CULTURAL FLOWS

TOOGIMBIE WETLANDS & GOORAMAN SWAMP ECOLOGICAL CHARACTERISATION REPORT

NATIONAL CULTURAL FLOWS RESEARCH PROJECT

For First Nations People, water is a sacred source of life. The natural flow of water sustains aquatic ecosystems that are central to our spirituality, our social and cultural economy and wellbeing. The rivers are the veins of Country, carrying water to sustain all parts of our sacred landscape. The wetlands are the kidneys, filtering the water as it passes through the land.

First Nations Peoples have rights and a moral obligation to care for water under their law and customs. These obligations connect across communities and language groups, extending to downstream communities, throughout catchments and over connected aquifer and groundwater systems.

The project partners acknowledge all of the Traditional Owners across Australia who care for the waterways that sustain our Country. We pay deepest respects to their Ancestors and Elders who have protected and maintained water resources for thousands of years, and passed on the knowledge, stories and lessons through the generations.

We acknowledge the nations of Murray Lower Darling Rivers Indigenous Nations and Northern Basin Aboriginal Nations who continue to fight for their inherent right to water, and who had a pivotal role in creating and directing the National Cultural Flows Research Project.

We thank the Murrawarri and Nari Nari Nations who worked tirelessly as part of the research team to develop the cultural flows assessment approaches for this project.

This report has been prepared by Rural Solutions South Australia for the Cultural Flows Planning and Research Committee as part of the National Cultural Flows Research Project, developed by and for First Nations with the aim of helping to embed First Nations' water allocations in Australia's water management framework. Funding for the Research Project has been generously provided by the Murray Darling Basin Authority, the Commonwealth Environmental Water Office, the National Water Initiative, and the Department of Families, Housing, Community Services and Indigenous Affairs. Report authored by Dr Rhonda Butcher and Peter Cottingham with contributions from Klynton Wanganeen and Michael Ghillar Anderson.

Cover photo: Arthur Mostead – Banrock Station Wetlands in South Australia, courtesy of Murray-Darling Basin Authority. Artwork 'Cultural flows' by Luke Penrith. Cover graphic design by Mazart Design Studio.

Key Acronyms and Abbreviations

ANAE	Australian National Aquatic Ecosystem
ARI	Average Recurrence Interval
CAL	Cultural Access Licence
CEWH	Commonwealth Environmental Water Holder
DOC	Dissolved Organic Carbon
EBM	Ecosystem based management
IPA	Indigenous Protected Area
IPBES	Intergovernmental Platform on Biodiversity and Ecosystem Services
KM	Kilometres
M	Metres
MDBA	Murray Darling Basin Authority
MEA	Millennium Ecosystem Assessment
ML	Megalitres
ML/D	Megalitres per day
MLDRIN	Murray Lower Darling Rivers Indigenous Nations
MM	Millimetres
NAILSMA	Northern Australia Land and Sea Management Alliance
NBAN	Northern Basin Aboriginal Nations
NNTC	National Native Title Council
NPWS	National Parks and Wildlife Services
NSW	New South Wales
OEH	Office of Environment and Heritage
TAK	Traditional Aboriginal Knowledge
TEK	Traditional Ecological Knowledge

Terminology and Definitions

Aboriginal	The people who are the original inhabitants of the land.
Aboriginal Environmental Outcomes	The term "Aboriginal environmental outcomes" has been proposed to describe and communicate the benefits to Aboriginal people that can be derived from environmental watering. Aboriginal environmental outcomes result from healthier rivers and wetlands, for example improved fish populations, more reeds that can be harvested and increased bird breeding events. In essence, Aboriginal environmental outcomes provide tangible physical benefits to community and country (Definition of Aboriginal environmental outcomes, pamphlet). This definition was endorsed by representatives of the Murray Lower Darling Rivers Indigenous Nations (MLDRIN) and Northern Basin Aboriginal Nations (NBAN) and is recognised by the Murray Darling Basin Authority (MDBA), Victorian Environmental Water Holder (VEWH) and Department of Environment, Land, Water and Planning (DELWP).
Authorised Knowledge Holder	a person, normally a Traditional Owner, who has been provided cultural and/or traditional knowledge of a particular place or thing through customary law and is recognised by the Traditional Owner community to have the authority to speak on or share that particular knowledge where appropriate.
Community	A group of people living in the same place or having a particular characteristic in common (e.g. people living in a suburb or town).
Cultural flows	Water entitlements that are legally and beneficially owned by Aboriginal Nations of a sufficient and adequate quantity and quality to improve the spiritual, cultural, environmental, social and economic conditions of those Aboriginal Nations. This is our inherent right. This definition was endorsed by representatives from thirty-one Aboriginal nations at a joint meeting of the Murray Lower Darling River Indigenous Nations (MLDRIN) and the Northern Basin Aboriginal Nations (NBAN) -The Echuca Declaration, September 2010 (NCFRP 2016).
Environmental flows	Environmental flows describe the quantity, timing, and quality of water flows required to sustain freshwater and estuarine ecosystems and the human livelihoods and well-being that depend on these ecosystems.
Key Contact	The nominated key contact for each case study area, as provided in the case study area applications to the National Cultural Flows Research Project.
Nation facilitator	Nominated member from each case study area Nation that will receive support and training to participate in the facilitation of research engagement activities. The nominated Nation Facilitator will support the Project Team to conduct engagement sessions and workshops in a culturally respectful and appropriate manner, to suit local needs and issues; and the two-

	way flow of information and ideas between the Project Team and participants / Traditional Owners.
Nation	An aggregate of people that are united by a shared descent, culture and/or language and who inhabit a particular state or territory and who have a shared body of law and custom.
The Project	The National Cultural Flows Research Project.
Contract Project Manager	Rural Solutions SA (Rowena Brown is the Interim Contract Project Manager).
Project Team	Rural Solutions SA Project Team (including Rural Solutions SA staff and subcontractors).
Research Committee	National Cultural Flows Planning and Research Committee.
Research Manager	National Cultural Flows Research Project – NNTC Research Manager (Alanna Maguire).
Research partner	A Traditional Owner, individual of the Research Committee and/or community nominated participant who is recognised as speaking for country. Individuals may be involved in any/all aspects of the National Cultural Flows Research Project.
Stakeholder	A person with an interest or concern to any and/or all aspects of the National Cultural Flows Research Project.
Traditional Owner	The Aboriginal person or people who possess rights, interests and responsibilities for an area of country. These rights, interests and responsibilities are defined by traditional law and custom and are also handed down through this customary law. Traditional Owners are recognized as having a primary interest in the land and their existence is not contingent on recognition of such under white law.

Ecological Terminology and Definitions

Aquatic ecosystem	Ecosystems that depend on flows, or periodic or sustained inundation/ waterlogging for their ecological integrity (e.g. wetlands, rivers, karst and other groundwater-dependent ecosystems, saltmarshes and estuaries) but do not generally include marine waters (defined as areas of marine water the depth of which at low tide exceeds six meters, but to be interpreted by jurisdictions). See also ecosystem
Assessment (wetland)	The identification of the status of, and threats to, wetlands as a basis for the collection of more specific information through monitoring activities. See also condition and condition assessment
Benefits	Benefits/services are defined in accordance with the Millennium Ecosystem Assessment definition of ecosystem services as "the

	benefits that people receive from ecosystems (Ramsar Convention 2005a), Resolution IX.1 Annex A). See also "Ecosystem Services".
Biodiversity	Biodiversity, or biological diversity, means the variety of life or variety of living things; and living things means plants, and animals, and microbes, and fungi, their DNA, and ecosystems. Biodiversity, in the full sense of the term, is not monitored and is not readily quantified.
Biota	The animal and plant life of a particular region or habitat.
Conceptual model	Conceptual models can take a number of forms. They are often defined as a type of diagram which shows of a set of relationships between factors that are believed to impact or lead to a target condition; a diagram that defines theoretical entities, objects, or conditions of a system and the relationships between them. In the context of this project conceptual models will illustrate the response of cultural and ecological values to the delivery of cultural flows.
Condition (ecosystem, vegetation, community, species)	The state or health of individual animals or plants, communities or ecosystems. Condition of an ecosystem, vegetation type, ecological community or species describes whether, and how much, it differs from an unimpacted or reference state. Condition can be described using a number of attributes. For example in assessing vegetation condition, the most commonly-used attributes are abundance or extent, vegetation structural features, species composition, nativeness, age structure and vigour. Condition is referential, meaning the vegetation attributes at a site are compared to a reference condition or benchmark or ideal state for that site. In the case of a species, typically a tree, or a stand of trees, condition means vigour, and condition describes how vigorous the canopy appears to be. Condition is based on observations of the canopy such as canopy cover, foliage density, and extent of dieback.
Condition assessment	A means to assess long-term changes in natural conditions and to assess long-term changes resulting from widespread anthropogenic activity.
Diversity	Diversity is the number of entities in a sample and the evenness of their abundance; in the case of species diversity, number and evenness are combined into a single value, using a diversity index. Most often diversity means species diversity, but other types of diversity can be described and reported on such as structural diversity, community diversity, genetic diversity and functional diversity in ecological studies: in these cases, 'diversity' is used rather loosely to mean variability, with no standard quantitative measures. The term 'biodiversity' is not the same as species diversity and has it has its own meaning.

Ecological character	The combination of the ecosystem components, processes and benefits/services that characterise the wetland at a given point in time. [Within this context, ecosystem benefits are defined in accordance with the MA definition of ecosystem services as "the benefits that people receive from ecosystems".] (Resolution IX.1 Annex A) (Ramsar 2012).
Ecological community	An assemblage of organisms characterised by a distinctive combination of species occupying a common environment and interacting with one another (ANZECC and ARMCANZ 2000).
Ecosystem components	Include the physical, chemical and biological parts of a wetland.
Ecosystem processes	Are changes or reactions which occur naturally within wetland ecosystems. They may be physical, chemical or biological. This equates to process such as carbon cycling, denitrification, acidification, sedimentation, migration, breeding, reproduction, etc.
Ecosystem functions	Are activities or actions which occur naturally in wetlands as a product of the interactions between the ecosystem structure and processes. Functions as defined by Ramsar include flood water control; nutrient, sediment and contaminant retention; food web support; shoreline stabilization and erosion controls; storm protection; and stabilization of local climatic conditions, particularly rainfall and temperature.
Ecosystem services	The benefits that people receive or obtain from an ecosystem. The components of ecosystem services are provisioning (for example food and water), regulating (for example flood control), cultural (for example spiritual, recreational), and supporting (for example nutrient cycling, ecological value). (Millennium Ecosystem Assessment 2005). See also "Benefits"
Geomorphology	The study of the evolution and configuration of landforms.
Goal	A goal is a concise, general statement of the overall purpose of a program. For example: • "To ensure that environmental water allocations provide the greatest ecological benefits to receiving waterbodies" • "To manage wetlands to provide habitat for breeding migratory birds"
Indicator (ecological)	Refers to representative, measurable parameter which conveys useful information concerning ecosystem condition. These can be physico-chemical and/or biological. Ecological indicators assess the condition of the environment, and can provide an early warning signal of changes in the environment. They can also be used to diagnose the cause of an environmental problem. Ideally the suite of indicators used in a monitoring program should represent key information about structure, function, and composition of the ecological system (Dale and Beyer 2001).
Intervention	A management activity that seeks to change an ecosystem's state or condition and achieve a management objective. In this case the

	intervention is the delivery of a cultural flow. See also intervention monitoring.
Intervention monitoring	Supports the evaluation of management interventions by quantifying the response to specific management interventions.
Inventory (wetland)	The collection and/or collation of core information for wetland management, including the provision of an information base for specific assessment and monitoring activities.
Monitoring (wetland)	Collection of specific information for management purposes in response to questions derived from assessment activities, and the use of these monitoring results for implementing management. (Note that the collection of time-series information that is not question-driven from wetland assessment should be termed surveillance rather than monitoring).The key aspects of an environmental monitoring program therefore are: • It is specific and hypothesis driven (i.e. it answers a specific question); • It involves the collection of information over time (i.e. multiple sampling events); and • It is used to inform ecosystem management.
Richness	Richness is the number recorded. It is most commonly used to refer to species, as in species richness. See: species richness.
Species richness	Species richness is the number of species recorded, for example, in a sample. Species richness is sensitive to sampling effort (number of quadrats, size of quadrats, total area sampled).
Traditional Aboriginal Knowledge	"Traditional Aboriginal knowledge includes the cultural traditions, values, beliefs, and worldviews of Aboriginal peoples as distinguished from Western scientific knowledge. Traditional Knowledge is cumulative and dynamic, it is based on direct experience, testing, observation of patterns over long periods of time, and teachings and recording in the collective memory through oral tradition, storytelling, ceremonies and songs. It is a holistic and inclusive form of knowledge" (adapted from Dei 1993:105; Augustine n.d.).

EXECUTIVE SUMMARY

The National Cultural Flows Research Project ("the Project") is about developing rigorous and defendable knowledge, with the aim of securing water entitlements for the benefit of Aboriginal people across Australia (NNTC, 2014). This research relies on the participation of members of the Aboriginal Nations at two case study sites within the Murray Darling Basin to investigate and measure the cultural values of water to Aboriginal people. While the focus of the research is on the Murray Darling Basin, the project has been established for the benefit of all Aboriginal nations across Australia.

The Project will assess both tangible and intangible facets of water delivered to achieve cultural outcomes, with the primary focus of developing methodologies that will record and assess Aboriginal cultural values and uses regarding watering requirements. The long-term view is that the information collected from this project will inform the development of a proposed National Cultural Flows framework that can be applied outside of the Basin, to inform the recognition of Aboriginal water rights.

The Project consists of the following components (NCFRP 2014):

- **One**: Describe the Aboriginal cultural water values and needs across Australia (completed January 2014).
- **Two**: Develop and use methodologies to describe and measure the cultural water uses, values and needs of particular Australian Aboriginal communities – Nari Nari near Hay, New South Wales (NSW), and Murrawarri at Gooraman Swamp, northern NSW.
- **Three**: Quantify water volumes to meet cultural values and needs (both Nari Nari and Murrawarri), and scientific assessment of a trial flow at Toogimbie Indigenous Protected Area (IPA), near Hay NSW.
- **Four**: Develop and implement a monitoring methodology of the ecological and socioeconomic, health and wellbeing outcomes of cultural flows and analyse how they compare with environmental flow outcomes.
- **Five:** Recommend policy, legal, and institutional changes that will enable the implementation of cultural flows.
- **Six**: Building the capacity of Aboriginal organisations to build support for cultural water provisions and to implement recommendations for improved local and national water management, planning, policies and laws.

This ecological characterisation report forms part of Component Two of the project. The primary focus of this report is on the ecological character of the two cultural water trial sites, Toogimbie IPA and Gooraman Swamp, near Weilmoringle New South Wales (NSW); cultural character of the trial sites will be summarised and reported separately (see NCFRP 2016).

For each of the trial sites, an ecological character description is presented herein, describing the Traditional Aboriginal Knowledge and western science ecological knowledge, focusing primarily on the water dependent components, processes, functions and services. Each description includes setting the trial site in a catchment context and a description of the key ecosystem components, processes, functions, provides the services and benefits. The different ecosystem types present within each trial site are described and the threats to the cultural and environmental values are listed. Understanding of these characteristics, how they interact and respond to wetting and drying, are captured in conceptual models. Overall, the ecological character description aids in planning, setting objectives, identifying monitoring requirements, and identifying knowledge gaps which are related to cultural water management.

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1 INTRODUCTION

1.1 Project background

The National Cultural Flows Research Project ("the Project") is about developing rigorous and defendable knowledge, with the aim of securing water entitlements for the benefit of Aboriginal people across Australia (NCFRP 2014). This research relies on the participation of members of the Aboriginal Nations at two case study sites (Toogimbie Indigenous Protected Area (IPA) and Gooraman Swamp) within the Murray Darling Basin to investigate and measure the cultural values of water to Aboriginal people – it's driven by Aboriginal people, for Aboriginal people. The Project will assess both tangible and intangible facets of water delivered to achieve cultural outcomes, with the primary focus of developing methodologies that will record and assess Aboriginal cultural values and uses regarding watering requirements.

The definition of "cultural flows" was endorsed by representatives from 31 Aboriginal nations at a joint meeting of the Murray Lower Darling River Indigenous Nations (MLDRIN) and the Northern Basin Aboriginal Nations (NBAN) - The Echuca Declaration, September 2010 as:

> *…water entitlements that are legally and beneficially owned by the Indigenous Nations of a sufficient and adequate quantity and quality to improve the spiritual, cultural, environmental, social and economic conditions of those Nations. This is our inherent right (MLDRIN 2007).*

The Project seeks to assess the use of water delivered to achieve cultural outcomes in partnership with two Aboriginal Nations (Nari Nari and Murrawarri). The approach is outlined in NCFRP (2016) and is built around planning to conduct watering trials, combining cultural, ecological and hydrological components. The long-term view is that the information collected from this project will inform future Australian water resource planning and implementation processes more generally and will provide further evidence for a proposed National Cultural Flows Framework that can be applied outside of the Basin, to inform the recognition of Aboriginal water rights.

Oversight of the Project is by the National Cultural Flows Planning and Research Committee (the Research Committee). The Research Committee represents its member organisations: MLDRIN; NBAN and the Northern Australia Land and Sea Management Alliance (NAILSMA) along with representatives from the office of Commonwealth Environmental Water Holder (CEWH), Murray Darling Basin Authority (MDBA), National Native Title Council (NNTC) and nominated State government agencies.

The Project objectives, as originally designed by the Research Committee consisted of six components (NCFRP 2014):

- **One**: Describe the Aboriginal cultural water values and needs across Australia (completed January 2014).
- **Two**: Develop and use methodologies to describe and measure the cultural water uses, values and needs of particular Australian Aboriginal communities – Nari Nari near Hay, New South Wales (NSW), and Murrawarri at Weilmoringle, northern NSW.
- **Three**: Quantify water volumes to meet cultural values and needs (both Nari Nari and Murrawarri), and scientific assessment of a trial flow at Toogimbie IPA, near Hay NSW.
- **Four**: Develop and implement a monitoring methodology of the ecological and socioeconomic, health and wellbeing outcomes of cultural flows and analyse how they compare with environmental flow outcomes.

- **Five:** Recommend policy, legal, and institutional changes that will enable the implementation of cultural flows.
- **Six**: Building the capacity of Aboriginal organisations to build support for cultural water provisions and to implement recommendations for improved local and national water management, planning, policies and laws.

1.1.1 Context for this report

This report is part of Component Two and outlines the ecological character of the two trial sites. It identifies the key ecological components, processes, functions, services and benefits which underpin the ecological integrity of the sites. This is used to help understand the relationship between Traditional Aboriginal Knowledge (TAK), cultural values and ecological response to cultural water management.

This report is structured as follows:

- Chapter 1 –An introduction to the concept of Traditional Aboriginal Knowledge and purpose of developing an ecological character for each case study site.
- Chapter 2 – An ecological character description and conceptual model of the Toogimbie IPA case study site.
- Chapter 3 – An ecological character description and conceptual model of the Gooraman Swamp case study site.

1.2 Cultural knowledge systems

1.2.1 Traditional Aboriginal Knowledge (TAK)

Cultural knowledge of natural ecosystems is often referred to as Traditional Ecological Knowledge (TEK) or TAK. *Traditional* knowledge refers to how the knowledge is acquired and used, not necessarily its antiquity, although in some systems this is also an aspect of TEK. TAK is typically holistic in outlook and adaptive by nature, gathered over generations by observers whose lives depended on this information and its use (Berkes et al. 2000; Berks 2012).

There are no standard or agreed definitions of Traditional Knowledge, however for the purposes of this report the following is adopted:

> *TAK includes the cultural traditions, values, beliefs, and worldviews of Aboriginal peoples as distinguished from Western scientific knowledge. TAK is cumulative and dynamic, it is based on direct experience, testing, observation of patterns over long periods of time, and teachings and recording in the collective memory through oral tradition, storytelling, ceremonies and songs. It is a holistic and inclusive form of knowledge* (modified from Dei 1993, Augustine n.d.)

In this context TAK refers both to ways of knowing, (the learning process) and also to information, or knowledge as the thing known (Berkes 2012). For example knowledge of species names, life cycles, habitats, etc. is best described as information and often has strong overlap with 'Western' science. Most TAK exists as oral forms held by Aboriginal custodians with widely dispersed records such as artworks, private journals, linguistic dictionaries, unpublished reports, community publications, academic journal articles, books, photos and videos contributing to documented knowledge (Ens et al. 2015). The work of Dykes et al. (2006) collating the names and uses of plants by the Murrawarri is a good example of TAK information specific to the trial sites (see section 3.5.2).

