %	9.70	72.40	48.65	32.30	67.00	54.58
Turbidity	3.70	81.90	31.36	0.00	21.70	10.48
Chla (µg/L)	0.00	1.89	0.66	0.43	13.47	3.61
TSS (mg/L)	2.31	18.33	8.61	2.70	15.05	7.52
TN (µg/L)	322.30	828.68	568.68	282.91	631.35	448.05
TP (µg/L)	15.90	115.12	53.56	12.79	81.13	47.73
NOx (µg/L)	72.33	185.55	137.12	26.41	224.40	111.07
SRP (µg/L)	2.43	15.22	6.87	0.30	7.93	3.88

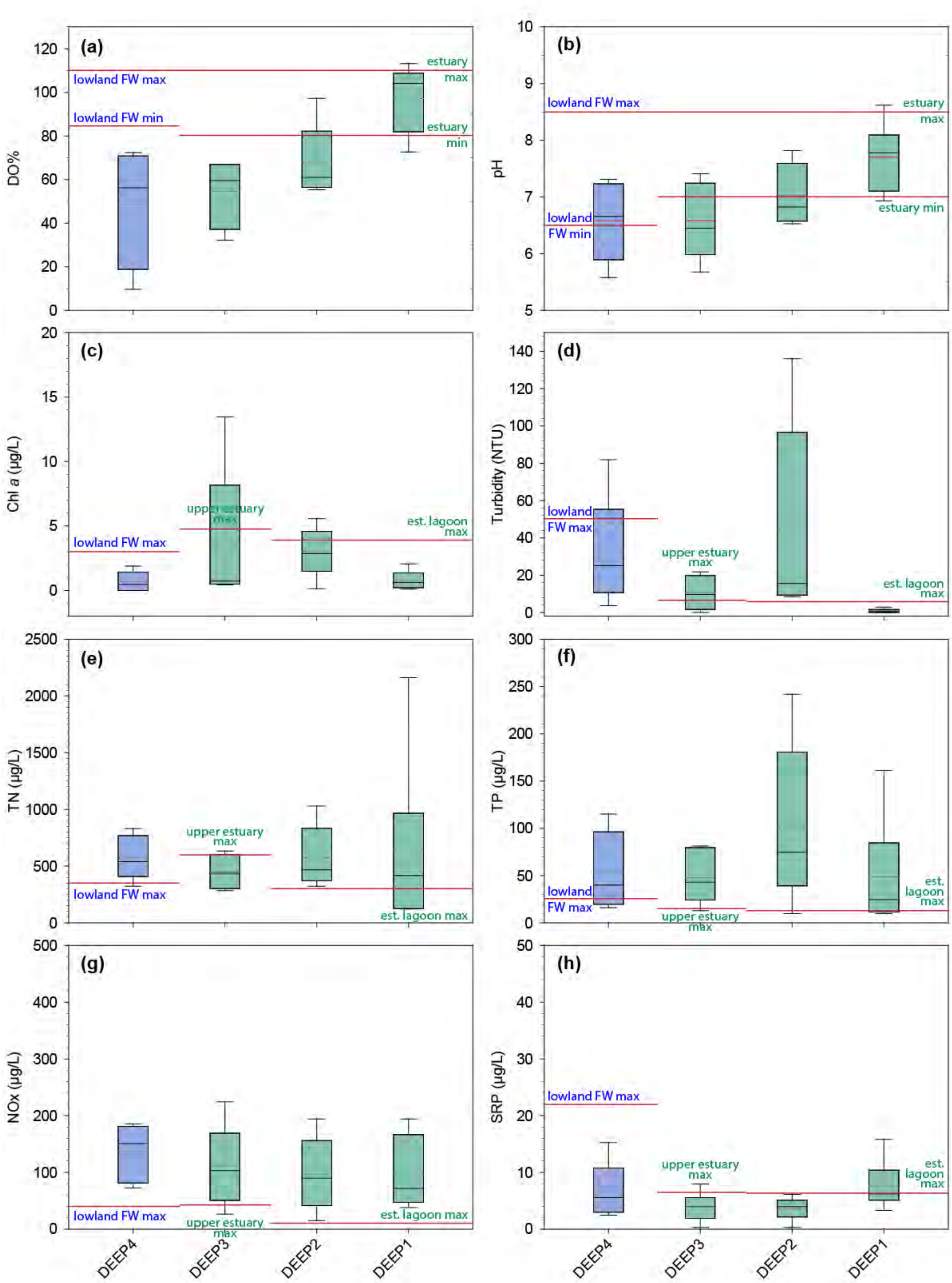


Figure 3.18 *Mean (grey line), median (black line), 25th and 75th percentiles, and range of water quality variables in Deep Creek from 2016-2017. Green and blue boxes represent estuary and freshwater sites, respectively. Red lines represent the relevant maximum or minimum guideline value for each type of system.*

Table 3.75 *Minimums, maximums and means of measured water quality variables for two sites DEEP2 and DEEP1 on Deep Creek.*

	DEEP2			DEEP1		
Variable	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**
Temperature	18.55	31.37	24.54	19.21	28.19	23.87
pH	6.53	7.82	7.02	6.93	8.62	7.70
EC	25.10	52.60	44.60	48.90	58.80	53.20
Salinity (PPT)	15.18	34.97	28.90	32.04	38.92	35.02
DO (mg/L)	4.28	5.94	5.00	5.12	7.87	6.93
DO %	55.40	97.20	67.62	72.70	113.20	97.08
Turbidity	8.30	136.00	44.75	0.00	2.90	0.90
Chla (µg/L)	0.14	5.57	3.00	0.11	2.06	0.76
TSS (mg/L)	25.38	143.33	78.61	13.24	32.80	17.66
TN (µg/L)	322.20	1028.70	572.83	121.04	2162.44	634.89
TP (µg/L)	9.66	241.88	101.63	9.66	161.12	48.46
NOx (µg/L)	14.93	194.28	96.95	37.89	194.28	97.11
SRP (µg/L)	0.30	6.12	3.64	3.30	15.81	7.63

Table 3.76 *Exceedances[1] observed in Deep Creek for pH, conductivity (EC), percent saturated dissolved oxygen (DO), turbidity, chlorophyll a (Chl-a), total nitrogen (TN), total phosphorus (TP), bioavailable nitrogen (NOx) and soluble reactive phosphorus (SRP).*

Site	pH	EC	DO %	Turbidity	Chl-a	TN	TP	NOx	SRP
DEEP4	2(40%)2,0	0(0%)	4(100%)4,0	1(20%)	0(0%)	5(83%)	4(67%)	6(100%)	0(0%)
DEEP3	3(60%)3,0	NA	4(100%)4,0	3(60%)	1(20%)	1(17%)	5(83%)	5(83%)	1(17%)
DEEP2	4(67%)4,0	NA	4(80%)4,0	6(100%)	1(20%)	6(100%)	5(83%)	6(100%)	0(0%)
DEEP1	2(33%)1,1	NA	2(40%)1,1	0(0%)	0(0%)	4(67%)	3(50%)	6(100%)	2(33%)

[1] Numbers in black represent the total number and percent of exceedances. Numbers in blue and red represent the numbers of measurements lower than the minimum guideline value and higher than the maximum guideline value, respectively. The number of exceedances includes all depths sampled so may be greater than the number of times sampled. Turbidity, chlorophyll a, and nutrients only have maximum trigger guidelines.

3.7.5 Aquatic macroinvertebrates

DEEP4 recorded 206 and 141 individual macroinvertebrates across 15 and 16 macroinvertebrate families during the 2016 spring and 2017 autumn sampling periods, respectively (Table 3.77). In spring, abundance was dominated by Atyidae shrimp (74 individuals) and richness was dominated by Coleoptera (Aquatic Beetles) with five families. In contrast, Leptophlebiid mayflies were the most abundant family in autumn (52 individuals) and the most diverse order in autumn was again Coleoptera with six families.

Mean SIGNAL2 scores for DEEP4 were higher in autumn (5.6) than spring (4.7), with the lower mean spring score likely attributed to lower abundances of high-scoring Ephemeroptera (Mayflies). SIGNAL2 score ranges were similar between seasons.

DEEP4 received a low overall Ecohealth score of 50 (D) for aquatic macroinvertebrate community condition. Macroinvertebrate indicator results were mixed with respect to their comparison with averages for the Nambucca catchment, with both total and EPT abundance below, richness equal to, and SIGNAL2 score greater than the averages for the Nambucca catchment. While DEEP4 supported a diversity of macroinvertebrate fauna indicated by a wide SIGNAL2 score range, the remaining macroinvertebrate indicators suggested the water quality and habitat conditions in the Nambucca Catchment at Deep Creek were in poor condition. This was partially supported by both the Ecohealth water quality and riparian condition assessments which each returned poor scores of 54 (D) and 59 (D+), respectively. Despite being higher in the catchment and in close proximity to heavily forested headwaters, the low macroinvertebrate score at DEEP4 is likely attributed to disconnected pools and reduced streamflow due to drier than average climatic conditions during the sampling period.

Table 3.77 *Summary of aquatic macroinvertebrate indicator scores and the overall macroinvertebrate grade for the freshwater site in the Deep Creek subcatchment.*

	DEEP4	
Macroinvertebrate indicator	**Spring 2016**	**Autumn 2017**
Total abundance	206	141
Family richness	15	16
EPT abundance	74	57
EPT richness	8	8
Mean SIGNAL2 score	4.7	5.6
SIGNAL2 score range	1 - 8	2 – 8
Ecohealth score (grade)	**50 (D)**	

PART 4

SUMMARY AND RECOMMENDATIONS

4.1 Background

The development of a standardised framework for collecting, analyzing and presenting riverine, coastal and estuarine assessments of ecological condition has been identified as a key need for coastal Councils and State natural resource management agencies, who are required to monitor natural resource condition, and water quality and quantity in these systems. This project was conducted over a 12-month period from July 2016 to June 2017 in the Nambucca catchment covering the subcatchments of the Nambucca River and its tributaries of Missabotti, Buckrabendinni, South, Newee and Warrell Creeks; Taylors Arm and its tributaries of Thumb, Baker and Tom Maras Creeks; as well as the Deep Creek catchment to the north of the Nambucca catchment. This project aimed to contribute to the assessment of the ecological condition of these subcatchments by:

- Assessing the health of coastal catchments using standardised indicators and reporting for estuaries and freshwater river reaches using hydrology, water quality, riparian vegetation, geomorphic condition, aquatic macroinvertebrate communities and fish as indicators of aquatic ecosystem health, and
- Contributing scientific information to the development of report cards for communicating the health of the estuarine and freshwater systems of the Macleay catchment.

This section provides a summary for each of the study subcatchments, identifying major issues with geomorphic condition, riparian condition, water quality and aquatic macroinvertebrate communities, and the potential drivers of change in these systems. Management priorities are provided for each site based on the Ecohealth data contained in this report. However, these are long-term recommendations and we emphasize that Council weigh these against their short- and intermediate NRM priorities when incorporating these into their long-term NRM strategy.

Prioritizing recommendations for investment in the Nambucca LGA

Riparian management recommendations for each of the 31 Nambucca Ecohealth sites are summarised below (Table 3.78). The most frequently occurring management priority was weed monitoring, which has been recommended for all 31 sites. Weed control/removal closely followed, with native plantings to increase riparian vegetation width/continuity and habitat connectivity the next most frequently recommended management priorities (Table 3.78). Details on each of the recommended management priorities and their relationship to existing management strategies (MS) outlined in the Nambucca Estuary Management Plan (BMT WBM 2008) are further discussed below.

Table 3.78 *Nambucca Catchment management recommendation summaries for each of the 31 Ecohealth sites in the 2017 assessment.*

	Weeds			Riparian fencing and livestock		Native plantings		Management considerations			
sites	**monitor**	**control/ removal**	**strategic phase-out**	**install/improve fencing**	**remove livestock**	**width and continuity**	**connectivity project**	**address bank erosion**	**undertake project/s**	**maintain current practices**	**Totals**
NAMB1	Y	Y	Y			Y			Y		5
NAMB2	Y	Y	Y			Y	Y	Y	Y		7
OYST1	Y	Y		Y	Y	Y	Y				6
NAMB3	Y	Y		Y	Y	Y	Y	Y			7
NAMB4	Y	Y	Y	Y	Y	Y	Y	Y			8
NAMB5	Y	Y	Y	Y	Y	Y	Y	Y			8
NAMB6	Y	Y	Y	Y	Y	Y	Y				7
NAMB7	Y	Y		Y	Y	Y					5
TAYL1	Y	Y		Y	Y	Y	Y	Y			7
TAYL2	Y	Y		Y	Y	Y	Y				6
TAYL3	Y	Y		Y	Y	Y	Y				6
TAYL4	Y	Y		Y	Y	Y	Y				6
TAYL5	Y	Y							Y		3
DEEP1	Y	Y				Y		Y	Y		5
DEEP2	Y								Y	Y	3
DEEP3	Y	Y				Y	Y		Y		5
DEEP4	Y	Y	Y	Y	Y	Y	Y				7
SOUC1	Y	Y	Y	Y	Y		Y		Y		7
SOUC2	Y	Y	Y	Y	Y	Y	Y	Y			8
SOUC3	Y	Y	Y	Y	Y	Y	Y				7
MISC1	Y	Y	Y	Y	Y	Y	Y		Y		8
NEWC1	Y			Y	Y			Y		Y	5
BUCC1	Y	Y	Y	Y	Y	Y	Y				7
BUCC2	Y	Y		Y	Y	Y					5
BAKC1	Y	Y	Y	Y	Y	Y	Y				7
THUM1	Y	Y		Y	Y	Y	Y	Y			7
MARC1	Y	Y		Y	Y	Y	Y				6
WARR1	Y	Y						Y		Y	4
WARR2	Y	Y		Y		Y	Y				5
WARR3	Y	Y			Y	Y	Y				5
EUNC1	Y	Y					Y				3
Totals	31	29	12	22	22	25	23	10	8	3	185

Weed monitoring: Active monitoring and repeated surveying of sites offers early detection of weed species presence, potential spread and range expansion and directly informs management decisions. Weed detection should be undertaken by skilled personel to ensure correct weed species identification and accurate population and species distribution information is obtained. Relates to Nambucca Estuary Management Plan MS no’s 1, 6, 8, 16, 19, 21 and 22.

Weed species control/removal: The early control and removal of weed species reduces the likelihood of potential exotic weed infestations which can outcompete native species and lead to the degradation of a vegetation community. A major impact of weed species is their ability to displace and replace native plant species and alter habitat values for native fauna. Weed control and or removal through chemical, mechanical, or physical means should be undertaken by skilled and trained staff to ensure correct weed species identification and appropriate removal techniques are applied. Relates to Nambucca Estuary Management Plan MS no’s 1, 6, 8, 10, 16, 19, 21 and 22.

Weed species strategic phase-out: The strategically staggered removal of a weed species (e.g. Camphor Laurel) should allow for the necessary time required for native plantings to replace the removed weed species, while simultaneously maintaining bank stability and wildlife habitat. Relates to Nambucca Estuary Management Plan MS no’s 1, 6, 8, 10, 16, 19, 21 and 22.

Riparian fencing instalment/improvement: The presence of fencing indicates that there has been an attempt made to exclude livestock and other agricultural activities from the riparian zone. Riparian fencing that excludes livestock can promote woody and non-woody debris accumulation and allow for canopy, midstory and understory native species recovery. If strategically implemented, riparian fencing can be used in combination with native plantings to increase riparian vegetation width, continuity and to improve proximity to intact remnant stands of vegetation. Relates to Nambucca Estuary Management Plan MS no's 1, 6, 8, 15, 16, 19, 21, 22 and 25.

Riparian livestock removal: The presence of livestock in the riparian zone accelerates the deterioration of riparian condition and over time can result in a decline in biodiversity and ecological integrity. Livestock overgrazing of riparian zones can have far reaching impacts and lead to tree and shrub decline, loss of understorey and succession plants, compaction due to pugging, river bank erosion and eutrophication, algal blooms and an increase in weed species. While the exclusion of stock from waterways is not legislated, the Fisheries Management Act 1994 and 2010 Regulations prohibit the movement and grazing of cattle on marine vegetation, including estuarine macrophytes such as mangroves and mangrove seedlings. Additionally, where river banks are left unfenced resulting stock access to creeks often results in faecal contamination of the waterway. Livestock effluent entering waterways from uncontrolled cattle access has been recognised as a major risk to Oyster growers in the Nambucca catchment (NROF, 2014). Relates to Nambucca Estuary Management Plan MS no's 1, 5, 6, 7, 8, 10, 15, 16, 19, 21, 22 and 25.

Native plantings to increase vegetation continuity/width: Riparian vegetation continuity and riparian vegetation width supports habitat complexity, biodiversity and ecosystem function. An effective riparian zone acts as a corridor of biological connectivity that regulates water quality and temperature, supports complex terrestrial and aquatic food webs, buffers and filters terrestrial nutrient imput into aquatic ecosystems, stabilises river banks and offers and resilience and resistence to environmental change. Revegetating degraded riparian systems with native/endemic plantings can assist the long-term site regeneration of native species and over time begin to restore ecological process and return habitat complexity. Increasing riparian vegetation continuity and or riparian vegetation width requires land holder and community engagement along with a combination of management techniques depending on site conditions and level of degradation. Relates to Nambucca Estuary Management Plan MS no's 1, 5, 6, 7, 8, 10, 14, 16, 19, 20, 21, 22 and 25.

Native planting projects to increase habitat connectivity: Enhancing habitat connectivity between terrestrial and aquatic ecosytems increases habitat complexity, biodiversity and ecosystem function at a landscape scale. Linking riparian zones to areas of significant vegetation to increase habitat connectivity requires land holder and community engagement along with a combination of management techniques depending on site conditions and level of degradation. Relates to Nambucca Estuary Management Plan MS no's 1, 5, 6, 7, 8, 10, 14, 16, 19, 20, 21, 22 and 25.

Bank Erosion Prevention Techniques: River bank erosion in the Nambucca Catchment has been accelerated through the removal of deep rooted woody riparian vegetation, the grazing of livestock, excessive historical gravel extraction (Doyle 2003) and wash from boating activities. The loss of sediment from riparian zones reduces aquatic health, results in the loss of a valuable agricultural resource and results in changes to the hydrology of aquatic ecosystems. Hard bank-erosion control techniques such as rock revetment or timber fillets, such as those recently installed in the main stem of the Nambucca River, can reduce the rate of erosion at steep actively eroding sites and assist with riparian vegetation reestablishment, e.g. mangroves in estuarine systems. However, careful consideration should be given before undertaking works to address active erosion. While rock revetment works may address erosion issues in some systems, in others the use of heavy machinery may cause disturbance to the ecology of a system such that it outweighs any potential benefits (e.g. weed invasion, habitat removal and accelerated erosion). Fencing and stock exclusion and undertaking planting programs are soft approaches to preventing river bank erosion that might be more suitable in some circumstances. Relates to Nambucca Estuary Management Plan MS no's 1, 2, 4, 5, 6, 7, 8, 9, 10, 11, 14, 15, 16, 19, 20, 21 and 22

Projects: Refers to additional projects, ideas and recommendations that consider site specific issues, such as: (1) investigation/research into large scale canopy dieback (e.g. NAMB2); (2) site monitoring through the use of surveillance cameras and signs to monitor the activity of 4WD's encouraging responsible use, curb illegal dumping of rubbish thereby reducing the risk of wildfire and weed invasion; (3) controlling vehicle access and/or identifying vehicle boundaries and sensitive ecological areas through the use of wooden bollards; (4) reconsideration of projects that have previously been promoted (e.g. NAMB1 and TAYL1); and (5) the installation of informative signage at key public river access points throughout the Nambucca Catchment can engage and enhance visitor understanding and appreciation of site characteristics by highlighting local biodiversity values, restoration efforts undertaken by council and river health issues, which can promote interest in riparian management, restoration projects and the responsible use of these areas. Relates to Nambucca Estuary Management Plan MS no's 1, 2, 4, 5, 6, 7, 8, 9, 10, 11, 15, 16, 19, 20, 21 and 22.

Maintaining Current Management Practices: Recognises the effectiveness and importance of current management techniques and encourages the continuation of current practices. Relates to Nambucca Estuary Management Plan MS no's 1, 4, 5, 6, 7, 8, 10, 15, 16, 19, 20, 21 and 22.

4.2 Subcatchment summaries

4.2.1 Nambucca River (North Arm)

Freshwater reaches

- Geomorphic condition was good at NAMB8: localized scour of streambed downstream of causeway and moderate bank erosion due to floods.
- Riparian condition was moderate at NAMB8: moderately disturbed riparian zone with reduced riparian vegetation width and continuity, prevalence of weeds and noxious weeds in midstory and understory.
- Water quality was poor at NAMB8: frequent high TN and TP concentrations and persistent high NOx concentrations; regular low DO%.
- Aquatic macroinvertebrates were poor at NAMB8: all indicators except family richness were below the catchment average.

- Geomorphic condition was poor at NAMB7: significant pugging and trampling of banks and streambed from cattle access.
- Riparian condition was poor at NAMB7: highly disturbed riparian zone with stock access and weeds and noxious weeds throughout canopy, midstory and understory.
- Water quality was poor at NAMB7: persistent high concentrations of TN and NOx; regular low DO%.
- Aquatic macroinvertebrates were good at NAMB7: all indicators were well above the catchment average.

- Geomorphic condition was moderate at NAMB6: significant slumping and moderate erosion on right bank due to cattle access.
- Riparian condition was poor at NAMB6: highly disturbed riparian zone with reduced riparian vegetation width and continuity, prevalence of weeds and noxious weeds in midstory and understory, and stock access.
- Water quality was poor at NAMB8: frequent high concentrations of TN and persistent high concentrations of NOx.
- Aquatic macroinvertebrates were moderate at NAMB6: SIGNAL2 scores were above the catchment average, with total abundance, family richness and EPT scores equal to the catchment average.

Management Priorities – NAMB8, NAMB7 and NAMB6

- Weed monitoring.
- Weed species control.
- Increase vegetation width and continuity with assisted native plantings.
- Riparian fencing and livestock removal.
- Investigate non-point sources of TN and NOx.

Management Priority – NAMB8

- Weed species control and removal of: Wild Tobacco (*Solanum mauritianum*), Lantana (*Lantana camara*), Senna (*Senna pendula* var. *glabrata*), Mistflower (*Ageratina riparia*), Crofton Weed (*Ageratina adenophora*), Green Cestrum (*Cestrum parqui*), Wandering Jew (*Tradescantia fluminensis*) and Salvinia (*Salvinia molesta*).

Management Priorities – NAMB7

- Weed species control/removal/staggered removal of: Camphor Laurel (*Cinnamomum camphora*), Cockspur Coral Tree (*Erythrina crista-galli*), Lantana (*Lantana camara*), Small-leaved Privet (*Ligustrum sinense*), Fireweed (*Senecio madagascariensis*), Mexican Poppy (*Argemone mexicana*) and Salvinia (*Salvinia molesta*).
- Increase habitat connectivity by linking up plantings to existing patches of proximal remnant riparian vegetation and linking up corridors to surrounding stands of significant vegetation.

Management Priorities – NAMB6

- Weed species control/removal/staggered removal of: Camphor Laurel (*Cinnamomum camphora*), Willow (*Salix* sp.), Lantana (*Lantana camara*), Small-leaved Privet (*Ligustrum sinense*), Mickey-mouse Plant (*Ochna serrulata*), Noogoora Burr (*Xanthium occidentale*) Fireweed (*Senecio madagascariensis*), Wandering Jew (*Tradescantia fluminensis*), Mexican Poppy (*Argemone* sp.) and Giant Water lily (*Nymphaea* sp.).
- Increase habitat connectivity by linking up plantings to existing patches of proximal remnant riparian vegetation.
- Consider soft bank erosion control techniques.

Estuarine reaches

- Geomorphic condition was poor at NAMB5: severe bank erosion, particularly on the left bank.
- Riparian condition was poor at NAMB5: very highly disturbed riparian zone with stock impact and dominance of weeds and noxious weeds throughout canopy, midstory and understory.
- Water quality was very poor at NAMB5: frequent high concentrations of TN, TP and SRP, and persistent high concentrations of NOx; regular low DO%.

- Geomorphic condition was moderate at NAMB4: active erosion on both banks due to tidal/wave action and cattle access.
- Riparian condition was poor at NAMB4: highly disturbed riparian zone with stock impact and dominance of weeds and noxious weeds in midstory and understory, and exposure of tree roots due to active bank erosion.
- Water quality was poor at NAMB4: frequent high concentrations of TN and TP, and persistent high concentrations of NOx and SRP; regular low DO%.

- Geomorphic condition was good at NAMB3: minor bank erosion due to tidal/wave action.
- Riparian condition was moderate at NAMB3: moderately disturbed riparian zone with prevalence of weeds and noxious weeds in understory, and exposure of tree roots due to active bank erosion.
- Water quality was poor at NAMB3: persistent high nutrient concentrations (TN, TP, NOx, SRP).

- Geomorphic condition was good at NAMB2: minor bank erosion from tidal/wave action and stock access.
- Riparian condition was moderate at NAMB2: mildly disturbed riparian zone with prevalence of weeds and noxious weeds in understory, and stock impact.
- Water quality was moderate at NAMB2: frequent high TN and TP concentrations, and persistent high NOx and SRP concentrations.

- Geomorphic condition was good at NAMB1: rock revetment on left bank and depositional zone on right bank.
- Riparian condition was poor at NAMB1: very highly disturbed riparian zone with presence of weeds and noxious weeds in all structural layers of riparian vegetation.
- Water quality was poor at NAMB1: frequent high TN and TP concentrations, and persistent high NOx and SRP concentrations.