TAK doesn't necessarily focus only on ecological relationships but can extend to include knowledge regarding resource use, medical processes, sourcing and preparation of food, water use, and implement construction and use, among others. Spiritual and religious knowledge are key elements of TAK. An example of TAK is illustrated in Text Box . TAK is often specific to communities or unique to a given nation (Berkes 2012).

The Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES), charged with strengthening the knowledge base for decision-makers concerned with biodiversity conservation and the importance of the environment for human well-being, operates under the guiding principle of recognising and respecting the contribution of Aboriginal and local knowledge to the conservation and sustainable use of biodiversity and ecosystems (Sutherland et al. 2014). Similarly, the participation of Aboriginal communities and contribution of TAK is seen as critical in decision making for managing water resources in Australia for cultural outcomes. TAK will in many cases, but not all, support the 'Western' science understanding of how aquatic ecosystems will respond to water management. However, it is important to note that relying on western science and management principles alone will not achieve the desired cultural outcomes of the communities.

1.2.2 Ecological knowledge and ecosystem based management

Cultural integrity is dependent on ecological integrity, with many traditional knowledge systems characterised by the use of local ecological knowledge to interpret and respond to feedbacks from the environment to guide the direction of resource management (Berkes et al. 2000). In this sense traditional systems have similarities to ecosystem stewardship (Chapin et al. 2015) and adaptive management with its emphasis on learning by doing. The concept of stewardship is described by Chapin et al. (2015) as the careful and responsible management of something that you are responsible to care for, and which safeguards the valuables of not just one self but also of others, a process that has potential to create meaning and build respect and dignity for the competencies and skills embedded with stewardship. Such stewardship has been around for centuries in Australia; however this term is considered inadequate to truly capture the relationship that Aboriginal Australians have with nature.

For example Australian totemism is linked to the Dreamtime and unites Aboriginal Australians with species, processes, and ecosystems (see and Appendix 3).

> *"Our law and culture is intrinsically linked as family units. One depends on the other. We humans have the responsibility for the protection of our family within nature who cannot think or act for itself. Our philosophy to the environment is to leave it as it is. Interference will only cause displacement which will impact on others without you knowing it. This is the holistic view. That is, always consider that what one does now will impact on something else. That is an action we do now, will always cause a re-action somewhere else. Man today think in little boxes, very few can think outside of the box. Nature is very fragile, this is why we are family and family takes care of its own."* (Michael Ghillar Anderson, pers. comm.).

Totemism is a world or holistic view which includes humans as an integral part of nature, not a separate entity. Elkin's (1951: 133) defines it as ". . . . *a view of nature and life, of the universe and man, which colours and influences the Aborigines' social groupings and mythologies, inspires their rituals and links them to the past. It unites them with nature's activities and species in a bond of mutual life-giving*. . . ." (Elkin 1951 cited in Berndt and Berndt 1996). It clearly goes beyond simple stewardship in the sense of Chapin et al. (2015).

Ecosystem based management (EBM) as defined in 'western' science, is a relatively recent advent in natural resource management. EBM represents a shift from a single-species, extraction-oriented focus in resource management toward a more holistic approach that attempts to include multiple interrelated dimensions of ecological integrity and ecosystems as well as consider human wellbeing (Millennium Ecosystem Assessment 2005, McLeod and Leslie 2012 cited in Breslow et al. 2016). EBM is most advanced in marine environments (e.g. Samhouri et al. 2014, Link and Browman 2014) but similar integrative approaches to resource management also exist for inland aquatic ecosystems, for example integrated catchment management and integrated water resource management have been in action for a number of decades. In Australia the Integrated Ecosystem Condition Assessment Framework being developed by the Australian Government which will be applicable to different connected aquatic ecosystem types (e.g. rivers, floodplains, lakes, marshes and estuaries) at multiple scales (e.g. asset, landscape, catchment), and to the key ecosystem functions that they provide.

Knowledge and understanding of ecosystems and their connectivity is a central aspect of Aboriginal management of country, and has been employed for centuries.

> *"One must understand that each ecosystem has a relationship to each other. That is Hilly/mountainous country and high ground country feed them with water runoff and the water is carried through these systems to ensure that other ecosystems are watered. This is what being a* (Michael Ghillar Anderson Anderson, pers. comm.).

Over the recent decades there has been a significant increase in the number of community driven Aboriginal natural and cultural resource management projects in Australia, resulting from in increasing legislative support for Aboriginal land ownership and self-determination. This has been recently described as the fastest growing sector of Australia's conservation effort (Hill et al. 2013 cited in Ens et al. 2015) with Australian TAK providing significant contributions to national biological conservation priorities, particularly in relation to fire management, threatened fauna and water rights and planning (see Ens et al. 2015 and references therein).

Noble et al. (2016) note the cultural significance for freshwater biota, such as eels, other finfish, bivalves, and crayfish, to Aboriginal peoples and their understanding and respect for the freshwater ecosystems on which their community survival depends in Australia, New Zealand and North America. Integrating Aboriginal stewardship and ecological knowledge into effective co-management strategies for sustainable freshwater fisheries, such as Aboriginal rangers, research partnerships, and Indigenous Protected Areas (IPA), is becoming more widely accepted and practised (Ens et al. 2015, Nobel et al. 2016).

Text Box 1: Euahlayi Totemism and the Eco-Systems. Prepared by Michael Ghillar Anderson)

The Euahlayi totemic association with the natural eco-system (the world, as it is said by the Bhurrah [people] of the Euahlayi) is a relationship referred to as, the family. In this case, we all have obligations to each other. Man is not superior, but rather, the carer and must always be on hand to protect their family. It is said by the old people, that, if you fail to protect your mob [family], they will all die out and disappear.

The Euahlayi Bhurrah (people) describes their mob [family] (eco-system) as shown in the figure overleaf and in Appendix C. This is only a brief insight into the Euahlayi totemic connections with the Bhurrah's (people). The relationship arises from the fact that the Names of the Phraties, represent the "Mimi's" (Creator Grand-mothers). All that belongs to an eco-system are the children of the Mimi. The 'Mimi's' are; Nyoongar; Mirri-yhar; Ghurrie and Murroo- ghoo, Bibblar (these two are twin sisters).

Mimi	Nyoongar	Mirri-yhar	Ghurrie	**Murro-ghoo** and **Bibblar** (twin sisters)
Clan	**Nyoongarbhurrah**; People of the Kurrajong Tree	**Mirri-yhar**; Lignum	**Ghurriebhurrah**; People of the 'Ghurrie'	**Murroo- ghoo, Bibblar**; that is, the Bibble Box and Belah trees
Head totem(s)	Dthoolung-gay-yar (Bilbi) {now extinct in the Euahlayi 'Dthouri' (country/land)	Bhee-wee (large yellow and black stripped goanna)	Emu	Ghoo-you (Bandicoot) and Moodthi (opossum)
Group totems	• Ooboon, blue tongue lizard • Dthoo-you, red belly black snake • Bouy-you-gar, centipedes • Dthoo-you-gurar, Myall earth worm • Dthurrinbandi, large green frog (known as croaking frog) • Oooyan, curlew • Bouy-you-doorinillee, grey crane • Dirree-ree-ree, willy-wagtail • Millan, sour top (onion like. Is poisonous if not soaked in water for 24 hurs) • Wee, small guppy or much fish found on open land waters • Ghurree-yhar, crocodile • Wah-R, shells of muscles	• Gay-gay, cat fish • Tucki, boney bream also known as Silver bream • Ghoorree-quin-quin, butcher bird • Ghoo-ghoo-rrah-ghar-ghar, Kookaburra • Dtheen-bee, divers • Birroo-birroo, sand pipers • Dtheegun-boyer, soldier bird • Weedar, bower bird • M|oorreegoo, black ibis • Bollon, white crane • Noodle-noodle, whistling duck • Moonun-googy-goo-we, horse fly • Moonin, mosquito • Gulghurrar, water lizard • Ghurray, native pine • Gweebit, native type passionfruit • Mooloowerh, a shrub with creamy flowers • Goodooga, big yam • Curly Mitchell grass • Guddee-boon-doo, bitter bark extract • Boonburr, sap of the black wattle • Dtalinghar, native fuschsia	• Good-do, Murray cod • Ingar, crayfish • Boomool, shrimp • Gumbarl, silver bream • Moogra-bhar, magpie geese • Bhi-yhar-mull, black swan • Eerin, little night owl • Beer-won, native swallow • Bullar-bullar, butterflys • Gidghee, an acacia tree • Dtheen-yee, ironbark tree • Guthar, quandong • Grew-wee, fruit bearing tree like quandong • Nyew-un, wild melon • Yarran, big River Red Gum by rivers edge • Binnar-mayah, big salt bush • Mitchell grass • Ghar-whar-ghoo, the water spirit, featherless emu who lives in the Wurruboorrool (Milky Way) belongs to this group (eco-system) • Dtheeli-why, Sacred fire	• Why-amber, turtle • Mungghee, pipi type muscle • Moondo, wasp • Goo-you, king brown snake • Murgar-moogar-wee, scrub spider • Bay-yer, green ant • Doo-you-wee, red=black meat ant • Dthayar-minnar, small carpet snake • Doommar, top knot pigeon • Gwenee-boo, robin redbreast • Munghee-wurray-wurray-mul, seagull • Boondoon, kingfisher • Eurah, dog wood • Bingar-wingul, needle bush • Never fail grass • Gibboon, small yam • Bumble, wild orang, *Capparis mitchellianni* • Illay, hop bush • Mirri, wild current bush • Birrar, whitewood • Biggi-billar, porcupine (Echidna) • Gulg-ghar, ant beds

Figure 1: Euahlayi Totemism and the Eco-Systems

1.3 Describing ecological character

1.3.1 Content

The primary focus of this report is on the ecological character of the two cultural water trial sites, Toogimbie IPA, near Hay and Gooraman Swamp, near Weilmoringle New South Wales (NSW); cultural character of the trial sites is summarised and reported separately (NCFRP 2016). For each of the trial sites an ecological character description is presented, describing the western science ecological knowledge, focusing primarily on the water dependent components, processes, functions and services. Where there is documented TAK, such as Dykes et al., this is incorporated, however the emphasis of this report is on the 'Western' science description of the ecology of the sites.

The character descriptions include the following:

- Catchment and river system overview.
- Site description including spatial boundary.
- Known environmental values.
- Ecosystem types.
- Ecosystem components.
- Ecosystem processes and functions.
- Ecosystem services.
- Threats to ecological character.
- Conceptual models.

1.3.2 Approach adopted

The approach of the Australian Government in describing ecological character for meeting Ramsar Convention obligations has been used as the basis for describing the ecological characteristics of the two sites, focusing on components, processes and functions. Ecosystem services include many of the cultural values associated with each of the sites and will be addressed in detail in other outputs from the project. For the purposes of this report the following terminology applies:

- **Ecosystem components** include the physical, chemical and biological parts of a wetland (from large scale to very small scale, e.g. habitat, species and genes) (Ramsar Convention 2005, Resolution IX.1 Annex A).
- **Ecosystem processes** are changes or reactions which occur naturally within wetland ecosystems. They may be physical, chemical or biological. This equates to process such as carbon cycling, denitrification, acidification, sedimentation, migration, breeding, reproduction, etc. (from Ramsar Convention, Resolution V1.1).
- **Ecosystem functions** are activities or actions which occur naturally in wetlands as a product of the interactions between the ecosystem structure and processes. Functions as defined by Ramsar include flood water control; nutrient, sediment and contaminant retention; food web support; shoreline stabilization and erosion controls; storm protection; and stabilization of local climatic conditions, particularly rainfall and temperature (from Ramsar Convention, Resolution V1.1).
- **Ecosystem services** have been classified in a number of ways since being first introduced by Daily (1997), and became widely accepted with the advent of the Millennium Ecosystem Assessment (MEA) in 2005 (Millennium Ecosystem Assessment 2005, Costanza 2008, TEEB 2010). In this project, the refinement of the MEA classification approach proposed by Fisher et al. (2008) has been adopted which redefines the MEA "ecosystem services" as including: benefits, intermediate and final ecosystem services:

- Intermediate ecosystem services as those that form part of a 'cascade of services' that support one another and underpin final services. And,
- Final ecosystem services as those that are directly used by people to provide benefits.

Overall, ecological character is the sum of the components, processes, functions and the services and benefits supplied by a wetland ecosystem. An ecological character description describes what is present (components), how they interact (processes), what the wetland does (functions) and how humans can benefit from the services provided (Figure 2).

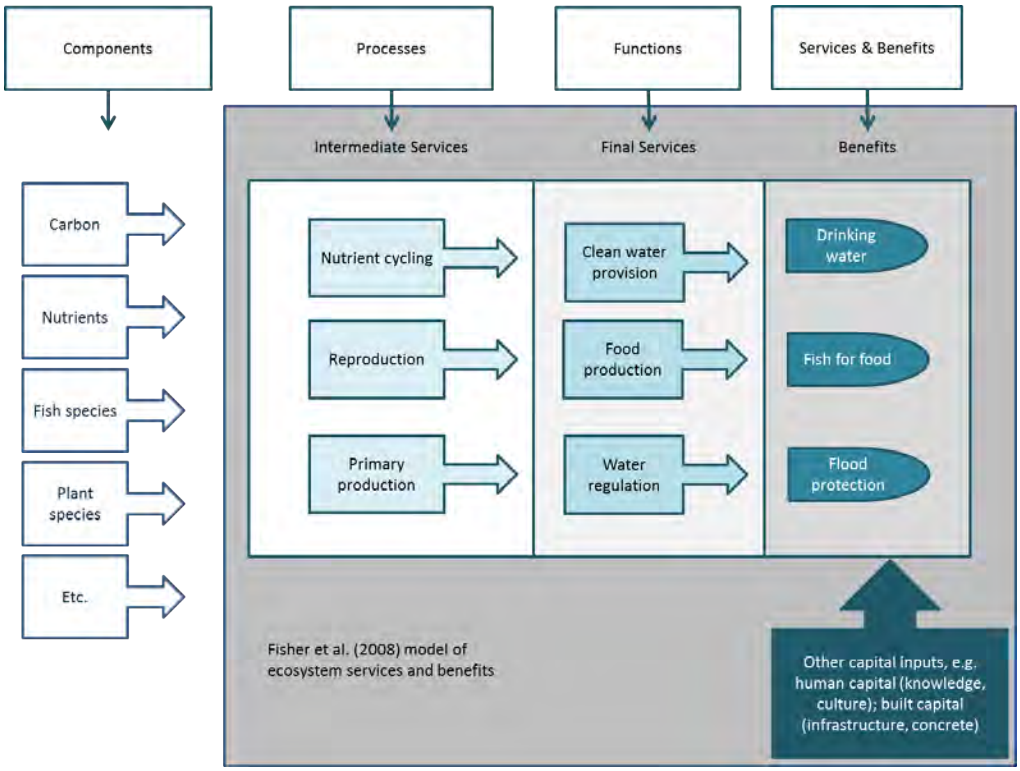


Figure 2: Modified Fisher et al. (2008) model of ecosystem services and benefits (modified from Butcher 2014).

2 ECOLOGICAL CHARACTER OF THE TOOGIMBIE IPA

2.1 Catchment and river system overview

The Toogimbie IPA is located on the floodplain of the Murrumbidgee River in southwestern NSW, at the eastern margin of the main Lowbidgee Floodplain that extends from Hay downstream to the Murray River (NSW OEH & NSW Office of Water 2014). In this reach, the main river channel sits within a very flat and expansive floodplain with extensive marginal swamps and wetlands (SKM 2011). The local climate is made up of temperature extremes in summer and winter (Table 1), but relatively consistent rainfall patterns (e.g. monthly winter-spring rainfall of approximately 26 to 36 mm, summer-autumn monthly rainfall of approximately 26 to 35 millimetres (mm); source: Bureau of Meteorology; http://www.bom.gov.au/climate/averages/tables/cw_075031.shtml)).

Table 1: Summary of monthly climatic statistics for Hay, NSW (1881-2015)

Statistic	J	F	M	A	M	J	J	A	S	O	N	D
Mean maximum temperature (°C)	33.1	32.6	29.2	24.1	19.3	15.8	15.1	17.3	20.7	24.6	28.4	31.2
Mean minimum temperature (°C)	16.7	16.5	13.8	9.9	6.8	4.5	3.5	4.6	6.7	9.5	12.5	14.9
Mean rainfall (mm)	27.3	29.7	30.1	27.7	34.6	35.8	31.1	31.9	31.2	34.6	25.8	26.8

The Murrumbidgee River is the second largest river in the Murray-Darling Basin and is home to more than 25 per cent of the Murray-Darling Basin's population. Land use is dominated by dryland grazing and cereal based cropping, which account for more than 75 per cent of land use in the Murrumbidgee River Valley. An additional five per cent of the catchment is irrigated, producing rice, grapes, citrus, vegetables and other crops and livestock (MDBA 2014). The Murrumbidgee catchment also includes the Ramsar listed site of Fivebough and Tuckerbill Swamps, and two wetlands of national importance - the Mid-Murrumbidgee Wetlands and the Lowbidgee Floodplain (Environment Australia 2001, NSW Government 2014).

An overview of the Murrumbidgee River operating environment can be obtained from SKM (2011). Cultural, environmental and irrigation assets can be watered by releases from Blowering and Burrinjuck dams, but water delivery is constrained to in-channel flows that inundate the main river channel and low lying wetlands and creek systems with commence-to-flow thresholds occurring below bankfull height (Commonwealth of Australia, 2012a, 2014). Low-lying wetland assets include the Mid-Murrumbidgee wetlands, and areas of the Yanco-Billabong Creek system and Old Man Creek system. Pumping water directly to wetlands is possible in some cases, including at Toogimbie Station.

2.2 Toogimbie IPA

Toogimbie Station is located approximately 35 kilometres (km) west of the town of Hay on the Hay Plain, adjacent to the Murrumbidgee River in south-western NSW. It is a former pastoral property dating from the introduction of farming to the region in the late 1800s (DEWR 2007). Covering around 460 square km, Toogimbie IPA is owned and managed by the Nari Nari Tribal Council.

(NNTC) (Figure 3). The Toogimbie IPA landscape includes flat former pasture lands contrasting with eucalypt-lined creeks and waterways, and a nearby floodplain. Particularly important to the Nari Nari people is Toogimbie's wetlands, which are home to totem animals, native resources and traditional medicines.

The Hay area was once part of a major Aboriginal trade route and large social and cultural network (DEWR 2007). Much of the cultural history of the local Aboriginal people was disrupted by European settlement. Toogimbie IPA activities seek to preserve important assets such as protecting scarred trees, campsites and burial mounds, as well as helping to reconnect the people to their land. Toogimbie IPA represents both a visual and spiritual link between the health of the land, its water systems and its people.

The Toogimbie IPA is situated on the broad floodplain of the lowland Murrumbidgee River. The natural flow pattern of the river is for high flows in winter and spring fed by upland areas that include the Australia Alps, followed by low flows in summer and autumn. However, upstream water storage and flow regulation means that overbank flows that would sustain ecosystem processes and important river, floodplain and wetland flora and fauna, are now of reduced frequency and duration (MDBA 2012a and 2012b).

2.2.1 System bounds – Toogimbie IPA cultural water trial boundary

The Toogimbie property covers approximately 7,500 hectares, of which approximately 4,600 hectares is included in the Toogimbie IPA and 2,900 hectares held under lease. Approximately 2,000 hectares (MDW Ltd 2011, Smits 2014) across the north of the property is floodplain that is inundated from the Murrumbidgee River when river levels exceed 26,000 megalitres per day (ML/D) (Figure 3). This area includes a river bank/riparian terrace and low-lying floodplain with flood runners. There are also higher depressions flooded from rainfall runoff.

Within the Toogimbie IPA, approximately 900 hectares are contained in four previous irrigation bays (cells), of which three have the potential to receive water as part of the cultural watering trial (Figure 5). The fourth cell is unlikely to be watered as the infrastructure (e.g. embankments) at the western boundary is currently insufficient to contain water on site.

As part of the original cultural water trial, the floodplain and associated flood runners within cells 1 to 3 were identified as the main areas of interestfor the watering trial. These cells were selected because they are enclosed by embankments, thus enabling water management between each of the cells. While cell 4 was identified as a 'control' (similar to other cells but not receiving water as part of the trial) and point of comparison for assessing the outcomes of the intended flow trial.

However, owing to the intervention of a natural flooding event at the Toogimbie site, the scheduled flow trial could not be undertaken as originally planned. Instead, a post-flood environmental assessment was undertaken which enabled the before and after effects of the flood to be compared.

Figure 3: Case study site in relation to Toogimbie IPA and hydrological features

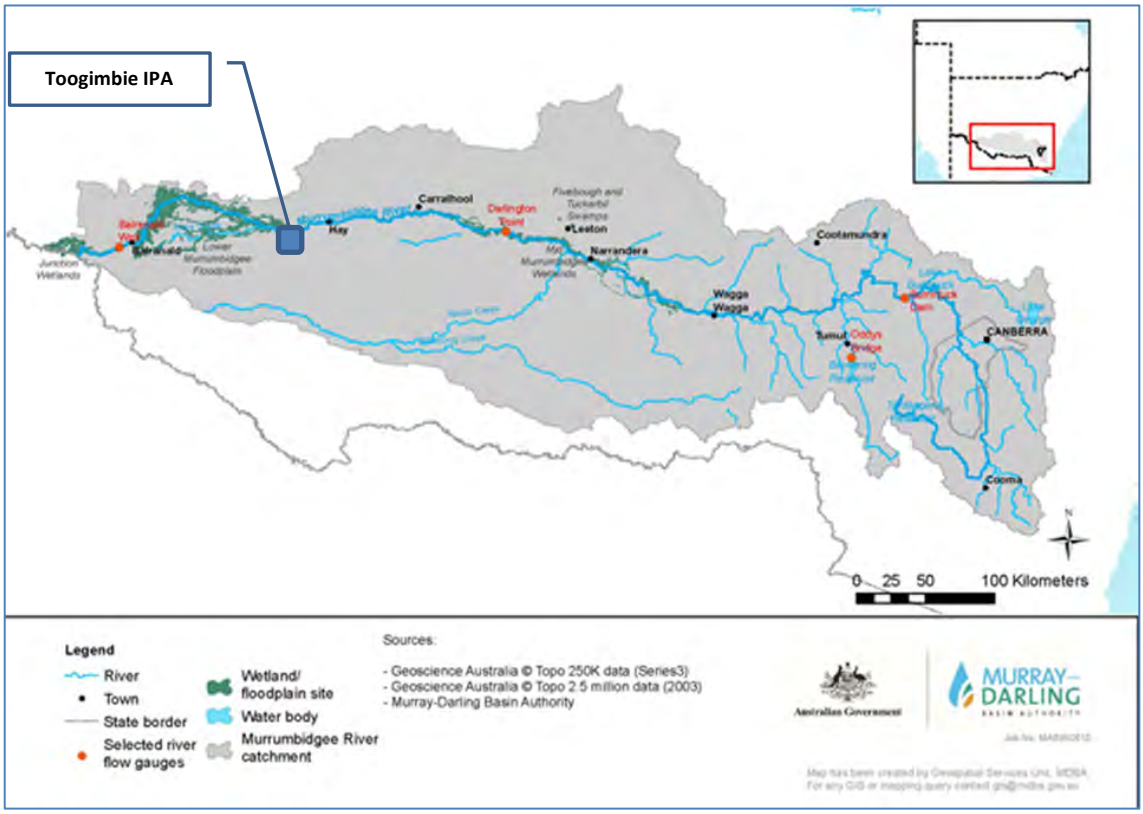


Figure 4: Map of the Murrumbidgee River Valley (courtesy of the MDBA).

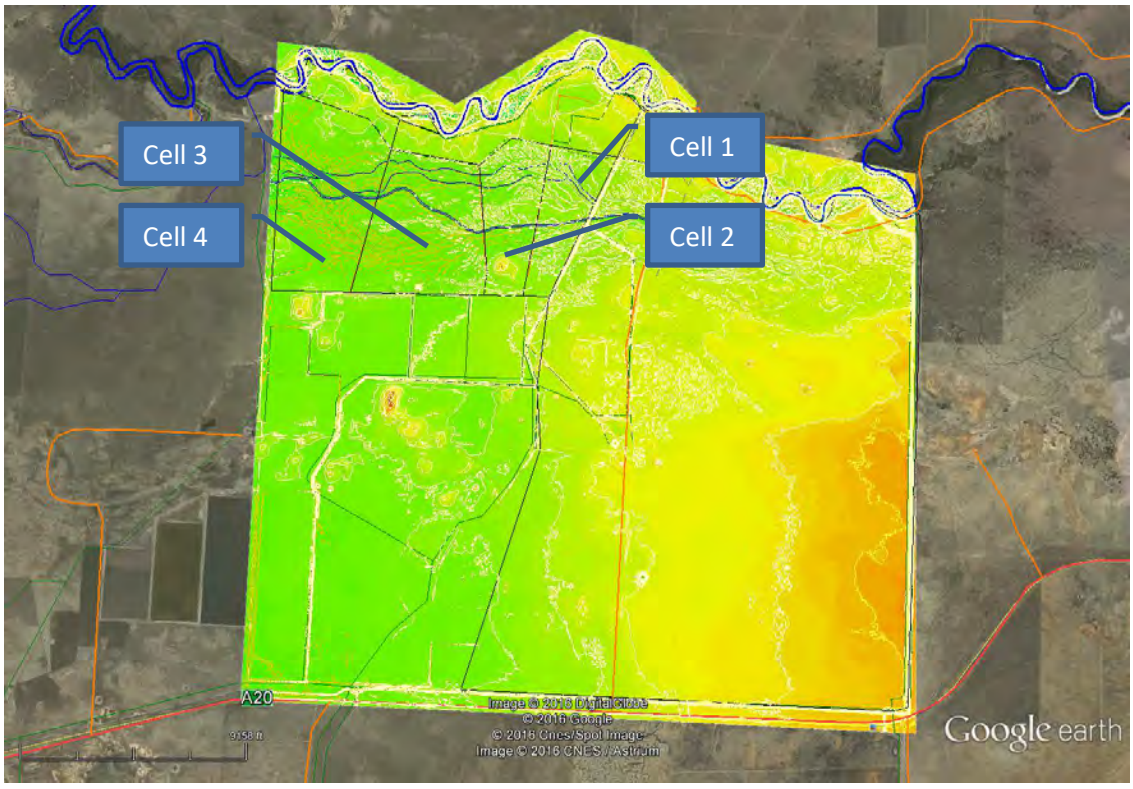


Figure 5: Locality of the watering units (cells) that will be the focus of the cultural watering trial (C. Gippel, pers. comm.).

2.3 Cultural values and TAK

2.3.1 Cultural values

The management plan for Toogimbie IPA (Nari Nari Tribal Council 2012) identifies the following cultural values attached to the site:

- A sense of ownership and connection to Culture and Country.
- A place to share and experience knowledge, stories and practices as a community.
- A place to visit and reconnect physically to Culture and Country.
- The location of significant Aboriginal sites, especially burial and occupation sites.
- Socio-economic potential for community.
- Maintenance of bush medicine and food sources for generations to come.
- A place to harvest fish, hunt and gather foods and medicinal plants.
- The potential to gather and share Cultural knowledge, stories and experiences with others.

2.3.2 Toogimbie IPA Traditional Aboriginal knowledge

Published and publicly available TAK is limited for the Toogimbie trial site. Research into TAK has not taken place and the Nari Nari community is seeking to rectify this through the use of cultural water and ongoing stewardship of the IPA.

> "*The project [NCFRP] has triggered so many memories and stories, which I have never shared or spoken about with family or friends about my life and culture*". - Ian Woods, pers. comms 2016. (Key nation Contact, Nari Nari Tribal Council)

Some TAK has been recorded during field trips associated with the cultural watering and include the following (see NCFRP in prep):

- The Nari Nari understand that wetlands and rivers are connected systems, and that what occurs upstream is significant and impacts on what happens downstream.
- Aboriginal stewardship of water resources acknowledges downstream users.

> *"My understanding of the wetland has increased [as a result of the project]. I always knew lignum needed to be watered, but not how much, or how often in order for it to be healthy"*
>
> *"The science backs up the cultural data and our science*".
>
> - Ian Woods, pers. comms 2016. (Key nation Contact, Nari Nari Tribal Council)

2.3.3 Culturally significant species

Flora and fauna identified as culturally significant at the Toogimbie IPA are listed in Table 2. Descriptions of TAK for Black swan, lignum, and Nardoo are presented in Text Boxes 2 to 4 overleaf.

Table 2: Culturally significant species at Toogimbie IPA (Williams and Sides, 2008).

Wiradjuri name	Common name	Scientific name
dhuundhuu / ngiyaran / gunyig	Black swan	*Cygnus atratus*
maliyan	Wedge tail eagle	*Aquila audax*

Wiradjuri name	Common name	Scientific name
bururrgan	Straw necked ibis	*Threskiornis spinicollis*
gulambali / gulaygali / birriyag	Pelican	*Pelecanus conspicillatus*
murrugaya	Spoonbills	*Platalea regia* (Royal spoonbill) *Platalea flavipes* (Yellow spoonbill)
bagadaa / muliyan / yibaay	Hawk	Several possible species
gulaangga(frog)	Southern bell frog	*Litoria raniformis*
gweeargal	Lignum	*Duma floruenta*
nagaadha / ngaadhu / ngarru	Nardoo	*Marsilea* sp.
budhaay / budhaany	Old man weed	*Centipeda cunninghamii*
bulaguy / miranggul	Old man saltbush	*Atriplex nummularia*
gubudha / dhiriil / dyirill	Common reed	*Phragmites australis*
gulumba / gulibaa	Box tree, coolabah	*Eucalyptus microtheca*

Text Box 2: Aboriginal values of the Black Swan.

Note: The following example of TAK is for demonstrative purposes only. It is not intended to be representative of all Aboriginal communities or individuals. TAK will vary depending on cultural context. Information provided is based on the shared cultural knowledge of Narungga Elders from Yorke Peninsula, South Australia.

Black Swans

When a non-Aboriginal person looks at a black swan they look at a beautiful wild bird. When an Aboriginal person looks at the black swan through our unique cultural lens, we see something much more than the majestic beauty of the wild bird. We see the connectedness of the black swan to the cultural and spiritual wellbeing and other aspects which the black swan brings to the lives of Aboriginal people.

Historically there is a whole education aspect to what the swan 'is'. In simple terms it is food and so is the egg. The feathers were used for down to sleep on before mattresses became commonplace and on occasion used as quills to write with. In Aboriginal society the importance of totems or Tjukurpa's are well documented and totemic responsibility is for the sustainability of the particular totem. Totems have a spiritual connection to the creation and these connections are passed down through the lore, via songs, stories and ceremony. Every living thing has its place and role in the world. Education and transference of knowledge of is important.

In relation to the black swan, the hunting of it is a process which includes mastering the skills of making and using the various implements made from a variety of natural materials. This leads on to knowledge of what type of wood and where to source the wood. What implements are used or needed to make the spear, boomerangs, wadi's and woomera's to be used and the stone used to cut and fashion the wood into the right shape and size.

- Stone is needed to make the axe and knife that is used to cut and shape the wood to make the tools.
- Kangaroo sinew and gum from a particular tree is needed to form the bond which will ensure the sharpened stone is fixed to the wooden handle to make the stone axe.
- Fire is needed to close the bond.

Often one or more of the materials required to complete the above activities (fire, stone, wood), would be sourced through trade as there are not many places where all the required raw materials are readily available.

Once the swan is captured, the sharing of the meat is not a simple thing. Particular parts of the bird are eaten by different members of the family. This is to ensure that all share the bounty, but the hierarchy of what is eaten and by whom are historical and culturally defined. While the meat from the body is consumed, the wings will often be used as a broom to keep the camp sites clean.

When available, the eggs are considered an excellent source of food. To collect them, first you need to prepare a scoop. This makes gathering the egg easier and ensures you are not bitten by a snake (who also wants the egg for food). The scoop is usually made from a branch with a fork cut to affix a woven net / basket. To make the scoop, you need a long thin branch with a fork on the end. Cut the branch about six inches above the fork and then attach a net that is woven from the rushes on the banks of the river.

To prepare the rushes, first they need to be dried and have the fibers broken so that they are pliable for weaving. The small woven basket is attached to the branch where the fork is cut using kangaroo sinew, gum and heat from the fire to consolidate the melting of the sinew. This is the same method when making the stone and hunting tools.

To access the best nests a canoe is often required. This is made by taking bark from a large tree, leaving behind what is now referred to as a culturally modified or scarred tree. While making the canoe you also have to make paddles and a couple of coolamons to gather other food. This is a lengthy process which take times. Not all trees are suitable for canoe or coolamon production. Once removed the wood is treated and smoked prior to use.

To make all of these things it takes time and if you don't take notice of the weather and the season you will miss the optimum time to harvest. The swan eggs will be all hatched and not suitable for eating. So knowledge of the seasons and breeding cycles of the swan is critical.

Some of the eggs are eaten by cooking in the ashes and others are blown so that they can be used for making ornaments. All of this is about survival, the spiritual connectedness to the environment and the education of children to ensure the knowledge and practices are passed on. There is a reason for every living thing to be here on earth and the creation stories tell how things come to be.

As you can see there is much more to the swan in Aboriginal society than looking at its beauty. There is a whole spiritual, cultural and education process that leads to the catching, eating and cultural use of the bird. Catching a swan is not a moment in time activity. These ares extensive and important cultural practices, learning and teachings that go into the activity. This ensures the cultural wellbeing and survival of Aboriginal people throughout millennia, by knowing our role in keeping and maintaining the balance between the spirit world and the terrestrial world.

These connections outlined here for the swan are also important for other species of water birds, bush foods and plants such as the emu, nardoo and lignum.

Text Box 2: Traditional Aboriginal Knowledge relating to Lignum.
Note: The TAK noted in the example below is for demonstrative purposes only and is not representative of all Aboriginal communities or individuals. TAK will vary depending on cultural context.

Lignum is a large shrub which grows on the flood plains, in intermittent wetlands, billabongs and alongside creeks and rivers in areas where the black box and red river gums are plentiful (Williams and Sides, 2008:89). It provides nesting opportunities, cover and safety for a variety water birds.

The importance of lignum to Aboriginal people is not so much in its use, but rather in the role it plays within the ecosystem. As a valuable food source, lignum helps support an array of birds and native animals (such as *Durrawiyung, Burrurgiyan* and *Wululu* – teal and pink-eared ducks and straw-necked ibis) and in-turn supports hunting and tucker for Aboriginal people (McKemey and White, 2011:129; Williams and Sides, 2008:89). When healthy and bountiful, lignum can provide excellent cover for Aboriginal people when hunting.

Lignum bush recorded at Toogimbie IPA post 2016 flood. Image © NCFRP.

Text Box 3: Traditional Aboriginal Knowledge relating to Nardoo.
Note: The TAK noted in the example below is for demonstrative purposes only and is not representative of all Aboriginal communities or individuals. TAK will vary depending on cultural context.

Nardoo is an important plant for Aboriginal people. Although well-known for its potential contribution to the demise of Burke and Wills, nardoo is one of many poisonous plants that Aboriginal people eat (McKemey and White, 2011:207). Children would be educated in the importance of knowing which plants to eat, which has a poisonous effect on the body and how to treat or prepare the plant to ensure it is safe to eat.

Nardoo is an aquatic fern found in damp and wet areas, where it can often form a dense mat on the edge of billabongs and other still areas of water (Williams and Sides, 2008:88). The plant is easily identifiable owing to its four leaflets, which resemble a four-leaf clover (McKemey and White, 2011:207). The spores of the plant are contained in a small, hard sporocarp, which is the part eaten by Aboriginal people (not the leaves).

The sporocarp seeds once collected are dried before being ground into a flour and then mixed with a little water to form dough. The dough is cooked in the ashes to make small loaves of bread, or it is mixed with a larger quantity of water and drunk as a thin porridge or gruel (McKemey and White, 2011:207).

To prepare the flour, grinding stones would be required. If the community did not have access to the correct stone (raw) material, they would be required to trade with neighbouring communities. As the stones are quite heavy, rather than carry them from place to place, they would often be turned upside down and stored in a safe place for people travelling through or for a particular ground when they returned (HLALC & Schade, 2008:26).

Yandruwandha elder, Benny Kerwin (cited in Hercus and Sutton 1986) explained to Gavan Breen how the nardoo was prepared:

> "*Ngardu ngala, parndringa ngandra, nga pinakanga nhulu pitjili. Ngapala ngapa kurrari nga thayinga ngapali. Kathi thukali ngala thayi-rnangatji marna-ngadikinitji mandri-rnanga. Kathi thukali, walya kalpurru thalpali or walya darlamurruli, ngarru kathi thukali mandri-rnanga*."
>
> "Then there is the nardoo. They crush it and then rock it in a coolamon. Then they pour the water on it and eat it with the water…They eat it by spooning it into their mouths with a mussel [shell], not with a coolabah leaf or with bark, only with a mussel".

Ian Woods, an elder of the Nari Nari, remembers in addition to eating, nardoo was used to make flour. The flour would be placed on the ground encircling the base of the tree as a bait for possums. The possums would be attracted to the flour, making them easier to hunt. Once captured, the fur of the possum would then be used to make skin cloaks and other bits of equipment, while the meat would be consumed (Woods pers. comms 2016).

2.3.4 Relationship to environmental values

The Toogimbie IPA management plan (Nari Nari Tribal Council 2012) identifies environmental values attached to the site that the Nari Nari community seeks to improve by the use of cultural and environmental water. These include:

- Significant nesting and breeding area for wetland bird species.
- Shrubland and plains country, unaffected by stock, and with noxious and feral species controlled.
- Riparian zones, streambank areas and the Murrumbidgee River - habitat for native aquatic and mammal species.
- The potential to attract regional threatened species, once habitat is further established and improved.
- A protected area within surrounding farmland.

2.4 Environmental values

A number of environmental values have been assigned to the Toogimbie IPA (NNTC 2012, Smits 2013), including:

- Streambank, riparian and floodplain vegetation in a region that has been cleared of much of its native vegetation.
- Streambank vegetation that provides structural habitat (e.g. snags, undercuts) for native fish in the adjacent Murrumbidgee River.
- Wetland and floodplain habitat for plant and animal species (birds, reptiles, amphibians, mammals):
    - Significant foraging areas for birds, with potential to expand the number of waterbirds that forage and/or perhaps breed as wetland and vegetation rehabilitation initiatives continue.

The cultural values associated with the site are presented separately in a cultural character description for the site (see Preliminary Findings Report, Component 2).

2.5 Ecosystem types

The Australian National Aquatic Ecosystem (ANAE) classification has been applied to river, wetland and floodplain units within the Toogimbie IPA. ANAE uses attributes such as water regime and vegetation attributes as part of its classification (Brooks et al. 2012). The ecosystem types present at Toogimbie IPA have been taken from the ANAE classification applied to aquatic ecosystems of the Murray Darling Basin (Table 3). Of most relevance for the watering trial are the lignum swamp and lignum floodplain areas that make up a large portion of the cells that will receive water.

Table 3: Summary of aquatic ecosystem types present at the Toogimbie IPA (modified from Brooks et al. 2012).

Category	ANAE Type	Comment
Riverine	Permanent lowland stream	Main channel of the Murrumbidgee River. Riparian vegetation consists predominantly of river red gum and black box woodland that extends approximately 0-300 metres from the banks of the river.

Palustrine	None listed	The presence of river red gum and black box woodlands bordering the Murrumbidgee River and lignum floodplain in low lying areas suggests the following wetland types are present: • Intermittent river red gum swamp • Intermittent black box swamp • Intermittent lignum floodplain swamps
Floodplain	River red gum forest floodplain Shrubland floodplain Sedge/forb/grassland floodplain	The presence of lignum suggests that: Lignum shrubland floodplain is also present.

Note: see Brooks et al. 2012 for details of the ANAE classification

2.6 Ecosystem components

This report focuses on biota likely to have a strong response to watering; therefore, not all biota that might occur at the site will be discussed in detail. Consideration will mostly be limited to wetland dependent species, as these are the ones most likely to respond to water management.

2.6.1 Hydrology

The hydrological connection of floodplain areas with the main channel of the Murrumbidgee River is a crucial ecological component of the Toogimbie IPA. This river-floodplain connectivity drives numerous ecosystem processes and functions, and provides habitat for the flora and fauna that occupies or utilises the floodplain (Hay Local Aboriginal Land Council & Schade 2008, Pennay et al. 2002).

River regulation caused by upper catchment dams (Burrinjuck and Blowering dams) and water management downstream from the dams has strongly influenced the frequency and duration of floodplain inundation along the lower Murrumbidgee River. Bankfull discharge at Hay is approximately 27,000 ML/d and river regulation has resulted in a decrease in the frequency of overbank flows. For example, it was found that flood frequency declined by 43% between 1970 and 1998 (Page et al. 2005). The natural seasonal pattern (higher winter-spring flows and lower summer-autumn flows) remains, but average daily flows in each month are now less than would have occurred without water resource development (MDBA 2012a, Figure 6).

When flooding occurs, water enters Toogimbie IPA directly from the Murrumbidgee River at the top north-eastern corner of the property (Figure 7), and from the property directly to the east (upstream). Water then spreads onto the floodplain and passes through various floodplain and irrigation blocks before discharging to the Fiddlers Creek system, which is the upper portion of the Lowbidgee floodplain. In recent years, and given the reduced frequency of flooding, the Nari Nari people have made use of a Cultural Access Licence (CAL) under the Murrumbidgee Water Sharing Plan (Government of NSW 2003) to pump water from the Murrumbidgee River for the purposes of floodplain vegetation rehabilitation.