Management Priorities – NAMB5, NAMB4, NAMB3, NAMB2 and NAMB1

- Weed monitoring.
- Investigate non-point sources of TN and TP.

Management Priorities – NAMB5

- Weed control/removal: specifically Camphor Laurel (*Cinnamomum camphora*), Lantana (*Lantana camara*), Wild Tobacco (*Solanum mauritianum*), Small-leaved Privet (*Ligustrum sinense*), Castor Oil Plant (*Ricinus communis*), Mickey-mouse Plant (*Ochna serrulata*), Fireweed (*Senecio madagascariensis*), Wandering Jew (*Tradescantia fluminensis*) and Balloon Vine (*Cardiospermum grandiflorum*).
- Riparian fencing and livestock removal.
- Increase riparian vegetation width by expanding riparian zone with assisted native plantings.
- Consider soft bank erosion control techniques.
- Increase riparian connectivity by expanding upon and linking up existing patches of significant, proximal riparian vegetation and create vegetation corridors to significant stands of vegetation to the north and south.

Management Priorities – NAMB4

- Weed control/removal: specifically Fireweed (*Senecio madagascariensis*), Broadleaf Paspalum (*Paspalum mandiocanum*) and Prairie Grass (*Bromus catharticus*).
- Riparian fencing and livestock removal.
- Increase vegetation width and continuity by expanding riparian zone, particularly to the north of NAMB4.
- Increase habitat connectivity by expanding upon existing riparian zone vegetation and linking up corridors to enhance significant wetland vegetation located to the southwest.
- Consider soft bank erosion prevention techniques.

Management Priorities – NAMB3

- Weed control/removal: specifically Camphor Laurel (*Cinnamomum camphora*), Lantana (*Lantana camara*), Senna (*Senna pendula* var. *glabrata*) and Asparagus Fern Species (*Asparagus aethiopicus* and *A.macowanii*).
- Increase vegetation width and continuity by expanding riparian zone on opposite (southern) side of Gumma Road.
- Increase habitat connectivity by expanding upon riparian zone vegetation and linking up existing corridors to enhance significant wetland vegetation in Gumma Swamp (e.g. Gumma Gumma Creek riparian zone).
- Consider soft/hard bank erosion control techniques.
- Investigate Swamp Oak dieback on Goat Island.

Management Priorities – NAMB2

- Weed control/removal: specifically Lantana (*Lantana camara*), Groundsel Bush (*Baccharis halimifolia*), Coastal Morning Glory (*Ipomoea cairica*), Buffalo Grass (*Stenotaphrum secundatum*) and Broadleaf Paspalum (*Paspalum mandiocanum*).
- Installing adequate riparian fencing and remove livestock.
- Increase vegetation width and continuity by expanding riparian zone on southern side.
- Increase habitat connectivity by expanding upon and linking up existing vegetation corridors to significant vegetation the south and to the east.

Management Priorities – NAMB1

- Weed control/removal: specifically Camphor Laurel (*Cinnamomum camphora*), Lantana (*Lantana camara*), Bitou Bush (*Chrysanthemoides monilifera* subsp. *rotundata*), Brazillian Pepper Bush (*Schinus terebinthifolius*), Senna (*Senna pendula* var. *glabrata*), Asparagus Fern (*Asparagus* spp.) and Mother of Millions (*Bryophyllum delagoense*).
- Native riparian plantings.
- Consider adopting low-impact aspects of the Sand Island Precinct (plan 13 of the Nambucca Master Plan, 2010).

4.2.2 Tributaries of the Nambucca River

Missabotti Creek

- Geomorphic condition was moderate at MISC1: significant bedload transport through site.
- Riparian condition was poor at MISC1: highly disturbed riparian zone with prevalence of weeds and noxious weeds in midstory and understory, and stock impact.
- Water quality was poor at MISC1: frequent high TN and TP concentrations and persistent high NOx concentrations; occasional low DO%.
- Aquatic macroinvertebrates were very good at MISC1: all indicators scored well above the catchment average; equal highest macroinvertebrate grade in the Nambucca catchment.

Management Priorities – MISC1

- Investigate non-point sources of TN and TP.
- Weed monitoring.
- Weed species control/removal/staggered removal of: Camphor Laurel (*Cinnamomum camphora*), Lantana (*Lantana camara*), Small-leaved Privet (*Ligustrum sinense*), Wild Tobacco (*Solanum mauritianum*), Fireweed (*Senecio madagascariensis*), Silver-leaved Desmodium (*Desmodium uncinatum*) and Japanese Honeysuckle (*Lonicera japonica*).
- Riparian fencing and livestock removal.
- Increase vegetation width and continuity with assisted native plantings.
- Increase habitat connectivity by linking the riparian vegetation to significant stands of vegetation to the east and west with the assistance of native plantings and existing patches of proximal remnant riparian vegetation.
- Biodiversity information signs highlighting riparian restoration works/importance.

Buckrabendinni Creek

- Geomorphic condition was good at BUCC2: moderate bank erosion due to floods.
- Riparian condition was poor at BUCC2: highly disturbed riparian zone with historic clearing, occasional stock impact, and weeds and noxious weeds throughout midstory and understory.
- Water quality was poor at BUCC2: frequent high TN and NOx concentrations; frequent low DO%.
- Aquatic macroinvertebrates were very good at BUCC2: all indicators scored well above the catchment average.

- Geomorphic condition was very poor at BUCC1: severe slumping on both banks and moderate erosion of left bank due to cattle access.
- Riparian condition was poor at BUCC1: very highly disturbed riparian zone with stock access and weeds and noxious weeds throughout canopy, midstory and understory.
- Water quality was poor at BUCC1: frequent high TN and SRP concentrations and persistent high TP and NOx concentrations; persistent low DO%.
- Aquatic macroinvertebrates were poor at BUCC1: all indicators except for SIGNAL2 score were equal to the catchment average: SIGNAL2 score was below the catchment average.

Management Priorities – BUCC2 and BUCC1

- Investigate sources of TN and TP between BUCC2 and BUCC1.
- Weed monitoring.
- Weed species control.
- Riparian fencing and livestock removal.
- Increase vegetation width and continuity with assisted native plantings.

Management Priority – BUCC2

- Weed species control and removal of: Lantana (*Lantana camara*), Privet species (*Ligustrum lucidum* and *L.sinense*), Arsenic Bush (*Senna septemtrionalis*), Crofton Weed (*Ageratina adenophora*) and Balloon Vine (*Cardiospermum grandiflorum*).

Management Priorities – BUCC1

- Weed species control/removal/staggered removal of: Camphor Laurel (*Cinnamomum camphora*), Lantana (*Lantana camara*), Broad-leaved Privet (*Ligustrum lucidum*), Mistflower (*Ageratina riparia*), Noogoora Burr (*Xanthium occidentale*), Fireweed (*Senecio madagascariensis*), Wandering Jew (*Tradescantia fluminensis*), Balloon Vine (*Cardiospermum grandiflorum*) and Giant Water lily (*Nymphaea* sp.).
- Increase habitat connectivity by linking up plantings to existing patches of proximal remnant riparian vegetation and linking up corridors to surrounding stands of significant vegetation.

South Creek

- Geomorphic condition was good at SOUC3: minor scour around bridge.
- Riparian condition was poor at SOUC3: highly disturbed riparian zone with historic clearing, stock access and weeds and noxious weeds throughout midstory and understory.
- Water quality was poor at SOUC3: persistent high TN and NOx concentrations; frequent high TP concentration; persistent low DO%.
- Aquatic macroinvertebrates were moderate at SOUC3: all indicators scored above the catchment average except for EPT score which was below the catchment average.

- Geomorphic condition was moderate at SOUC2: severe undercutting on left bank.
- Riparian condition was poor at SOUC2: very highly disturbed riparian zone with historic clearing, stock access and weeds and noxious weeds throughout canopy and midstory.
- Water quality was poor at SOUC2: persistent high TN and NOx concentrations, frequent high TP concentrations; persistent low DO%.
- Aquatic macroinvertebrates were very poor at SOUC2: all indicators scored well below the catchment average.

- Geomorphic condition was moderate at SOUC1: moderate trampling and erosion of right bank due to heavy human access.
- Riparian condition was poor at SOUC1: highly disturbed riparian zone with historic clearing, stock access and weeds and noxious weeds throughout canopy, midstory and understory.
- Water quality was poor at SOUC1: persistent high TN and NOx concentrations, frequent high TP concentration; persistent low DO%.
- Aquatic macroinvertebrates were very poor at SOUC1: all indicators scored well below the catchment average.

Management Priorities – SOUC3, SOUC2 and SOUC1

- Weed monitoring.
- Riparian fencing and livestock removal.
- Investigate non-point source inputs of TN.

Management Priorities – SOUC3

- Weed species control/removal/staggered removal of: Lantana (*Lantana camara*), Castor Oil Plant (*Ricinus communis*), Crofton Weed (*Ageratina adenophora*), Annual Ragweed (*Ambrosia artemisiifolia*), Mistflower (*Ageratina riparia*), Fireweed (*Senecio madagascariensis*), Polka Dot Plant (*Hypoestes phyllostachya*), Wandering Jew (*Tradescantia fluminensis*) and Glory lily (*Gloriosa superba*).
- Increase vegetation width and habitat quality by expanding upon existing riparian corridors with native plantings already connected to significant stands of vegetation.

Management Priorities – SOUC2

- Weed species control/removal/staggered removal of: Camphor Laurel (*Cinnamomum camphora*), Willow (*Salix* sp.), Lantana (*Lantana camara*), Broad-leaf Privet (*Ligustrum lucidum*), Small-leaved Privet (*Ligustrum sinense*), Mistflower (*Ageratina riparia*), Crofton Weed (*Ageratina adenophora*), Narrow-leaved Rattlepod (*Crotalaria lanceolata*) and Fireweed (*Senecio madagascariensis*).
- Increase vegetation width and continuity with assisted native plantings.
- Increase habitat connectivity by linking up plantings to existing patches of proximal remnant riparian vegetation and linking up corridors to surrounding stands of significant vegetation.
- Consider soft bank erosion control techniques.

Management Priorities – SOUC1

- Investigate sources of turbidity between SOUC2 and SOUC1.
- Weed species control/removal/staggered removal: specifically Camphor Laurel (*Cinnamomum camphora*), Cockspur Coral tree (*Erythrina crista-galli*), Lantana (*Lantana camara*), Broad-leaf Privet (*Ligustrum lucidum*) and Small-leaved Privet (*Ligustrum sinense*), Mistflower (*Ageratina riparia*), Noogoora Burr (*Xanthium occidentale*), Wandering Jew (*Tradescantia fluminensis*), Morning Glory (*Ipomoea indica*), Balloon Vine (*Cardiospermum grandiflorum*) and Salvinia (*Salvinia molesta*).
- Biodiversity information signs to encourage community engagement.
- Increase habitat connectivity by expanding upon and linking up existing patches of significant, proximal riparian vegetation.

Newee Creek

- Geomorphic condition was moderate at NEWC1: moderate erosion on right bank from tidal/wave action.
- Riparian condition was very good at NEWC1: minimally disturbed riparian zone with historic clearing, stock access and reduced cover in midstory and macrophyte layers.
- Water quality was very poor at NEWC1: persistent high TN, TP and NOx concentrations, frequent high SRP concentration; frequent low DO%.

Management Priority – NEWC1

- Investigate non-point sources of TN and TP and whether the sediments surrounding the site of the old abattoir are a point source for TN and TP.
- Weed monitoring.
- Riparian fencing and livestock removal.
- Consider soft/hard bank erosion prevention techniques.
- Maintain current management practices.

4.2.3 Taylors Arm

Freshwater reaches

- Geomorphic condition was good at TAYL5: localized erosion on left bank.
- Riparian condition was very good at TAYL5: highly disturbed riparian zone with historic clearing, stock access and weeds and noxious weeds throughout midstory and understory.
- Water quality was moderate at TAYL5: persistent high NOx concentrations, frequent high TN and TP concentrations; frequent low DO%.
- Aquatic macroinvertebrates were poor at TAYL5: all indicators except for SIGNAL2 scored below the catchment average; SIGNAL2 scored above the catchment average.

- Geomorphic condition was poor at TAYL4: moderate erosion of both banks and significant pugging of streambed by cattle access.
- Riparian condition was poor at TAYL4: highly disturbed riparian zone with historic clearing, stock access and weeds and noxious weeds throughout midstory and understory.
- Water quality was poor at TAYL4: persistent high TN and NOx concentrations, infrequent high TP concentrations; persistent low DO%.
- Aquatic macroinvertebrates were very good at TAYL4: all indicators scored well above the catchment average.

- Geomorphic condition was poor at TAYL3: severe smothering of streambed with fine sediments and significant erosion of right bank; heavy trampling and pugging from cattle access.
- Riparian condition was poor at TAYL3: highly disturbed riparian zone with historic clearing, stock access and weeds and noxious weeds throughout understory.
- Water quality was poor at TAYL3: persistent high TN and NOx concentrations, frequent high TP concentrations; frequent low DO%.
- Aquatic macroinvertebrates were moderate at TAYL3: well above average total abundance and EPT scores, while family richness and SIGNAL2 scores were below the catchment average.

Management Priorities – TAYL5, TAYL4 and TAYL3

- Weed monitoring.
- Investigate non-point sources of TN.

Management Priorities – TAYL5

- Weed species control and removal: specifically Lantana (*Lantana camara*), Crofton Weed (*Ageratina adenophora*) and Wandering Jew (*Tradescantia fluminensis*).
- Installation of vehicle bollards.
- Biodiversity information signs.

Management Priorities – TAYL4

- Weed species control and removal: specifically Willow (*Salix* sp.), Lantana (*Lantana camara*), Small-leaved Privet (*Ligustrum sinense*), Arsenic Bush (*Senna septemtrionalis*), Noogoora Burr (*Xanthium occidentale*), Wandering Jew (*Tradescantia fluminensis*), and Fireweed (*Senecio madagascariensis*).
- Increase vegetation width and continuity with assisted native plantings.
- Increase habitat connectivity by connecting plantings to existing patches of proximal remnant riparian vegetation and linking up with corridors to surrounding stands of significant vegetation (e.g. east and west).
- Improved riparian fencing and livestock removal.

Management Priorities – TAYL3

- Weed species control and removal: specifically Camphor Laurel (*Cinnamomum camphora*), Castor Oil Plant (*Ricinus communis*), Lantana (*Lantana camara*), Noogoora Burr (*Xanthium occidentale*), Fireweed (*Senecio madagascariensis*), Wandering Jew (*Tradescantia fluminensis*) and Japanese Honeysuckle (*Lonicera japonica*).
- Increase vegetation width and continuity with assisted native plantings.
- Increase habitat connectivity by expanding upon and linking up corridors to surrounding stands of significant vegetation (e.g. north and south).
- Riparian fencing and livestock removal.

Estuarine reaches

- Geomorphic condition was poor at TAYL2: significant fine sediment on streambed and significant erosion on left bank.
- Riparian condition was moderate at TAYL2: moderately disturbed riparian zone with historic clearing, stock access and weeds and noxious weeds throughout midstory and understory.
- Water quality was very poor at TAYL2: persistent high TN and TP concentrations, frequent high TP and SRP concentrations; frequent low DO%.

- Geomorphic condition was poor at TAYL1: severe bank erosion due to tidal/wave action, removal of riparian vegetation and stock access.
- Riparian condition was poor at TAYL1: highly disturbed riparian zone with historic clearing, stock access and weeds and noxious weeds throughout midstory and understory.
- Water quality was very poor at TAYL1: persistent high nutrient concentrations (TN, TP, NOx and SRP); frequent low DO%.

Management Priorities – TAYL2 and TAYL1

- Weed monitoring.
- Riparian fencing and livestock removal.
- Investigate non-point sources of TN and TP.

Management Priorities – TAYL2

- Weed species control and removal of: Lantana (*Lantana camara*), Castor Oil Plant (*Ricinus communis*), Privet species (*Ligustrum sinense* and *L.lucidum*), Annual Ragweed (*Ambrosia artemisiifolia*), Mistflower (*Ageratina riparia*) and Wandering Jew (*Tradescantia fluminensis*).
- Increase vegetation width and continuity with assisted native plantings.
- Increase habitat connectivity by linking up plantings to existing patches of proximal remnant riparian vegetation (e.g. to the south) and by linking up corridors to surrounding stands of significant vegetation (e.g. north, southeast and southwest, and to the south through TOMC1).

Management Priorities – TAYL1

- Weed species control: specifically Lantana (*Lantana camara*), Small-leaved Privet (*Ligustrum sinense*), Wild Tobacco (*Solanum mauritianum*), Fireweed (*Senecio madagascariensis*) Buffalo Grass (*Stenotaphrum secundatum*) and Paspalum (*Paspalum mandiocanum*).
- Increase riparian connectivity by expanding upon and linking up existing vegetation corridors to significant vegetation (100 Acre Swamp) to the west.
- Increase riparian vegetation width by expanding riparian zone.
- Consider bank erosion control techniques.

4.2.4 Tributaries of Taylors Arm

Thumb Creek

- Geomorphic condition was good at THUM1: localized bank erosion upstream of bridge.
- Riparian condition was poor at THUM1: highly disturbed riparian zone with stock access and weeds and noxious weeds throughout midstory and understory.
- Water quality was poor at THUM1: persistent high NOx concentrations; frequent high TN and TP concentrations; persistent low DO%.
- Aquatic macroinvertebrates were very good at THUM1: all indicators except SIGNAL2 scored well above the catchment average with SIGNAL2 score equaling the catchment average; equal highest macroinvertebrate grade in the Nambucca catchment.

Management Priorities – THUM1

- Weed monitoring.
- Weed species control.
- Weed species control and removal: specifically Cockspur Coral tree (*Erythrina crista-galli*), Small-leaved Privet (*Ligustrum sinense*), Lantana (*Lantana camara*), Green Cestrum (*Cestrum parqui*), Angel's Trumpet (*Brugmansia suaveolens*), Arsenic Bush (*Senna septemtrionalis*), Mistflower (*Ageratina riparia*), Noogoora Burr (*Xanthium occidentale*), Annual Ragweed (*Ambrosia artemisiifolia*), Wandering Jew (*Tradescantia fluminensis*) and Fireweed (*Senecio madagascariensis*).
- Increase vegetation width, continuity and habitat connectivity with assisted native plantings (continue and expand upon past plantings which are evidenton-site) by connecting plantings to existing patches of proximal remnant riparian vegetation and linking up with corridors to surrounding stands of significant vegetation (e.g. east and west).
- Remove livestock from riparian zone.
- Consider bank erosion control techniques.

Baker Creek

- Geomorphic condition was moderate at BAKE1: moderate bank erosion and smothering of streambed by fine sediment inputs during construction of new bridge upstream of site.
- Riparian condition was poor at BAKE1: highly disturbed riparian zone with historic clearing, stock access and weeds and noxious weeds throughout canopy, midstory and understory.
- Water quality was moderate at BAKE1: persistent high NOx concentrations, frequent high TN and TP concentrations; persistent low DO%.
- Aquatic macroinvertebrates were poor at BAKE1: all indicators were slightly below the catchment average.

Management Priorities – BAKE1

- Weed monitoring.
- Weed species control/removal/staggered removal: specifically Camphor Laurel (*Cinnamomum camphora*), Privet species (*Ligustrum sinense* and *L.lucidum*), Lantana (*Lantana camara*), Noogoora Burr (*Xanthium occidentale*), species Wandering Jew (*Tradescantia fluminensis*), Parrot's Feather (*Myriophyllum aquaticum*) and Giant Water lily (*Nymphaea* sp.).
- Increase vegetation width and continuity with assisted native plantings.
- Increase habitat connectivity by expanding upon and linking up corridors to surrounding stands of significant vegetation (e.g. south, southeast and southwest).
- Riparian fencing and livestock removal.

Tom Maras Creek

- Geomorphic condition was poor at TOMC1: significant pugging of streambed and erosion of right bank due to localized bridge scour and cattle access.
- Riparian condition was poor at TOMC1: highly disturbed riparian zone with historic clearing, stock access and weeds and noxious weeds throughout understory.
- Water quality was poor at TOMC1: persistent high TN, TP and NOx concentrations; persistent low DO%.
- Aquatic macroinvertebrates were very poor at TOMC1: all indicators were well below the catchment average; the lowest grade in the catchment.

Management Priority – TOMC1

- Investigate non-point sources of TN and TP.
- Weed monitoring.
- Weed species control and removal of: Camphor Laurel (*Cinnamomum camphora*), Lantana (*Lantana camara*) and Green Cestrum (*Cestrum parqui*), Annual Ragweed (*Ambrosia artemisiifolia*), Fireweed (*Senecio madagascariensis*) and Salvinia (*Salvinia molesta*).
- Increase vegetation width and continuity with assisted native plantings.
- Increase habitat connectivity by linking up plantings to existing patches of proximal remnant riparian vegetation (e.g. to the north and south) and by linking up corridors to surrounding stands of significant vegetation (e.g. to the east, west or north through TAYL2).
- Riparian fencing and livestock removal.

4.2.5 Warrell Creek

Freshwater reaches

- Geomorphic condition was moderate at EUNC1: localized gullying on left bank associated with road runoff.
- Riparian condition was good at EUNC1: mildly disturbed riparian zone with weeds and noxious weeds throughout midstory and understory.
- Water quality was poor at EUNC1: frequent high TP concentrations; occasional high NOx and SRP concentrations; persistent low DO%.
- Aquatic macroinvertebrates were very poor at EUNC1: all indicators except family richness scored below the catchment average; family richness was equal to the catchment average.

- Geomorphic condition was moderate at WARR3: localized bank slumping and excessive fine sediments on streambed.
- Riparian condition was moderate at WARR3: moderately disturbed riparian zone with historic clearing, stock access and weeds and noxious weeds throughout midstory and understory.
- Water quality was poor at WARR3: persistent high TN, TP and NOx concentrations; persistent low DO%.
- Aquatic macroinvertebrates were poor at WARR3: all indicators except for total abundance were well below the catchment average: total abundance was above the catchment average.

Management Priority – EUNC1 and WARR3

- Weed monitoring.

Management Priorities – EUNC1

- Weed control/removal: specifically Privet species (*Ligustrum sinense* and *L.lucidum*) and Annual Ragweed (*Ambrosia artemisiifolia*).
- Increase habitat connectivity by linking up plantings to existing patches of proximal remnant riparian vegetation (south).
- Investigate non-point sources of TP.

Management Priorities – WARR3

- Weed species control/removal of: specifically Camphor Laurel (*Cinnamomum camphora*), Arsenic Bush (*Senna septemtrionalis*), Small-leaved Privet (*Ligustrum sinense*), Lantana (*Lantana camara*), Mistflower (*Ageratina riparia*), Noogoora Burr (*Xanthium occidentale*), Annual Ragweed (*Ambrosia artemisiifolia*), Fireweed (*Senecio madagascariensis*), Wandering Jew (*Tradescantia fluminensis*) and Giant Water lily (*Nymphaea* sp.).
- Increase vegetation width and continuity with assisted native plantings.
- Increase habitat connectivity by linking up plantings to include existing patches of proximal remnant riparian vegetation (both north and south) and by linking up corridors to surrounding stands of significant vegetation (e.g.southwest and east).
- Livestock removal from riparian zone.
- Investigate non-point sources of TN and TP.

Estuarine reaches

- Geomorphic condition was good at WARR2: minor undercutting of banks due to tidal/wave action.
- Riparian condition was good at WARR2: mildly disturbed riparian zone with historic clearing, and weeds and noxious weeds throughout understory.
- Water quality was very poor at WARR2: persistent high TN, TP and NOx concentrations, frequent low DO%.

- Geomorphic condition was moderate at WARR1: bank slumping and exposure of tree roots.
- Riparian condition was very good at WARR1: low disturbance riparian zone with weeds and noxious weeds throughout midstory.
- Water quality was moderate at WARR1: frequent high concentrations of TN, NOx and SRP.

Management Priority – WARR2 and WARR1

- Weed monitoring.

Management Priorities – WARR2

- Weed control/removal: specifically Lantana (*Lantana camara*) and Broadleaf Paspalum (*Paspalum mandiocanum*).
- Riparian fencing to delineate riparian zone and protect vegetation from disturbance regimes such as lawn mowing, woody debris collection and removal and vegetation clearing.
- Increase habitat connectivity and vegetation width: maintain riparian condition, expand on vegetation width where practical and enhance connectivity with nearby significant vegetation e.g. Bald Hill riparian zone.
- Investigate non-point sources of TN and TP.

Management Priorities – WARR1

- Weed control/removal: specifically Bitou Bush (*Chrysanthemoides monilifera* subsp. *rotundata*), Lantana (*Lantana camara*), Coastal Morning Glory (*Ipomoea cairica*), Rhodes Grass (*Chloris gayana*) and Paspalum (*Paspalum* spp.).
- Consider soft bank erosion prevention techniques.
- Maintain current management practices.
- Investigate non-point sources of TN.

4.2.6 Deep Creek

Freshwater reach

- Geomorphic condition was very poor at DEEP4: severe bank slumping and trampling by cattle access.
- Riparian condition was poor at DEEP4: highly disturbed riparian zone with historic clearing, stock access and weeds and noxious weeds throughout canopy, midstory and understory.
- Water quality was poor at DEEP4: persistent high concentrations of TN and NOx, frequent high concentrations of TP; frequent low DO%.
- Aquatic macroinvertebrates were poor at DEEP4: total abundance and EPT score were below the catchment average, family richness was equal to the catchment average and SIGNAL2 score was above the catchment average.