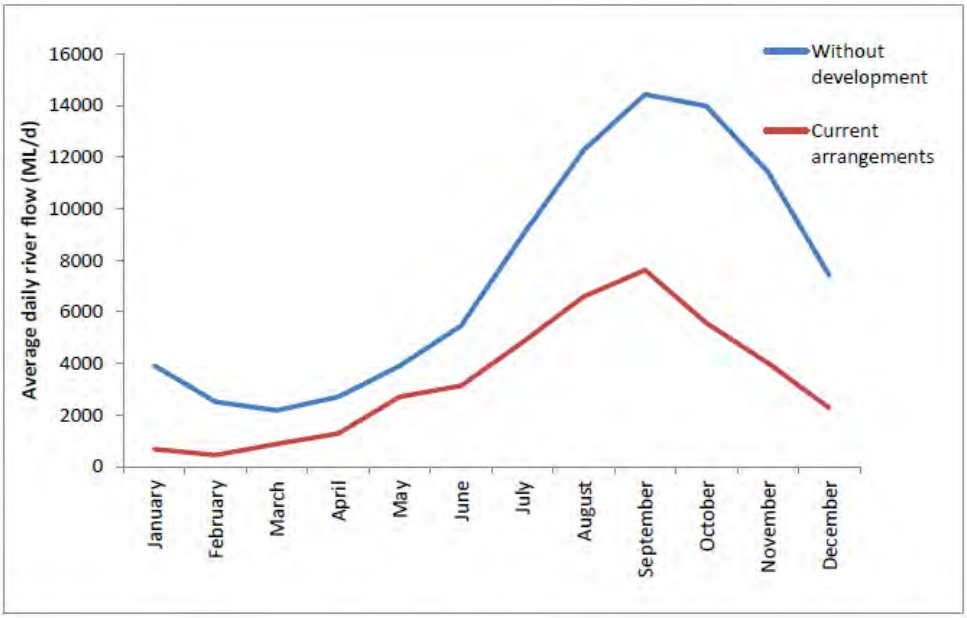


Figure 6: Modelled monthly flows for Murrumbidgee River at Balranald under without-development and baseline (current arrangement) conditions for the period 1895-2009 (from MDBA 2012a).

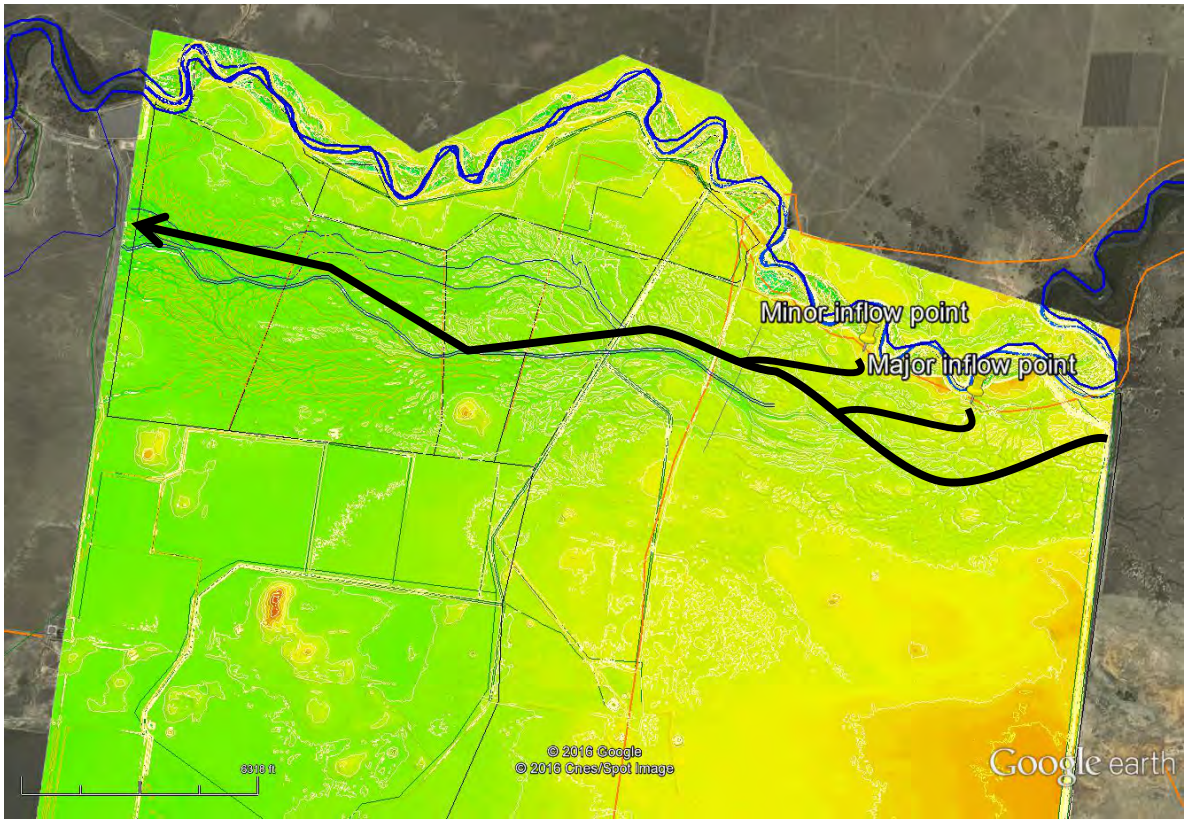


Figure 7: General path of natural floods across the Toogimbie IPA.

2.6.2 Vegetation

Prior to the return of Nari Nari Tribal Council ownership, Toogimbie was managed as an agricultural property, predominantly for cereal cropping (J. Woods, pers. comm.). Numerous factors, such as overgrazing, cropping, damage by feral pests (e.g. pigs), drought and reduced flood frequency meant that the condition of the land and associated native vegetation, including that of wetland and riparian areas, had become degraded. Since resuming management, the Nari Nari people have undertaken extensive rehabilitation works as part of their plan of management (NNTC 2012), including revegetation works that include replanting, reseeding and watering.

The Toogimbie IPA contains remnant areas of river red gum and black box woodlands adjacent to the Murrumbidgee River (up to approximately 300 metres (m) from the river), surrounded by lignum and saltbush (chenopod) shrubland and grasslands in floodplain areas (Smits 2014). These vegetation communities contain numerous plants that are highly significant to the Nari Nari people, being a source of food, fibre (e.g. for making baskets and other utensils), medicines, tools and shelter (Hay Local Aboriginal Council & Schade 2008).

A recent vegetation survey (Smits 2014) along thirteen 100 m transects recorded a total of 83 native species and 10 weed species across the four irrigation cells (note: transects did not include river red gum and black box areas near the banks of the Murrumbidgee River). Native species predominated along each transect, with weed species making up 0 to 27% of the species recorded. Some of the most common native species present at the site include:

- Lignum (*Duma florulenta).*
- Nitre goosefoot (*Chenopodium nitrariaceum*).
- Milkweed plains spurge (*Euphorbia planiticola*).

- Grey raspwort (*Haloragis glauca*).
- Common nardoo (*Marsilia drummondii*).
- Lagoon spurge (*Phyllanthus lacunarius*).

In addition, the Atlas of NSW Wildlife (OEH, www.bionet.nsw.gov.au) lists 57 plant species at the site (Appendix 1), of which 42 are native species and 15 are introduced. Overall, the high proportion of native species in an area previously cleared for agriculture suggests that rehabilitation of vegetation at Toogimbie IPA is succeeding, although still a work in progress (NNTC 2012).

The water requirements of many of the floodplain species encountered in lignum and saltbush (chenopod) shrubland and grasslands would be met if watering of the floodplain was targeted to meet the growth and regeneration requirements of lignum (see Table 4).

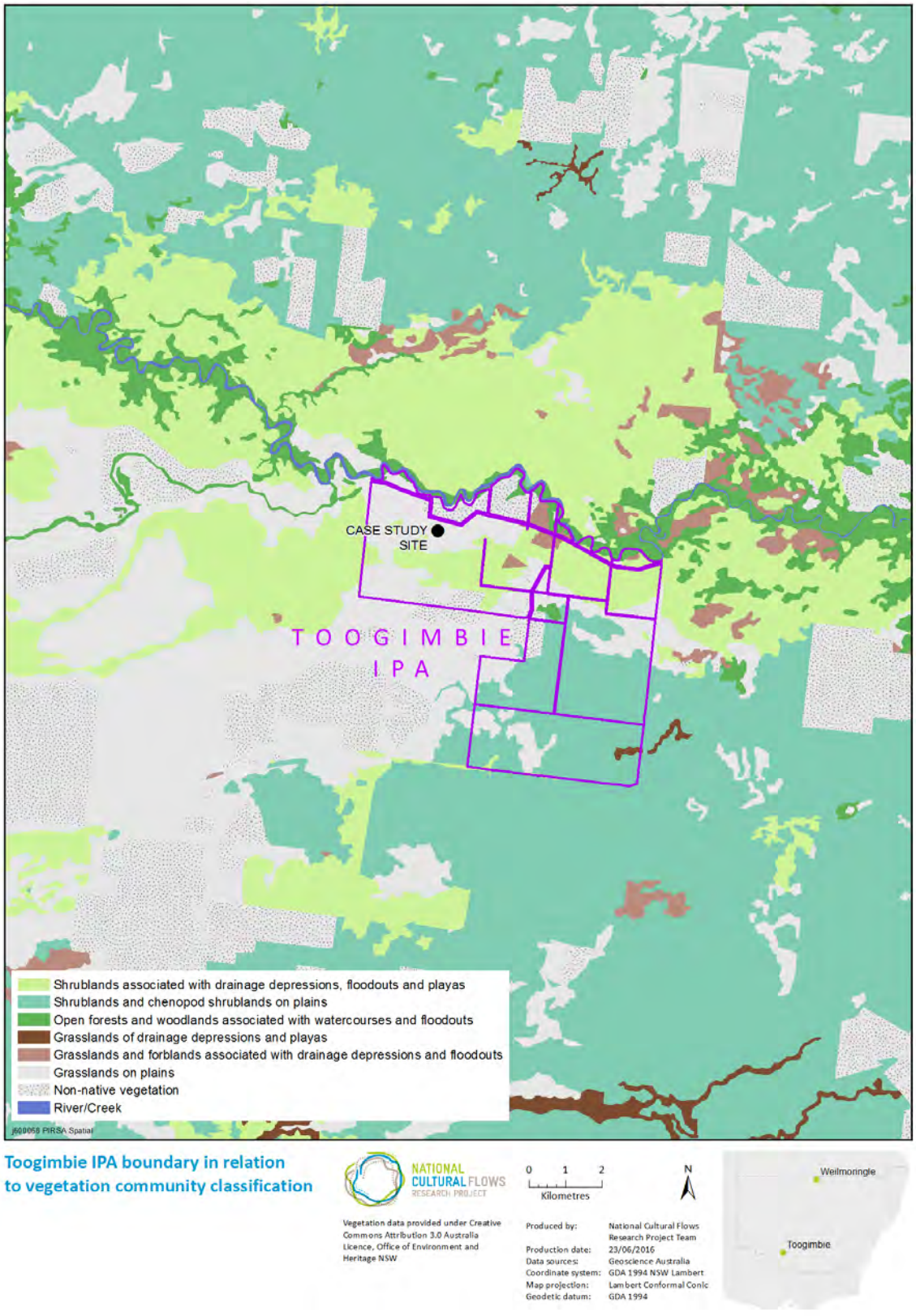


Figure 8: Toogimbie IPA and Case study Site in relation to vegetation community classification.

Table 4: Water requirements of lignum (*Duma florulenta*) from Roberts and Marston (2011).

Flow component	Water regime required to promote canopy health	Water regime required to promote regeneration and seed establishment	Water regime required to promote Seed germination
Frequency	About one to three years for large shrubs with vigorous canopy; every three to five years for healthy shrubs. Can tolerate less frequent flooding every seven to 10 years for small shrubs, but growth not vigorous. Small shrubs are not suitable as nesting platforms.	Sequential or sustained flooding may be needed to trigger flowering, set and then disperse seeds, and flood or water level recession to trigger germination.	Once per 12 to 18 months over first three years: desirable but not critical.
Depth	Not critical, generally less than 1 m.	Not critical.	Shallow, 5 to 15 centimetres.
Duration	About three to seven months for vigorous canopy. Avoid continuous flooding.	Not known. Long enough to wet soils.	Short, four to six weeks.
Timing/preferred season	Not critical. Follow natural pattern for site, or provide conditions suitable for understorey, wetland plant communities or dependent biota.	Critical. Autumn to winter. Flooding for dispersal and post-flood recession germination need to be within a few months of seed release, which is in autumn.	Before or during summer.
Seed establishment		Seedlings establish on wet soils of flood recession but growth is not maintained under drying conditions. Brief follow-up flooding when about nine to 12 months old to renew soil moisture (or substantial winter rainfall) would increase seedling establishment but is not critical. Maintenance-type floods should be avoided until seedlings are well established.	Re-flood after five to seven years to maintain vigour. Rootstock may survive unflooded with only rainfall for up to 10 years, but branches totally dead. Must be followed by optimal flooding conditions to re-establish vigour. Does not form a persistent seed bank. Periodic recruitment from seed is probably important to maintain genetic diversity

2.6.1 Fish

There is relatively little habitat suitable for sustaining native fish, other than in the Murrumbidgee River. Fish may on occasion enter floodplain and wetland areas of the Toogimbie property when water is pumped from the Murrumbidgee River, but do not survive once the floodplain and wetlands dry.

2.6.2 Birds

A fauna survey conducted in November 2002 (Pennay et al. 2002, Appendix 2) recorded 63 bird species on the Toogimbie IPA property, with the greatest diversity in and near the woodlands present along the Murrumbidgee River. The Atlas of NSW Wildlife (OEH, www.bionet.nsw.gov.au) lists 43 bird species at or adjacent to the site, including eight species of waterbird (Appendix 1). A recent bird survey within the four irrigation cells (did not include river red gum and black box areas) recorded 46 bird species (Smits 2014), which included seventeen species not listed for the site on the Atlas of NSW Wildlife. Waterbirds such as swans and ibis are also common visitors when the floodplain is inundated, whether by natural floods or environmental watering (J. Woods, pers. comm.).

Four species of cormorant, Australian pelican, herons and egrets have been recorded from the site. These species include fish as a large part, or all, of their diet. The cormorants and pelicans are likely feeding in the river, but resting and roosting in the wetland areas, whereas the herons and egrets will feed in both areas. Recent records for ducks are limited and probably reflect a limited survey effort at the site, with records only for Pacific black duck and Australian wood duck (Pennay et al. 2002, Smits 2014). Cryptic species, such as the rails and crakes are often difficult to see, with records for black-tailed native hen being the only species from this group.

The sensitivity of waterbirds to water level changes is largely dependent upon their nesting and rearing strategies. Except for fish-eating waterbirds, the depth of flooding is not directly an important feature for most species of waterbird, although many species do have preferences. In general, reed-nesting waterbirds that hatch in a relatively underdeveloped state and stay in the nest and are cared for by their parents such as ibis and spoonbills, are typically the most sensitive to changes in water level. Tree nesters that care for their young such as cormorants are also sensitive to water changes. Reed-nesting waterbirds that hatch in a relatively advanced and mobile state and are capable of leaving the nest (e.g. Brolga, swans and coots) are less sensitive to changes in water levels, whilst some of the ducks which nest in trees are the least sensitive (Cottingham et al. 2016).

Waterbirds are often placed in functional groups, or guilds of species (e.g. Kingsford et al. 2012 and 2013), or are identified as being colonial nesting species. These groupings are:

- Herbivores.
- Piscivores.
- Ducks and Grebes.
- Large wading birds.
- Shorebirds.
- Colonial nesting species.

Examples of the water requirements of two herbivore species are presented in Table 5 and Table 6. The species were chosen as they are culturally significant (Black swans) are likely to occur at the site and also represent a range of flooding requirements for successful breeding within the group.

In other words, the species represent the extremes or range of flooding requirements in terms of duration and presumably water depth around the nest for breeding and foraging needs. Therefore, for environmental watering, it is assumed that targeting the water requirements of the species with the maximum or longest breeding and minimum and ideal flooding duration, will satisfy the breeding and flooding requirements of all other species within that functional group (Cottingham et al. 2016).

Table 5: Water requirements to maintain Eurasian coot and Black swan (modified from Cottingham et al. 2016).

Flow component	Eurasian coot, *Fulica atra*	Black swan, *Cygnus atratus*
Life expectancy	Maximum longevity in the wild is reported to be approximately 7 years.	Anecdotally estimated to be 10 years in the wild for Black swan.
Frequency	Based on a maximum longevity of 7 years, it has been estimated that to maintain breeding populations, Eurasian coot requires: • A minimum large flood frequency of 1 flood in every 3 years; and • Small maintenance floods every 1-2 years.	To maintain breeding populations, Black swan requires: • A minimum large flood frequency of 1 flood in every 5 years; and • Small maintenance floods every 1-2 years.
Depth	Forages in both open shallow (< 0.5 m) and deep waters (> 1 m), on floating matts of aquatic vegetation and on grasslands away from edges of wetlands.	Forages in both open shallow (< 0.5 m) and deep waters (> 1 m), and also on exposed mudflats.
Duration	Eurasian coot is reported to prefer both permanent and ephemeral wetlands.	Black swan favours large, open permanent wetlands, though it will also use ephemeral wetlands.
Timing/preferred season	Eurasian coot primarily breeds between September and October in NSW; however, breeding may occur whenever conditions are suitable (e.g. opportunistically throughout the year).	Breeding season occurs from autumn to spring in NSW; however, breeding may occur whenever conditions are suitable (e.g. opportunistically throughout the year).
Rate of rise and fall	Not known if important.	Not known if important.

Table 6: Water requirements to support breeding for Eurasian coot and Black swan (modified from Cottingham et al. 2016).

Flow component	Eurasian coot, *Fulica atra*	Black swan, *Cygnus atratus*
Age at first breeding	The age at first breeding for Eurasian coot is not known.	Black swans do not reach sexually maturity until 18-36 months old.
Stimulus	Flooding is the stimulus for breeding in Eurasian coot, as indicated by relationships established between breeding and rainfall, abundance and rainfall, and abundance and deep permanent waters, and observations of coots breeding on floodwaters.	Flooding is the primary stimulus and season a secondary stimulus for breeding in Black swan. This is based on: use of ephemeral waters following flooding; correlations between peak breeding and rainfall/rainfall with a one-month lag; breeding and maximum area of aquatic plants; breeding at any time in response to rainfall; occurrence in deep seasonal waters; abundance varying with season rather than water level in some studies; and observations of sexual activity on a seasonal basis.
Frequency	Based on a maximum longevity of approximately 7 years, to maintain breeding populations, Eurasian coot requires: • A minimum large flood frequency of 1 flood in every 3 years; and • Small maintenance floods every 1-2 years.	Based on longevity of 10 years, that to maintain breeding populations, Black swan requires: • A minimum large flood frequency of 1 flood in every 5 years; and • Small maintenance floods every 1-2 years.
Depth	Based on nesting locations and the relationships between abundance and deep permanent water, the ideal flood depth to enable Eurasian coot to successfully breed is reported to be 0.3-2.0 m. Water depth must be sufficient to prevent the brood territory from becoming dry prior to young becoming independent (i.e. minimum 0.3-0.5 m deep).	The ideal flood depth to enable Black swan to successfully breed is 0.3-2.0 m. Water depth must be sufficient to prevent the brood territory from becoming dry prior to young becoming independent (i.e. minimum 0.3-0.5 m deep).
Duration (e.g. based on season, and lag, nest-building, incubation and fledging times)	For Eurasian coot, and for a flood in late-winter or spring to early-summer: • The minimum lag time to commence breeding is 1 month; • The ideal lag time to commence breeding varies is 2-3 months; • The breeding duration is 2 months;	For Black swan, and for a flood in late-winter or spring to early-summer: • The minimum lag time to commence breeding is less than 1 month; • The ideal lag time to commence breeding is 1 month; • The breeding duration is 7-8 months;

	• The minimum duration of flooding to enable successful breeding is 3 months; and • The ideal flood duration to enable successful breeding varies from 4-5 months. Clutch sizes range from 1 to 11 eggs, but the large clutch sizes may reflect clutches from two females laying in one nest. Incubation period varies from 23-26 days. The time for fledging is not known.	• The minimum duration of flooding to enable successful breeding is 7-9 months; and • The ideal flood duration to enable successful breeding is 9 months. Incubation period is 35-48 days. Young swans can fly after the primary feathers have developed, at 150-170 days.
Timing/preferred season	Eurasian coot primarily breeds between September and October in NSW, and between August to January in Victoria; however, breeding may occur whenever conditions are suitable (e.g. opportunistically throughout the year).	Breeding season varies from April to October in NSW, and primarily from June to September in Victoria; however, it may occur whenever conditions are suitable (e.g. opportunistically throughout the year).
Rate of rise and fall	Eurasian coot construct nests in vegetation over water at water depths in excess of 0.3 m but no deeper than 2.0 m. Further, coot abundance is generally correlated with deep permanent wetlands. Therefore, breeding can still be successful when the rate of water recession is at a moderate speed.	Nests are established at 0.3-0.6 m above the water level and as far as possible from the shoreline. Furthermore, the abundance of swans is reportedly highest on wetlands with depths of greater than 2 m. Therefore, swans may need to maximise flooding of nests and that the rate of water recession required to enable successful breeding is slow.
Inter-flood dry period	Inter-flood drying may enhance breeding in ephemeral wetlands. Drying is not considered to be critical for breeding success; flooding following drying (1-3 months) in ephemeral wetlands may enhance wetland productivity and breeding success.	Inter-flood drying may promote breeding success in Black swans and considered it plausible that swans benefit from an inter-flood drying period (e.g. 1-3 months). However, it has also been noted that the plants that swans consume do not require inter-flood drying, and therefore, this notion remains unconfirmed.
Other habitat requirements	Eurasian coots occupy large, deep, open permanent and ephemeral wetlands often with an abundance of submerged or emergent aquatic vegetation. Favoured habitats include lakes, swamps, billabongs, pools, ponds, lagoons, watercourses and adjoining grasslands. Eurasian coots are commonly seen on inland saline wetlands. Nests comprising a mound of plant material are constructed at the edges of floating or dense emergent vegetation, generally at 0.25-0.35 m above the water level, but occasionally up to 0.75 m over water; sites include trees, logs, shrubs, rushes, sedges, reeds or grass tussocks.	Black swan favour large, deep, open permanent wetlands with an abundance of aquatic vegetation, including lakes, swamps, reservoirs, sewage ponds, rivers and adjoining grasslands. They also commonly use ephemeral wetlands during widespread flooding. Black swans are also commonly seen on inland saline wetlands. Nests are a mound of vegetation constructed in shallow water 0.3-0.6 m deep, and often anchored to aquatic vegetation, such as reeds (Cumbungi, spike-rushes), or on stumps or bases on trees in wooded swamps, on floating debris or on the ground on islands.