Management Priorities – DEEP4

- Weed monitoring.
- Weed species control/removal staggered removal of: specifically Camphor Laurel (*Cinnamomum camphora*), Lantana (*Lantana camara*), Small-leaved Privet (*Ligustrum sinense*), Mistflower (*Ageratina riparia*), Fireweed (*Senecio madagascariensis*) and Morning Glory (*Ipomoea indica*).
- Increase vegetation width and continuity with assisted native plantings.
- Increase habitat connectivity by linking up plantings to existing patches of proximal remnant riparian vegetation (e.g. to the east) and by linking up corridors to surrounding stands of significant vegetation (e.g. north, southeast and southwest).
- Riparian fencing and livestock removal.
- Investigate non-point sources of TN and TP.

Estuarine reaches

- Geomorphic condition was moderate at DEEP3: trampling of right bank from human traffic.
- Riparian condition was moderate at DEEP3: mildly disturbed riparian zone with historic clearing, and weeds and noxious weeds throughout midstory and understory.
- Water quality was very poor at DEEP3: persistent high concentrations of TN and NOx, frequent high TP concentrations; frequent low DO%.

- Geomorphic condition was very good at DEEP2: minor trampling from human traffic.
- Riparian condition was excellent at DEEP2: relatively undisturbed riparian zone with minor historic clearing.
- Water quality was very poor at DEEP2: persistent high concentrations of TN, TP and NOx; frequent low DO%.

- Geomorphic condition was moderate at DEEP1: significant trampling from human traffic.
- Riparian condition was good at DEEP1: mildly disturbed riparian zone with weeds and noxious weeds throughout midstory and understory.
- Water quality was poor at DEEP1: persistent high nconcentrations of NOx and SRP, frequent high concentrations of TN and TP.

Management Priorities – DEEP3, DEEP2 and DEEP1

- Weed monitoring.
- Installation of biodiversity information signs.
- Investigate sources of TN to lower lagoon (DEEP1) and TP to upper lagoon (DEEP2).

Management Priorities – DEEP3

- Weed species control/removal of: Camphor Laurel (*Cinnamomum camphora*), Lantana (*Lantana camara*), Castor Oil Plant (*Ricinus communis*), Crofton Weed (*Ageratina adenophora*), Annual Ragweed (*Ambrosia artemisiifolia*), Fireweed (*Senecio madagascariensis*) and Egeria (*Egeria densa*).
- Increase vegetation width and continuity with assisted native plantings.
- Increase habitat connectivity by linking up plantings to existing patches of proximal remnant riparian vegetation (e.g. to the east) and by linking up corridors to surrounding stands of significant vegetation (e.g. south and north).
- Installation of vehicle bollards.

Management Priorities – DEEP2

- Surveillance cameras and signs.
- Installation of vehicle bollards.
- Maintain current management practices.

Management Priorities – DEEP1

- Weed control/removal: specifically Bitou Bush (*Chrysanthemoides monilifera* subsp. *rotundata*), Senna (*Senna pendula* var. *glabrata*), Asparagus Ferns (*Asparagus* spp.) and Coastal Morning Glory (*Ipomoea cairica*).
- Increase vegetation width with assisted native plantings.
- Consider soft bank erosion prevention techniques.

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Appendix 1

Macrophytes = 1, Grasses = 2, Graminoides = 3, Herbs/Forbs = 4, Shrubs = 5, Trees = 6, Vines = 7, SOI = 8

Growth Form	Native/ Exotic	Noxious sp.	Growth Form	Family	Genus	Species	Common Name	NAMB1	NAMB2	NAMB3	NAMB4	NAMB5	NAMB6	NAMB7	NAMB8
Saltmarsh/Mangrove	N		0	*Myrsinaceae*	*Aegiceras*	*corniculatum*	River Mangrove		1	1	1				
Saltmarsh/Mangrove	N		0	*Acanthaceae*	*Avicennia*	*marina subsp. australasica*	Grey Mangrove		1	1	1				
Saltmarsh/Mangrove	N		0	*Cyperaceae*	*Baumea*	*juncea*	Estuarine Twig Rush								
Saltmarsh/Mangrove	N		0	*Apochynaceae*	*Cynanchum*	*carnosum*	Mangrove Vine								
Saltmarsh/Mangrove	N		0	*Euphorbiaceae*	*Excoecaria*	*agallocha*	Milk Mangrove								
Saltmarsh/Mangrove	N		0	*Hydrocharitaceae*	*Halophila*	*ovalis*	Paddle Weed								
Saltmarsh/Mangrove	N		0	*Poaceae*	*Paspalum*	*vaginatum*	Saltwater Couch								
Saltmarsh/Mangrove	N		0	*Chenopodiaceae*	*Sarcocornia*	*quinqueflora*	Samphire			1					
Macroalgae	N		0	*Sargassaceae*	*Sargassum*	sp.	Seaweed	1							
Saltmarsh/Mangrove	N		0	*Poaceae*	*Sporobolus*	*virginicus var. minor or virginicus*	Marine/Sand Couch			1	1				
Saltmarsh/Mangrove	N		0	*Chenopodiaceae*	*Suaeda*	*australis*	Austral Seablite			1					
Saltmarsh/Mangrove	N		0	*Zostereaceae*	*Zostera*	*muelleri* subsp. *capricorni*	Zostera	?		1	?				
Macrophytes	N		1	*Salviniaceae*	*Azolla*	pinata	Duck Weed						1		1
Macrophytes	N		1	*Plantaginaceae*	*Bacopa*	monnieri	Bacopa								
Macrophytes	N		1	*Cyperaceae*	*Baumea*	juncea	Bare Twig-rush								
Macrophytes	N		1	*Cyperaceae*	*Bolboschoenus*	*fluviatilis*	Marsh Club-rush								
Macrophytes	E		1	*Callitrichaceae*	*Callitriche*	*stagnalis*	Common Starwort					1		1	
Macrophytes	N		1	*Cyperaceae*	*Carex*	appressa	Tall Sedge								
Macrophytes	N		1	*Characeae*	*Chara*	*cera*	Stonewort								
Macrophytes	N		1	*Cyperaceae*	*Cladium*	*procerum*	Leafy Twig-rush								
Macrophytes	E		1	*Asteraceae*	*Cotula*	*coronopifolia*	Water Buttons								
Macrophytes	N		1	*Juncaginaceae*	*Cycnogeton*	*sp.*	Water Ribbons								
Macrophytes	E		1	*Hydrocharitaceae*	*Egeria*	*densa*	Egeria								
Macrophytes	E		1	*Elatinaceae*	*Elatine*	*gratioloides*	Waterwort						1		
Macrophytes	N		1	*Elatinaceae*	*Elatine*	*gratioloides*	Waterwort								
Macrophytes	N		1	*Cyperaceae*	*Eleocharis*	*acuta*	Pinrush					1			
Macrophytes	N		1	*Cyperaceae*	*Eleocharis*	*equisetina*	Pinrush								
Macrophytes	N		1	*Cyperaceae*	*Eleocharis*	*sphacelata*	Tall Spikerush								
Macrophytes	N		1	*Cyperaceae*	*Fimbristylis*	*ferruginea*	Rusty Sedge								
Macrophytes	N		1	*Hydrocharitaceae*	*Hydrilla*	*verticillata*	Water Thyme						1		
Macrophytes	N		1	*Apiaceae*	*Hydrocotyle*	*tripartita*	Pennywort								1
Macrophytes	N		1	*Cyperaceae*	*Isolepis*	*sp.*	inundata or subtilissima						1	1	1
Macrophytes	N		1	*Juncaceae*	*Juncus*	*prismatocarpus*	Branching Rush								
Macrophytes	N		1	*Juncaceae*	*Juncus*	*krausii* subsp. *australiensis*	Sea Rush			1	1				
Macrophytes	N		1	*Onagraceae*	*Ludwigia*	*peploides*	Water Primrose						1		1
Macrophytes	E		1	*Haloragaceae*	*Myriophyllum*	*aquaticum*	Parrot's Feather								
Macrophytes	N		1	*Haloragaceae*	*Myriophyllum*	*crispatum*									
Macrophytes	N		1	*Haloragaceae*	*Myriophyllum*	*verrucosum*	Red Water-milfoil								
Macrophytes	N		1	*Haloragaceae*	*Myriophyllum*	*variifolium*	Varied Water-milfoil							1	1
Macrophytes	E		1	*Nymphaeaceae*	*Nymphaea*	*sp.af. alba/mexicana*	Giant Waterlily						1		
Macrophytes	N		1	*Nymphaeaceae*	*Nymphoides*	*indica*	Water Snowflake						1		
Macrophytes	N		1	*Hydrocharitaceae*	*Ottelia*	*ovalifolia*	Swamp Lily								
Macrophytes	N		1	*Poaceae*	*Paspalum*	*distichum*	Water Couch					1	1		1
Macrophytes	N		1	*Philydraceae*	*Philydrum*	*lanuginosum*	Frogsmouth						1		
Macrophytes	N		1	*Poaceae*	*Phragmites*	*australis*	Common Reed					1			
Macrophytes	N		1	*Potamogetonaceae*	*Potomogeton*	*ochreatus*	Blunt Pondweed					1			
Macrophytes	N		1	*Potamogetonaceae*	*Potomogeton*	*octandrus*	Pondweed						1		
Macrophytes	E		1	*Brassicaceae*	*Rorippa*	*nasturtium-aquaticum*	Watercress								
Macrophytes	E		1	*Salviniaceae*	*Salvinia*	*molesta*	Salvinia							1	1
Macrophytes	N		1	*Cyperaceae*	*Schoenoplectiella*	*mucronata*	Triangular Club Rush								
Macrophytes	N		1	*Cyperaceae*	*Schoenoplectus*	*validus*	River Club Rush								
Macrophytes	N		1	*Sparganiaceae*	*Sparganium*	*subglobosum*	Floating Burr-reed								
Macrophytes	N		1	*Juncaginaceae*	*Triglochin*	*striata*	Streaked Arrowgrass								
Macrophytes	N		1	*Typhaceae*	*Typha*	*orientalis*	Broadleaf Cumbungi					1			
Macrophytes	N		1	*Hydrocharitaceae*	*Vallisneria*	*australis*	Ribbonweed								
Macrophytes	N		1	*Hydrocharitaceae*	*Vallisneria*	*nana*	Freshwater Eelgrass					1	1	1	

Macrophytes = 1, Grasses = 2, Graminoides = 3, Herbs/Forbs = 4, Shrubs = 5, Trees = 6, Vines = 7, SOI = 8

Growth Form	Native/ Exotic	Noxious sp.	Growth Form	Family	Genus	Species	Common Name	NAMB1	NAMB2	NAMB3	NAMB4	NAMB5	NAMB6	NAMB7	NAMB8
Grasses	E		2	Poaceae	Andropogon	viginicus	Whisky Grass								1
Grasses	E		2	Poaceae	Bambusa	sp.	Bamboo								
Grasses	E		2	Poaceae	Bromus	catharticus	Prairie Grass				1				1
Grasses	E		2	Poaceae	Chloris	gayana	Rhodes Grass								1
Grasses	N		2	Poaceae	Cynodon	dactylon	Couch	1			1		1	1	1
Grasses	E		2	Poaceae	Digitaria	sp.	Summer Grass						1	1	
Grasses	E		2	Poaceae	Echinochloa	crus-gali	Barnyard Grass								
Grasses	N		2	Poaceae	Echinopogon	ovatus	Forest Hedgehog Grass								
Grasses	N		2	Poaceae	Entolasia	stricta	Wiry Panic		1						
Grasses	E		2	Poaceae	Eragrostis	tenuifolia	Elastic Grass								
Grasses	E		2	Poaceae	Festuca	arundinaceae	Tall Fescue								
Grasses	N		2	Poaceae	Imperata	cylindrica	Blady Grass	1						1	1
Grasses	N		2	Poaceae	Ischaemum	triticeum	Thigh-socket Grass								
Grasses	N		2	Poaceae	Lachnagrostis	filiformis	Blown Grass								
Grasses	E		2	Poaceae	Lolium	rigidum	Wimmera Ryegrass								
Grasses	N		2	Poaceae	Microlaena	stipoides	Rice Grass					1			
Grasses	N		2	Poaceae	Oplismenus	imbecillis	Creeping Beard Grass								
Grasses	N		2	Poaceae	Oplismenus	aemulus	Australian Basket Grass							1	1
Grasses	N		2	Poaceae	Ottochloa	gracillima	Pademelon Grass					1			
Grasses	E		2	Poaceae	Panicum	repens	Torpedo Grass						1		
Grasses	N		2	Poaceae	Panicum	bisulcatum	Black-seeded Panic								
Grasses	N		2	Poaceae	Panicum	effusum	Hairy Panic								1
Grasses	E		2	Poaceae	Paspalum	urvillei	Vasey Grass								
Grasses	E		2	Poaceae	Paspalum	longifolium									
Grasses	E		2	Poaceae	Paspalum	dilatatum	Paspalum							1	1
Grasses	E		2	Poaceae	Paspalum	mandiocanum	Broadleaf Paspalum		1	1	1	1	1	1	1
Grasses	E		2	Poaceae	Pennisetum	clandestinum	Kikuyu							1	
Grasses	E		2	Poaceae	Setaria	palmifolia	Palm Grass								
Grasses	E		2	Poaceae	Setaria	sphacelata	Pigeon Grasses					1	1	1	1
Grasses	N		2	Poaceae	Sporobolus	crebra	Slender Rat's Tail Grass							1	1
Grasses	E		2	Poaceae	Stenotaphrum	secundatum	Buffalo Grass			1		1			
Grasses	E		2	Poaceae	Urochloa	panicoides	Liverseed Grass								
Grasses	N		2	Poaceae	Zoysia	macrantha	Prickly Couch	1							
Graminoides	N		3	Cyperaceae	Carex	fascicularis	Tassel Sedge								
Graminoides	N		3	Cyperaceae	Carex	pumila	Strand Sedge								
Graminoides	N		3	Cyperaceae	Carex	species	Sedge								
Macrophytes	N		3	Amaryllidaceae	Crinum	pedunculatum	Swamp Lily			1					
Graminoides	E		3	Cyperaceae	Cyperus	eragrostis	Umbrella Sedge								1
Graminoides	N		3	Cyperaceae	Cyperus	exaltatus	Tall Flat Sedge								
Graminoides	N		3	Cyperaceae	Cyperus	sp.	Flat Sedge								
Graminoides	N		3	Cyperaceae	Ficinia	nodosa	Knobby club-rush								
Graminoides	N		3	Cyperaceae	Fimbristylis	dichotoma	Common Fringe Sedge			1					
Graminoides	N		3	Cyperaceae	Ghania	siebriana	Red-fruit Saw-sedge								
Graminoides	N		3	Cyperaceae	Ghania	clarkei	Tall Saw-sedge								
Graminoides	N		3	Juncaceae	Juncus	bufonius	Toad Rush			1					
Graminoides	N		3	Juncaceae	Juncus	usitatus	Common Rush								
Graminoides	N		3	Lomandraceae	Lomandra	longifolia	Spiny-headed Mat-rush		1						
Graminoides	N		3	Lomandraceae	Lomandra	hystrix	Soft Lomandra						1	1	1
Herbs/Forbs	N		4	Pteridaceae	Adiantum	sp.	Maidenhair sp.					1			
Herbs/Forbs	E		4	Asteracea	Ageratina	adenophora	Crofton Weed								1
Herbs/Forbs	E		4	Asteracea	Ageratina	riparia	Mistflower								1
Herbs/Forbs	E		4	Asteracea	Ageratum	houstonianum	Blue Billy Goat Weed					1	1	1	1
Herbs/Forbs	N		4	Amaranthaceae	Alternanthera	denticulata	Lesser Joyweed						1		1
Herbs/Forbs	E		4	Amaranthaceae	Amaranthus	spinosus	Needle Burr								
Herbs/Forbs	E		4	Asteraceae	Ambrosia	artemisiifolia	Annual Ragweed								
Herbs/Forbs	E		4	Asteraceae	Anagallis	arvensis	Scarlet Pimpernel								1
Herbs/Forbs	E		4	Papaveraceae	Argemone	ochroleuca/mexicana	Mexican Poppy						1	1	
Herbs/Forbs	N		4	Aspleniaceae	Asplenium	australasicum	Bird's Nest fern		1						
Herbs/Forbs	N		4	Chenopodiaceae	Atriplex	australasica	Grey Saltbush			1					

Macrophytes = 1, Grasses = 2, Graminoides = 3, Herbs/Forbs = 4, Shrubs = 5, Trees = 6, Vines = 7, SOI = 8

Growth Form	Native/ Exotic	Noxious sp.	Growth Form	Family	Genus	Species	Common Name	NAMB1	NAMB2	NAMB3	NAMB4	NAMB5	NAMB6	NAMB7	NAMB8
Herbs/Forbs	E		4	*Asteracea*	*Bidens*	*pilosa/subalternans*	Coblers Pegs						1	1	1
Herbs/Forbs	N		4	*Blechnaceae*	*Blechnum*	*patersonii*	Strap Water Fern								
Herbs/Forbs	N		4	*Blechnaceae*	*Blechnum*	*cartilagineum*	Gristle Fern					1			1
Herbs/Forbs	E		4	*Crassulaceae*	*Bryophyllum*		Mother of Millions	1							
Herbs/Forbs	E		4	*Brassicaceae*	*Cardamine*	*hirsuta*	Common Bittercress							1	
Herbs/Forbs	N		4	*Aizoaceae*	*Carpobrotus*	*glaucescens*	Pigface	1							
Herbs/Forbs	N		4	*Thelypteridaceae*	*Christella*	*dentata*	Binung								
Herbs/Forbs	E		4	*Asteracea*	*Cirsium*	*vulgare*	Spear Thistle								1
Herbs/Forbs	E		4	*Areacea*	*Colocasia*	*esculenta*	Taro								1
Herbs/Forbs	N		4	*Commelinaceae*	*Commelina*	*cyanea*	Scurvy Weed							1	
Herbs/Forbs	E		4	*Asteracea*	*Conyza*	*bonariensis*	Fleabane							1	1
Herbs/Forbs	E		4	*Fabaceae*	*Crotalaria*	*lanceolata*	Narrow-leaved Rattlepod								
Herbs/Forbs	E		4	*Apiaceae*	*Cyclospermum*	*leptophyllum*	Slender Celery						1		
Herbs/Forbs	N		4	*Orchidaceae*	*Dendrobium*	*linguiforme*	Tongue Orchid								
Herbs/Forbs	E		4	*Fabaceae*	*Desmodium*	*uncinatum*	Silver-leaved Desmodium								
Herbs/Forbs	N		4	*Fabaceae*	*Desmodium*	*rhytidophyllum*	Tick-trefoil								
Herbs/Forbs	N		4	*Phormaceae*	*Dianella*	*caerulea*	Blue Flax-lily		1						
Herbs/Forbs	N		4	*Convolvulaceae*	*Dichondra*	*repens*	Kidney Weed								
Herbs/Forbs	N		4	*Asteracea*	*Eclipta*	*prostrata*	False Daisy						1		
Herbs/Forbs	N		4	*Chenopodiaceae*	*Einadia*	*hastata*	Berry Saltbush			1	1				
Herbs/Forbs	N		4	*Urticaceae*	*Elatostema*	*stipitatum*	Rainforest Spinach								
Herbs/Forbs	E		4	*Rubiaceae*	*Galium*	*aparine*	Cleavers						1	1	
Herbs/Forbs	N		4	*Fabaceae*	*Glycine*	*sp.*	Glycine					1			
Herbs/Forbs	E		4	*Acanthaceae*	*Hypoestes*	*phyllostachya*	Polka Dot Plant								
Herbs/Forbs	N		4	*Dennstaedtiaceae*	*Hypolepis*	*muelleri*	Harsh Ground Fern								1
Herbs/Forbs	N		4	*Fabaceae*	*Kennedia*	*rubicunda*	Dusky Coral Pea								1
Herbs/Forbs	N		4	*Lindsaeaceae*	*Lindsaea*	*sp.*	Wedge Fern								
Herbs/Forbs	N		4	*Lobeliaceae*	*Lobelia*	*trigonocaulis*	Forest Lobelia								
Herbs/Forbs	N		4	*Lobeliaceae*	*Lobelia*	*anceps*	Angled Lobelia								
Herbs/Forbs	E		4	*Lamiaceae*	*Mentha*	*x rotundifolia*	Peppermint							1	1
Herbs/Forbs	N		4	*Polypodiaceae*	*Microsorum*	*scandens*	Fragrant Fern								
Herbs/Forbs	E		4	*Caryophylaceae*	*Paronychia*	*brasiliana*	Brazillian Whitlow						1		
Herbs/Forbs	N		4	*Polygonaceae*	*Persicaria*	*orientalis*	Princes Feathers								1
Herbs/Forbs	N		4	*Polygonaceae*	*Persicaria*	*decipiens*	Slender Knotweed						1		
Herbs/Forbs	N		4	*Polygonaceae*	*Persicaria*	*strigosa*	Hairy Knotweed					1	1	1	1
Herbs/Forbs	N		4	*Polygonaceae*	*Persicaria*	*hydropiper*	Knotweed						1	1	1
Herbs/Forbs	E		4	*Phytolaccaceae*	*Phytolacca*	*octandra*	Ink Weed			1			1	1	1
Herbs/Forbs	N		4	*Polypodiaceae*	*Platycerium*	*bifurcatum*	Elkhorn Fern								1
Herbs/Forbs	N		4	*Polypodiaceae*	*Platycerium*	*superbum*	Staghorn					1			1
Herbs/Forbs	N		4	*Araceae*	*Pothos*	*longipes*	Pothos								
Herbs/Forbs	N		4	*Acanthaceae*	*Pseuderanthemum*	*variabile*	Love Flower								
Herbs/Forbs	N		4	*Asteraceae*	*Pseudognaphalium*	*luteoalbum*	Jersey Cudweed								
Herbs/Forbs	N		4	*Dennstaedtiaceae*	*Pteridium*	*esculentum*	Common Bracken						1		1
Herbs/Forbs	N		4	*Polypodiaceae*	*Pyrrosia*	*confluens*	Robber Fern								
Herbs/Forbs	N		4	*Ranunculaceae*	*Ranunculus*	*sp.*	Buttercup species								
Herbs/Forbs	N		4	*Ranunculaceae*	*Ranunculus*	*inundatus*	stream side								
Herbs/Forbs	N		4	*Ranunculaceae*	*Ranunculus*	*plebeius*	Forest Buttercup								
Herbs/Forbs	E		4	*Brassicaceae*	*Rapistrum*	*rugosum*	Turnip Weed								
Herbs/Forbs	E		4	*Polygonaceae*	*Rumex*	*crispus*	Curled Dock								
Herbs/Forbs	N		4	*Polygonaceae*	*Rumex*	*brownii*	Swamp Dock					1			1
Herbs/Forbs	E		4	*Asteracea*	*Senecio*	*madagascariensis*	Fireweed				1	1	1	1	1
Herbs/Forbs	N		4	*Aizoaceae*	*Sesuvium*	*portulacastrum*									
Herbs/Forbs	E		4	*Lamiaceae*	*Sida*	*rhombifolia*	Sidratusa						1		
Herbs/Forbs	E		4	*Solanaceae*	*Solanum*	*americanum*	Glossy Nightshade				1				
Herbs/Forbs	E		4	*Solanaceae*	*Solanum*	*sp.*	Silver nightshade (mauriteanum)								
Herbs/Forbs	N		4	*Aizoaceae*	*Tetragonia*	*tetragonioides*	New Zealand Spinach			1					
Herbs/Forbs	E		4	*Commelinaceae*	*Tradescantia*	*fluminensis*	Wandering Jew					1	1		1
Herbs/Forbs	E		4	*Fabaceae*	*Trifolium*	*repens*	White Clover								
Herbs/Forbs	N		4	*Urticaceae*	*Urtica*	*incisa*	Stinging Nettle							1	
Herbs/Forbs	E		4	*Scrophulariaceae*	*Verbascum*	*virgatum*	Green Mullein								1

Macrophytes = 1, Grasses = 2, Graminoides = 3, Herbs/Forbs = 4, Shrubs = 5, Trees = 6, Vines = 7, SOI = 8