2.6.3 Reptiles and amphibians

A total of 13 reptile and amphibian species were recorded at Toogimbie IPA by Pennay et al. (2002), including three frog species, eight lizard and two snake species:

- Spotted grass grog (*Linnodynastes tasmaniensis*).
- Plains froglet (*Crinia parinsignifera*).
- Peron's tree frog (*Litoria peronei*).
- Tessellated gecko (*Diplodactylus tessellatus*).
- Eastern bearded dragon (*Pogona barbata*).
- Central bearded dragon (*Pogona vitticeps*).
- Lace monitor (*Varanus varius*).
- Shiny-palmed shinning-skink (*Cryptoblepharus carnabyi*).
- Common dwarf skink (*Menetia greyii*).
- South-eastern morethia skink (*Morethia boulengeri*).
- Shingleback (*Trachydosaurus rugosus*).
- Carpet python (*Morelia spilota variegate*).
- Eastern brown snake (*Pseudonaja textilis*).

Smits (2014) opportunistically identified three frog species when conducting vegetation and waterbird surveys in 2014:

- Eastern common froglet (*Crinia significa*).
- Spotted marsh frog (*Limnodynastes tasmaniensis*).
- Plains froglet (*Crinia insignifica*).

A further thirteen frog species were also listed by Smits (2014) as potentially occurring at the site, based on their known distributions and habitat requirements. Further dedicated surveys are required to confirm the full suite of reptile and amphibian species that occur at the site.

Turtles are present in the Murrumbidgee River adjacent to the property, and are occasionally found in the irrigation channels on the property, but have not been found in floodplain or wetlands areas (J. Woods, pers. comm.).

2.6.4 Mammals

The fauna survey of Pennay et al. (2002) recorded nine woodland species of bat at the property, particularly within black box woodland:

- White-striped freetail-bat (*Nyctinomus australis).*
- Gould's long-eared bat (*Nyctophilus gouldi).*
- Lesser long-eared bat (*Nyctophilus geoffroyi).*
- Gould's wattled bat (*Chalinolobus gouldii).*
- Chocolate wattled bat (*Chalinolobus morio).*
- Inland broad-nosed bat (*Scotorepens balstoni).*
- Little forest bat (*Vespadelus vulturnus).*
- *Mormopterus* sp. (big penis).
- *Mormopterus* sp. (little penis).

The Atlas of NSW Wildlife also listed eight bat species as occurring at or adjacent to the Toogimbie IPA (Appendix 1).

Other native mammals recorded at the site (Pennay et al. 2002) include short-beaked echidna (*Tachyglossus aculeatus*), red kangaroo (*Macropus rufus)* as well as eastern and western grey kangaroo *(Macropus fuliginosus* and *Macropus giganteus*), brush tail possum (*Trichosurus vulpecula*) and paucident planigale (*Planigale gilesi*).

2.7 Ecosystem processes and function

Although not quantified, a number of ecosystem processes, such as primary production, carbon and nutrient cycling, will occur at the site when watered. These processes will add to the resilience of the site as a floodplain-wetland complex and play a central role in the boom and bust ecology of intermittent wetlands. Important functions which occur at the site are most likely linked to hydrological connectivity, with the transfer of nutrients and carbon onto the floodplain providing energy to support primary and secondary consumers (food webs) (Figure 9 and Figure 10). As rehabilitation measures continue, and over time, the site may also become a seed bank of native plant species. Other ecological processes likely to occur at the wetland include provision of habitat for waterbirds, with the possibility of breeding by waterfowl species.

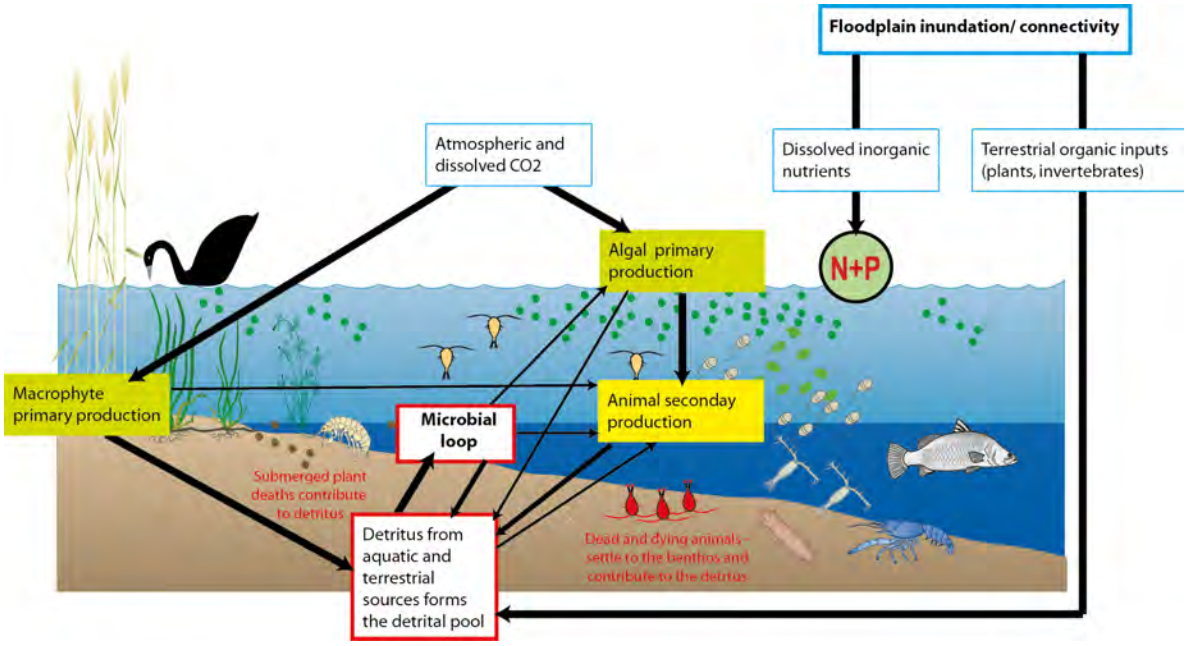


Figure 9. Conceptual model of main energy pathways in floodplain wetlands. Size of arrows indicate strength/importance of pathway for contributing energy to food webs.

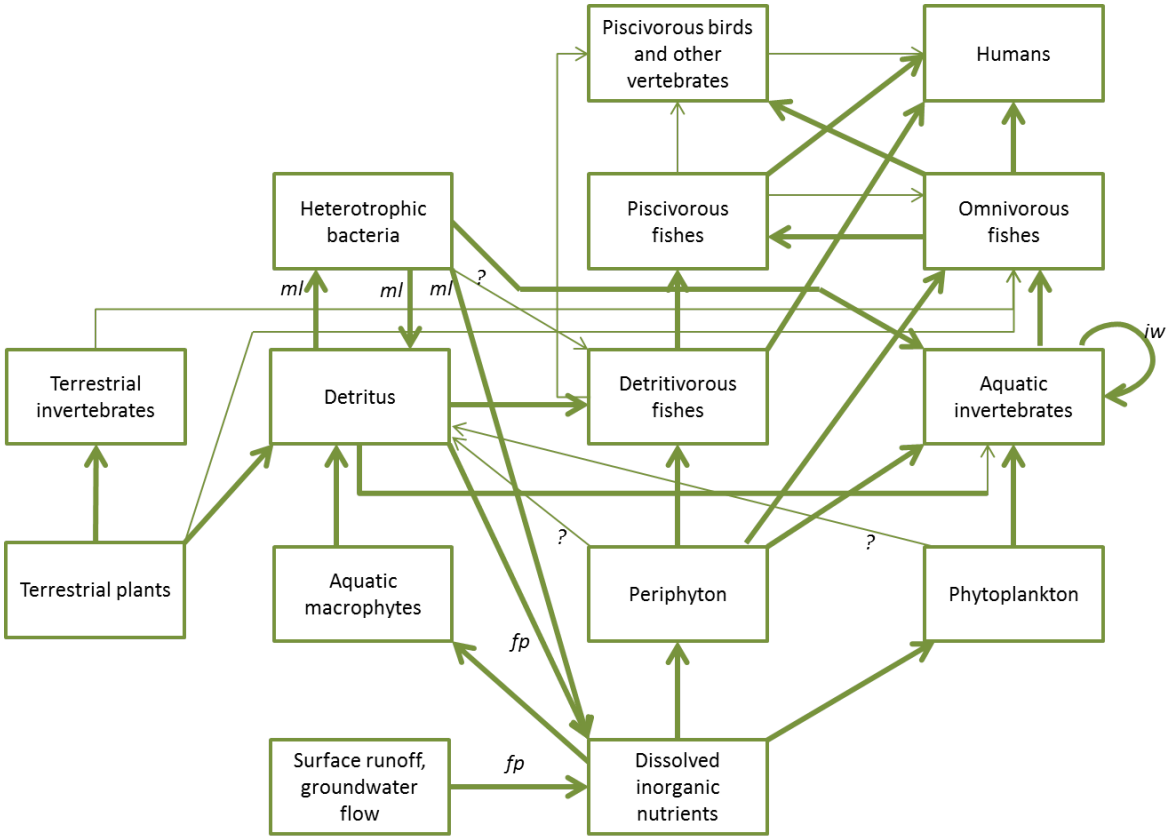


Figure 10. Generalized food web for floodplain-river ecosystems.

Note: Boxes are aggregate material pools and vectors represent consumer resource interactions with thick arrows representing dominant pathways (ml= microbial loop path, fp = nutrient pathways enhanced by flood pulses, iw = invertebrate web having complex trophic structure involving invertebrates and ? = poorly quantified pathways) (modified from Winemiller 2004).

2.8 Ecosystem services and benefits

The Millennium Ecosystem Assessment (Millennium Ecosystem Assessment 2005) defines four main categories of ecosystem services:

1. **Provisioning services** - the products obtained from the ecosystem such as food, fuel and fresh water;
2. **Regulating services** – the benefits obtained from the regulation of ecosystem processes such as climate regulation, water regulation and natural hazard regulation;
3. **Supporting services** – the services necessary for the production of all other ecosystem services such as water cycling, nutrient cycling and habitat for biota. These services will generally have an indirect benefit to humans or a direct benefit over a long period of time; and
4. **Cultural services** – the benefits people obtain through spiritual enrichment, recreation, education and aesthetics.

2.8.1 Provisioning services

Products obtained from the local ecosystem for human consumption (e.g. fish, water) are mainly sourced from the Murrumbidgee River, rather than the floodplain or wetland areas of Toogimbie

IPA. However, a number of provisioning services from the wetlands identified through the field work include the provision of economic, spiritual, health and wellbeing values, traditional medicines and food.

2.8.2 Regulating services

Toogimbie IPA is situated on the floodplain of the lower Murrumbidgee River. It is, therefore, an integral part of the river-floodplain system, as allowing dispersal of water onto the floodplain plays promotes ecological connectivity (see Section 2.7.3), as well as contributing to natural hazard regulation of flood waters.

2.8.3 Supporting services

Hydrological processes, habitat provision and ecological connectivity

Hydrological processes, particularly flooding that connects the main channel of the Murrumbidgee River with its floodplain, are important for supporting riparian and floodplain habitats at Toogimbie IPA, and the diversity of flora and fauna populations that depend on them. Hydrological processes are particularly important for sustaining river red gum, black box and lignum communities and in turn the habitat for birds, amphibians and mammals (see previous Section 2.5).

Ecological connectivity can relate to water mediated movement of flora, fauna, energy and materials through the landscape (Pringle 2001, 2003) and is a well-established principle in the maintenance of spatially structured populations. Ecological connectivity helps to support other wetland or wetland aggregations, contribute to terrestrial ecosystems, or species transfer or movement. It also helps to support hydrological processes, and can provide a pathway for seed dispersal, or interconnected habitat for migratory birds (DEWHA 2008).

Threatened species

While there are currently few threatened species recorded as regularly inhabiting the site, Toogimbie IPA has the potential to support a range of threatened flora and fauna species as rehabilitation efforts continue to improve the extent and quality of habitat (NNTC 2012, Table 7).

Table 7: Regional threatened species potentially supported at Toogimbie IPA (from NNTC 2012)

Biota	Threatened species
Plants	• Mossigiel daisy (*Brachyscome papillosa*) • Slender Darling-pea (*Swainsona murrayana*) • Menindee nightshade (*Solanum karsense*) • Chariot wheels (*Maireana cheelii*) • Winged peppercress (*Lepidium monoplocoides*)
Amphibians	• Southern bell frog (*Litoria raniformis*)

Biota	Threatened species
Birds	• White-bellied sea-eagle (*Haliaeetus leucogaster*) • Mallee fowl (*Leipoa ocellata*) • Australasian bittern (*Botaurus poiciloptilus*) • Australian painted snipe (*Rostratula australis*) • Plains wanderer (*Pedionomus torquatus*) • Latham's snipe (*Gallinago hardwickii*)

Carbon cycling

Organic carbon is a major nutrient in freshwater systems and an important primary source of food in aquatic food webs. In forested catchments, the major terrestrial inputs of carbon to rivers are (Bunn et al. 2007):

- Coarse woody debris – logs and branches from riparian and floodplain vegetation.
- Particulate organic matter – litter inputs directly from riparian trees or washed from other areas of the floodplain. And,
- Dissolved organic carbon – released from wetlands and floodplains and carried to the river on return flows.

Coarse woody debris and particulate organic matter, which must be broken down within the river / wetland to dissolved organic carbon in order to enter the food web; dissolved organic carbon can be directly transported from the floodplain to receiving waters. Inundation of the floodplain leads to mineralisation of organic carbon in litter and sediments. The period of time since the last flood, together with seasonal factors such as temperature influence the amount of carbon released (Howitt, Baldwin & Rees 2005).

In addition to acting as a source of carbon to receiving aquatic ecosystems, floodplains also act as a store of organic carbon. In particular sediments containing particulate organic carbon may be deposited on the floodplain during inundation events. Disruption to lateral connectivity between floodplain wetlands and rivers alters water movement, as well as fluxes of materials and energy (nutrients and carbon) and biota (plant propagules and animals) between the two ecosystem types (Bond et al. 2014, Baldwin et al. 2016). Export of dissolved organic carbon (DOC) from floodplain ecosystems into the main river channel has been shown to be reduced substantially when lateral connectivity is disrupted (e.g. Thoms 2003).

Both Toogombie and Gooraman Swamp would play a role in carbon cycling within the floodplain and also in the river when return flows occur.

2.8.4 Cultural services

Cultural services provided by the site is presented in the separate cultural character report (NCFRP 2016).

2.9 Threats to ecological character

The current plan of management for Toogimbie IPA has identified the main threats to the ecological and cultural character of the site:

- Noxious plants and feral animals.
- Regulation of the river system, affecting inundation of wetland areas and revegetation areas.
- Bush/wild fires.
- Climate change and extremes of weather (drought/floods).
- Impact from surrounding farming enterprises.
- Loss of community strength.
- Funding threats.
- Visitor impacts.
- Poaching.

The main noxious weeds at the site include:

- Bridal Creeper (*Asparagus asparagoides*).
- Blackberry (*Rubus Frticosus aggregate*).
- Grounsel (*Baccharis halimifolia*).
- Bathurst burr (*Xanthium Spinosum*).
- Apple thorn *(Datura stramonium*).
- Box thorn (*Lycium*).
- Noogoora burr (*Xanthium pungens*).
- Lippia (*Phyla canescens*).
- Mustard weed (*Sisymbrium orientale*).

The main feral animals of concern include:

- Rabbit (*Oryctolagus cuninculus*).
- Fox (*Vulpes vul*pes).
- Feral cat (*Felis catus*).
- Wild Pig (*Sus scrofa*).

2.10 Conceptual models

Conceptual models of the ecological character of the site focus on the key components, processes and services which are expected to respond to water management. Lignum floodplain habitat and vegetation responses are likely to occur from the watering. Price & Gawne (2009) developed a series of ecological models which illustrate the key characteristics of major wetland types. The conceptual model for lignum shrubland swamps is presented in Figure 11.

In addition, stressor models will be developed for each site that show the potential risks associated with delivering cultural water and the relationship of the existing threats and stressors to the key ecological components, processes and services which may affect the outcomes achieved from cultural watering. These models will be informed and refined based on community feedback. A draft stressor model is presented in Figure 12.

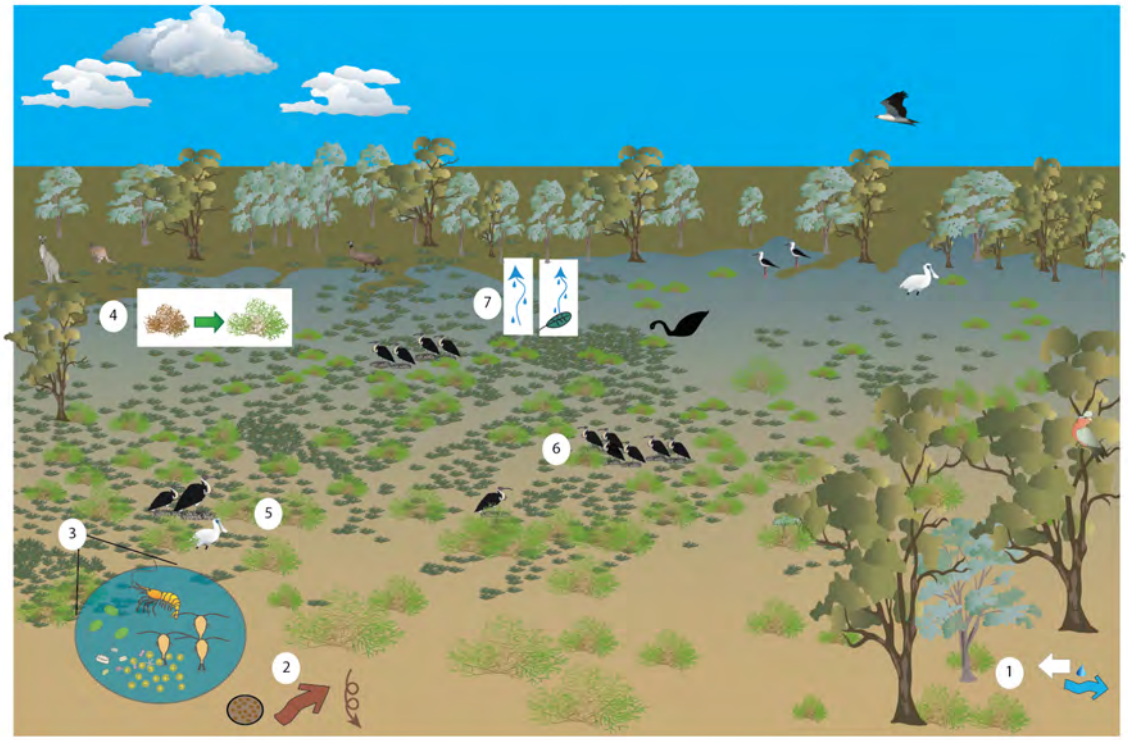
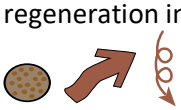
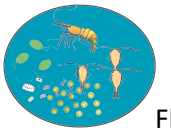


Figure 11: Lignum shrubland swamp conceptual model.

Key to Figure 11:

1.  Altered water regimes in the main river means that overbank flows are limited, and water delivery is achieved by pumping. Once water is on the floodplain it will promote regeneration in floodplain vegetation, both grasses and woody vegetation.
2.  As Toogimbie is filled predominantly from pumped water, the water quality on the floodplain will initially reflect that of the parent river, being turbid with fine particulate organic matter, some sedimentation or settling will occur on the floodplain
3.  Floodplain systems and intermittent wetlands display a typical boom and bust cycle of seed germination and egg hatching from the seed and egg banks respectively, resulting in a plant and animal community typical of an intermittent semi-arid zone floodplain wetland, with short term high productivity and temporary water specialists.
4.  The arrival of water onto the floodplain will trigger vigorous growth in the lignum and other aquatic plants.
5.  Presence of water supports a diversity of waterbirds, most likely predominantly ducks, grebes, swan, spoonbills, ibis and rails and crakes.
6.  Flooding may support breeding of waterbirds, most likely duck species. Some colonial nesting species such as ibis and cormorants may also breed in the lignum and riparian woodlands.

7. Evaporation and evapotranspiration will be high in summer months, with rates of fall likely to be rapid if the wetland is only shallowly inundated.

Biological processes characteristic of fully inundated Toogimbie wetland include:

Overland flooding promotes floodplain vegetation growth, particularly grasses, along the fringes of the inundated wetland which in turn supports grazing animals and foraging areas for important cultural foods such as emu and kangaroo.

Once full, water remains in the wetland for several months and supports a productive and complex aquatic ecosystem, with features characteristic of boom and bust ecosystems (see section 2.6). Aquatic macrophytes establish from the seed bank and also arrive as propagules from inflows. Invertebrates hatch from the soils on wetting and establish both micro and macroinvertebrate communities which in turn support larger invertebrates, frogs and waterbirds.

Periodic flooding of the wetland sustain River Red Gum trees, promoting regeneration in and around the edges of the wetland. Larger floods reaching to the Black Box woodlands are less frequent and water remains on the floodplain for less time.

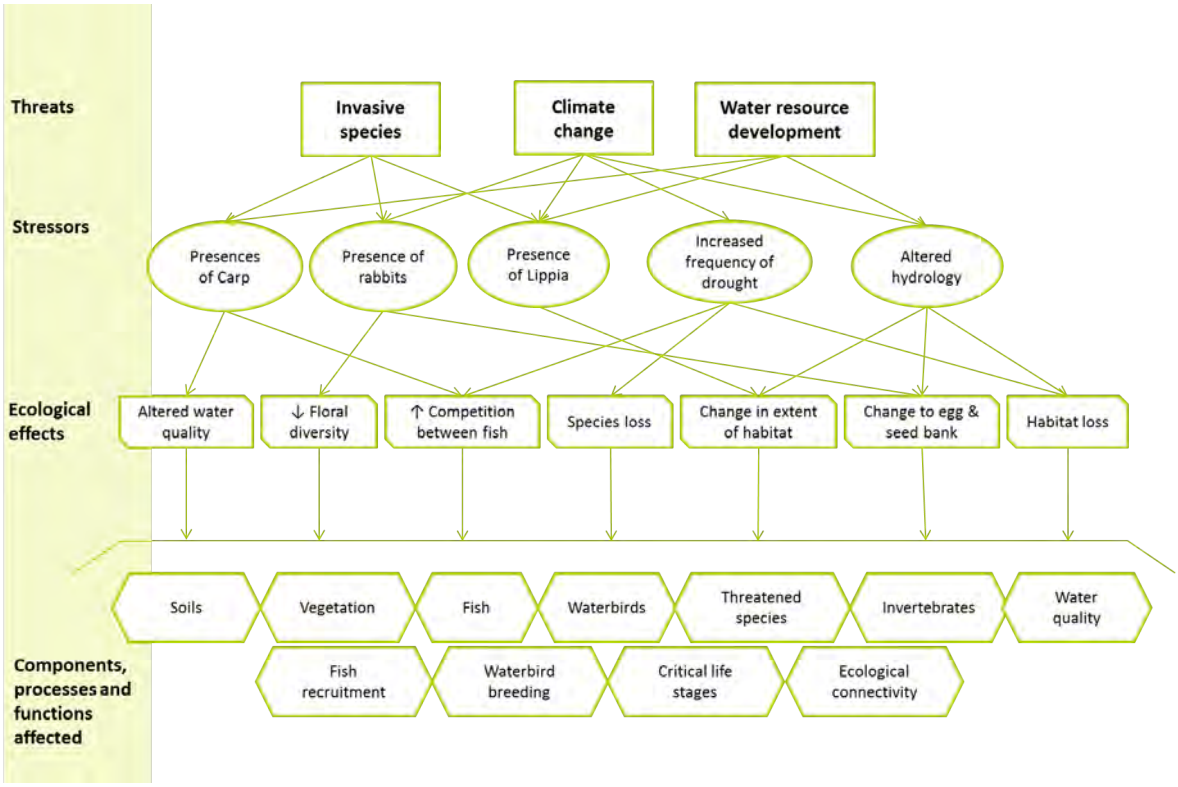


Figure 12: Stressor model for Toogimbie.

3 ECOLOGICAL CHARACTER OF THE GOORMAN SWAMP SITE

3.1 Catchment and river system overview

Weilmoringle and Gooraman Swamp are in the northern Basin zone of the Murray Darling Basin (Figure 13), which comprises all rivers and catchments of the Darling River upstream of Menindee Lakes on the Darling River, covering an area of approximately 640,000 square km (Sheldon et al. 2014). The northern Basin is characterised by extremely variable rainfall and consequently, river flow. The rivers are less regulated and there has been less scientific investigation of the systems than in the southern Basin, all of which provides challenges for management of water for environmental outcomes (Sheldon et al. 2014).

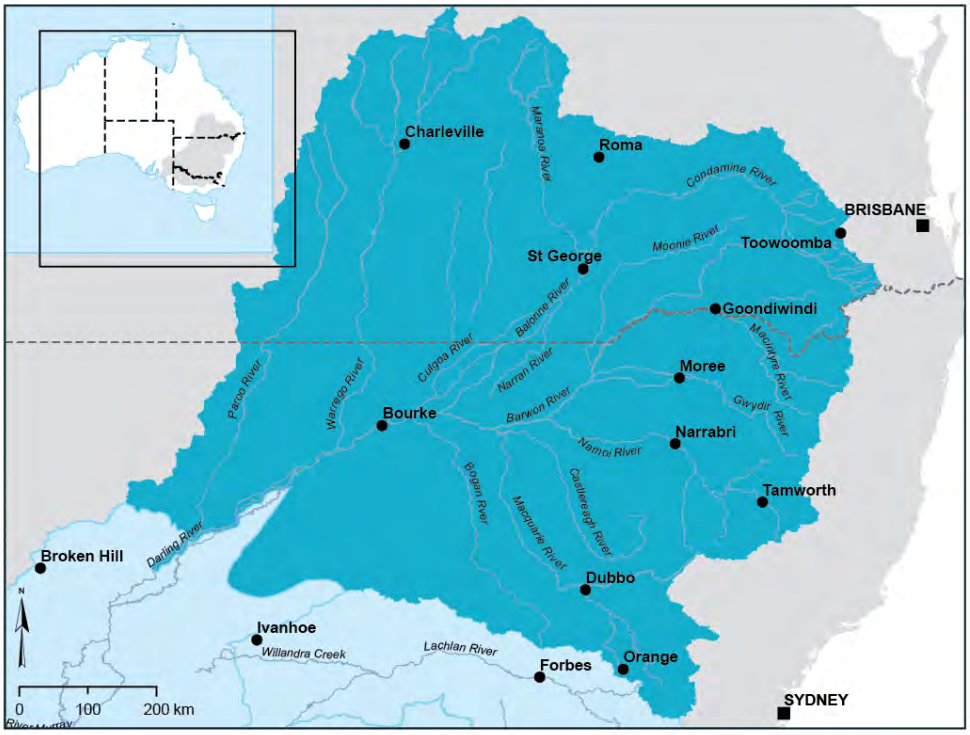


Figure 13. Northern Basin (from Sheldon et al. 2014).

Weilmoringle is located on the floodplain of the Culgoa River in northern NSW, approximately 20 km southwest of the Culgoa National Park. The Culgoa River is a branch of the Balonne River that rises in southern Queensland. The river flows in a southwesterly direction for approximately 490 km from downstream of St George in southern Queensland to its confluence with the Darling River in NSW, between Bourke and Brewarrina.

The regional climate is semi-arid, with an average annual rainfall of approximately 410 mm (based on records for Brewarrina, Table 8), and is typified by cool winters and hot summers. The rainfall pattern is that of a summer-rainfall region, with highest mean rainfall in January to February and lowest rainfall in winter and spring (source: Bureau of Meteorology, http://www.bom.gov.au/climate/averages/tables/cw_048015.shtml)

Table 8: Summary of monthly climatic statistics for Brewarrina, NSW (1872-2015)

Statistic	J	F	M	A	M	J	J	A	S	O	N	D
Mean maximum temperature (°C)	36.1	35.0	32.3	27.5	22.4	18.6	18.2	20.6	24.9	29.0	32.5	35.0
Mean minimum temperature (°C)	20.7	20.4	17.4	12.6	8.5	5.6	4.4	5.7	9.0	12.9	16.2	18.9
Mean rainfall (mm)	50.8	48.5	39.8	29.3	30.8	32.7	28.8	21.5	24.8	29.2	34.5	38.7

Gooraman Swamp and surrounding land is situated within the western district of the Darling Riverine Plains Bioregion. The bioregion is characterized by extensive floodplains of 10 major rivers: the Barwon-Darling, Culgoa, Birrie, Bokhara, Narran, Gwydir, Namoi, Castlereagh, Macquarie and Bogan. It has been estimated that 10 to 20% of the native vegetation in the Western Division has been cleared for agriculture, which is less than other parts of the bioregion (NPWS 2002). The area surrounding Gooraman Swamp is comprised of Northern Riverine Woodlands, which is a habitat type that includes river red gum woodlands along river frontages and extensive coolibah–black box woodlands on the floodplains of the Culgoa River. As noted by the National Parks and Wildlife Services (NPWS) (2002) and Hunter (2005), the riverine woodlands on the Culgoa River floodplain (particularly in the nearby Culgoa National Park) are the largest and least disturbed area of contiguous coolibah woodland left in NSW.

3.2 Gooraman Swamp

Found in north central NSW, near the Queensland border, the Weilmoringle IPA covers an area of 3,500 hectares. Gooraman Swamp is located entirely within the IPA boundary.

3.2.1 System bounds –Gooraman Swamp trial site boundary

See Figure 14 overleaf for Gooraman Swamp trial site in relation to IPA boundary and key hydrological features.

In accordance with the project scope no cultural watering trial was conducted at Gooraman Swamp.

Figure 14: Gooraman Swamp case study site in relation to Weilmoringle IPA boundary and key hydrological features.

3.3 Cultural values and TAK

3.3.1 Cultural values

Cultural values associated with Gooraman Swamp and its surrounds, including the Culgoa River, have been identified from ongoing discussions, meetings and field visits with the Murrawarri community. A detailed description of this process is provided in NCFRP (2016). Values attached to the site include:

- A sense of connection and obligation to culture and country.
- A place to visit and reconnect physically to culture and country.
- The location of sites of significance and associated cultural practices.
- A source of bush medicine, food and natural resources that can maintain or improve the health of Murrawarri.
- A source of socio-economic potential for Murrawarri.

3.3.2 Gooraman Swamp Traditional Aboriginal Knowledge (TAK)

Published and publicly available TAK is limited for the Gooraman Swamp trial site, apart from the work done by Dykes et al. (2006). Some TAK has been recorded during field trips associated with the project and include the following (see NCFRP in prep):

Cultural water is important …"*because if you get in the Culgoa, down to Weilmoringle, and you fill that waterhole up, and you have enough water flowing down the system, then there are a number of waterholes, the connection to this place here. [Gooraman Swamp] is his home. The connection then allows him to travel. It's the same – there are all different names for him all through the Murray. There's a common connection.... We need the cultural flow to fulfil our spiritual side of it, into Gooraman Swamp*."

"Prior to the extraction of water upstream [for the extensive cotton and agricultural practices], the Culgoa had a banker flow approximately every 12 months with a major flood event reaching Gooraman Swamp approximately every three years".

"*Cultural flows research and all this stuff with the Murray Darling – we are three years behind everyone else. Could be more. Because all of the environmentalists have got their science in, and we are still collecting our science. And the proposal is that any decision in the Murray Darling Basin would be based on science. Well, what about Aboriginal science? From that perspective, we need to work to help get the scientists to think that way as well. It's difficult. Bringing those two sciences together can tell the story*."

"Once you fulfil the water requirements of Gooraman Swamp, it also triggers all of these Aboriginal environmental outcomes. Because once the swamp is full, the birdlife come back. A lot of the people from Weilmoringle were evacuated out during the 2011 floods. So they have never seen the results of the flood at the swamp. We'd sit there of an afternoon, and there would be thousands and thousands of birds just coming back to nest. It was full for probably nine months, or it at least had water in it for eight or nine months. I don't know whether you've seen all the old nests in the trees? It's also a breeding place for all different types of birds. Including migratory birds that came in, like pelicans, brolgas coming back."

- Fred Hooper, pers. comms 2016 (Key nation contact, Murrawarri)

3.3.3 Culturally significant species

Culturally significant species at Gooraman Swamp include those listed in Table 9. In addition species identified as having exceptional, spiritual, ceremonial, and medicinal or food value by Dykes et al. (2006) are also of cultural significance (see Table 13 and Table 14 below).

Table 9: Culturally significant species identified by the Murrawarri (Dykes et al. 2006).

Murrawarri name	Common name	Scientific name
	Murray cod	*Maccullochella peelii*
	Yellow belly	*Macquaria ambigua*
	Catfish	*Tandanus tandanus*
Kuruwa	River red gum	*Eucalyptus camaldulensis*
	Black box	*Eucalyptus largiflorens*
	River coolabah	*Eucalyptus coolibah*
Wumbul	Swamp paperbark	*Melaleuca trichostachya*
Wirrara	Lignum	*Duma florulenta*
Wirpil, Willpill	Dogwood	*Eremophila bignoniiflora*
Mururru	Gidgee - ring	*Acacia cambagei 'ringed'*
Thupppie	Snotty gobble	*Diplatia grandibractea*
	Emu	*Dromaius novaehollandiae*
	Wild turkey	
	Echidna	*Tachyglossus aculeatus*
	Identified water bird species including: cranes, spoonbills, ibis, wood ducks, divers (diving kingfishers?) and grass parrots	Various species including: *Platalea regia, P. flavipes, Threskiornis spinicollis, T. moluccus, Chenonetta jubata,* among others.

Text Box 4: Emu.

Note: The following example is for demonstrative purposes only and is not intended to be representative of all Aboriginal communities or individuals. TAK will vary depending on cultural context. Information provided is based on shared cultural knowledge of Narungga Elders, from Yorke Peninsula, South Australia

For Aboriginal people the seasons dictate and connect creation and emu in a special way.

The emu, as with the black swan, is a well-known part of the Aboriginal diet. It is consumed at various stages of its life from egg to adult, with both eggs and chicks favoured.

Knowing the habits of the emu and the different roles of the adult male and female is vital in being able to both harvest and hunt them. Teaching children how to track is very important and often done in the sand. It is part of the cultural upbringing of the child and ensures the transference of knowledge from one generation to the next.

The egg, once collected is carved for decoration. In order to carve the egg you have to have the proper stone tools and know the egg intimately. This enables you to get the right shades by going to the right depth and angle in the carving process to build the picture you are carving. If you collect the egg too late in the season, the shell will have weaked and will not be suitable for carving. In addition to decorating, the shell of the egg is often used as a drinking or water container. Half shells can be made into a cup and when the eggs are blown and cleaned they can be used to carry and store water by blocking the ends with small bits of wood.

The emu is able to find water for drinking when it is not obvious to other animals or birds and for this reason they are vital to the Aboriginal way of life. In observing the tracks and movements of the emu, people are able to locate valuable sources of water, in much the same way that coastal groups watch shags fly low over the sea to spot where the schools of fish are.

Some members of the group will have the emu as their totem or Tjukurpa. The emu is an important part of storytelling and is represented symbolically and physically (through feathers) in dance and ceremonies across Australia. The significance of the emu to Aboriginal life and its connection to the creation can be seen via the Milky Way. The Southern Cross is the beak of the emu and it is visible in the night sky during the times when the emu egg is suitable for harvesting. If harvested too soon you cannot remove the yolk from the egg, and if left too late, it is not a viable food source owing to the fact the chick has already begun form.

3.4 Environmental values

Data for the Swamp and surrounding IPA is limited however there is information for the nearby Culgoa National Park and the Culgoa River which are expected to have similar attributes, and in particular similar flora and fauna. Most data, including the vegetation surveys and identification of culturally significant plants (Dyke 2002) are regionally based assessments, with site specific data lacking. Where information can be attributed to being specific to the site this is noted.

A number of environmental values have been assigned to the Gooraman Swamp site (Hunter 2005, NPWS 2002), including:

- Streambank, riparian and floodplain vegetation in a region that has been cleared of much of its native vegetation. This includes contiguous vegetation communities such as coolibah-black box woodland.
- Streambank vegetation that provides structural habitat (e.g. snags, undercuts) for native fish in the Culgoa River.
- Wetland and floodplain habitat for plant and animal species, including threatened reptile, bird and mammal species.

3.5 Ecosystem types

The ecosystem types present at Gooraman Swamp have been taken from the ANAE classification applied to aquatic ecosystems of the Murray Darling Basin (Table 10). The dominant and most significant ecosystem type is the black box and coolibah woodland floodplain associations. River red gum woodland is present fringing the Culgoa and also throughout the basin of Gooraman Swamp. No palustrine habitat is present in the study area.

Table 10: Summary of aquatic ecosystem types present at the Weilmoringle (modified from Brooks et al. 2012)

Category	ANAE Type	Comment
Riverine	Temporary lowland stream	Main channel of the Culgoa River. Riparian vegetation consists predominantly of river red gum fringe, and coolabah-black box woodland at higher elevation.
Floodplain	Coolibah woodland and forest floodplain Woodland floodplain	The woodland floodplain is characterised by several dominant species including river red gum, Coolibah, black box and bimble box. River cooba is also present.

Note: see Brooks et al. 2012 for details of the ANAE classification.

3.6 Ecosystem components

3.6.1 Hydrology

Gooraman Swamp is part of the Culgoa River floodplain in the Lower Balonne Region of the Condamine Balonne Catchment (Figure 15). The lower Balonne Region is an extensive floodplain with a range of geomorphic features, including levees, scrolls, swales, distributary channels, in-channel benches, palaeochannels, cutoffs and flat floodplain surfaces (Foster, Thoms & Parsons 2002, Thoms 2003), covering an area of 19,800 square km. The Culgoa and Narran Rivers are the dominant flow channels, carrying 35 and 28% of the long-term mean annual flow at St George. The remaining channels flow only during higher discharges (Foster, Thoms & Parsons 2002). Channel gradients are low with capacities declining with distance downstream resulting in an extensive and regular inundation of the floodplain during high discharge (Foster, Thoms & Parsons 2002).