Growth Form	Native/ Exotic	Noxious sp.	Growth Form	Family	Genus	Species	Common Name	NAMB1	NAMB2	NAMB3	NAMB4	NAMB5	NAMB6	NAMB7	NAMB8
Herbs/Forbs	E		4	*Verbenaceae*	*Verbena*	*bonariensis*	Purpletop						1	1	1
Herbs/Forbs	N		4	*Violaceae*	*Viola*	*banksii*	Wild Violet								
Herbs/Forbs	N		4	*Campanulaceae*	*Wahlenbergia*	*spp.*	Bluebell								
Herbs/Forbs	E		4	*Asteraceae*	*Xanthium*	*occidentale*	Noogoora Burr						1		
Shrubs	N		5	*Mimosoideae*	*Acacia*	*floribunda*	White Sally Wattle								
Shrubs	N		5	*Mimosoideae*	*Acacia*	*longifolia subsp. longifolia*	Sydney Golden Wattle					1			
Shrubs	N		5	*Mimosoideae*	*Acacia*	*longifolia subsp. sophorae*	Coastal Wattle	1							
Shrubs	N		5	*Mimosoideae*	*Acacia*	*implexa*	Hickory Wattle						1		1
Shrubs	N		5	*Fabaceae*	*Acacia*	*irrorata*	Green Wattle		1			1	1		
Shrubs	N		5	*Fabaceae*	*Acacia*	*obtusifolia*	Blunt Leaf Wattle								
Shrubs	N		5	*Fabaceae*	*Acacia*	*maidenii*	Maiden's Wattle								
Shrubs	N		5	*Fabaceae*	*Acacia*	*sp.*	Wattle species								
Shrubs	N		5	*Myrtaceae*	*Acmena*	*smithii*	Lilly Pilly								
Shrubs	N		5	*Zingiberaceae*	*Alpinia*	*caerula*	Native Ginger								1
Shrubs	E		5	*Asparagaceae*	*Asparagus*	*spp.*	Asparugus Ferns								
Shrubs	E		5	*Asparagaceae*	*Asparagus*	*macowanii*	Pompom Asparugus		1						
Shrubs	E		5	*Asparagaceae*	*Asparagus*	*aethiopicus*	Ground Asparugus	1	1						
Shrubs	E		5	*Asteracea*	*Baccharis*	*halimifolia*	Groundsel Bush			1					
Shrubs	N		5	*Myrtaceae*	*Backhousia*	*myrtifolia*	Ironwood								
Shrubs	N		5	*Proteacea*	*Banksia*	*integrifolia subsp. intergrifolia*	Coast Banksia	1							
Shrubs	N		5	*Phyllanthaceae*	*Breynia*	*oblongifolia*	Coffee Bush								
Shrubs	E		5	*Solanceae*	*Brugmansia*	*suaveolens*	Angel's Trumpet								
Shrubs	N		5	*Cunoniaceae*	*Callicoma*	*serratifolia*	Black Wattle								
Shrubs	N		5	*Myrtaceae*	*Callistemon*	*salignus*	Willow Bottlebrush								
Shrubs	N		5	*Myrtaceae*	*Callistemon*	*viminalis*	Weeping Bottlebrush								
Shrubs	E		5	*Solanceae*	*Cestrum*	*parqui*	Green Cestrum								1
Shrubs	E		5	*Asteracea*	*Chrysanthemoides*	*monilifera subsp. rotundata*	Bitou Bush	1							
Shrubs	E		5	*Rutaceae*	*Citrus*	*x taitensis*	Rough Lemon								
Shrubs	N		5	*Malvaceae*	*Commersonia*	*fraseri*	Brush Kurrajong						1		
Shrubs	N		5	*Asteliaceae*	*Cordyline*	*petiolaris*	Broad-leaved Palm lily								1
Shrubs	N		5	*Asteliaceae*	*Cordyline*	*stricta*	Narrow-leaved Palm Lily								
Shrubs	N		5	*Euphorbiaceae*	*Croton*	*verreauxii*	Green Native Cascarilla								
Shrubs	N		5	*Sapindaceae*	*Cupaniopsis*	*anacardioides*	Tuckeroo	1	1						
Shrubs	N		5	*Rousseaceae*	*Cuttsia*	*virburnea*	Elderberry								1
Shrubs	N		5	*Cyatheaceae*	*Cyathea*	*australis*	Rough Tree-fern								1
Shrubs	N		5	*Dicksoniaceae*	*Dicksonia*	*antarctica*	Soft Tree Fern								
Shrubs	N		5	*Sapindaceae*	*Dodonaea*	*triquetra*	Large-leaf Hop-bush								
Shrubs	N		5	*Moraceae*	*Ficus*	*coronata*	Sandpaper Fig					1		1	1
Shrubs	N		5	*Phyllanthaceae*	*Glochidion*	*fernandi*	Cheese Tree		1		1	1			1
Shrubs	N		5	*Sapindaceae*	*Guioa*	*semiglauca*	Guioa						1		
Shrubs	N		5	*Malvaceae*	*Hibiscus*	*heterophyllus*	Native Rosella								
Shrubs	N		5	*Euphorbiaceae*	*Homalanthus*	*populifolius*	Bleeding Heart								1
Shrubs	N		5	*Pittosporaceae*	*Hymenosporum*	*flavum*	Native Frangipani								1
Shrubs	E		5	*Verbenaceae*	*Lantana*	*camara*	Lantana	1	1	1		1	1	1	1
Shrubs	N		5	*Myrtaceae*	*Leptospermum*	*laevigatum*	Coast Teatree	1							
Shrubs	N		5	*Myrtaceae*	*Leptospermum*	*brachyandrum*	Silver Weeping Teatree						1	1	
Shrubs	E		5	*Oleaceae*	*Ligustrum*	*lucidum*	Broad-leaf Privet							1	
Shrubs	E		5	*Oleaceae*	*Ligustrum*	*sinense*	Small-leaved Privet					1	1		
Shrubs	N		5	*Arecaceae*	*Linospadix*	*monostachyos*	Walking Stick Plam								
Shrubs	N		5	*Arecaceae*	*Livistona*	*australis*	Cabbage Tree Palm	1							
Shrubs	N		5	*Myrtaceae*	*Melaleuca*	*styphelioides*	Prickly-leaved Teatree								
Shrubs	N		5	*Ericaceae*	*Monotoca*	*elliptica*	Tree-broom Heath	1							
Shrubs	N		5	*Lauraceae*	*Neolitsea*	*australiensis*	Green Bolly Gum				1				
Shrubs	N		5	*Oleaceae*	*Notelaea*	*longifolia*	Large mock olive		1						
Shrubs	E		5	*Ochnaceae*	*Ochna*	*serrulata*	Mickey-mouse Plant					1	1		
Shrubs	N		5	*Asteracea*	*Ozothamnus*	*diosmifolius*	White Dogwood		1						
Shrubs	N		5	*Myrtaceae*	*Persoonia*	*stradbrokensis or levis*	Geebung hybrid								
Shrubs	N		5	*Pittosporaceae*	*Pittosporum*	*multiflorum*	Orange Thorn								
Shrubs	N		5	*Pittosporaceae*	*Pittosporum*	*undulatum*	Sweet Pittosporum	1	1						
Shrubs	N		5	*Polypodiaceae*	*Platycerium*	*bifurcatum*	Elkhorn Fern								

Macrophytes = 1, Grasses = 2, Graminoides = 3, Herbs/Forbs = 4, Shrubs = 5, Trees = 6, Vines = 7, SOI = 8

Growth Form	Native/ Exotic	Noxious sp.	Growth Form	Family	Genus	Species	Common Name	NAMB1	NAMB2	NAMB3	NAMB4	NAMB5	NAMB6	NAMB7	NAMB8
Shrubs	N		5	*Fabaceae*	*Pultenaea*	*retusa*	Notched Bush-pea								1
Shrubs	E		5	*Euphorbiaceae*	*Ricinus*	*communis*	Castor Oil Plant					1			
Shrubs	E		5	*Rosaceae*	*Rosa*	*rubiginosa*	Sweet Briar								
Shrubs	E		5	*Anacardiaceae*	*Schinus*	*terebinthifolius*	Brazilian Pepper Tree	1							
Shrubs	E		5	*Caesalpinioideae*	*Senna*	*pendula var. glabrata*	Senna	1	1						1
Shrubs	E		5	*Caesalpinioideae*	*Senna*	*septemtrionalis*	Arsenic Bush								
Shrubs	E		5	*Solanaceae*	*Solanum*	*mauritianum*	Wild Tobacco					1	1	1	1
Shrubs	N		5	*Myrtaceae*	*Syzygium*	*australe*	Brush Cherry	1						1	
Shrubs	N		5	*Winteraceae*	*Tasmannia*	*insipida*	Brush Pepperbush								
Trees	N		6	*Rutaceae*	*Acronychia*	*pubescens*	Hairy Acronychia								
Trees	N		6	*Ulmaceae*	*Aphananthe*	*philippinensis*	Rough-leaved Elm								
Trees	N		6	*Araucariaceae*	*Araucaria*	*cunninghamii*	Hoop Pine								
Trees	N		6	*Arecaceae*	*Archontophoenix*	*cunninghamiana*	Bangalow Palm								1
Trees	N		6	*Casuarinaceae*	*Casuarina*	*glauca*	Swamp Oak	1	1	1		1			
Trees	N		6	*Casuarinaceae*	*Casuarina*	*cunninghamiana subsp. cunninghamiana*	River Oak						1	1	1
Trees	N		6	*Cunoniaceae*	*Cerratopetalum*	*apetalum*	Coachwood								
Trees	E		6	*Lauraceae*	*Cinnamomum*	*camphora*	Camphor Laurel	1	1			1	1	1	
Trees	N		6	*Lauraceae*	*Cryptocarya*	*meisneriana*	Thick-leaved Laurel								
Trees	N		6	*Lauraceae*	*Cryptocarya*	*triplinervis*	Three-veined Cryptocarya								
Trees	N		6	*Elaeocarpaceae*	*Elaeocarpus*	*obovatus*	Hard Quandong								
Trees	N		6	*Lauraceae*	*Endiandra*	*discolor*	Rose Wallnut								
Trees	E		6	*Fabaceae*	*Erythrina*	*crista-galli*	Cockspur Coral tree							1	
Trees	N		6	*Myrtaceae*	*Eucalyptus*	*microcorys*	Tallowwood								
Trees	N		6	*Myrtaceae*	*Eucalyptus*	*pilularis*	Blackbutt								
Trees	N		6	*Myrtaceae*	*Eucalyptus*	*tereticornis*	Forest Red Gum		1					1	
Trees	N		6	*Myrtaceae*	*Eucalyptus*	*grandis*	Flooded Gum				1		1	1	1
Trees	N		6	*Moraceae*	*Ficus*	*macrophylla*	Morton Bay Fig	1							
Trees	N		6	*Moraceae*	*Ficus*	*watkinsiana*	Strangler Fig	1			1				
Trees	N		6	*Moraceae*	*Ficus*	*sp.*	Strangler Fig species								
Trees	N		6	*Proteacea*	*Grevillea*	*robusta*	Silky Oak					1			
Trees	N		6	*Sapindaceae*	*Jagera*	*pseudorhus*	Foam Bark Tree		1			1			
Trees	N		6	*Myrtaceae*	*Lophostemon*	*confertus*	Brush Box					1			1
Trees	N		6	*Myrtaceae*	*Melaleuca*	*quinquenervia*	Broad-leaved Paperbark				1				
Trees	N		6	*Meliaceae*	*Melia*	*azedarach*	White Cedar						1		1
Trees	E		6	*Moraceae*	*Morus*	*alba*	White Mulberry								
Trees	N		6	*Proteacea*	*Orites*	*excelsus*	Mountain Silky Oak								
Trees	N		6	*Paracryphiaceae*	*Quintinia*	*verdonii*	Grey Possumwood								
Trees	E		6	*Salicaceae*	*Salix*	*sp.*	Willow						1		
Trees	N		6	*Cunoniaceae*	*Schizomeria*	*ovata*	Crabapple								
Trees	N		6	*Elaeocarpaceae*	*Sloanea*	*australis*	Maiden's Blush								
Trees	N		6	*Elaeocarpaceae*	*Sloanea*	*woollsii*	Yellow Carabeen								
Trees	N		6	*Moraceae*	*Streblus*	*brunonianus*	Whalebone Tree								
Trees	N		6	*Myrtaceae*	*Syncarpia*	*glomulifera*	Turpentine								
Trees	N		6	*Meliaceae*	*Toona*	*australis*	Red Cedar								
Trees	N		6	*Myrtaceae*	*Tristaniopsis*	*laurina*	Watergum						1		
Trees	N		6	*Myrtaceae*	*Waterhousea*	*floribunda*	Weeping Lilly Pilly								

Macrophytes = 1, Grasses = 2, Graminoides = 3, Herbs/Forbs = 4, Shrubs = 5, Trees = 6, Vines = 7, SOI = 8

Growth Form	Native/ Exotic	Noxious sp.	Growth Form	Family	Genus	Species	Common Name	NAMB1	NAMB2	NAMB3	NAMB4	NAMB5	NAMB6	NAMB7	NAMB8
Vines	N		7	*Pittosporaceae*	*Billardiera*	*scandens*	Hairy Apple Berry								
Vines	N		7	*Convolvulaceae*	*Calystegia*	*marginata*	Arrow Vine								
Vines	E		7	*Sapindaceae*	*Cardiospermum*	*grandiflorum*	Balloon Vine					1			
Vines	N		7	*Lauraceae*	*Cassytha*	*filiformis*	Dodder Laurel								
Vines	N		7	*Celastraceae*	*Celastrus*	*subspicatus*	Large-leaved Staff Vine								
Vines	N		7	*Vitaceae*	*Cissus*	*hypoglauca*	Water Vine								1
Vines	N		7	*Vitaceae*	*Cissus*	*antarctica*	Kangaroo Vine								1
Vines	?		7	*Convolvulaceae*	*Cuscuta*	*sp.*	Dodder								
Vines	N		7	*Apocynaceae*	*Cynanchum*	*carnosum*	Mangrove Vine								
Vines	N		7	*Luzuriageae*	*Eustrephus*	*latifolius*	Wombat Berry								
Vines	N		7	*Flagellariaceae*	*Flagellaria*	*indica*	Whip Vine								
Vines	E		7	*Colchiaceae*	*Gloriosa*	*superba*	Glory Lily								
Vines	E		7	*Araliaceae*	*Hedera*	*helix*	English Ivy								
Vines	N		7	*Dilleniaceae*	*Hibbertia*	*scandens*	Climbing Guinea Fower	1							
Vines	E		7	*Convolvulaceae*	*Ipomoea*	*indica*	Morning Glory						1		
Vines	E		7	*Convolvulaceae*	*Ipomoea*	*cairica*	Coastal Morning Glory	1	1	1					
Vines	N		7	*Menispermaceae*	*Legnephora*	*moorei*	Round-leaf Vine								
Vines	E		7	*Caprifoloaceae*	*Lonicera*	*japonica*	Japanese Honeysuckle						1		
Vines	N		7	*Moraceae*	*Maclura*	*cochinchinensis*	Cockspur Thorn			1		1		1	
Vines	N		7	*Apocynaceae*	*Parsonsia*	*straminea*	Silkpod				1	1			
Vines	E		7	*Passifloraceae*	*Passiflora*	*sp.*	Common passionfruit								1
Vines	N		7	*Ripogonaceae*	*Ripogonum*	*discolor*	Prickly Supplejack								
Vines	E		7	*Rosaceae*	*Rosa*	*sp.*	Rose cultivar								
Vines	N		7	*Rosaceae*	*Rubus*	*rosifolius*	Native Raspberry							1	1
Vines	N		7	*Smilaceae*	*Smilax*	*glyciphylla*	Sweet Sarsaparilla								
Vines	N		7	*Smilaceae*	*Smilax*	*australis*	Lawyer Vine	1	1						
Vines	N		7	*Menispermaceae*	*Stephania*	*japonica*	Snake Vine	1							

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Growth Form	Native/ Exotic	Noxious sp.	Growth Form	Family	Genus	Species	Common Name	SOUC1	SOUC2	SOUC3	BUCC1	BUCC2	MISC1	NEWC1
Saltmarsh/Mangrove	N		0	*Myrsinaceae*	*Aegiceras*	*corniculatum*	River Mangrove							1
Saltmarsh/Mangrove	N		0	*Acanthaceae*	*Avicennia*	*marina subsp. australasica*	Grey Mangrove							1
Saltmarsh/Mangrove	N		0	*Cyperaceae*	*Baumea*	*juncea*	Estuarine Twig Rush							
Saltmarsh/Mangrove	N		0	*Apochynaceae*	*Cynanchum*	*carnosum*	Mangrove Vine							
Saltmarsh/Mangrove	N		0	*Euphorbiaceae*	*Excoecaria*	*agallocha*	Milk Mangrove							
Saltmarsh/Mangrove	N		0	*Hydrocharitaceae*	*Halophila*	*ovalis*	Paddle Weed							
Saltmarsh/Mangrove	N		0	*Poaceae*	*Paspalum*	*vaginatum*	Saltwater Couch							
Saltmarsh/Mangrove	N		0	*Chenopodiaceae*	*Sarcocornia*	*quinqueflora*	Samphire							1
Macroalgae	N		0	*Sargassaceae*	*Sargassum*	sp.	Seaweed							
Saltmarsh/Mangrove	N		0	*Poaceae*	*Sporobolus*	*virginicus var. minor or virginicus*	Marine/Sand Couch							1
Saltmarsh/Mangrove	N		0	*Chenopodiaceae*	*Suaeda*	*australis*	Austral Seablite							
Saltmarsh/Mangrove	N		0	*Zostereaceae*	*Zostera*	*muelleri* subsp. *capricorni*	Zostera							?
Macrophytes	N		1	*Salviniaceae*	*Azolla*	pinata	Duck Weed	1	1		1	1		
Macrophytes	N		1	*Plantaginaceae*	*Bacopa*	monnieri	Bacopa							
Macrophytes	N		1	*Cyperaceae*	*Baumea*	juncea	Bare Twig-rush							
Macrophytes	N		1	*Cyperaceae*	*Bolboschoenus*	*fluviatilis*	Marsh Club-rush							
Macrophytes	E		1	*Callitrichaceae*	*Callitriche*	*stagnalis*	Common Starwort	1			1	1		
Macrophytes	N		1	*Cyperaceae*	*Carex*	appressa	Tall Sedge							
Macrophytes	N		1	*Characeae*	*Chara*	*cera*	Stonewort						1	
Macrophytes	N		1	*Cyperaceae*	*Cladium*	*procerum*	Leafy Twig-rush							
Macrophytes	E		1	*Asteraceae*	*Cotula*	*coronopifolia*	Water Buttons							
Macrophytes	N		1	*Juncaginaceae*	*Cycnogeton*	*sp.*	Water Ribbons			1				
Macrophytes	E		1	*Hydrocharitaceae*	*Egeria*	*densa*	Egeria							
Macrophytes	E		1	*Elatinaceae*	*Elatine*	*gratioloides*	Waterwort							
Macrophytes	N		1	*Elatinaceae*	*Elatine*	*gratioloides*	Waterwort							
Macrophytes	N		1	*Cyperaceae*	*Eleocharis*	*acuta*	Pinrush							
Macrophytes	N		1	*Cyperaceae*	*Eleocharis*	*equisetina*	Pinrush							
Macrophytes	N		1	*Cyperaceae*	*Eleocharis*	*sphacelata*	Tall Spikerush							
Macrophytes	N		1	*Cyperaceae*	*Fimbristylis*	*ferruginea*	Rusty Sedge							
Macrophytes	N		1	*Hydrocharitaceae*	*Hydrilla*	*verticillata*	Water Thyme							
Macrophytes	N		1	*Apiaceae*	*Hydrocotyle*	*tripartita*	Pennywort					1	1	
Macrophytes	N		1	*Cyperaceae*	*Isolepis*	*sp.*	inundata or subtilissima			1		1	1	
Macrophytes	N		1	*Juncaceae*	*Juncus*	*prismatocarpus*	Branching Rush						1	
Macrophytes	N		1	*Juncaceae*	*Juncus*	*krausii* subsp. *australiensis*	Sea Rush							1
Macrophytes	N		1	*Onagraceae*	*Ludwigia*	*peploides*	Water Primrose		1		1	1	1	
Macrophytes	E		1	*Haloragaceae*	*Myriophyllum*	*aquaticum*	Parrot's Feather							
Macrophytes	N		1	*Haloragaceae*	*Myriophyllum*	*crispatum*								
Macrophytes	N		1	*Haloragaceae*	*Myriophyllum*	*verrucosum*	Red Water-milfoil						1	
Macrophytes	N		1	*Haloragaceae*	*Myriophyllum*	*variifolium*	Varied Water-milfoil							
Macrophytes	E		1	*Nymphaeaceae*	*Nymphaea*	*sp.af. alba/mexicana*	Giant Waterlily		1		1			
Macrophytes	N		1	*Nymphaeaceae*	*Nymphoides*	*indica*	Water Snowflake		1					
Macrophytes	N		1	*Hydrocharitaceae*	*Ottelia*	*ovalifolia*	Swamp Lily	1			1	1	1	
Macrophytes	N		1	*Poaceae*	*Paspalum*	*distichum*	Water Couch					1		
Macrophytes	N		1	*Philydraceae*	*Philydrum*	*lanuginosum*	Frogsmouth		1					
Macrophytes	N		1	*Poaceae*	*Phragmites*	*australis*	Common Reed							1
Macrophytes	N		1	*Potamogetonaceae*	*Potomogeton*	*ochreatus*	Blunt Pondweed	1						
Macrophytes	N		1	*Potamogetonaceae*	*Potomogeton*	*octandrus*	Pondweed		1	1	1	1		
Macrophytes	E		1	*Brassicaceae*	*Rorippa*	*nasturtium-aquaticum*	Watercress					1		
Macrophytes	E		1	*Salviniaceae*	*Salvinia*	*molesta*	Salvinia	1						
Macrophytes	N		1	*Cyperaceae*	*Schoenoplectiella*	*mucronata*	Triangular Club Rush		1			1	1	
Macrophytes	N		1	*Cyperaceae*	*Schoenoplectus*	*validus*	River Club Rush					1		
Macrophytes	N		1	*Sparganiaceae*	*Sparganium*	*subglobosum*	Floating Burr-reed							
Macrophytes	N		1	*Juncaginaceae*	*Triglochin*	*striata*	Streaked Arrowgrass							
Macrophytes	N		1	*Typhaceae*	*Typha*	*orientalis*	Broadleaf Cumbungi							
Macrophytes	N		1	*Hydrocharitaceae*	*Vallisneria*	*australis*	Ribbonweed							
Macrophytes	N		1	*Hydrocharitaceae*	*Vallisneria*	*nana*	Freshwater Eelgrass			1				

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Growth Form	Native/ Exotic	Noxious sp.	Growth Form	Family	Genus	Species	Common Name	SOUC1	SOUC2	SOUC3	BUCC1	BUCC2	MISC1	NEWC1
Grasses	E		2	*Poaceae*	*Andropogon*	*viginicus*	Whisky Grass					1		
Grasses	E		2	*Poaceae*	*Bambusa*	*sp.*	Bamboo	1						
Grasses	E		2	*Poaceae*	*Bromus*	*catharticus*	Prairie Grass	1	1		1			
Grasses	E		2	*Poaceae*	*Chloris*	*gayana*	Rhodes Grass	1			1			
Grasses	N		2	*Poaceae*	*Cynodon*	*dactylon*	Couch	1	1	1	1			
Grasses	E		2	*Poaceae*	*Digitaria*	*sp.*	Summer Grass				1		1	
Grasses	E		2	*Poaceae*	*Echinochloa*	*crus-gali*	Barnyard Grass					1		
Grasses	N		2	*Poaceae*	*Echinopogon*	*ovatus*	Forest Hedgehog Grass							
Grasses	N		2	*Poaceae*	*Entolasia*	*stricta*	Wiry Panic							
Grasses	E		2	*Poaceae*	*Eragrostis*	*tenuifolia*	Elastic Grass				1			
Grasses	E		2	*Poaceae*	*Festuca*	*arundinaceae*	Tall Fescue							
Grasses	N		2	*Poaceae*	*Imperata*	*cylindrica*	Blady Grass		1					
Grasses	N		2	*Poaceae*	*Ischaemum*	*triticeum*	Thigh-socket Grass							
Grasses	N		2	*Poaceae*	*Lachnagrostis*	*filiformis*	Blown Grass		1					
Grasses	E		2	*Poaceae*	*Lolium*	*rigidum*	Wimmera Ryegrass		1					
Grasses	N		2	*Poaceae*	*Microlaena*	*stipoides*	Rice Grass	1	1	1			1	
Grasses	N		2	*Poaceae*	*Oplismenus*	*imbecillis*	Creeping Beard Grass							
Grasses	N		2	*Poaceae*	*Oplismenus*	*aemulus*	Australian Basket Grass						1	
Grasses	N		2	*Poaceae*	*Ottochloa*	*gracillima*	Pademelon Grass			1				
Grasses	E		2	*Poaceae*	*Panicum*	*repens*	Torpedo Grass							
Grasses	N		2	*Poaceae*	*Panicum*	*bisulcatum*	Black-seeded Panic							
Grasses	N		2	*Poaceae*	*Panicum*	*effusum*	Hairy Panic							
Grasses	E		2	*Poaceae*	*Paspalum*	*urvillei*	Vasey Grass							
Grasses	E		2	*Poaceae*	*Paspalum*	*longifolium*			1		1			
Grasses	E		2	*Poaceae*	*Paspalum*	*dilatatum*	Paspalum	1	1	1	1		1	
Grasses	E		2	*Poaceae*	*Paspalum*	*mandiocanum*	Broadleaf Paspalum	1		1			1	
Grasses	E		2	*Poaceae*	*Pennisetum*	*clandestinum*	Kikuyu							
Grasses	E		2	*Poaceae*	*Setaria*	*palmifolia*	Palm Grass							
Grasses	E		2	*Poaceae*	*Setaria*	*sphacelata*	Pigeon Grasses	1	1			1	1	
Grasses	N		2	*Poaceae*	*Sporobolus*	*crebra*	Slender Rat's Tail Grass	1			1	1		
Grasses	E		2	*Poaceae*	*Stenotaphrum*	*secundatum*	Buffalo Grass							
Grasses	E		2	*Poaceae*	*Urochloa*	*panicoides*	Liverseed Grass							
Grasses	N		2	*Poaceae*	*Zoysia*	*macrantha*	Prickly Couch							
Graminoides	N		3	*Cyperaceae*	*Carex*	*fascicularis*	Tassel Sedge							
Graminoides	N		3	*Cyperaceae*	*Carex*	*pumila*	Strand Sedge							
Graminoides	N		3	*Cyperaceae*	*Carex*	*species*	Sedge							
Macrophytes	N		3	*Amaryllidaceae*	*Crinum*	*pedunculatum*	Swamp Lily							
Graminoides	E		3	*Cyperaceae*	*Cyperus*	*eragrostis*	Umbrella Sedge				1	1		
Graminoides	N		3	*Cyperaceae*	*Cyperus*	*exaltatus*	Tall Flat Sedge							
Graminoides	N		3	*Cyperaceae*	*Cyperus*	*sp.*	Flat Sedge						1	
Graminoides	N		3	*Cyperaceae*	*Ficinia*	*nodosa*	Knobby club-rush							
Graminoides	N		3	*Cyperaceae*	*Fimbristylis*	*dichotoma*	Common Fringe Sedge							
Graminoides	N		3	*Cyperaceae*	*Ghania*	*siebriana*	Red-fruit Saw-sedge							
Graminoides	N		3	*Cyperaceae*	*Ghania*	*clarkei*	Tall Saw-sedge							
Graminoides	N		3	*Juncaceae*	*Juncus*	*bufonius*	Toad Rush							
Graminoides	N		3	*Juncaceae*	*Juncus*	*usitatus*	Common Rush	1	1	1	1	1	1	
Graminoides	N		3	*Lomandraceae*	*Lomandra*	*longifolia*	Spiny-headed Mat-rush							
Graminoides	N		3	*Lomandraceae*	*Lomandra*	*hystrix*	Soft Lomandra	1	1	1	1	1	1	
Herbs/Forbs	N		4	*Pteridaceae*	*Adiantum*	*sp.*	Maidenhair sp.	1						
Herbs/Forbs	E		4	*Asteracea*	*Ageratina*	*adenophora*	Crofton Weed		1	1		1		
Herbs/Forbs	E		4	*Asteracea*	*Ageratina*	*riparia*	Mistflower	1	1	1	1			
Herbs/Forbs	E		4	*Asteracea*	*Ageratum*	*houstonianum*	Blue Billy Goat Weed	1	1	1	1	1	1	
Herbs/Forbs	N		4	*Amaranthaceae*	*Alternanthera*	*denticulata*	Lesser Joyweed				1			
Herbs/Forbs	E		4	*Amaranthaceae*	*Amaranthus*	*spinosus*	Needle Burr				1			
Herbs/Forbs	E		4	*Asteraceae*	*Ambrosia*	*artemisiifolia*	Annual Ragweed			1				
Herbs/Forbs	E		4	*Asteraceae*	*Anagallis*	*arvensis*	Scarlet Pimpernel					1	1	
Herbs/Forbs	E		4	*Papaveraceae*	*Argemone*	*ochroleuca/mexicana*	Mexican Poppy							
Herbs/Forbs	N		4	*Aspleniaceae*	*Asplenium*	*australasicum*	Bird's Nest fern							
Herbs/Forbs	N		4	*Chenopodiaceae*	*Atriplex*	*australasica*	Grey Saltbush							