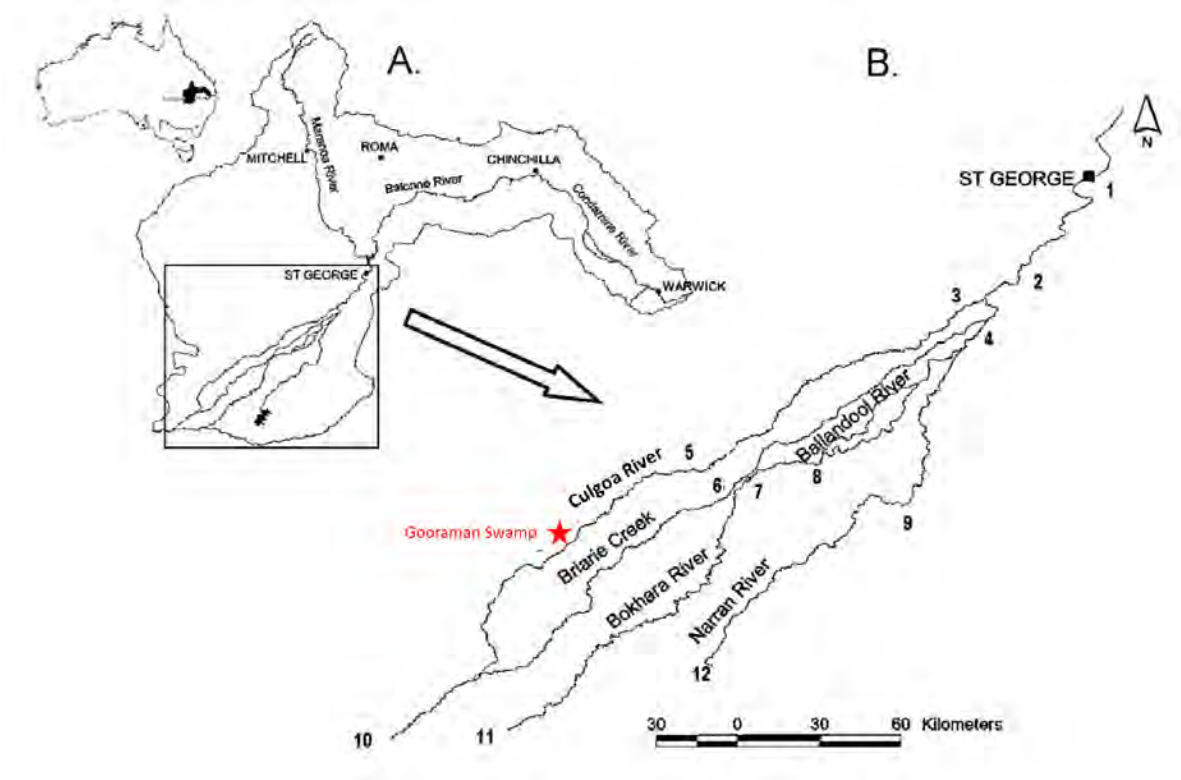


Figure 15: The Condamine Balonne Catchment.

Note: (A) Approximate location of Gooraman Swamp and intersecting river system of the Lower Balonne (B) with location of the of the flow stations indicated by numbers (modified from Thoms 2003).

Large-scale water-resources and floodplain development within the catchment has significantly altered the spatial and temporal patterns of hydrological characteristics in the Lower Balonne floodplain (Thoms 2003). In general the magnitude, frequency and duration of flooding events have all been reduced. In addition the construction of levees and water storages has also reduced the reactive floodplain surface area (Thoms 2003).

Inundation of the Lower Balonne Floodplain occurs in three phases, smaller flows in excess of 26,450 ML/D at St George (equivalent to an average recurrence interval (ARI) of 1.5 years based on an annual flood series) result in the initial wetting of the floodplain surface. The floodwaters are confined essentially to the central region of the floodplain until flows exceed 60,000 Ml/day (ARI of 2.5 years) which floods significantly larger areas of floodplain and floodwaters begin to re-enter the Culgoa River approximately 30 km downstream of the bifurcation of the Condamine–Balonne River. Most of the floodplain is inundated once flows exceed 160,512 ML/D (ARI of 10.5 years) (Figure 16). Overall, the western and central regions of the Lower Balonne Floodplain are flooded more frequently than the eastern regions (Sims & Thoms 2002, Thoms et al. 2002, Thoms 2003).

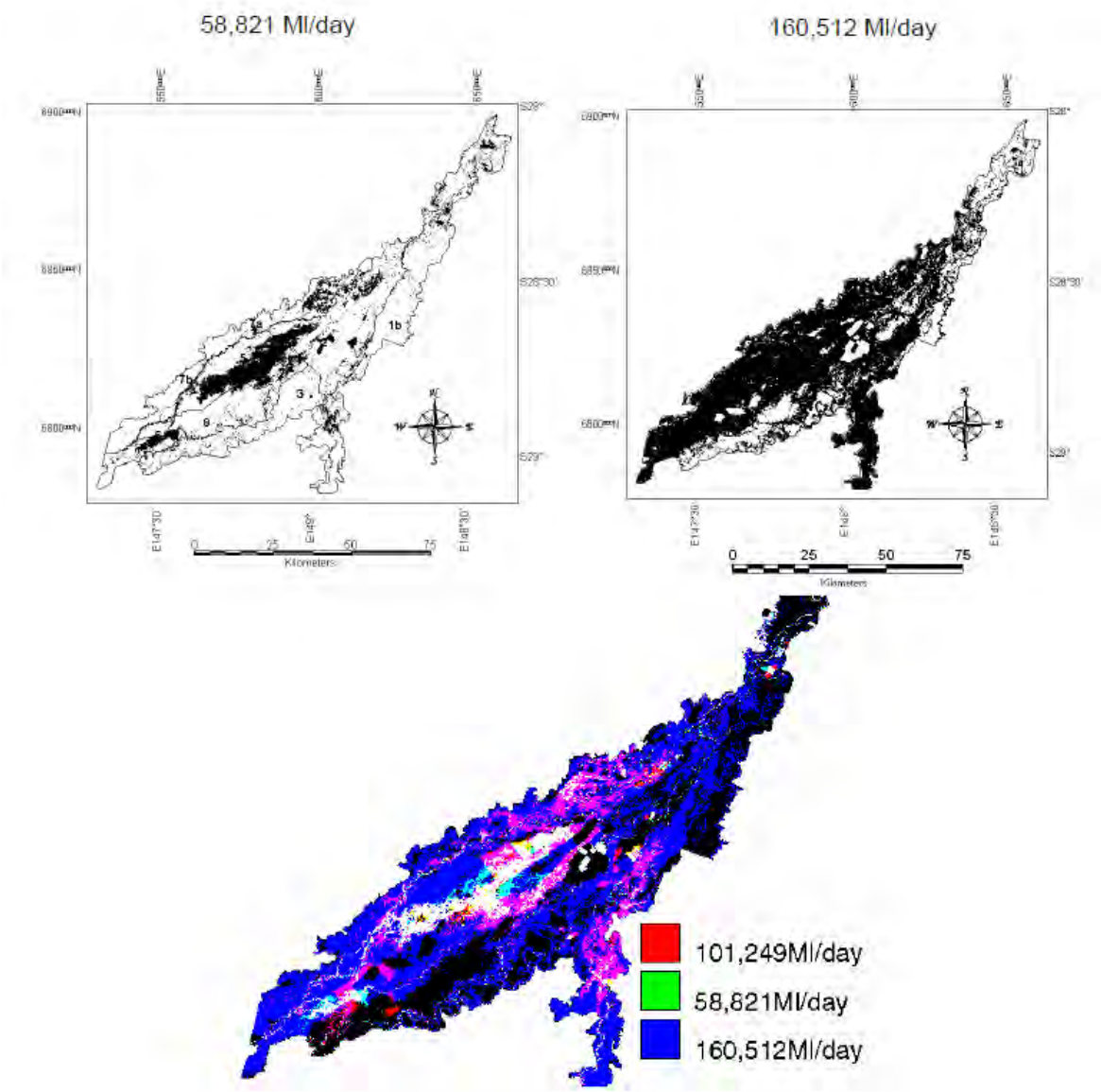


Figure 16: The inundation character of the Lower Balonne floodplain between St George and the NSW/Queensland border. The map shows the distribution of floods of different magnitude (from Thoms et al. 2002).

Characterised as a dryland river, the Culgoa system is a 'boom and bust' system, where peaks in productivity occur when flooding occurs after long dry periods. Large scale colonial waterbird breeding events are a good example of a boom period, however booms also occur in other biota including algae, higher plants, invertebrates and fish (Kingsford 2000, Kingsford et al. 2002, Thoms et al. 2003).

Changes in the hydrology of the Lower Balonne system at St George are summarised in Table 11 using simulated data, with similar magnitude of change carried downstream to impact on the floodplain in the vicinity of Gooraman Swamp. Upstream water resource development has reduced the total volume of water entering the Lower Balonne region as well as the frequency of smaller floods (up to an ARI of 10 years).

Table 11: Hydrological change in the Condamine-Balonne system at St George, calculated using simulated flow data (IQQM) for 1900–1998. '

Parameter	Reference	Current 1996–97	% Change
MEDIAN ANNUAL (megalitres (ML))	976,997	688,457	– 29.53 %
1.5 ARI (ML/day)	31,813	16,672	– 47.59 %
2 ARI (ML/day)	56,287	43,879	– 22.04 %
5 ARI (ML/day)	123,663	118,268	– 4.63 %
10 ARI (ML/day)	183,788	166,832	– 9.22 %

Note: Reference' is simulated with no flow regulating structures, abstractions of water and catchment development, and uses long-term mean climatic conditions. These 'reference' flows are assumed to represent natural flow conditions. The 'current' simulated output uses water and catchment development conditions present in 1996–97 and also uses long-term mean climatic conditions(from Thoms et al. 2002).

Water resource development has also led to changes in the number of events and the duration of individual flow events in the Lower Balonne (Figure 17). A comparison of simulated reference and current data suggests that there has been a reduction in the number of flood events and their duration with water resource development (Thoms et al. 2002).

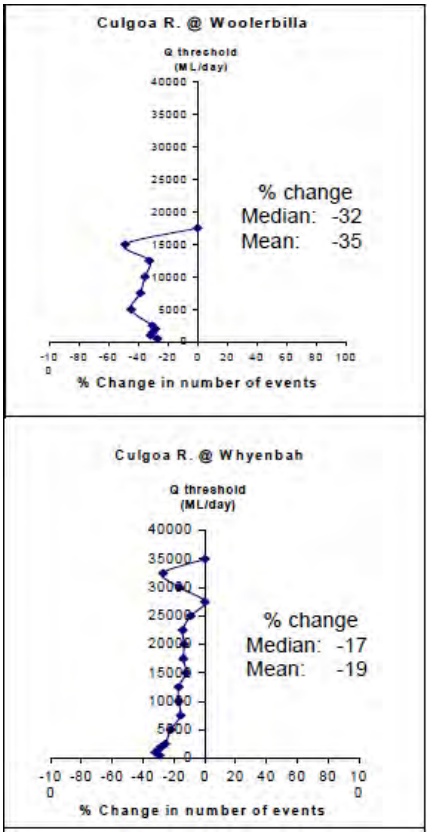


Figure 17: The percent change in the number of flow events of different sizes. A comparison of simulated reference and current conditions for the period 1898–1999 was used (from Thoms et al. 2002).

MDBA (2012c) provides flow thresholds estimated for peak flows at Brenda to achieve the ecological target of providing a flow regime which ensures the current extent of native vegetation of the riparian, floodplain and wetland communities is sustained in a healthy, dynamic and resilient condition (Table 12). The gauging station at Brenda is a hydrological indicator site for the Lower Balonne floodplain system. Indicator sites were selected by the MDBA on the assumption that "*provision of an adequate flow regime at indicator sites is representative of the environmental water requirements of the broader suite of key environmental assets and key ecosystem functions across the Basin*" *(MDBA 2011)* (Sheldon et al. 2014).

Table 12: The relationship between ecologically relevant thresholds as defined for the Balonne River at St. George as expressed at Brenda on the Culgoa River using the regression equation in MDBA (2012c).

Target	Ecologically relevant threshold at St. George (ML/d)	Correlated flows at Brenda (ML/d)
Inundation of riparian river red gum and coolibah forests	26,000	11,840
Inundation of lignum communities and coolibah open forest / woodland	45,000	18,630
Floodplain connections	70,000	26,465
Significant floodplain inundation	120,000	38,385

Gooraman Swamp is a deflation basin perched on the floodplain to the west of the Culgoa River. The local vegetation is similar to the broader Culgoa floodplain vegetation, consisting of river red gum (*Eucalyptus camaldulensis*) and black box (*E. largiflorens*) woodlands, co-dominant with coolibah (*E. coolabah*). The wetland is dominated by woody vegetation, with large trees both within and adjacent to the actual basin of the wetland. Gooraman Swamp is approximately 28 hectares in size and has a volume of approximately 320 ML at a full supply level (125.6 m Australian height datum (Figure 18). Once overbank flows commence there are several flow paths which transport water to Gooraman Swamp, the lower flood pathway is illustrated in Figure 18.

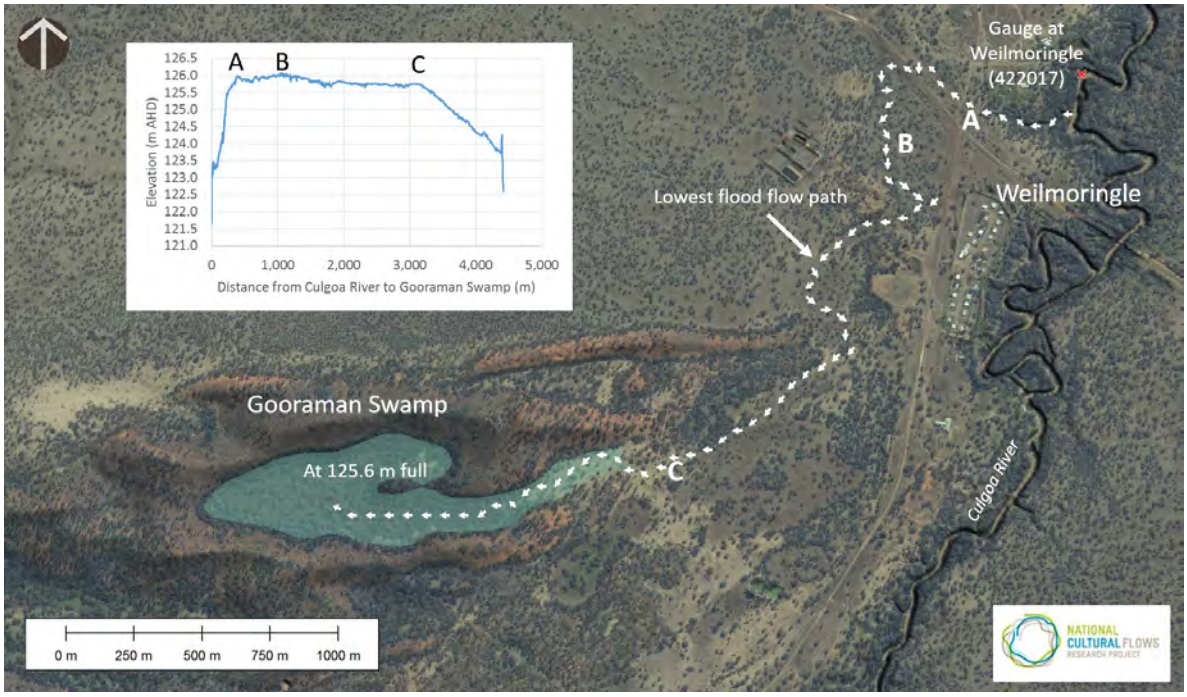


Figure 18: Aerial photograph showing the inundated area of Gooraman Swamp at full supply level and lowest flood flow path.

3.6.2 Vegetation

Ninety-six plant species have been recorded in the vicinity of Weilmoringle (10 km x 10 km grid centred of Gooraman Swamp) on the Atlas of NSW Wildlife; this includes 22 plant species recorded at four sites in and directly adjacent to Gooraman Swamp (see Appendix 1).

The distribution of floodwater strongly influences the distribution of floodplain vegetation communities across the Culgoa floodplain. There are five main vegetation communities in the Lower Balonne that vary across the floodplain in response to distance from individual watercourses, and along the floodplain in response to flooding pattern (Thoms et al. 2002, Hunter 2005). Coolibah (*Eucalyptus coolabah*) and river red gum (*E. camaldulensis*) are located adjacent to watercourses, while lignum (*Duma florulenta*) and nutgrass (*Cyperus bifax*) are found in areas of moderately high inundation frequency. Areas that are not watered as often are dominated by open and dry grassland types, particularly neverfail (*Eragrostis setifolia*), lovegrass/cane grass (*Eragrostis* spp.), buffle grass (*Cenchrus ciliaris* – introduced pasture species) and chenopods (Thoms et al. 2002).

Major changes in native vegetation composition occur across the Culgoa National Park in relation to flood frequency and the period of inundation (Hunter 2005, MDBA 2012c). In particular, Hunter (2005) found that the ability for certain sections of the floodplain to retain water for an extended period was an important feature in determining vegetation patterns.

A recent vegetation study that included vegetation communities in northern NSW, including the Culgoa River (Eco Logical 2015), confirmed this pattern of flood-dependent vegetation with the riparian woodlands of river red gum fringing the major rivers (including the Darling, Bokhara and Culgoa) and extensive floodplain woodlands dominated by coolibah (*E. coolabah*) and black box (*E. largiflorens*). Along the ephemeral channels and within low lying depressions, various wetland communities occur, including large semi-permanent billabong wetlands and inland lakes, and smaller ephemeral wetlands dominated by *Eleocharis* spp. *Marsilea* spp. and *Nymphoides* spp. The

shrub lignum (*Duma florulenta*) is commonly associated with minor channels and low lying areas throughout the region.

Vegetation surrounding the Culgoa River in the vicinity of Weilmoringle was noted by Eco Logical (2015) to include river red gum tall to very tall open forest/woodland wetland (plant community type (PCT) 26, as described in Eco Logical 2015). Vegetation back from the river frontage includes black box-gidgee-chenopod low open woodland wetland on alluvial clay soils (PCT 197, described by Eco Logical 2015), as well as brigalow-gidgee open woodland on clay plains (PCT 31, described by Eco Logical 2015).

Coolibah – Black Box Woodland of the northern riverine plains in the Darling Riverine Plains and Brigalow Belt South bioregions is listed as an Endangered Ecological Community in NSW under the Threatened Species Conservation Act 1995 (MDBA 2012c) and under the *Environmental Protection, Biodiversity and Conservation Act 1999 Cwth* (TSSC 2011). In this community coolibah is typically dominant but may occur in association with a wide range of other species including river cooba (*Acacia stenophylla*), black box and river red gum (NSW Scientific Committee 2011). The Coolibah – Black Box Woodlands are found on the grey, self-mulching clays of periodically waterlogged floodplains, swamp margins, ephemeral wetlands, and stream levees. They are characterised by a grassy understory and significant amounts of woody debris. Duration of inundation varies in response to local topography. The presence of this threatened community within the vicinity of Gooraman Swamp is not known, but may occur in the area.

Dykes et al. (2006) identified 29 species of plants as having exceptional cultural value and are considered significant as they help Murrawarri define themselves and their relationship to their country[1]. These species are listed in Table 13 with those which are considered aquatic or wetland dependent highlighted, or those associated with floodplain communities such as the black box and coolabah woodlands (i.e. means they can tolerate intermittent inundation). Additional species identified as being of ceremonial and spiritual importance are listed in Table 14. **Note** that this list of species is not specific to Gooraman Swamp and it may be that not all species will be present within the site.

Table 13. Plant species of exceptional cultural value (from Dykes et al. 2006).

Note: Blue shading indicates wetland dependent species, light green shading indicates species found associated with floodplain/wetland dependent species (i.e. associated with black box, coolibah, lignum) (modified from Dykes et al. 2006).

Primary Murrawarri name	Common name	Scientific name
Wirpil	Dogwood	*Eremophila bignoniflora*
Pawyil	Emu bush	*Eremphila longifolia*
Mururru	Gidgee - ring	*Acacia cambagei 'ringed'*
	Cane grass	*Eragrostis australasice*
	Curly Mitchell grass	*Astrebia lappacea*
	Kangaroo grass	*Themeda australis*

[1] 'Country' is a broad concept that includes land, water, sky, minerals, people, other species, ancestors, social relations, and sacred and heritage sites, with all of these elements intimately intertwined (from .

Primary Murrawarri name	Common name	Scientific name
Wirruwinj	Mitchell grass	*Astrebia* spp.
	Never fail grass	*Eragrostis setifolia*
	Nut grass	*Cyperus* sp.
Turrinj	Spinifex	*Triodiamitchellii* var *breviloba*
Turrinj	Spinifex	*T.* var *pubivargina*
Kuwaaru / Kurmanu	Emu apple	*Owenia acidula*
	Prickly wattle	*Acacia victoriae*
	Hopbush	*Dodonaea* spp.
Thirin	Narrow leaf hopbush	*Dodonaea viscosa* subsp. *angustissima*
Kurinj	Leopardwood	*Flindersia maculosa*
Wirrara	Lignum	*Duma florulenta*
Thawinj-thawinj	Nardoo	*Marsilea drumondii*
Muntilinh	Native banana	*Marsdenia australis*
Pampul	Native orange – rough skin	*Capparis mitchellii*
Pampul	Native orange – smooth skin	*C. loranthifolia* var. *loranthifolia*
Ngabaan	Nepine	*C. lasiantha*
Kuwarti	Quandong	*Santalum acuminatum*
Kartiwantu	Quinine Bush	*Alstonia constricta*
Thupppie	Snotty gobble, Coolibah mistletoe	*Diplatia grandibractea*
Wiirla	Superjack	*Ventilago viminalis*
Timpuru	Wilga	*Geijera parviflora*
Gargaloo	Yam - land	*Parsonsia eucalyptophyla*
Kimay	Yam - water	*Triglochin* spp.