Macrophytes = 1, Grasses = 2, Graminoides = 3, Herbs/Forbs = 4, Shrubs = 5, Trees = 6, Vines = 7, SOI = 8

Growth Form	Native/ Exotic	Noxious sp.	Growth Form	Family	Genus	Species	Common Name	SOUC1	SOUC2	SOUC3	BUCC1	BUCC2	MISC1	NEWC1
Herbs/Forbs	E		4	*Asteracea*	*Bidens*	*pilosa/subalternans*	Coblers Pegs	1	1	1		1	1	
Herbs/Forbs	N		4	*Blechnaceae*	*Blechnum*	*patersonii*	Strap Water Fern							
Herbs/Forbs	N		4	*Blechnaceae*	*Blechnum*	*cartilagineum*	Gristle Fern			1				
Herbs/Forbs	E		4	*Crassulaceae*	*Bryophyllum*		Mother of Millions							
Herbs/Forbs	E		4	*Brassicaceae*	*Cardamine*	*hirsuta*	Common Bittercress							
Herbs/Forbs	N		4	*Aizoaceae*	*Carpobrotus*	*glaucescens*	Pigface							
Herbs/Forbs	N		4	*Thelypteridaceae*	*Christella*	*dentata*	Binung					1		
Herbs/Forbs	E		4	*Asteracea*	*Cirsium*	*vulgare*	Spear Thistle			1	1	1	1	
Herbs/Forbs	E		4	*Areacea*	*Colocasia*	*esculenta*	Taro					1		
Herbs/Forbs	N		4	*Commelinaceae*	*Commelina*	*cyanea*	Scurvy Weed				1	1	1	
Herbs/Forbs	E		4	*Asteracea*	*Conyza*	*bonariensis*	Fleabane	1	1	1	1		1	
Herbs/Forbs	E		4	*Fabaceae*	*Crotalaria*	*lanceolata*	Narrow-leaved Rattlepod		1					
Herbs/Forbs	E		4	*Apiaceae*	*Cyclospermum*	*leptophyllum*	Slender Celery	1						
Herbs/Forbs	N		4	*Orchidaceae*	*Dendrobium*	*linguiforme*	Tongue Orchid							
Herbs/Forbs	E		4	*Fabaceae*	*Desmodium*	*uncinatum*	Silver-leaved Desmodium	1				1	1	
Herbs/Forbs	N		4	*Fabaceae*	*Desmodium*	*rhytidophyllum*	Tick-trefoil							
Herbs/Forbs	N		4	*Phormaceae*	*Dianella*	*caerulea*	Blue Flax-lily							
Herbs/Forbs	N		4	*Convolvulaceae*	*Dichondra*	*repens*	Kidney Weed							
Herbs/Forbs	N		4	*Asteracea*	*Eclipta*	*prostrata*	False Daisy							
Herbs/Forbs	N		4	*Chenopodiaceae*	*Einadia*	*hastata*	Berry Saltbush							
Herbs/Forbs	N		4	*Urticaceae*	*Elatostema*	*stipitatum*	Rainforest Spinach							
Herbs/Forbs	E		4	*Rubiaceae*	*Galium*	*aparine*	Cleavers							
Herbs/Forbs	N		4	*Fabaceae*	*Glycine*	*sp.*	Glycine							
Herbs/Forbs	E		4	*Acanthaceae*	*Hypoestes*	*phyllostachya*	Polka Dot Plant			1				
Herbs/Forbs	N		4	*Dennstaedtiaceae*	*Hypolepis*	*muelleri*	Harsh Ground Fern				1			
Herbs/Forbs	N		4	*Fabaceae*	*Kennedia*	*rubicunda*	Dusky Coral Pea					1		
Herbs/Forbs	N		4	*Lindsaeaceae*	*Lindsaea*	*sp.*	Wedge Fern							
Herbs/Forbs	N		4	*Lobeliaceae*	*Lobelia*	*trigonocaulis*	Forest Lobelia							
Herbs/Forbs	N		4	*Lobeliaceae*	*Lobelia*	*anceps*	Angled Lobelia							
Herbs/Forbs	E		4	*Lamiaceae*	*Mentha*	*x rotundifolia*	Peppermint				1	1		
Herbs/Forbs	N		4	*Polypodiaceae*	*Microsorum*	*scandens*	Fragrant Fern							
Herbs/Forbs	E		4	*Caryophylaceae*	*Paronychia*	*brasiliana*	Brazillian Whitlow	1					1	
Herbs/Forbs	N		4	*Polygonaceae*	*Persicaria*	*orientalis*	Princes Feathers				1			
Herbs/Forbs	N		4	*Polygonaceae*	*Persicaria*	*decipiens*	Slender Knotweed						1	
Herbs/Forbs	N		4	*Polygonaceae*	*Persicaria*	*strigosa*	Hairy Knotweed		1		1	1	1	
Herbs/Forbs	N		4	*Polygonaceae*	*Persicaria*	*hydropiper*	Knotweed	1	1	1	1	1	1	
Herbs/Forbs	E		4	*Phytolaccaceae*	*Phytolacca*	*octandra*	Ink Weed		1			1	1	
Herbs/Forbs	N		4	*Polypodiaceae*	*Platycerium*	*bifurcatum*	Elkhorn Fern			1				
Herbs/Forbs	N		4	*Polypodiaceae*	*Platycerium*	*superbum*	Staghorn			1	1			
Herbs/Forbs	N		4	*Araceae*	*Pothos*	*longipes*	Pothos							
Herbs/Forbs	N		4	*Acanthaceae*	*Pseuderanthemum*	*variabile*	Love Flower							
Herbs/Forbs	N		4	*Asteraceae*	*Pseudognaphalium*	*luteoalbum*	Jersey Cudweed	1						
Herbs/Forbs	N		4	*Dennstaedtiaceae*	*Pteridium*	*esculentum*	Common Bracken	1	1	1			1	
Herbs/Forbs	N		4	*Polypodiaceae*	*Pyrrosia*	*confluens*	Robber Fern				1			
Herbs/Forbs	N		4	*Ranunculaceae*	*Ranunculus*	*sp.*	Buttercup species							
Herbs/Forbs	N		4	*Ranunculaceae*	*Ranunculus*	*inundatus*	stream side					1		
Herbs/Forbs	N		4	*Ranunculaceae*	*Ranunculus*	*plebeius*	Forest Buttercup		1					
Herbs/Forbs	E		4	*Brassicaceae*	*Rapistrum*	*rugosum*	Turnip Weed				1			
Herbs/Forbs	E		4	*Polygonaceae*	*Rumex*	*crispus*	Curled Dock	1						
Herbs/Forbs	N		4	*Polygonaceae*	*Rumex*	*brownii*	Swamp Dock			1	1	1		
Herbs/Forbs	E		4	*Asteracea*	*Senecio*	*madagascariensis*	Fireweed		1	1	1		1	
Herbs/Forbs	N		4	*Aizoaceae*	*Sesuvium*	*portulacastrum*								
Herbs/Forbs	E		4	*Lamiaceae*	*Sida*	*rhombifolia*	Sidratusa	1		1	1		1	
Herbs/Forbs	E		4	*Solanaceae*	*Solanum*	*americanum*	Glossy Nightshade							
Herbs/Forbs	E		4	*Solanaceae*	*Solanum*	*sp.*	Silver nightshade (mauriteanum)							
Herbs/Forbs	N		4	*Aizoaceae*	*Tetragonia*	*tetragonioides*	New Zealand Spinach							
Herbs/Forbs	E		4	*Commelinaceae*	*Tradescantia*	*fluminensis*	Wandering Jew	1		1	1			
Herbs/Forbs	E		4	*Fabaceae*	*Trifolium*	*repens*	White Clover					1		
Herbs/Forbs	N		4	*Urticaceae*	*Urtica*	*incisa*	Stinging Nettle					1		
Herbs/Forbs	E		4	*Scrophulariaceae*	*Verbascum*	*virgatum*	Green Mullein			1				

Macrophytes = 1, Grasses = 2, Graminoides = 3, Herbs/Forbs = 4, Shrubs = 5, Trees = 6, Vines = 7, SOI = 8

Growth Form	Native/ Exotic	Noxious sp.	Growth Form	Family	Genus	Species	Common Name	SOUC1	SOUC2	SOUC3	BUCC1	BUCC2	MISC1	NEWC1
Herbs/Forbs	E		4	*Verbenaceae*	*Verbena*	*bonariensis*	Purpletop		1	1	1	1	1	
Herbs/Forbs	N		4	*Violaceae*	*Viola*	*banksii*	Wild Violet							
Herbs/Forbs	N		4	*Campanulaceae*	*Wahlenbergia*	*spp.*	Bluebell						1	
Herbs/Forbs	E		4	*Asteraceae*	*Xanthium*	*occidentale*	Noogoora Burr	1			1			
Shrubs	N		5	*Mimosoideae*	*Acacia*	*floribunda*	White Sally Wattle							
Shrubs	N		5	*Mimosoideae*	*Acacia*	*longifolia subsp. longifolia*	Sydney Golden Wattle							
Shrubs	N		5	*Mimosoideae*	*Acacia*	*longifolia subsp. sophorae*	Coastal Wattle							
Shrubs	N		5	*Mimosoideae*	*Acacia*	*implexa*	Hickory Wattle	1	1				1	
Shrubs	N		5	*Fabaceae*	*Acacia*	*irrorata*	Green Wattle						1	
Shrubs	N		5	*Fabaceae*	*Acacia*	*obtusifolia*	Blunt Leaf Wattle							
Shrubs	N		5	*Fabaceae*	*Acacia*	*maidenii*	Maiden's Wattle			1		1		
Shrubs	N		5	*Fabaceae*	*Acacia*	*sp.*	Wattle species							
Shrubs	N		5	*Myrtaceae*	*Acmena*	*smithii*	Lilly Pilly							
Shrubs	N		5	*Zingiberaceae*	*Alpinia*	*caerula*	Native Ginger							
Shrubs	E		5	*Asparagaceae*	*Asparagus*	*spp.*	Asparagus Ferns							
Shrubs	E		5	*Asparagaceae*	*Asparagus*	*macowanii*	Pompom Asparugus							
Shrubs	E		5	*Asparagaceae*	*Asparagus*	*aethiopicus*	Ground Asparagus							
Shrubs	E		5	*Asteracea*	*Baccharis*	*halimifolia*	Groundsel Bush							
Shrubs	N		5	*Myrtaceae*	*Backhousia*	*myrtifolia*	Ironwood				1	1		
Shrubs	N		5	*Proteacea*	*Banksia*	*integrifolia subsp. intergrifolia*	Coast Banksia							
Shrubs	N		5	*Phyllanthaceae*	*Breynia*	*oblongifolia*	Coffee Bush							
Shrubs	E		5	*Solanaceae*	*Brugmansia*	*suaveolens*	Angel's Trumpet							
Shrubs	N		5	*Cunoniaceae*	*Callicoma*	*serratifolia*	Black Wattle							
Shrubs	N		5	*Myrtaceae*	*Callistemon*	*salignus*	Willow Bottlebrush							
Shrubs	N		5	*Myrtaceae*	*Callistemon*	*viminalis*	Weeping Bottlebrush							
Shrubs	E		5	*Solanaceae*	*Cestrum*	*parqui*	Green Cestrum							
Shrubs	E		5	*Asteracea*	*Chrysanthemoides*	*monilifera subsp. rotundata*	Bitou Bush							
Shrubs	E		5	*Rutaceae*	*Citrus*	*x taitensis*	Rough Lemon							
Shrubs	N		5	*Malvaceae*	*Commersonia*	*fraseri*	Brush Kurrajong							
Shrubs	N		5	*Asteliaceae*	*Cordyline*	*petiolaris*	Broad-leaved Palm lily							
Shrubs	N		5	*Asteliaceae*	*Cordyline*	*stricta*	Narrow-leaved Palm Lily							
Shrubs	N		5	*Euphorbiaceae*	*Croton*	*verreauxii*	Green Native Cascarilla							
Shrubs	N		5	*Sapindaceae*	*Cupaniopsis*	*anacardioides*	Tuckeroo							
Shrubs	N		5	*Rousseaceae*	*Cuttsia*	*virburnea*	Elderberry							
Shrubs	N		5	*Cyatheaceae*	*Cyathea*	*australis*	Rough Tree-fern							
Shrubs	N		5	*Dicksoniaceae*	*Dicksonia*	*antarctica*	Soft Tree Fern							
Shrubs	N		5	*Sapindaceae*	*Dodonaea*	*triquetra*	Large-leaf Hop-bush							
Shrubs	N		5	*Moraceae*	*Ficus*	*coronata*	Sandpaper Fig	1	1	1	1	1	1	
Shrubs	N		5	*Phyllanthaceae*	*Glochidion*	*fernandi*	Cheese Tree			1		1	1	
Shrubs	N		5	*Sapindaceae*	*Guioa*	*semiglauca*	Guioa							
Shrubs	N		5	*Malvaceae*	*Hibiscus*	*heterophyllus*	Native Rosella							
Shrubs	N		5	*Euphorbiaceae*	*Homalanthus*	*populifolius*	Bleeding Heart							
Shrubs	N		5	*Pittosporaceae*	*Hymenosporum*	*flavum*	Native Frangipani							
Shrubs	E		5	*Verbenaceae*	*Lantana*	*camara*	Lantana	1	1	1	1	1	1	
Shrubs	N		5	*Myrtaceae*	*Leptospermum*	*laevigatum*	Coast Teatree							
Shrubs	N		5	*Myrtaceae*	*Leptospermum*	*brachyandrum*	Silver Weeping Teatree		1				1	
Shrubs	E		5	*Oleaceae*	*Ligustrum*	*lucidum*	Broad-leaf Privet	1	1		1	1		
Shrubs	E		5	*Oleaceae*	*Ligustrum*	*sinense*	Small-leaved Privet	1	1			1	1	
Shrubs	N		5	*Arecaceae*	*Linospadix*	*monostachyos*	Walking Stick Plam							
Shrubs	N		5	*Arecaceae*	*Livistona*	*australis*	Cabbage Tree Palm							
Shrubs	N		5	*Myrtaceae*	*Melaleuca*	*styphelioides*	Prickly-leaved Teatree							
Shrubs	N		5	*Ericaceae*	*Monotoca*	*elliptica*	Tree-broom Heath							
Shrubs	N		5	*Lauraceae*	*Neolitsea*	*australiensis*	Green Bolly Gum							
Shrubs	N		5	*Oleaceae*	*Notelaea*	*longifolia*	Large mock olive							
Shrubs	E		5	*Ochnaceae*	*Ochna*	*serrulata*	Mickey-mouse Plant							
Shrubs	N		5	*Asteracea*	*Ozothamnus*	*diosmifolius*	White Dogwood							
Shrubs	N		5	*Myrtaceae*	*Persoonia*	*stradbrokensis or levis*	Geebung hybrid							
Shrubs	N		5	*Pittosporaceae*	*Pittosporum*	*multiflorum*	Orange Thorn							
Shrubs	N		5	*Pittosporaceae*	*Pittosporum*	*undulatum*	Sweet Pittosporum					1		
Shrubs	N		5	*Polypodiaceae*	*Platycerium*	*bifurcatum*	Elkhorn Fern							

Macrophytes = 1, Grasses = 2, Graminoides = 3, Herbs/Forbs = 4, Shrubs = 5, Trees = 6, Vines = 7, SOI = 8

Growth Form	Native/ Exotic	Noxious sp.	Growth Form	Family	Genus	Species	Common Name	SOUC1	SOUC2	SOUC3	BUCC1	BUCC2	MISC1	NEWC1
Shrubs	N		5	*Fabaceae*	*Pultenaea*	*retusa*	Notched Bush-pea							
Shrubs	E		5	*Euphorbiaceae*	*Ricinus*	*communis*	Castor Oil Plant			1				
Shrubs	E		5	*Rosaceae*	*Rosa*	*rubiginosa*	Sweet Briar							
Shrubs	E		5	*Anacardiaceae*	*Schinus*	*terebinthifolius*	Brazilian Pepper Tree							
Shrubs	E		5	*Caesalpinioideae*	*Senna*	*pendula var. glabrata*	Senna							
Shrubs	E		5	*Caesalpinioideae*	*Senna*	*septemtrionalis*	Arsenic Bush					1		
Shrubs	E		5	*Solanaceae*	*Solanum*	*mauritianum*	Wild Tobacco		1	1	1	1	1	
Shrubs	N		5	*Myrtaceae*	*Syzygium*	*australe*	Brush Cherry				1			
Shrubs	N		5	*Winteraceae*	*Tasmannia*	*insipida*	Brush Pepperbush							
Trees	N		6	*Rutaceae*	*Acronychia*	*pubescens*	Hairy Acronychia							
Trees	N		6	*Ulmaceae*	*Aphananthe*	*philippinensis*	Rough-leaved Elm							
Trees	N		6	*Araucariaceae*	*Araucaria*	*cunninghamii*	Hoop Pine							
Trees	N		6	*Arecaceae*	*Archontophoenix*	*cunninghamiana*	Bangalow Palm	1						
Trees	N		6	*Casuarinaceae*	*Casuarina*	*glauca*	Swamp Oak							1
Trees	N		6	*Casuarinaceae*	*Casuarina*	*cunninghamiana subsp. cunninghamiana*	River Oak	1	1	1	1	1	1	
Trees	N		6	*Cunoniaceae*	*Cerratopetalum*	*apetalum*	Coachwood							
Trees	E		6	*Lauraceae*	*Cinnamomum*	*camphora*	Camphor Laurel	1	1		1		1	
Trees	N		6	*Lauraceae*	*Cryptocarya*	*meisneriana*	Thick-leaved Laurel							
Trees	N		6	*Lauraceae*	*Cryptocarya*	*triplinervis*	Three-veined Cryptocarya							
Trees	N		6	*Elaeocarpaceae*	*Elaeocarpus*	*obovatus*	Hard Quandong				1			
Trees	N		6	*Lauraceae*	*Endiandra*	*discolor*	Rose Wallnut							
Trees	E		6	*Fabaceae*	*Erythrina*	*crista-galli*	Cockspur Coral tree	1						
Trees	N		6	*Myrtaceae*	*Eucalyptus*	*microcorys*	Tallowwood							
Trees	N		6	*Myrtaceae*	*Eucalyptus*	*pilularis*	Blackbutt							
Trees	N		6	*Myrtaceae*	*Eucalyptus*	*tereticornis*	Forest Red Gum							
Trees	N		6	*Myrtaceae*	*Eucalyptus*	*grandis*	Flooded Gum					1	1	
Trees	N		6	*Moraceae*	*Ficus*	*macrophylla*	Morton Bay Fig							
Trees	N		6	*Moraceae*	*Ficus*	*watkinsiana*	Strangler Fig							
Trees	N		6	*Moraceae*	*Ficus*	*sp.*	Strangler Fig species							
Trees	N		6	*Proteacea*	*Grevillea*	*robusta*	Silky Oak							
Trees	N		6	*Sapindaceae*	*Jagera*	*pseudorhus*	Foam Bark Tree							
Trees	N		6	*Myrtaceae*	*Lophostemon*	*confertus*	Brush Box							
Trees	N		6	*Myrtaceae*	*Melaleuca*	*quinquenervia*	Broad-leaved Paperbark							
Trees	N		6	*Meliaceae*	*Melia*	*azedarach*	White Cedar			1		1	1	
Trees	E		6	*Moraceae*	*Morus*	*alba*	White Mulberry							
Trees	N		6	*Proteacea*	*Orites*	*excelsus*	Mountain Silky Oak							
Trees	N		6	*Paracryphiaceae*	*Quintinia*	*verdonii*	Grey Possumwood							
Trees	E		6	*Salicaceae*	*Salix*	*sp.*	Willow		1					
Trees	N		6	*Cunoniaceae*	*Schizomeria*	*ovata*	Crabapple							
Trees	N		6	*Elaeocarpaceae*	*Sloanea*	*australis*	Maiden's Blush							
Trees	N		6	*Elaeocarpaceae*	*Sloanea*	*woollsii*	Yellow Carabeen							
Trees	N		6	*Moraceae*	*Streblus*	*brunonianus*	Whalebone Tree							
Trees	N		6	*Myrtaceae*	*Syncarpia*	*glomulifera*	Turpentine							
Trees	N		6	*Meliaceae*	*Toona*	*australis*	Red Cedar							
Trees	N		6	*Myrtaceae*	*Tristaniopsis*	*laurina*	Watergum	1	1		1	1		
Trees	N		6	*Myrtaceae*	*Waterhousea*	*floribunda*	Weeping Lilly Pilly	1	1					

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Growth Form	Native/ Exotic	Noxious sp.	Growth Form	Family	Genus	Species	Common Name	SOUC1	SOUC2	SOUC3	BUCC1	BUCC2	MISC1	NEWC1
Vines	N		7	*Pittosporaceae*	*Billardiera*	*scandens*	Hairy Apple Berry							
Vines	N		7	*Convolvulaceae*	*Calystegia*	*marginata*	Arrow Vine							
Vines	E		7	*Sapindaceae*	*Cardiospermum*	*grandiflorum*	Balloon Vine	1			1	1		
Vines	N		7	*Lauraceae*	*Cassytha*	*filiformis*	Dodder Laurel							
Vines	N		7	*Celastraceae*	*Celastrus*	*subspicatus*	Large-leaved Staff Vine	1						
Vines	N		7	*Vitaceae*	*Cissus*	*hypoglauca*	Water Vine					1		
Vines	N		7	*Vitaceae*	*Cissus*	*antarctica*	Kangaroo Vine					1		
Vines	?		7	*Convolvulaceae*	*Cuscuta*	*sp.*	Dodder							
Vines	N		7	*Apocynaceae*	*Cynanchum*	*carnosum*	Mangrove Vine							
Vines	N		7	*Luzuriageae*	*Eustrephus*	*latifolius*	Wombat Berry							
Vines	N		7	*Flagellariaceae*	*Flagellaria*	*indica*	Whip Vine							
Vines	E		7	*Colchiaceae*	*Gloriosa*	*superba*	Glory Lily			1				
Vines	E		7	*Araliaceae*	*Hedera*	*helix*	English Ivy	1						
Vines	N		7	*Dilleniaceae*	*Hibbertia*	*scandens*	Climbing Guinea Fower							
Vines	E		7	*Convolvulaceae*	*Ipomoea*	*indica*	Morning Glory	1						
Vines	E		7	*Convolvulaceae*	*Ipomoea*	*cairica*	Coastal Morning Glory							
Vines	N		7	*Menispermaceae*	*Legnephora*	*moorei*	Round-leaf Vine							
Vines	E		7	*Caprifoloaceae*	*Lonicera*	*japonica*	Japanese Honeysuckle						1	
Vines	N		7	*Moraceae*	*Maclura*	*cochinchinensis*	Cockspur Thorn		1	1	1			
Vines	N		7	*Apocynaceae*	*Parsonsia*	*straminea*	Silkpod					1		
Vines	E		7	*Passifloraceae*	*Passiflora*	*sp.*	Common passionfruit			1				
Vines	N		7	*Ripogonaceae*	*Ripogonum*	*discolor*	Prickly Supplejack							
Vines	E		7	*Rosaceae*	*Rosa*	*sp.*	Rose cultivar							
Vines	N		7	*Rosaceae*	*Rubus*	*rosifolius*	Native Raspberry					1	1	
Vines	N		7	*Smilaceae*	*Smilax*	*glyciphylla*	Sweet Sarsaparilla					1		
Vines	N		7	*Smilaceae*	*Smilax*	*australis*	Lawyer Vine							
Vines	N		7	*Menispermaceae*	*Stephania*	*japonica*	Snake Vine							

Macrophytes = 1, Grasses = 2, Graminoides = 3, Herbs/Forbs = 4, Shrubs = 5, Trees = 6, Vines = 7, SOI = 8

Growth Form	Native/ Exotic	Noxious sp.	Growth Form	Family	Genus	Species	Common Name	TAYL1	TAYL2	TAYL3	TAYL4	TAYL5	BAKE1	MARC1	THUM1
Saltmarsh/Mangrove	N		0	*Myrsinaceae*	*Aegiceras*	*corniculatum*	River Mangrove	1							
Saltmarsh/Mangrove	N		0	*Acanthaceae*	*Avicennia*	*marina subsp. australasica*	Grey Mangrove	1							
Saltmarsh/Mangrove	N		0	*Cyperaceae*	*Baumea*	*juncea*	Estuarine Twig Rush								
Saltmarsh/Mangrove	N		0	*Apochynaceae*	*Cynanchum*	*carnosum*	Mangrove Vine								
Saltmarsh/Mangrove	N		0	*Euphorbiaceae*	*Excoecaria*	*agallocha*	Milk Mangrove								
Saltmarsh/Mangrove	N		0	*Hydrocharitaceae*	*Halophila*	*ovalis*	Paddle Weed								
Saltmarsh/Mangrove	N		0	*Poaceae*	*Paspalum*	*vaginatum*	Saltwater Couch								
Saltmarsh/Mangrove	N		0	*Chenopodiaceae*	*Sarcocornia*	*quinqueflora*	Samphire								
Macroalgae	N		0	*Sargassaceae*	*Sargassum*	sp.	Seaweed								
Saltmarsh/Mangrove	N		0	*Poaceae*	*Sporobolus*	*virginicus var. minor or virginicus*	Marine/Sand Couch	1							
Saltmarsh/Mangrove	N		0	*Chenopodiaceae*	*Suaeda*	*australis*	Austral Seablite								
Saltmarsh/Mangrove	N		0	*Zostereaceae*	*Zostera*	*muelleri* subsp. *capricorni*	Zostera	1							
Macrophytes	N		1	*Salviniaceae*	*Azolla*	pinata	Duck Weed			1	1		1		
Macrophytes	N		1	*Plantaginaceae*	*Bacopa*	monnieri	Bacopa								
Macrophytes	N		1	*Cyperaceae*	*Baumea*	juncea	Bare Twig-rush								
Macrophytes	N		1	*Cyperaceae*	*Bolboschoenus*	*fluviatilis*	Marsh Club-rush						1		
Macrophytes	E		1	*Callitrichaceae*	*Callitriche*	*stagnalis*	Common Starwort					1		1	
Macrophytes	N		1	*Cyperaceae*	*Carex*	appressa	Tall Sedge	1							
Macrophytes	N		1	*Characeae*	*Chara*	*cera*	Stonewort								
Macrophytes	N		1	*Cyperaceae*	*Cladium*	*procerum*	Leafy Twig-rush								
Macrophytes	E		1	*Asteraceae*	*Cotula*	*coronopifolia*	Water Buttons	1							
Macrophytes	N		1	*Juncaginaceae*	*Cycnogeton*	*sp.*	Water Ribbons								
Macrophytes	E		1	*Hydrocharitaceae*	*Egeria*	*densa*	Egeria								
Macrophytes	E		1	*Elatinaceae*	*Elatine*	*gratioloides*	Waterwort								
Macrophytes	N		1	*Elatinaceae*	*Elatine*	gratioloides	Waterwort							1	
Macrophytes	N		1	*Cyperaceae*	*Eleocharis*	*acuta*	Pinrush								
Macrophytes	N		1	*Cyperaceae*	*Eleocharis*	*equisetina*	Pinrush								
Macrophytes	N		1	*Cyperaceae*	*Eleocharis*	*sphacelata*	Tall Spikerush								
Macrophytes	N		1	*Cyperaceae*	*Fimbristylis*	*ferruginea*	Rusty Sedge								
Macrophytes	N		1	*Hydrocharitaceae*	*Hydrilla*	*verticillata*	Water Thyme								
Macrophytes	N		1	*Apiaceae*	*Hydrocotyle*	*tripartita*	Pennywort			1	1	1			1
Macrophytes	N		1	*Cyperaceae*	*Isolepis*	*sp.*	inundata or subtilissima			1	1		1		1
Macrophytes	N		1	*Juncaceae*	*Juncus*	*prismatocarpus*	Branching Rush								
Macrophytes	N		1	*Juncaceae*	*Juncus*	*krausii* subsp. *australiensis*	Sea Rush	1							
Macrophytes	N		1	*Onagraceae*	*Ludwigia*	*peploides*	Water Primrose			1	1		1	1	
Macrophytes	E		1	*Haloragaceae*	*Myriophyllum*	*aquaticum*	Parrot's Feather						1		
Macrophytes	N		1	*Haloragaceae*	*Myriophyllum*	*crispatum*					1				
Macrophytes	N		1	*Haloragaceae*	*Myriophyllum*	*verrucosum*	Red Water-milfoil								
Macrophytes	N		1	*Haloragaceae*	*Myriophyllum*	*variifolium*	Varied Water-milfoil			1	1				
Macrophytes	E		1	*Nymphaeaceae*	*Nymphaea*	*sp.af. alba/mexicana*	Giant Waterlily						1		
Macrophytes	N		1	*Nymphaeaceae*	*Nymphoides*	*indica*	Water Snowflake							1	
Macrophytes	N		1	*Hydrocharitaceae*	*Ottelia*	*ovalifolia*	Swamp Lily								
Macrophytes	N		1	*Poaceae*	*Paspalum*	*distichum*	Water Couch			1	1				1
Macrophytes	N		1	*Philydraceae*	*Philydrum*	*lanuginosum*	Frogsmouth								
Macrophytes	N		1	*Poaceae*	*Phragmites*	*australis*	Common Reed								
Macrophytes	N		1	*Potamogetonaceae*	*Potomogeton*	*ochreatus*	Blunt Pondweed				1				
Macrophytes	N		1	*Potamogetonaceae*	*Potomogeton*	*octandrus*	Pondweed			1	1		1	1	
Macrophytes	E		1	*Brassicaceae*	*Rorippa*	*nasturtium-aquaticum*	Watercress		1	1	1	1			1
Macrophytes	E		1	*Salviniaceae*	*Salvinia*	*molesta*	Salvinia							1	
Macrophytes	N		1	*Cyperaceae*	*Schoenoplectiella*	*mucronata*	Triangular Club Rush						1		
Macrophytes	N		1	*Cyperaceae*	*Schoenoplectus*	*validus*	River Club Rush		1				1		
Macrophytes	N		1	*Sparganiaceae*	*Sparganium*	*subglobosum*	Floating Burr-reed						1		
Macrophytes	N		1	*Juncaginaceae*	*Triglochin*	*striata*	Streaked Arrowgrass								
Macrophytes	N		1	*Typhaceae*	*Typha*	*orientalis*	Broadleaf Cumbungi								
Macrophytes	N		1	*Hydrocharitaceae*	*Vallisneria*	*australis*	Ribbonweed								
Macrophytes	N		1	*Hydrocharitaceae*	*Vallisneria*	*nana*	Freshwater Eelgrass		1	1	1				

Macrophytes = 1, Grasses = 2, Graminoides = 3, Herbs/Forbs = 4, Shrubs = 5, Trees = 6, Vines = 7, SOI = 8

Growth Form	Native/ Exotic	Noxious sp.	Growth Form	Family	Genus	Species	Common Name	TAYL1	TAYL2	TAYL3	TAYL4	TAYL5	BAKE1	MARC1	THUM1
Grasses	E		2	*Poaceae*	*Andropogon*	*viginicus*	Whisky Grass								
Grasses	E		2	*Poaceae*	*Bambusa*	*sp.*	Bamboo								
Grasses	E		2	*Poaceae*	*Bromus*	*catharticus*	Prairie Grass	1		1	1		1	1	
Grasses	E		2	*Poaceae*	*Chloris*	*gayana*	Rhodes Grass						1	1	
Grasses	N		2	*Poaceae*	*Cynodon*	*dactylon*	Couch	1	1	1	1		1		1
Grasses	E		2	*Poaceae*	*Digitaria*	*sp.*	Summer Grass		1						1
Grasses	E		2	*Poaceae*	*Echinochloa*	*crus-gali*	Barnyard Grass								
Grasses	N		2	*Poaceae*	*Echinopogon*	*ovatus*	Forest Hedgehog Grass								
Grasses	N		2	*Poaceae*	*Entolasia*	*stricta*	Wiry Panic								
Grasses	E		2	*Poaceae*	*Eragrostis*	*tenuifolia*	Elastic Grass								
Grasses	E		2	*Poaceae*	*Festuca*	*arundinaceae*	Tall Fescue								
Grasses	N		2	*Poaceae*	*Imperata*	*cylindrica*	Blady Grass			1			1		
Grasses	N		2	*Poaceae*	*Ischaemum*	*triticeum*	Thigh-socket Grass								
Grasses	N		2	*Poaceae*	*Lachnagrostis*	*filiformis*	Blown Grass								
Grasses	E		2	*Poaceae*	*Lolium*	*rigidum*	Wimmera Ryegrass						1		
Grasses	N		2	*Poaceae*	*Microlaena*	*stipoides*	Rice Grass		1	1					
Grasses	N		2	*Poaceae*	*Oplismenus*	*imbecillis*	Creeping Beard Grass					1			1
Grasses	N		2	*Poaceae*	*Oplismenus*	*aemulus*	Australian Basket Grass							1	
Grasses	N		2	*Poaceae*	*Ottochloa*	*gracillima*	Pademelon Grass		1			1	1	1	
Grasses	E		2	*Poaceae*	*Panicum*	*repens*	Torpedo Grass								
Grasses	N		2	*Poaceae*	*Panicum*	*bisulcatum*	Black-seeded Panic								
Grasses	N		2	*Poaceae*	*Panicum*	*effusum*	Hairy Panic								
Grasses	E		2	*Poaceae*	*Paspalum*	*urvillei*	Vasey Grass							1	
Grasses	E		2	*Poaceae*	*Paspalum*	*longifolium*									
Grasses	E		2	*Poaceae*	*Paspalum*	*dilatatum*	Paspalum	1			1		1		1
Grasses	E		2	*Poaceae*	*Paspalum*	*mandiocanum*	Broadleaf Paspalum		1	1	1	1	1	1	1
Grasses	E		2	*Poaceae*	*Pennisetum*	*clandestinum*	Kikuyu								
Grasses	E		2	*Poaceae*	*Setaria*	*palmifolia*	Palm Grass								
Grasses	E		2	*Poaceae*	*Setaria*	*sphacelata*	Pigeon Grasses			1				1	1
Grasses	N		2	*Poaceae*	*Sporobolus*	*crebra*	Slender Rat's Tail Grass								
Grasses	E		2	*Poaceae*	*Stenotaphrum*	*secundatum*	Buffalo Grass	1							
Grasses	E		2	*Poaceae*	*Urochloa*	*panicoides*	Liverseed Grass								
Grasses	N		2	*Poaceae*	*Zoysia*	*macrantha*	Prickly Couch								
Graminoides	N		3	*Cyperaceae*	*Carex*	*fascicularis*	Tassel Sedge								
Graminoides	N		3	*Cyperaceae*	*Carex*	*pumila*	Strand Sedge								
Graminoides	N		3	*Cyperaceae*	*Carex*	*species*	Sedge				1	1	1		1
Macrophytes	N		3	*Amaryllidaceae*	*Crinum*	*pedunculatum*	Swamp Lily								
Graminoides	E		3	*Cyperaceae*	*Cyperus*	*eragrostis*	Umbrella Sedge			1	1		1		
Graminoides	N		3	*Cyperaceae*	*Cyperus*	*exaltatus*	Tall Flat Sedge						1		
Graminoides	N		3	*Cyperaceae*	*Cyperus*	*sp.*	Flat Sedge			1					
Graminoides	N		3	*Cyperaceae*	*Ficinia*	*nodosa*	Knobby club-rush								
Graminoides	N		3	*Cyperaceae*	*Fimbristylis*	*dichotoma*	Common Fringe Sedge								
Graminoides	N		3	*Cyperaceae*	*Ghania*	*siebriana*	Red-fruit Saw-sedge								
Graminoides	N		3	*Cyperaceae*	*Ghania*	*clarkei*	Tall Saw-sedge								
Graminoides	N		3	*Juncaceae*	*Juncus*	*bufonius*	Toad Rush								
Graminoides	N		3	*Juncaceae*	*Juncus*	*usitatus*	Common Rush			1	1	1	1	1	1
Graminoides	N		3	*Lomandraceae*	*Lomandra*	*longifolia*	Spiny-headed Mat-rush								
Graminoides	N		3	*Lomandraceae*	*Lomandra*	*hystrix*	Soft Lomandra		1	1	1	1	1	1	1
Herbs/Forbs	N		4	*Pteridaceae*	*Adiantum*	*sp.*	Maidenhair sp.					1			
Herbs/Forbs	E		4	*Asteracea*	*Ageratina*	*adenophora*	Crofton Weed					1			
Herbs/Forbs	E		4	*Asteracea*	*Ageratina*	*riparia*	Mistflower		1						1
Herbs/Forbs	E		4	*Asteracea*	*Ageratum*	*houstonianum*	Blue Billy Goat Weed			1					1
Herbs/Forbs	N		4	*Amaranthaceae*	*Alternanthera*	*denticulata*	Lesser Joyweed						1		1
Herbs/Forbs	E		4	*Amaranthaceae*	*Amaranthus*	*spinosus*	Needle Burr								
Herbs/Forbs	E		4	*Asteraceae*	*Ambrosia*	*artemisiifolia*	Annual Ragweed		1		1			1	1
Herbs/Forbs	E		4	*Asteraceae*	*Anagallis*	*arvensis*	Scarlet Pimpernel								1
Herbs/Forbs	E		4	*Papaveraceae*	*Argemone*	*ochroleuca/mexicana*	Mexican Poppy				1				
Herbs/Forbs	N		4	*Aspleniaceae*	*Asplenium*	*australasicum*	Bird's Nest fern								
Herbs/Forbs	N		4	*Chenopodiaceae*	*Atriplex*	*australasica*	Grey Saltbush								

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Growth Form	Native/ Exotic	Noxious sp.	Growth Form	Family	Genus	Species	Common Name	TAYL1	TAYL2	TAYL3	TAYL4	TAYL5	BAKE1	MARC1	THUM1
Herbs/Forbs	E		4	*Asteracea*	*Bidens*	*pilosa/subalternans*	Coblers Pegs			1	1		1		
Herbs/Forbs	N		4	*Blechnaceae*	*Blechnum*	*patersonii*	Strap Water Fern					1			
Herbs/Forbs	N		4	*Blechnaceae*	*Blechnum*	*cartilagineum*	Gristle Fern		1	1	1	1	1		
Herbs/Forbs	E		4	*Crassulaceae*	*Bryophyllum*		Mother of Millions								
Herbs/Forbs	E		4	*Brassicaceae*	*Cardamine*	*hirsuta*	Common Bittercress					1			
Herbs/Forbs	N		4	*Aizoaceae*	*Carpobrotus*	*glaucescens*	Pigface								
Herbs/Forbs	N		4	*Thelypteridaceae*	*Christella*	*dentata*	Binung					1			1
Herbs/Forbs	E		4	*Asteracea*	*Cirsium*	*vulgare*	Spear Thistle			1	1		1	1	1
Herbs/Forbs	E		4	*Areacea*	*Colocasia*	*esculenta*	Taro		1		1	1			1
Herbs/Forbs	N		4	*Commelinaceae*	*Commelina*	*cyanea*	Scurvy Weed		1				1	1	1
Herbs/Forbs	E		4	*Asteracea*	*Conyza*	*bonariensis*	Fleabane		1			1		1	
Herbs/Forbs	E		4	*Fabaceae*	*Crotalaria*	*lanceolata*	Narrow-leaved Rattlepod								
Herbs/Forbs	E		4	*Apiaceae*	*Cyclospermum*	*leptophyllum*	Slender Celery			1	1				1
Herbs/Forbs	N		4	*Orchidaceae*	*Dendrobium*	*linguiforme*	Tongue Orchid								
Herbs/Forbs	E		4	*Fabaceae*	*Desmodium*	*uncinatum*	Silver-leaved Desmodium				1				
Herbs/Forbs	N		4	*Fabaceae*	*Desmodium*	*rhytidophyllum*	Tick-trefoil								
Herbs/Forbs	N		4	*Phormaceae*	*Dianella*	*caerulea*	Blue Flax-lily								
Herbs/Forbs	N		4	*Convolvulaceae*	*Dichondra*	*repens*	Kidney Weed								
Herbs/Forbs	N		4	*Asteracea*	*Eclipta*	*prostrata*	False Daisy								
Herbs/Forbs	N		4	*Chenopodiaceae*	*Einadia*	*hastata*	Berry Saltbush								
Herbs/Forbs	N		4	*Urticaceae*	*Elatostema*	*stipitatum*	Rainforest Spinach					1			
Herbs/Forbs	E		4	*Rubiaceae*	*Galium*	*aparine*	Cleavers								
Herbs/Forbs	N		4	*Fabaceae*	*Glycine*	*sp.*	Glycine								
Herbs/Forbs	E		4	*Acanthaceae*	*Hypoestes*	*phyllostachya*	Polka Dot Plant								
Herbs/Forbs	N		4	*Dennstaedtiaceae*	*Hypolepis*	*muelleri*	Harsh Ground Fern								
Herbs/Forbs	N		4	*Fabaceae*	*Kennedia*	*rubicunda*	Dusky Coral Pea								
Herbs/Forbs	N		4	*Lindsaeaceae*	*Lindsaea*	*sp.*	Wedge Fern					1			
Herbs/Forbs	N		4	*Lobeliaceae*	*Lobelia*	*trigonocaulis*	Forest Lobelia								
Herbs/Forbs	N		4	*Lobeliaceae*	*Lobelia*	*anceps*	Angled Lobelia								
Herbs/Forbs	E		4	*Lamiaceae*	*Mentha*	*x rotundifolia*	Peppermint								1
Herbs/Forbs	N		4	*Polypodiaceae*	*Microsorum*	*scandens*	Fragrant Fern		1			1			
Herbs/Forbs	E		4	*Caryophylaceae*	*Paronychia*	*brasiliana*	Brazillian Whitlow								
Herbs/Forbs	N		4	*Polygonaceae*	*Persicaria*	*orientalis*	Princes Feathers								
Herbs/Forbs	N		4	*Polygonaceae*	*Persicaria*	*decipiens*	Slender Knotweed								1
Herbs/Forbs	N		4	*Polygonaceae*	*Persicaria*	*strigosa*	Hairy Knotweed		1		1	1	1	1	
Herbs/Forbs	N		4	*Polygonaceae*	*Persicaria*	*hydropiper*	Knotweed		1	1	1	1	1	1	1
Herbs/Forbs	E		4	*Phytolaccaceae*	*Phytolacca*	*octandra*	Ink Weed						1		1
Herbs/Forbs	N		4	*Polypodiaceae*	*Platycerium*	*bifurcatum*	Elkhorn Fern					1			
Herbs/Forbs	N		4	*Polypodiaceae*	*Platycerium*	*superbum*	Staghorn					1			
Herbs/Forbs	N		4	*Araceae*	*Pothos*	*longipes*	Pothos					1			
Herbs/Forbs	N		4	*Acanthaceae*	*Pseuderanthemum*	*variabile*	Love Flower						1		
Herbs/Forbs	N		4	*Asteraceae*	*Pseudognaphalium*	*luteoalbum*	Jersey Cudweed								
Herbs/Forbs	N		4	*Dennstaedtiaceae*	*Pteridium*	*esculentum*	Common Bracken			1	1	1	1	1	
Herbs/Forbs	N		4	*Polypodiaceae*	*Pyrrosia*	*confluens*	Robber Fern						1		
Herbs/Forbs	N		4	*Ranunculaceae*	*Ranunculus*	*sp.*	Buttercup species			1					
Herbs/Forbs	N		4	*Ranunculaceae*	*Ranunculus*	*inundatus*	stream side								
Herbs/Forbs	N		4	*Ranunculaceae*	*Ranunculus*	*plebeius*	Forest Buttercup					1	1	1	
Herbs/Forbs	E		4	*Brassicaceae*	*Rapistrum*	*rugosum*	Turnip Weed								
Herbs/Forbs	E		4	*Polygonaceae*	*Rumex*	*crispus*	Curled Dock								
Herbs/Forbs	N		4	*Polygonaceae*	*Rumex*	*brownii*	Swamp Dock			1		1			
Herbs/Forbs	E		4	*Asteracea*	*Senecio*	*madagascariensis*	Fireweed	1		1	1			1	
Herbs/Forbs	N		4	*Aizoaceae*	*Sesuvium*	*portulacastrum*									
Herbs/Forbs	E		4	*Lamiaceae*	*Sida*	*rhombifolia*	Sidratusa			1	1		1	1	1
Herbs/Forbs	E		4	*Solanaceae*	*Solanum*	*americanum*	Glossy Nightshade								
Herbs/Forbs	E		4	*Solanaceae*	*Solanum*	*sp.*	Silver nightshade (mauriteanum)							1	
Herbs/Forbs	N		4	*Aizoaceae*	*Tetragonia*	*tetragoniodes*	New Zealand Spinach	1							
Herbs/Forbs	E		4	*Commelinaceae*	*Tradescantia*	*fluminensis*	Wandering Jew		1	1	1	1	1		1
Herbs/Forbs	E		4	*Fabaceae*	*Trifolium*	*repens*	White Clover			1					
Herbs/Forbs	N		4	*Urticaceae*	*Urtica*	*incisa*	Stinging Nettle		1	1	1				
Herbs/Forbs	E		4	*Scrophulariaceae*	*Verbascum*	*virgatum*	Green Mullein								

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Growth Form	Native/ Exotic	Noxious sp.	Growth Form	Family	Genus	Species	Common Name	TAYL1	TAYL2	TAYL3	TAYL4	TAYL5	BAKE1	MARC1	THUM1
Herbs/Forbs	E		4	*Verbenaceae*	*Verbena*	*bonariensis*	Purpletop		1	1	1				1
Herbs/Forbs	N		4	*Violaceae*	*Viola*	*banksii*	Wild Violet		1						
Herbs/Forbs	N		4	*Campanulaceae*	*Wahlenbergia*	*spp.*	Bluebell								
Herbs/Forbs	E		4	*Asteraceae*	*Xanthium*	*occidentale*	Noogoora Burr			1	1		1		1
Shrubs	N		5	*Mimosoideae*	*Acacia*	*floribunda*	White Sally Wattle								
Shrubs	N		5	*Mimosoideae*	*Acacia*	*longifolia subsp. longifolia*	Sydney Golden Wattle								
Shrubs	N		5	*Mimosoideae*	*Acacia*	*longifolia subsp. sophorae*	Coastal Wattle								
Shrubs	N		5	*Mimosoideae*	*Acacia*	*implexa*	Hickory Wattle								
Shrubs	N		5	*Fabaceae*	*Acacia*	*irrorata*	Green Wattle								
Shrubs	N		5	*Fabaceae*	*Acacia*	*obtusifolia*	Blunt Leaf Wattle								
Shrubs	N		5	*Fabaceae*	*Acacia*	*maidenii*	Maiden's Wattle								
Shrubs	N		5	*Fabaceae*	*Acacia*	*sp.*	Wattle species						1	1	
Shrubs	N		5	*Myrtaceae*	*Acmena*	*smithii*	Lilly Pilly								
Shrubs	N		5	*Zingiberaceae*	*Alpinia*	*caerula*	Native Ginger								
Shrubs	E		5	*Asparagaceae*	*Asparagus*	*spp.*	Asparagus Ferns								
Shrubs	E		5	*Asparagaceae*	*Asparagus*	*macowanii*	Pompom Asparugus								
Shrubs	E		5	*Asparagaceae*	*Asparagus*	*aethiopicus*	Ground Asparagus								
Shrubs	E		5	*Asteracea*	*Baccharis*	*halimifolia*	Groundsel Bush								
Shrubs	N		5	*Myrtaceae*	*Backhousia*	*myrtifolia*	Ironwood		1						
Shrubs	N		5	*Proteacea*	*Banksia*	*integrifolia subsp. intergrifolia*	Coast Banksia								
Shrubs	N		5	*Phyllanthaceae*	*Breynia*	*oblongifolia*	Coffee Bush								
Shrubs	E		5	*Solanaceae*	*Brugmansia*	*suaveolens*	Angel's Trumpet								1
Shrubs	N		5	*Cunoniaceae*	*Callicoma*	*serratifolia*	Black Wattle					1			1
Shrubs	N		5	*Myrtaceae*	*Callistemon*	*salignus*	Willow Bottlebrush								1
Shrubs	N		5	*Myrtaceae*	*Callistemon*	*viminalis*	Weeping Bottlebrush		1	1	1		1	1	1
Shrubs	E		5	*Solanaceae*	*Cestrum*	*parqui*	Green Cestrum							1	1
Shrubs	E		5	*Asteracea*	*Chrysanthemoides*	*monilifera subsp. rotundata*	Bitou Bush								
Shrubs	E		5	*Rutaceae*	*Citrus*	*x taitensis*	Rough Lemon				1				
Shrubs	N		5	*Malvaceae*	*Commersonia*	*fraseri*	Brush Kurrajong							1	
Shrubs	N		5	*Asteliaceae*	*Cordyline*	*petiolaris*	Broad-leaved Palm lily								
Shrubs	N		5	*Asteliaceae*	*Cordyline*	*stricta*	Narrow-leaved Palm Lily								
Shrubs	N		5	*Euphorbiaceae*	*Croton*	*verreauxii*	Green Native Cascarilla							1	
Shrubs	N		5	*Sapindaceae*	*Cupaniopsis*	*anacardioides*	Tuckeroo								
Shrubs	N		5	*Rousseaceae*	*Cuttsia*	*virburnea*	Elderberry					1			1
Shrubs	N		5	*Cyatheaceae*	*Cyathea*	*australis*	Rough Tree-fern								
Shrubs	N		5	*Dicksoniaceae*	*Dicksonia*	*antarctica*	Soft Tree Fern					1			
Shrubs	N		5	*Sapindaceae*	*Dodonaea*	*triquetra*	Large-leaf Hop-bush								
Shrubs	N		5	*Moraceae*	*Ficus*	*coronata*	Sandpaper Fig		1	1	1		1	1	1
Shrubs	N		5	*Phyllanthaceae*	*Glochidion*	*fernandi*	Cheese Tree	1	1			1			1
Shrubs	N		5	*Sapindaceae*	*Guioa*	*semiglauca*	Guioa								
Shrubs	N		5	*Malvaceae*	*Hibiscus*	*heterophyllus*	Native Rosella				1				1
Shrubs	N		5	*Euphorbiaceae*	*Homalanthus*	*populifolius*	Bleeding Heart								1
Shrubs	N		5	*Pittosporaceae*	*Hymenosporum*	*flavum*	Native Frangipani								
Shrubs	E		5	*Verbenaceae*	*Lantana*	*camara*	Lantana	1	1	1	1	1	1	1	1
Shrubs	N		5	*Myrtaceae*	*Leptospermum*	*laevigatum*	Coast Teatree								
Shrubs	N		5	*Myrtaceae*	*Leptospermum*	*brachyandrum*	Silver Weeping Teatree		1	1			1	1	1
Shrubs	E		5	*Oleaceae*	*Ligustrum*	*lucidum*	Broad-leaf Privet		1						
Shrubs	E		5	*Oleaceae*	*Ligustrum*	*sinense*	Small-leaved Privet	1	1		1		1		1
Shrubs	N		5	*Arecaceae*	*Linospadix*	*monostachyos*	Walking Stick Plam					1			
Shrubs	N		5	*Arecaceae*	*Livistona*	*australis*	Cabbage Tree Palm								
Shrubs	N		5	*Myrtaceae*	*Melaleuca*	*styphelioides*	Prickly-leaved Teatree								
Shrubs	N		5	*Ericaceae*	*Monotoca*	*elliptica*	Tree-broom Heath								
Shrubs	N		5	*Lauraceae*	*Neolitsea*	*australiensis*	Green Bolly Gum								
Shrubs	N		5	*Oleaceae*	*Notelaea*	*longifolia*	Large mock olive								
Shrubs	E		5	*Ochnaceae*	*Ochna*	*serrulata*	Mickey-mouse Plant								
Shrubs	N		5	*Asteracea*	*Ozothamnus*	*diosmifolius*	White Dogwood								
Shrubs	N		5	*Myrtaceae*	*Persoonia*	*stradbrokensis or levis*	Geebung hybrid								
Shrubs	N		5	*Pittosporaceae*	*Pittosporum*	*multiflorum*	Orange Thorn		1						
Shrubs	N		5	*Pittosporaceae*	*Pittosporum*	*undulatum*	Sweet Pittosporum								
Shrubs	N		5	*Polypodiaceae*	*Platycerium*	*bifurcatum*	Elkhorn Fern								

Macrophytes = 1, Grasses = 2, Graminoides = 3, Herbs/Forbs = 4, Shrubs = 5, Trees = 6, Vines = 7, SOI = 8

Growth Form	Native/ Exotic	Noxious sp.	Growth Form	Family	Genus	Species	Common Name	TAYL1	TAYL2	TAYL3	TAYL4	TAYL5	BAKE1	MARC1	THUM1
Shrubs	N		5	*Fabaceae*	*Pultenaea*	*retusa*	Notched Bush-pea								
Shrubs	E		5	*Euphorbiaceae*	*Ricinus*	*communis*	Castor Oil Plant		1	1					
Shrubs	E		5	*Rosaceae*	*Rosa*	*rubiginosa*	Sweet Briar							1	
Shrubs	E		5	*Anacardiaceae*	*Schinus*	*terebinthifolius*	Brazilian Pepper Tree								
Shrubs	E		5	*Caesalpinioideae*	*Senna*	*pendula var. glabrata*	Senna								
Shrubs	E		5	*Caesalpinioideae*	*Senna*	*septemtrionalis*	Arsenic Bush				1				1
Shrubs	E		5	*Solanaceae*	*Solanum*	*mauritianum*	Wild Tobacco	1		1	1	1	1	1	1
Shrubs	N		5	*Myrtaceae*	*Syzygium*	*australe*	Brush Cherry		1			1	1		
Shrubs	N		5	*Winteraceae*	*Tasmannia*	*insipida*	Brush Pepperbush					1			
Trees	N		6	*Rutaceae*	*Acronychia*	*pubescens*	Hairy Acronychia					1			
Trees	N		6	*Ulmaceae*	*Aphananthe*	*philippinensis*	Rough-leaved Elm		1						
Trees	N		6	*Araucariaceae*	*Araucaria*	*cunninghamii*	Hoop Pine								1
Trees	N		6	*Arecaceae*	*Archontophoenix*	*cunninghamiana*	Bangalow Palm					1			
Trees	N		6	*Casuarinaceae*	*Casuarina*	*glauca*	Swamp Oak	1							
Trees	N		6	*Casuarinaceae*	*Casuarina*	*cunninghamiana subsp. cunninghamiana*	River Oak		1	1	1				1
Trees	N		6	*Cunoniaceae*	*Cerratopetalum*	*apetalum*	Coachwood					1			
Trees	E		6	*Lauraceae*	*Cinnamomum*	*camphora*	Camphor Laurel			1			1	1	
Trees	N		6	*Lauraceae*	*Cryptocarya*	*meisneriana*	Thick-leaved Laurel								
Trees	N		6	*Lauraceae*	*Cryptocarya*	*triplinervis*	Three-veined Cryptocarya								
Trees	N		6	*Elaeocarpaceae*	*Elaeocarpus*	*obovatus*	Hard Quandong							1	
Trees	N		6	*Lauraceae*	*Endiandra*	*discolor*	Rose Wallnut								
Trees	E		6	*Fabaceae*	*Erythrina*	*crista-galli*	Cockspur Coral tree								1
Trees	N		6	*Myrtaceae*	*Eucalyptus*	*microcorys*	Tallowwood								
Trees	N		6	*Myrtaceae*	*Eucalyptus*	*pilularis*	Blackbutt								
Trees	N		6	*Myrtaceae*	*Eucalyptus*	*tereticornis*	Forest Red Gum								
Trees	N		6	*Myrtaceae*	*Eucalyptus*	*grandis*	Flooded Gum		1		1		1	1	
Trees	N		6	*Moraceae*	*Ficus*	*macrophylla*	Morton Bay Fig								1
Trees	N		6	*Moraceae*	*Ficus*	*watkinsiana*	Strangler Fig								
Trees	N		6	*Moraceae*	*Ficus*	*sp.*	Strangler Fig species					1			
Trees	N		6	*Proteacea*	*Grevillea*	*robusta*	Silky Oak								1
Trees	N		6	*Sapindaceae*	*Jagera*	*pseudorhus*	Foam Bark Tree					1			
Trees	N		6	*Myrtaceae*	*Lophostemon*	*confertus*	Brush Box		1			1			
Trees	N		6	*Myrtaceae*	*Melaleuca*	*quinquenervia*	Broad-leaved Paperbark								
Trees	N		6	*Meliaceae*	*Melia*	*azedarach*	White Cedar				1				
Trees	E		6	*Moraceae*	*Morus*	*alba*	White Mulberry						1		
Trees	N		6	*Proteacea*	*Orites*	*excelsus*	Mountain Silky Oak					1			
Trees	N		6	*Paracryphiaceae*	*Quintinia*	*verdonii*	Grey Possumwood						1		
Trees	E		6	*Salicaceae*	*Salix*	*sp.*	Willow			1	1				
Trees	N		6	*Cunoniaceae*	*Schizomeria*	*ovata*	Crabapple					1			
Trees	N		6	*Elaeocarpaceae*	*Sloanea*	*australis*	Maiden's Blush								
Trees	N		6	*Elaeocarpaceae*	*Sloanea*	*woollsii*	Yellow Carabeen				1	1			
Trees	N		6	*Moraceae*	*Streblus*	*brunonianus*	Whalebone Tree		1						
Trees	N		6	*Myrtaceae*	*Syncarpia*	*glomulifera*	Turpentine					1			
Trees	N		6	*Meliaceae*	*Toona*	*australis*	Red Cedar								
Trees	N		6	*Myrtaceae*	*Tristaniopsis*	*laurina*	Watergum		1		1			1	
Trees	N		6	*Myrtaceae*	*Waterhousea*	*floribunda*	Weeping Lilly Pilly				1				1

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Growth Form	Native/ Exotic	Noxious sp.	Growth Form	Family	Genus	Species	Common Name	TAYL1	TAYL2	TAYL3	TAYL4	TAYL5	BAKE1	MARC1	THUM1
Vines	N		7	*Pittosporaceae*	*Billardiera*	*scandens*	Hairy Apple Berry								
Vines	N		7	*Convolvulaceae*	*Calystegia*	*marginata*	Arrow Vine		1	1		1		1	1
Vines	E		7	*Sapindaceae*	*Cardiospermum*	*grandiflorum*	Balloon Vine								
Vines	N		7	*Lauraceae*	*Cassytha*	*filiformis*	Dodder Laurel						1		
Vines	N		7	*Celastraceae*	*Celastrus*	*subspicatus*	Large-leaved Staff Vine								
Vines	N		7	*Vitaceae*	*Cissus*	*hypoglauca*	Water Vine								
Vines	N		7	*Vitaceae*	*Cissus*	*antarctica*	Kangaroo Vine			1		1	1		1
Vines	?		7	*Convolvulaceae*	*Cuscuta*	*sp.*	Dodder								
Vines	N		7	*Apocynaceae*	*Cynanchum*	*carnosum*	Mangrove Vine								
Vines	N		7	*Luzuriageae*	*Eustrephus*	*latifolius*	Wombat Berry		1						
Vines	N		7	*Flagellariaceae*	*Flagellaria*	*indica*	Whip Vine		1						
Vines	E		7	*Colchiaceae*	*Gloriosa*	*superba*	Glory Lily								
Vines	E		7	*Araliaceae*	*Hedera*	*helix*	English Ivy								
Vines	N		7	*Dilleniaceae*	*Hibbertia*	*scandens*	Climbing Guinea Fower								
Vines	E		7	*Convolvulaceae*	*Ipomoea*	*indica*	Morning Glory								
Vines	E		7	*Convolvulaceae*	*Ipomoea*	*cairica*	Coastal Morning Glory								
Vines	N		7	*Menispermaceae*	*Legnephora*	*moorei*	Round-leaf Vine								
Vines	E		7	*Caprifoloaceae*	*Lonicera*	*japonica*	Japanese Honeysuckle			1					
Vines	N		7	*Moraceae*	*Maclura*	*cochinchinensis*	Cockspur Thorn	1	1				1	1	
Vines	N		7	*Apocynaceae*	*Parsonsia*	*straminea*	Silkpod				1		1		
Vines	E		7	*Passifloraceae*	*Passiflora*	*sp.*	Common passionfruit					1			
Vines	N		7	*Ripogonaceae*	*Ripogonum*	*discolor*	Prickly Supplejack					1			
Vines	E		7	*Rosaceae*	*Rosa*	*sp.*	Rose cultivar				1				
Vines	N		7	*Rosaceae*	*Rubus*	*rosifolius*	Native Raspberry		1		1	1	1		1
Vines	N		7	*Smilaceae*	*Smilax*	*glyciphylla*	Sweet Sarsaparilla					1			
Vines	N		7	*Smilaceae*	*Smilax*	*australis*	Lawyer Vine					1	1		
Vines	N		7	*Menispermaceae*	*Stephania*	*japonica*	Snake Vine								1

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Growth Form	Native/ Exotic	Noxious sp.	Growth Form	Family	Genus	Species	Common Name	DEEP1	DEEP2	DEEP3	DEEP4	WARR1	WARR2	WARR3	EUNC1
Saltmarsh/Mangrove	N		0	*Myrsinaceae*	*Aegiceras*	*corniculatum*	River Mangrove	1	1			1			
Saltmarsh/Mangrove	N		0	*Acanthaceae*	*Avicennia*	*marina subsp. australasica*	Grey Mangrove	1				1			
Saltmarsh/Mangrove	N		0	*Cyperaceae*	*Baumea*	*juncea*	Estuarine Twig Rush		1			1			
Saltmarsh/Mangrove	N		0	*Apochynaceae*	*Cynanchum*	*carnosum*	Mangrove Vine	1							
Saltmarsh/Mangrove	N		0	*Euphorbiaceae*	*Excoecaria*	*agallocha*	Milk Mangrove					1			
Saltmarsh/Mangrove	N		0	*Hydrocharitaceae*	*Halophila*	*ovalis*	Paddle Weed					1			
Saltmarsh/Mangrove	N		0	*Poaceae*	*Paspalum*	*vaginatum*	Saltwater Couch	1				1			
Saltmarsh/Mangrove	N		0	*Chenopodiaceae*	*Sarcocornia*	*quinqueflora*	Samphire	1				1			
Macroalgae	N		0	*Sargassaceae*	*Sargassum*	sp.	Seaweed								
Saltmarsh/Mangrove	N		0	*Poaceae*	*Sporobolus*	*virginicus var. minor or virginicus*	Marine/Sand Couch	1	1			1			
Saltmarsh/Mangrove	N		0	*Chenopodiaceae*	*Suaeda*	*australis*	Austral Seablite	1				1			
Saltmarsh/Mangrove	N		0	*Zostereaceae*	*Zostera*	*muelleri* subsp. *capricorni*	Zostera	?	?			1			
Macrophytes	N		1	*Salviniaceae*	*Azolla*	pinata	Duck Weed							1	
Macrophytes	N		1	*Plantaginaceae*	*Bacopa*	monnieri	Bacopa						1		
Macrophytes	N		1	*Cyperaceae*	*Baumea*	juncea	Bare Twig-rush						1		
Macrophytes	N		1	*Cyperaceae*	*Bolboschoenus*	*fluviatilis*	Marsh Club-rush							1	
Macrophytes	E		1	*Callitrichaceae*	*Callitriche*	*stagnalis*	Common Starwort								
Macrophytes	N		1	*Cyperaceae*	*Carex*	appressa	Tall Sedge			1					
Macrophytes	N		1	*Characeae*	*Chara*	*cera*	Stonewort				1				
Macrophytes	N		1	*Cyperaceae*	*Cladium*	*procerum*	Leafy Twig-rush						1		
Macrophytes	E		1	*Asteraceae*	*Cotula*	*coronopifolia*	Water Buttons								
Macrophytes	N		1	*Juncaginaceae*	*Cycnogeton*	*sp.*	Water Ribbons								
Macrophytes	E		1	*Hydrocharitaceae*	*Egeria*	*densa*	Egeria			1					
Macrophytes	E		1	*Elatinaceae*	*Elatine*	*gratioloides*	Waterwort								
Macrophytes	N		1	*Elatinaceae*	*Elatine*	*gratioloides*	Waterwort								
Macrophytes	N		1	*Cyperaceae*	*Eleocharis*	*acuta*	Pinrush								
Macrophytes	N		1	*Cyperaceae*	*Eleocharis*	*equisetina*	Pinrush						1		
Macrophytes	N		1	*Cyperaceae*	*Eleocharis*	*sphacelata*	Tall Spikerush							1	
Macrophytes	N		1	*Cyperaceae*	*Fimbristylis*	*ferruginea*	Rusty Sedge	1	1						
Macrophytes	N		1	*Hydrocharitaceae*	*Hydrilla*	*verticillata*	Water Thyme								
Macrophytes	N		1	*Apiaceae*	*Hydrocotyle*	*tripartita*	Pennywort								1
Macrophytes	N		1	*Cyperaceae*	*Isolepis*	*sp.*	inundata or subtilissima			1	1				1
Macrophytes	N		1	*Juncaceae*	*Juncus*	*prismatocarpus*	Branching Rush								
Macrophytes	N		1	*Juncaceae*	*Juncus*	*krausii* subsp. *australiensis*	Sea Rush	1	1	1		1			
Macrophytes	N		1	*Onagraceae*	*Ludwigia*	*peploides*	Water Primrose			1				1	
Macrophytes	E		1	*Haloragaceae*	*Myriophyllum*	*aquaticum*	Parrot's Feather								
Macrophytes	N		1	*Haloragaceae*	*Myriophyllum*	*crispatum*									
Macrophytes	N		1	*Haloragaceae*	*Myriophyllum*	*verrucosum*	Red Water-milfoil								
Macrophytes	N		1	*Haloragaceae*	*Myriophyllum*	*variifolium*	Varied Water-milfoil			1	1				
Macrophytes	E		1	*Nymphaeaceae*	*Nymphaea*	*sp.af. alba/mexicana*	Giant Waterlily						1	1	
Macrophytes	N		1	*Nymphaeaceae*	*Nymphoides*	*indica*	Water Snowflake			1				1	
Macrophytes	N		1	*Hydrocharitaceae*	*Ottelia*	*ovalifolia*	Swamp Lily				1				
Macrophytes	N		1	*Poaceae*	*Paspalum*	*distichum*	Water Couch			1					
Macrophytes	N		1	*Philydraceae*	*Philydrum*	*lanuginosum*	Frogsmouth								
Macrophytes	N		1	*Poaceae*	*Phragmites*	*australis*	Common Reed	1	1				1		
Macrophytes	N		1	*Potamogetonaceae*	*Potomogeton*	*ochreatus*	Blunt Pondweed								
Macrophytes	N		1	*Potamogetonaceae*	*Potomogeton*	*octandrus*	Pondweed							1	
Macrophytes	E		1	*Brassicaceae*	*Rorippa*	*nasturtium-aquaticum*	Watercress								
Macrophytes	E		1	*Salviniaceae*	*Salvinia*	*molesta*	Salvinia								
Macrophytes	N		1	*Cyperaceae*	*Schoenoplectiella*	*mucronata*	Triangular Club Rush			1	1				
Macrophytes	N		1	*Cyperaceae*	*Schoenoplectus*	*validus*	River Club Rush			1					
Macrophytes	N		1	*Sparganiaceae*	*Sparganium*	*subglobosum*	Floating Burr-reed								
Macrophytes	N		1	*Juncaginaceae*	*Triglochin*	*striata*	Streaked Arrowgrass						1		1
Macrophytes	N		1	*Typhaceae*	*Typha*	*orientalis*	Broadleaf Cumbungi								
Macrophytes	N		1	*Hydrocharitaceae*	*Vallisneria*	*australis*	Ribbonweed							1	
Macrophytes	N		1	*Hydrocharitaceae*	*Vallisneria*	*nana*	Freshwater Eelgrass							1	

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Growth Form	Native/ Exotic	Noxious sp.	Growth Form	Family	Genus	Species	Common Name	DEEP1	DEEP2	DEEP3	DEEP4	WARR1	WARR2	WARR3	EUNC1
Grasses	E		2	*Poaceae*	*Andropogon*	*viginicus*	Whisky Grass								
Grasses	E		2	*Poaceae*	*Bambusa*	*sp.*	Bamboo								
Grasses	E		2	*Poaceae*	*Bromus*	*catharticus*	Prairie Grass							1	
Grasses	E		2	*Poaceae*	*Chloris*	*gayana*	Rhodes Grass				1	1		1	
Grasses	N		2	*Poaceae*	*Cynodon*	*dactylon*	Couch	1	1	1			1	1	
Grasses	E		2	*Poaceae*	*Digitaria*	*sp.*	Summer Grass				1				
Grasses	E		2	*Poaceae*	*Echinochloa*	*crus-gali*	Barnyard Grass								
Grasses	N		2	*Poaceae*	*Echinopogon*	*ovatus*	Forest Hedgehog Grass							1	
Grasses	N		2	*Poaceae*	*Entolasia*	*stricta*	Wiry Panic	1	1	1					
Grasses	E		2	*Poaceae*	*Eragrostis*	*tenuifolia*	Elastic Grass								
Grasses	E		2	*Poaceae*	*Festuca*	*arundinaceae*	Tall Fescue			1					
Grasses	N		2	*Poaceae*	*Imperata*	*cylindrica*	Blady Grass	1	1		1	1			
Grasses	N		2	*Poaceae*	*Ischaemum*	*triticeum*	Thigh-socket Grass					1			
Grasses	N		2	*Poaceae*	*Lachnagrostis*	*filiformis*	Blown Grass			1				1	
Grasses	E		2	*Poaceae*	*Lolium*	*rigidum*	Wimmera Ryegrass							1	
Grasses	N		2	*Poaceae*	*Microlaena*	*stipoides*	Rice Grass							1	
Grasses	N		2	*Poaceae*	*Oplismenus*	*imbecillis*	Creeping Beard Grass	1							1
Grasses	N		2	*Poaceae*	*Oplismenus*	*aemulus*	Australian Basket Grass			1	1	1		1	
Grasses	N		2	*Poaceae*	*Ottochloa*	*gracillima*	Pademelon Grass		1	1	1	1	1	1	1
Grasses	E		2	*Poaceae*	*Panicum*	*repens*	Torpedo Grass			1					
Grasses	N		2	*Poaceae*	*Panicum*	*bisulcatum*	Black-seeded Panic							1	
Grasses	N		2	*Poaceae*	*Panicum*	*effusum*	Hairy Panic		1						
Grasses	E		2	*Poaceae*	*Paspalum*	*urvillei*	Vasey Grass								
Grasses	E		2	*Poaceae*	*Paspolum*	*longifolium*									
Grasses	E		2	*Poaceae*	*Paspalum*	*dilatatum*	Paspalum			1		1			
Grasses	E		2	*Poaceae*	*Paspalum*	*mandiocanum*	Broadleaf Paspalum	1		1	1	1	1	1	1
Grasses	E		2	*Poaceae*	*Pennisetum*	*clandestinum*	Kikuyu								
Grasses	E		2	*Poaceae*	*Setaria*	*palmifolia*	Palm Grass			1					
Grasses	E		2	*Poaceae*	*Setaria*	*sphacelata*	Pigeon Grasses			1				1	
Grasses	N		2	*Poaceae*	*Sporobolus*	*crebra*	Slender Rat's Tail Grass								
Grasses	E		2	*Poaceae*	*Stenotaphrum*	*secundatum*	Buffalo Grass	1							
Grasses	E		2	*Poaceae*	*Urochloa*	*panicoides*	Liverseed Grass				1				
Grasses	N		2	*Poaceae*	*Zoysia*	*macrantha*	Prickly Couch		1						
Graminoides	N		3	*Cyperaceae*	*Carex*	*fascicularis*	Tassel Sedge				1				
Graminoides	N		3	*Cyperaceae*	*Carex*	*pumila*	Strand Sedge					1			
Graminoides	N		3	*Cyperaceae*	*Carex*	*species*	Sedge								
Macrophytes	N		3	*Amaryllidaceae*	*Crinum*	*pedunculatum*	Swamp Lily	1		1		1	1		
Graminoides	E		3	*Cyperaceae*	*Cyperus*	*eragrostis*	Umbrella Sedge								
Graminoides	N		3	*Cyperaceae*	*Cyperus*	*exaltatus*	Tall Flat Sedge								
Graminoides	N		3	*Cyperaceae*	*Cyperus*	*sp.*	Flat Sedge								
Graminoides	N		3	*Cyperaceae*	*Ficinia*	*nodosa*	Knobby club-rush	1				1			
Graminoides	N		3	*Cyperaceae*	*Fimbristylis*	*dichotoma*	Common Fringe Sedge								
Graminoides	N		3	*Cyperaceae*	*Ghania*	*siebriana*	Red-fruit Saw-sedge				1				
Graminoides	N		3	*Cyperaceae*	*Ghania*	*clarkei*	Tall Saw-sedge		1				1	1	
Graminoides	N		3	*Juncaceae*	*Juncus*	*bufonius*	Toad Rush								
Graminoides	N		3	*Juncaceae*	*Juncus*	*usitatus*	Common Rush			1			1	1	1
Graminoides	N		3	*Lomandraceae*	*Lomandra*	*longifolia*	Spiny-headed Mat-rush	1	1			1			
Graminoides	N		3	*Lomandraceae*	*Lomandra*	*hystrix*	Soft Lomandra			1	1	1		1	1
Herbs/Forbs	N		4	*Pteridaceae*	*Adiantum*	*sp.*	Maidenhair sp.							1	1
Herbs/Forbs	E		4	*Asteracea*	*Ageratina*	*adenophora*	Crofton Weed			1					
Herbs/Forbs	E		4	*Asteracea*	*Ageratina*	*riparia*	Mistflower				1			1	
Herbs/Forbs	E		4	*Asteracea*	*Ageratum*	*houstonianum*	Blue Billy Goat Weed			1					
Herbs/Forbs	N		4	*Amaranthaceae*	*Alternanthera*	*denticulata*	Lesser Joyweed			1					
Herbs/Forbs	E		4	*Amaranthaceae*	*Amaranthus*	*spinosus*	Needle Burr								
Herbs/Forbs	E		4	*Asteraceae*	*Ambrosia*	*artemisiifolia*	Annual Ragweed			1				1	1
Herbs/Forbs	E		4	*Asteraceae*	*Anagallis*	*arvensis*	Scarlet Pimpernel								
Herbs/Forbs	E		4	*Papaveraceae*	*Argemone*	*ochroleuca/mexicana*	Mexican Poppy								
Herbs/Forbs	N		4	*Aspleniaceae*	*Asplenium*	*australasicum*	Bird's Nest fern								
Herbs/Forbs	N		4	*Chenopodiaceae*	*Atriplex*	*australasica*	Grey Saltbush								

Macrophytes = 1, Grasses = 2, Graminoides = 3, Herbs/Forbs = 4, Shrubs = 5, Trees = 6, Vines = 7, SOI = 8

Growth Form	Native/ Exotic	Noxious sp.	Growth Form	Family	Genus	Species	Common Name	DEEP1	DEEP2	DEEP3	DEEP4	WARR1	WARR2	WARR3	EUNC1
Herbs/Forbs	E		4	*Asteracea*	*Bidens*	*pilosa/subalternans*	Coblers Pegs			1	1				
Herbs/Forbs	N		4	*Blechnaceae*	*Blechnum*	*patersonii*	Strap Water Fern								
Herbs/Forbs	N		4	*Blechnaceae*	*Blechnum*	*cartilagineum*	Gristle Fern			1	1				1
Herbs/Forbs	E		4	*Crassulaceae*	*Bryophyllum*		Mother of Millions								
Herbs/Forbs	E		4	*Brassicaceae*	*Cardamine*	*hirsuta*	Common Bittercress								
Herbs/Forbs	N		4	*Aizoaceae*	*Carpobrotus*	*glaucescens*	Pigface					1			
Herbs/Forbs	N		4	*Thelypteridaceae*	*Christella*	*dentata*	Binung								
Herbs/Forbs	E		4	*Asteracea*	*Cirsium*	*vulgare*	Spear Thistle							1	
Herbs/Forbs	E		4	*Areacea*	*Colocasia*	*esculenta*	Taro								1
Herbs/Forbs	N		4	*Commelinaceae*	*Commelina*	*cyanea*	Scurvy Weed	1		1	1	1		1	1
Herbs/Forbs	E		4	*Asteracea*	*Conyza*	*bonariensis*	Fleabane							1	
Herbs/Forbs	E		4	*Fabaceae*	*Crotalaria*	*lanceolata*	Narrow-leaved Rattlepod								
Herbs/Forbs	E		4	*Apiaceae*	*Cyclospermum*	*leptophyllum*	Slender Celery				1			1	
Herbs/Forbs	N		4	*Orchidaceae*	*Dendrobium*	*linguiforme*	Tongue Orchid						1		
Herbs/Forbs	E		4	*Fabaceae*	*Desmodium*	*uncinatum*	Silver-leaved Desmodium			1					
Herbs/Forbs	N		4	*Fabaceae*	*Desmodium*	*rhytidophyllum*	Tick-trefoil		1						
Herbs/Forbs	N		4	*Phormaceae*	*Dianella*	*caerulea*	Blue Flax-lily		1						
Herbs/Forbs	N		4	*Convolvulaceae*	*Dichondra*	*repens*	Kidney Weed							1	
Herbs/Forbs	N		4	*Asteracea*	*Eclipta*	*prostrata*	False Daisy								
Herbs/Forbs	N		4	*Chenopodiaceae*	*Einadia*	*hastata*	Berry Saltbush					1			
Herbs/Forbs	N		4	*Urticaceae*	*Elatostema*	*stipitatum*	Rainforest Spinach								
Herbs/Forbs	E		4	*Rubiaceae*	*Galium*	*aparine*	Cleavers								
Herbs/Forbs	N		4	*Fabaceae*	*Glycine*	*sp.*	Glycine								
Herbs/Forbs	E		4	*Acanthaceae*	*Hypoestes*	*phyllostachya*	Polka Dot Plant								
Herbs/Forbs	N		4	*Dennstaedtiaceae*	*Hypolepis*	*muelleri*	Harsh Ground Fern								1
Herbs/Forbs	N		4	*Fabaceae*	*Kennedia*	*rubicunda*	Dusky Coral Pea								
Herbs/Forbs	N		4	*Lindsaeaceae*	*Lindsaea*	*sp.*	Wedge Fern								1
Herbs/Forbs	N		4	*Lobeliaceae*	*Lobelia*	*trigonocaulis*	Forest Lobelia			1					
Herbs/Forbs	N		4	*Lobeliaceae*	*Lobelia*	*anceps*	Angled Lobelia	1	1			1	1		
Herbs/Forbs	E		4	*Lamiaceae*	*Mentha*	*x rotundifolia*	Peppermint								
Herbs/Forbs	N		4	*Polypodiaceae*	*Microsorum*	*scandens*	Fragrant Fern								
Herbs/Forbs	E		4	*Caryophylaceae*	*Paronychia*	*brasiliana*	Brazillian Whitlow								
Herbs/Forbs	N		4	*Polygonaceae*	*Persicaria*	*orientalis*	Princes Feathers								
Herbs/Forbs	N		4	*Polygonaceae*	*Persicaria*	*decipiens*	Slender Knotweed								
Herbs/Forbs	N		4	*Polygonaceae*	*Persicaria*	*strigosa*	Hairy Knotweed			1	1			1	
Herbs/Forbs	N		4	*Polygonaceae*	*Persicaria*	*hydropiper*	Knotweed				1				
Herbs/Forbs	E		4	*Phytolaccaceae*	*Phytolacca*	*octandra*	Ink Weed								
Herbs/Forbs	N		4	*Polypodiaceae*	*Platycerium*	*bifurcatum*	Elkhorn Fern				1				
Herbs/Forbs	N		4	*Polypodiaceae*	*Platycerium*	*superbum*	Staghorn								
Herbs/Forbs	N		4	*Araceae*	*Pothos*	*longipes*	Pothos								
Herbs/Forbs	N		4	*Acanthaceae*	*Pseuderanthemum*	*variabile*	Love Flower							1	1
Herbs/Forbs	N		4	*Asteraceae*	*Pseudognaphalium*	*luteoalbum*	Jersey Cudweed								
Herbs/Forbs	N		4	*Dennstaedtiaceae*	*Pteridium*	*esculentum*	Common Bracken			1	1				1
Herbs/Forbs	N		4	*Polypodiaceae*	*Pyrrosia*	*confluens*	Robber Fern								
Herbs/Forbs	N		4	*Ranunculaceae*	*Ranunculus*	*sp.*	Buttercup species								
Herbs/Forbs	N		4	*Ranunculaceae*	*Ranunculus*	*inundatus*	stream side						1		
Herbs/Forbs	N		4	*Ranunculaceae*	*Ranunculus*	*plebeius*	Forest Buttercup							1	1
Herbs/Forbs	E		4	*Brassicaceae*	*Rapistrum*	*rugosum*	Turnip Weed								
Herbs/Forbs	E		4	*Polygonaceae*	*Rumex*	*crispus*	Curled Dock								
Herbs/Forbs	N		4	*Polygonaceae*	*Rumex*	*brownii*	Swamp Dock							1	
Herbs/Forbs	E		4	*Asteracea*	*Senecio*	*madagascariensis*	Fireweed	1		1	1			1	
Herbs/Forbs	N		4	*Aizoaceae*	*Sesuvium*	*portulacastrum*		1							
Herbs/Forbs	E		4	*Lamiaceae*	*Sida*	*rhombifolia*	Sidratusa								
Herbs/Forbs	E		4	*Solanaceae*	*Solanum*	*americanum*	Glossy Nightshade								
Herbs/Forbs	E		4	*Solanaceae*	*Solanum*	*sp.*	Silver nightshade (mauriteanum)							1	
Herbs/Forbs	N		4	*Aizoaceae*	*Tetragonia*	*tetragonioides*	New Zealand Spinach	1				1			
Herbs/Forbs	E		4	*Commelinaceae*	*Tradescantia*	*fluminensis*	Wandering Jew							1	
Herbs/Forbs	E		4	*Fabaceae*	*Trifolium*	*repens*	White Clover			1					
Herbs/Forbs	N		4	*Urticaceae*	*Urtica*	*incisa*	Stinging Nettle								
Herbs/Forbs	E		4	*Scrophulariaceae*	*Verbascum*	*virgatum*	Green Mullein								

Macrophytes = 1, Grasses = 2, Graminoides = 3, Herbs/Forbs = 4, Shrubs = 5, Trees = 6, Vines = 7, SOI = 8

Growth Form	Native/ Exotic	Noxious sp.	Growth Form	Family	Genus	Species	Common Name	DEEP1	DEEP2	DEEP3	DEEP4	WARR1	WARR2	WARR3	EUNC1
Herbs/Forbs	E		4	*Verbenaceae*	*Verbena*	*bonariensis*	Purpletop								
Herbs/Forbs	N		4	*Violaceae*	*Viola*	*banksii*	Wild Violet	1	1		1		1	1	1
Herbs/Forbs	N		4	*Campanulaceae*	*Wahlenbergia*	*spp.*	Bluebell								
Herbs/Forbs	E		4	*Asteraceae*	*Xanthium*	*occidentale*	Noogoora Burr							1	
Shrubs	N		5	*Mimosoideae*	*Acacia*	*floribunda*	White Sally Wattle			1			1		
Shrubs	N		5	*Mimosoideae*	*Acacia*	*longifolia subsp. longifolia*	Sydney Golden Wattle		1						
Shrubs	N		5	*Mimosoideae*	*Acacia*	*longifolia subsp. sophorae*	Coastal Wattle	1				1			
Shrubs	N		5	*Mimosoideae*	*Acacia*	*implexa*	Hickory Wattle								
Shrubs	N		5	*Fabaceae*	*Acacia*	*irrorata*	Green Wattle		1		1				
Shrubs	N		5	*Fabaceae*	*Acacia*	*obtusifolia*	Blunt Leaf Wattle								1
Shrubs	N		5	*Fabaceae*	*Acacia*	*maidenii*	Maiden's Wattle								
Shrubs	N		5	*Fabaceae*	*Acacia*	*sp.*	Wattle species			1					
Shrubs	N		5	*Myrtaceae*	*Acmena*	*smithii*	Lilly Pilly	1							
Shrubs	N		5	*Zingiberaceae*	*Alpinia*	*caerula*	Native Ginger								
Shrubs	E		5	*Asparagaceae*	*Asparagus*	*spp.*	Asparagus Ferns	1							
Shrubs	E		5	*Asparagaceae*	*Asparagus*	*macowanii*	Pompom Asparagus								
Shrubs	E		5	*Asparagaceae*	*Asparagus*	*aethiopicus*	Ground Asparagus								
Shrubs	E		5	*Asteracea*	*Baccharis*	*halimifolia*	Groundsel Bush								
Shrubs	N		5	*Myrtaceae*	*Backhousia*	*myrtifolia*	Ironwood								
Shrubs	N		5	*Proteacea*	*Banksia*	*integrifolia subsp. intergrifolia*	Coast Banksia	1				1			
Shrubs	N		5	*Phyllanthaceae*	*Breynia*	*oblongifolia*	Coffee Bush					1			
Shrubs	E		5	*Solanaceae*	*Brugmansia*	*suaveolens*	Angel's Trumpet								
Shrubs	N		5	*Cunoniaceae*	*Callicoma*	*serratifolia*	Black Wattle			1	1				1
Shrubs	N		5	*Myrtaceae*	*Callistemon*	*salignus*	Willow Bottlebrush		1			1	1		
Shrubs	N		5	*Myrtaceae*	*Callistemon*	*viminalis*	Weeping Bottlebrush			1					
Shrubs	E		5	*Solanaceae*	*Cestrum*	*parqui*	Green Cestrum								
Shrubs	E		5	*Asteracea*	*Chrysanthemoides*	*monilifera subsp. rotundata*	Bitou Bush	1				1			
Shrubs	E		5	*Rutaceae*	*Citrus*	*x taitensis*	Rough Lemon								
Shrubs	N		5	*Malvaceae*	*Commersonia*	*fraseri*	Brush Kurrajong							1	1
Shrubs	N		5	*Asteliaceae*	*Cordyline*	*petiolaris*	Broad-leaved Palm lily								
Shrubs	N		5	*Asteliaceae*	*Cordyline*	*stricta*	Narrow-leaved Palm Lily			1	1		1		
Shrubs	N		5	*Euphorbiaceae*	*Croton*	*verreauxii*	Green Native Cascarilla								
Shrubs	N		5	*Sapindaceae*	*Cupaniopsis*	*anacardioides*	Tuckeroo	1				1			
Shrubs	N		5	*Rousseaceae*	*Cuttsia*	*virburnea*	Elderberry								
Shrubs	N		5	*Cyatheaceae*	*Cyathea*	*australis*	Rough Tree-fern								
Shrubs	N		5	*Dicksoniaceae*	*Dicksonia*	*antarctica*	Soft Tree Fern			1					
Shrubs	N		5	*Sapindaceae*	*Dodonaea*	*triquetra*	Large-leaf Hop-bush		1						
Shrubs	N		5	*Moraceae*	*Ficus*	*coronata*	Sandpaper Fig			1	1		1	1	1
Shrubs	N		5	*Phyllanthaceae*	*Glochidion*	*fernandi*	Cheese Tree			1	1				
Shrubs	N		5	*Sapindaceae*	*Guioa*	*semiglauca*	Guioa								1
Shrubs	N		5	*Malvaceae*	*Hibiscus*	*heterophyllus*	Native Rosella								1
Shrubs	N		5	*Euphorbiaceae*	*Homalanthus*	*populifolius*	Bleeding Heart								
Shrubs	N		5	*Pittosporaceae*	*Hymenosporum*	*flavum*	Native Frangipani								
Shrubs	E		5	*Verbenaceae*	*Lantana*	*camara*	Lantana			1	1	1	1	1	1
Shrubs	N		5	*Myrtaceae*	*Leptospermum*	*laevigatum*	Coast Teatree					1			
Shrubs	N		5	*Myrtaceae*	*Leptospermum*	*brachyandrum*	Silver Weeping Teatree			1					
Shrubs	E		5	*Oleaceae*	*Ligustrum*	*lucidum*	Broad-leaf Privet								1
Shrubs	E		5	*Oleaceae*	*Ligustrum*	*sinense*	Small-leaved Privet				1			1	1
Shrubs	N		5	*Arecaceae*	*Linospadix*	*monostachyos*	Walking Stick Plam								1
Shrubs	N		5	*Arecaceae*	*Livistona*	*australis*	Cabbage Tree Palm						1		
Shrubs	N		5	*Myrtaceae*	*Melaleuca*	*styphelioides*	Prickly-leaved Teatree						1		
Shrubs	N		5	*Ericaceae*	*Monotoca*	*elliptica*	Tree-broom Heath								
Shrubs	N		5	*Lauraceae*	*Neolitsea*	*australiensis*	Green Bolly Gum								
Shrubs	N		5	*Oleaceae*	*Notelaea*	*longifolia*	Large mock olive				1				
Shrubs	E		5	*Ochnaceae*	*Ochna*	*serrulata*	Mickey-mouse Plant								
Shrubs	N		5	*Asteracea*	*Ozothamnus*	*diosmifolius*	White Dogwood								
Shrubs	N		5	*Myrtaceae*	*Persoonia*	*stradbrokensis or levis*	Geebung hybrid		1						
Shrubs	N		5	*Pittosporaceae*	*Pittosporum*	*multiflorum*	Orange Thorn	1					1		
Shrubs	N		5	*Pittosporaceae*	*Pittosporum*	*undulatum*	Sweet Pittosporum					1			
Shrubs	N		5	*Polypodiaceae*	*Platycerium*	*bifurcatum*	Elkhorn Fern						1		

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Growth Form	Native/ Exotic	Noxious sp.	Growth Form	Family	Genus	Species	Common Name	DEEP1	DEEP2	DEEP3	DEEP4	WARR1	WARR2	WARR3	EUNC1
Shrubs	N		5	*Fabaceae*	*Pultenaea*	*retusa*	Notched Bush-pea		1						
Shrubs	E		5	*Euphorbiaceae*	*Ricinus*	*communis*	Castor Oil Plant			1					
Shrubs	E		5	*Rosaceae*	*Rosa*	*rubiginosa*	Sweet Briar								
Shrubs	E		5	*Anacardiaceae*	*Schinus*	*terebinthifolius*	Brazilian Pepper Tree								
Shrubs	E		5	*Caesalpinioideae*	*Senna*	*pendula var. glabrata*	Senna	1							
Shrubs	E		5	*Caesalpinioideae*	*Senna*	*septemtrionalis*	Arsenic Bush							1	
Shrubs	E		5	*Solanaceae*	*Solanum*	*mauritianum*	Wild Tobacco	1		1				1	1
Shrubs	N		5	*Myrtaceae*	*Syzygium*	*australe*	Brush Cherry				1			1	1
Shrubs	N		5	*Winteraceae*	*Tasmannia*	*insipida*	Brush Pepperbush								
Trees	N		6	*Rutaceae*	*Acronychia*	*pubescens*	Hairy Acronychia								
Trees	N		6	*Ulmaceae*	*Aphananthe*	*philippinensis*	Rough-leaved Elm								
Trees	N		6	*Araucariaceae*	*Araucaria*	*cunninghamii*	Hoop Pine								
Trees	N		6	*Arecaceae*	*Archontophoenix*	*cunninghamiana*	Bangalow Palm	1		1					
Trees	N		6	*Casuarinaceae*	*Casuarina*	*glauca*	Swamp Oak	1	1			1	1		
Trees	N		6	*Casuarinaceae*	*Casuarina*	*cunninghamiana subsp. cunninghamiana*	River Oak								
Trees	N		6	*Cunoniaceae*	*Cerratopetalum*	*apetalum*	Coachwood								
Trees	E		6	*Lauraceae*	*Cinnamomum*	*camphora*	Camphor Laurel			1	1			1	
Trees	N		6	*Lauraceae*	*Cryptocarya*	*meisneriana*	Thick-leaved Laurel								1
Trees	N		6	*Lauraceae*	*Cryptocarya*	*triplinervis*	Three-veined Cryptocarya	1							
Trees	N		6	*Elaeocarpaceae*	*Elaeocarpus*	*obovatus*	Hard Quandong								
Trees	N		6	*Lauraceae*	*Endiandra*	*discolor*	Rose Wallnut							1	
Trees	E		6	*Fabaceae*	*Erythrina*	*crista-galli*	Cockspur Coral tree								
Trees	N		6	*Myrtaceae*	*Eucalyptus*	*microcorys*	Tallowwood		1						
Trees	N		6	*Myrtaceae*	*Eucalyptus*	*pilularis*	Blackbutt		1						
Trees	N		6	*Myrtaceae*	*Eucalyptus*	*tereticornis*	Forest Red Gum								
Trees	N		6	*Myrtaceae*	*Eucalyptus*	*grandis*	Flooded Gum			1	1		1	1	1
Trees	N		6	*Moraceae*	*Ficus*	*macrophylla*	Morton Bay Fig								
Trees	N		6	*Moraceae*	*Ficus*	*watkinsiana*	Strangler Fig								
Trees	N		6	*Moraceae*	*Ficus*	*sp.*	Strangler Fig species			1			1		
Trees	N		6	*Proteacea*	*Grevillea*	*robusta*	Silky Oak								
Trees	N		6	*Sapindaceae*	*Jagera*	*pseudorhus*	Foam Bark Tree								
Trees	N		6	*Myrtaceae*	*Lophostemon*	*confertus*	Brush Box			1	1				
Trees	N		6	*Myrtaceae*	*Melaleuca*	*quinquenervia*	Broad-leaved Paperbark	1	1				1		
Trees	N		6	*Meliaceae*	*Melia*	*azedarach*	White Cedar								
Trees	E		6	*Moraceae*	*Morus*	*alba*	White Mulberry								
Trees	N		6	*Proteacea*	*Orites*	*excelsus*	Mountain Silky Oak								
Trees	N		6	*Paracryphiaceae*	*Quintinia*	*verdonii*	Grey Possumwood								
Trees	E		6	*Salicaceae*	*Salix*	*sp.*	Willow								
Trees	N		6	*Cunoniaceae*	*Schizomeria*	*ovata*	Crabapple				1				
Trees	N		6	*Elaeocarpaceae*	*Sloanea*	*australis*	Maiden's Blush				1				
Trees	N		6	*Elaeocarpaceae*	*Sloanea*	*woollsii*	Yellow Carabeen								
Trees	N		6	*Moraceae*	*Streblus*	*brunonianus*	Whalebone Tree								
Trees	N		6	*Myrtaceae*	*Syncarpia*	*glomulifera*	Turpentine								
Trees	N		6	*Meliaceae*	*Toona*	*australis*	Red Cedar	1							
Trees	N		6	*Myrtaceae*	*Tristaniopsis*	*laurina*	Watergum			1	1			1	1
Trees	N		6	*Myrtaceae*	*Waterhousea*	*floribunda*	Weeping Lilly Pilly			1	1				

Macrophytes = 1, Grasses = 2, Graminoides = 3, Herbs/Forbs = 4, Shrubs = 5, Trees = 6, Vines = 7, SOI = 8

Growth Form	Native/ Exotic	Noxious sp.	Growth Form	Family	Genus	Species	Common Name	DEEP1	DEEP2	DEEP3	DEEP4	WARR1	WARR2	WARR3	EUNC1
Vines	N		7	*Pittosporaceae*	*Billardiera*	*scandens*	Hairy Apple Berry		1						
Vines	N		7	*Convolvulaceae*	*Calystegia*	*marginata*	Arrow Vine							1	
Vines	E		7	*Sapindaceae*	*Cardiospermum*	*grandiflorum*	Balloon Vine	1							
Vines	N		7	*Lauraceae*	*Cassytha*	*filiformis*	Dodder Laurel							1	
Vines	N		7	*Celastraceae*	*Celastrus*	*subspicatus*	Large-leaved Staff Vine								
Vines	N		7	*Vitaceae*	*Cissus*	*hypoglauca*	Water Vine			1					1
Vines	N		7	*Vitaceae*	*Cissus*	*antarctica*	Kangaroo Vine				1				
Vines	?		7	*Convolvulaceae*	*Cuscuta*	*sp.*	Dodder	1				1			
Vines	N		7	*Apocynaceae*	*Cynanchum*	*carnosum*	Mangrove Vine					1			
Vines	N		7	*Luzuriageae*	*Eustrephus*	*latifolius*	Wombat Berry	1			1	1			
Vines	N		7	*Flagellariaceae*	*Flagellaria*	*indica*	Whip Vine								
Vines	E		7	*Colchiaceae*	*Gloriosa*	*superba*	Glory Lily								
Vines	E		7	*Araliaceae*	*Hedera*	*helix*	English Ivy								
Vines	N		7	*Dilleniaceae*	*Hibbertia*	*scandens*	Climbing Guinea Fower								
Vines	E		7	*Convolvulaceae*	*Ipomoea*	*indica*	Morning Glory				1				
Vines	E		7	*Convolvulaceae*	*Ipomoea*	*cairica*	Coastal Morning Glory	1				1	1		
Vines	N		7	*Menispermaceae*	*Legnephora*	*moorei*	Round-leaf Vine								1
Vines	E		7	*Caprifoloaceae*	*Lonicera*	*japonica*	Japanese Honeysuckle								
Vines	N		7	*Moraceae*	*Maclura*	*cochinchinensis*	Cockspur Thorn					1		1	
Vines	N		7	*Apocynaceae*	*Parsonsia*	*straminea*	Silkpod	1	1	1	1	1	1	1	1
Vines	E		7	*Passifloraceae*	*Passiflora*	*sp.*	Common passionfruit								1
Vines	N		7	*Ripogonaceae*	*Ripogonum*	*discolor*	Prickly Supplejack								
Vines	E		7	*Rosaceae*	*Rosa*	*sp.*	Rose cultivar								
Vines	N		7	*Rosaceae*	*Rubus*	*rosifolius*	Native Raspberry								1
Vines	N		7	*Smilaceae*	*Smilax*	*glyciphylla*	Sweet Sarsaparilla								
Vines	N		7	*Smilaceae*	*Smilax*	*australis*	Lawyer Vine			1		1			1
Vines	N		7	*Menispermaceae*	*Stephania*	*japonica*	Snake Vine	1		1		1	1		1