Table 14. Plant species identified as both ceremonial and spiritual significance.

Note: Blue shading indicates wetland dependent species, light green shading indicates species found associated with floodplain/wetland dependent species (i.e. associated with black box, coolibah, lignum) (modified from Dykes et al. 2006).

Primary Murrawarri name	Common name	Scientific name
Wawurm	Belah	*Casurina cristata*
Paayilinj	Cyperus pine	*Caltritis gluacophylla*
Pawyil	Emu bush	*Eremphila longifolia*
Kuntuwa	Needlewood	*Hakea leucoptera*
Wampila	Paddymelon	*Cucumis* sp.
Kuruwa	River red gum, Ghost gum	*Euclayptus camaludensis*
Wumbul	Tea tree, Swamp paperbark	*Melaleuca trichostachya*

Water requirements for river red gum, coolibah and black box woodlands are presented in Table 15 (see also flow thresholds in section 3.5.1). Watering regimes which focus on achieving growth and reproduction of these species will be adequate to maintain the characteristics of the understory and wetland aquatic vegetation communities.

Table 15: Flood frequency and duration for selected flood-dependent species (modified from MDBA 2012c, based on Roberts & Marston 2011).

	River Red Gum (Eucalyptus camaldulensis)	Coolibah (*Eucalyptus coolabah)*	River Cooba (Acacia stenophylla)	Black-box (Eucalyptus largiflorens)
	River red gums are opportunistic water users and are able to meet their needs using water from a variety of sources, including groundwater. They are tolerant of elevated salinity levels (Roberts & Marston 2011).	Roberts & Marston (2011) found that the importance of flooding for adult coolibah had not been established, but that inundation is probably important for seedling establishment, and a sequence of floods, or flood and wet years, may be necessary to ensure seedlings are well established. Roberts & Marston (2011) found that although tolerant of hot dry conditions and infrequent flooding, coolibah is unlikely to persist if flow regime or regional hydrology becomes substantially drier.	Roberts & Marston (2011) found that flooding was important in determining the vigour of river cooba and implicated in germination and establishment of the species.	Black Box woodlands occur on floodplains, but also in areas that are almost never now flooded. It is a drought-hardy tree but functions best when vigorous. This summary is for trees on floodplains.
Frequency of inundation	About every one to three years for forests and about every two to four years for woodlands (Roberts & Marston 2011).	About every 10 to 20 years	About every three to seven years for large shrubs with vigorous canopy (Roberts & Marston 2011).	Every three to seven years.
Duration of inundation	About five to seven months for forests, and about two to four for woodlands (Roberts & Marston 2011).	Not known.	About two to three months (Roberts &Marston 2011).	About three to six months for vigorous canopy and flowering, two to three months for moderate to good canopy and flowering. Tolerates shorter flooding, but eventually becomes less vigorous, and flowering is diminished.

Critical Interval between inundations	Do not form a seed bank, hence it is important to maintain trees in good condition so that a good supply of seed is available. Inundation required after about three years for forests and five to seven years for woodlands (Roberts & Marston 2011). Longer intervals may be tolerated periodically, but if these become routine then tree condition is likely to deteriorate in the long term (Roberts & Marston 2011).	Not known, possible maintains vigour up to five years without flooding, with trees near creeks and waterholes able to maintain vigour for much longer periods (Roberts & Marston 2011).	Not known, possible maintains vigour up to five years without flooding, with trees near creeks and waterholes able to maintain vigour for much longer periods (Roberts & Marston 2011).	Re-flood after three to seven years to maintain trees in good condition. Flooding after a long interval should provide optimal conditions in order to re-establish vigour. Trees may survive 12 to 16 years with no flooding but in poor condition, forming dysfunctional woodlands, and with diminished capacity for full recovery. Does not form a seed bank, so flooding for regeneration should follow seed drop (Roberts & Marston 2011).

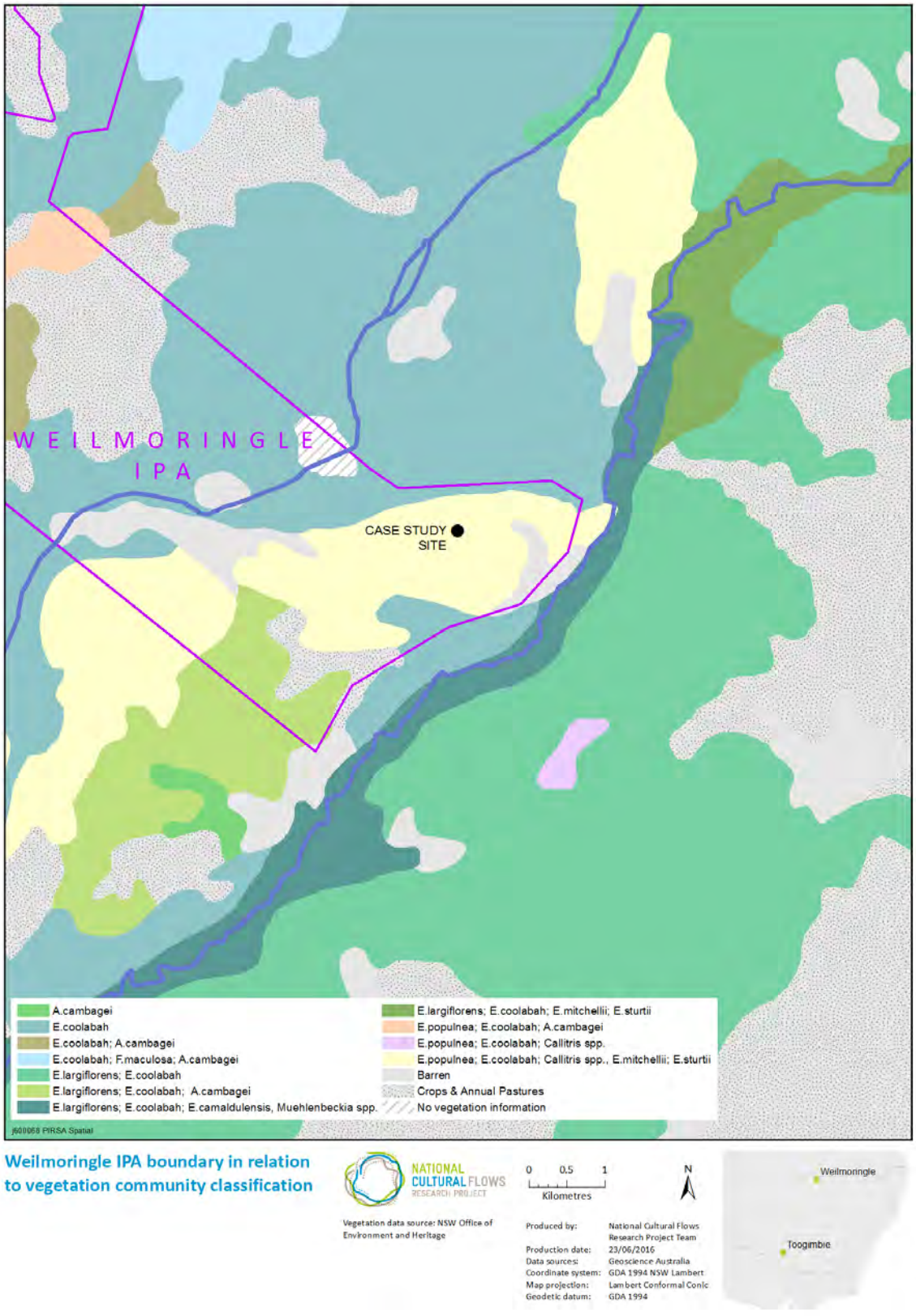


Figure 19: Weilmoringle IPA and Case Study Site in relation to vegetation community classification

3.6.3 Birds

Only four bird species were listed in the Atlas of NSW Wildlife, including bush stone-curlew, brown tree creeper, grey-crowned babbler and jacky winter. This is certainly an underestimate of the number of species present; however, each of the four bird species are of conservation significance in NSW (Appendix 1, section 3.7.3). NPWS (2002) identified an additional 11 species commonly found in the region, including:

- Barking Owl (*Ninox connivens*).
- Galah (*Eolophus roseicapilla*).
- Willie wagtail (*Rhipidura leucophrys*).
- Grey shrike-thrush (*Colluricincla harmonica*).
- Magpie lark (*Grallina cyanoleuca*).
- Black-faced cuckoo-shrike (*Coracina novaehollandiae*).
- White-plumed honeyeater (*Lichenostomus penicillatus*).
- Pied butcherbird (*Cracticus nigrogularis*).
- Australian magpie (*Cracticus tibicen*).
- Australian raven (*Corvus coronoides*).
- Red-tailed Black-Cockatoo (*Calyptorhynchus banksii*).

Dick & Andrew (1993) recorded 113 bird species (including one introduced) from the Culgoa and Birrie river floodplains, along with other surveys of the Lower Balonne indicating that most species showed a preference for the woodlands associated with the floodplain (Dick & Smith 1993, Smith 1993).Waterbirds likely to be present when the system is flooded include waterfowl including ducks and grebes, large waders such as spoonbills, crakes and rails, ibis, cranes such as Brolga, cormorants and other fish eating species and possibly kingfishers and raptors which utilise floodplain habitats.

3.6.4 Reptiles and amphibians

Two reptile species have been recorded in the vicinity of Gooraman Swamp (Atlas of NSW Wildlife, OEH, www.bionet.nsw.gov.au), certainly an under-representation of the number of species likely present in the riverine-floodplain landscape.

- Burns' Dragon (*Lophognathus burnsi*).
- Bearded Dragon (*Pogona barbata*).

3.6.5 Mammals

Three mammal species have been recorded in the vicinity of Weilmoringle (Atlas of NSW Wildlife, OEH, www.bionet.nsw.gov.au):

- Koala (*Phascolarctos cinereus*).
- Stripe-faced dunnart (*Sminthopsis macroura*).
- Little pied bat (*Chalinolobus picatus*).

As for other reptiles and birds, this is certain to be an under-representation of the number of species likely present in the riverine-floodplain landscape. However, the three species listed above are recognised as having conservation significance in NSW.

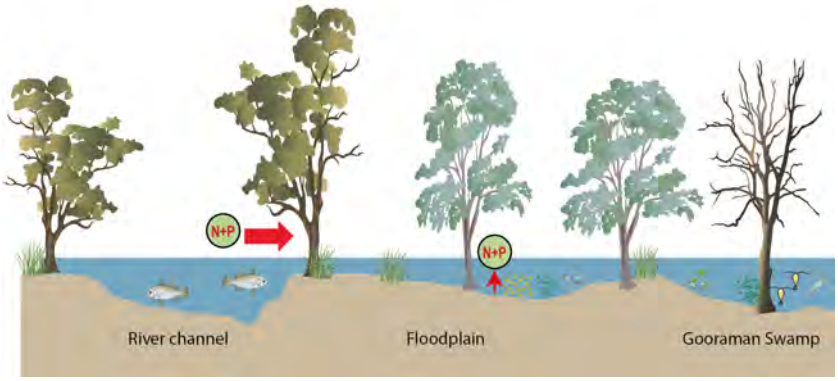
3.7 Ecosystem processes and function

As described for Toogimbie IPA (section 2.6), the river-floodplain system in the vicinity of Gooraman Swamp will also support a number of ecosystem process and functions, such as vegetation reproduction and carbon and nutrient cycling, particularly when watered. These processes and functions will add to the resilience of the site as a floodplain-wetland complex.

Gooraman Swamp is an intermittently filled wetland which exhibits a boom and bust ecology, where the boom period is associated with the arrival of floodwaters from the upstream catchment and through local rainfall events, followed by the bust period where the wetland dries and remains dry for up to several years (Kingsford, Curtin & Porter 1999, Bunn et al. 2006). The arrival of water onto the floodplain and Gooraman Swamp will trigger a range of ecological responses, many of which are linked to the timing and length of inundation. Flooding can trigger spectacular concentration of waterbirds, as reported post the 2011 floods, which reflect the incredible productivity of the wetlands and the availability of both abundant food resources and habitat. The bust period, when the wetlands dry involves a number of processes as well, and can include stranding of fish on the floodplain, abandonment of nest if rates of water recession are fast. A simple conceptual model of the wetting, full and drying phases for Gooraman Swamp are shown in Figure 20. These basic process would also occur at Toogimbie on wetting and drying.

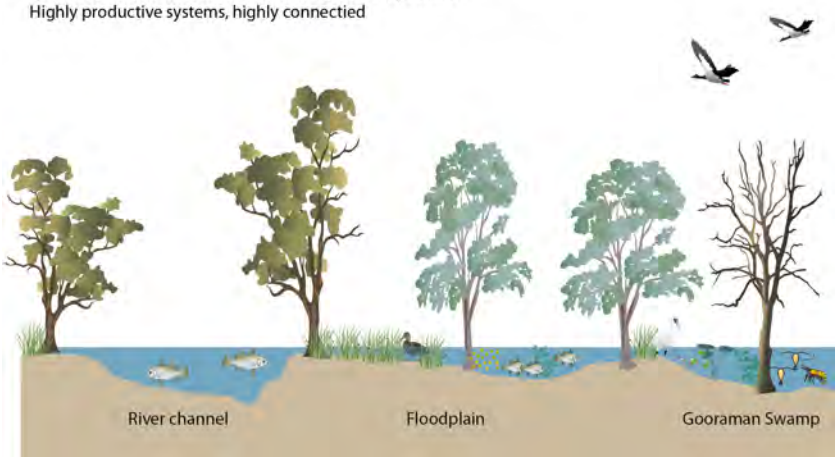
Boom and bust: wetting

On wetting - soils release nutrients, siltation may occur, sediments from river carry nutrients onto floodplain.
Cyanobacteria photosynthesise, reproduce and kick start primary productivity.
Aquatic plants on the floodplain germinate and grow from seedbank and propagules bought in on floodwaters.
Zooplankton emerge from eggbank.
Frogs may respond to flooding and lay eggs.
Fish may move onto floodplain to take advantage of food resource boom - ie zooplankton.
Reptiles, mammals and wodland birds take advantage of new growth in vegetation and prey.



Boom and bust: fully inundated

Biota move onto floodplain areas from river or other nearby wetlands
More species emerge from seed and egg banks
Waterbirds arrive, fish and amphibians move into waterholding areas
Species for which habitat requirements are met reproduce
Highly productive systems, highly connectied



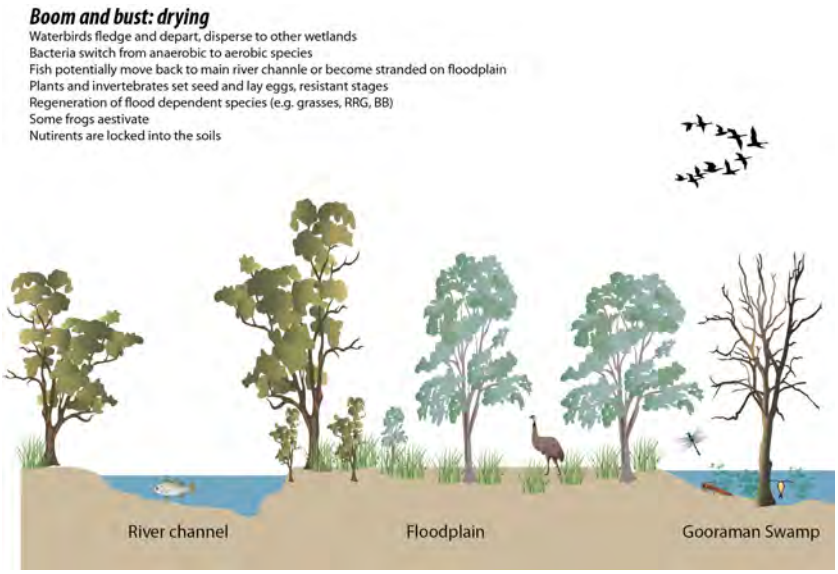


Figure 20. Conceptual model of boom and bust ecology for Gooraman Swamp illustrating connectivity between river, floodplain and wetland.

3.8 Ecosystem services and benefits

3.8.1 Provisioning services

Products obtained from the local ecosystem for human consumption (e.g. fish, water) are mainly sourced from the Culgoa River, rather than the floodplain or wetland areas of Weilmoringle IPA (i.e. Gooraman Swamp). However, a number of provisioning services from the wetlands identified through the field work include the provision of traditional medicines and food sourced from the floodplain post inundation (see cultural character report). Whilst not a direct service of the wetland the benefits from floodplain inundation and a more natural flow regime in the Culgoa include support of key harvest species on the floodplain such as kangaroo and emu, and cod, yellow-belly and catfish in the river.

3.8.2 Regulating services

Gooraman Swamp is situated on the floodplain of the Culgoa River. It is, therefore, an integral part of the wider river-floodplain system, as allowing dispersal of water onto the floodplain promotes ecological connectivity (see section 3.7.3). The site is intimately connected to both riverine and floodplain/wetland components of the local bioregion, however as there are no significant channels which can transport return flows back into the Culgoa, the role Gooraman Swamp has in terms of regulating hydrological regimes is limited to potential groundwater surface water interactions – although this is a knowledge gap for the site.

3.8.3 Supporting services

Hydrological processes, habitat provision and ecological connectivity

As noted in section 2.7.3, hydrological processes, particularly flooding that connects the main channel of a river with its floodplain, are important for supporting riparian and floodplain habitats, and the diversity of flora and fauna populations that depend on them. At Weilmoringle hydrological processes are particularly important for sustaining river red gum, black box and

coolibah woodland communities and in turn habitat for birds, amphibians and mammals (see previous Section 3.5). The characteristics of the vegetation are driven by the local topography soils and frequency and duration of flooding.

Threatened species and communities

The connected river-floodplain system, along with the woodlands and shrub lands at and surrounding Gooraman Swamp provide habitat that supports a number of threatened species (Table 16).

Table 16: Regionally threatened species supported in the vicinity of Weilmoringle (from NPWS 2002, Atlas of NSW Wildlife)

Biota	Threatened species
Reptiles	• Bearded dragon (*Pogona barbata*),
Birds	• Barking owl (*Ninox connivens*), • Bush Stone-curlew (*Burhinus grallarius*), • Brown treecreeper (eastern subspecies) (*Climacteris picumnus victoriae*), • Grey-crowned babbler (eastern subspecies) (*Pomatostomus temporalis temporalis*), • Jacky winter (*Microeca fascinans*), • Red-tailed black-Cockatoo (*Calyptorhynchus banksii*).
Mammals	• Koala (*Phascolarctos cinereus*), • Stripe-faced dunnart (*Sminthopsis macroura*) • Little pied bat (*Chalinolobus picatus*).

As stated in section 3.5.2 it is possible that the endangered Coolibah-Black box woodlands may occur in the area as well. Further botanical surveys would be required to confirm if the community is present or not.

3.8.4 Cultural services

Cultural services provided by the site will are presented in the separate cultural character report (see *NCFRP Aboriginal Water Interests for Establishing Cultural Flows Report* 2016).

3.9 Threats to ecological character

The Culgoa National Park plan of management (NPWS 2003) has identified a number of threats to ecological and cultural character, which are likely to be relevant to the Gooraman Swamp site also. These include:

- Noxious plants and feral animals.
- Regulation of the river system, affecting inundation of wetland areas and revegetation areas.
- Bush/wild fires.

The main noxious weeds at the site include:

- Spiny burr grass (*Cenchrus incertus*).
- African boxthorn (*Lycium ferrocissimum*).
- Noogoora burr (*Xanthium occid*entale).
- Bathurst burr (*Xanthium spinosum*) occur.
- Buffel grass (*Cenchrus ciliaris*).
- Saffron thistle (*Carthamus lanatus*).
- Mother-of-millions (*Bryophyllum tubiflora*).

The main feral animals of concern include:

- Wild Pig (*Sus scrofa*).
- Feral cat (*Felis catus*).
- Fox (*Vulpes vul*pes).
- Goats (Capra hircus).

3.10 Conceptual models

The stressor model developed will need to be refined in consultation with the Murrawarri community but illustrates the relationship of the existing threats and stressors to the key ecological components, processes and services which may affect the outcomes achieved from cultural watering. A draft stressor model is presented in Figure 21.

Conceptual models for Gooraman Swamp have focused on illustrating the ecological character focusing on key components, processes and services which are expected to respond to water management. The model developed is based on feedback from the community (via field visits) and an understanding of the ecological watering requirements of the dominant woodland communities. The ecological character model is shown in Figure 22. A conceptual model illustrating the key processes that occur in a boom and bust cycle of wetting and drying, typical of Gooraman Swamp is shown in Figure 22.

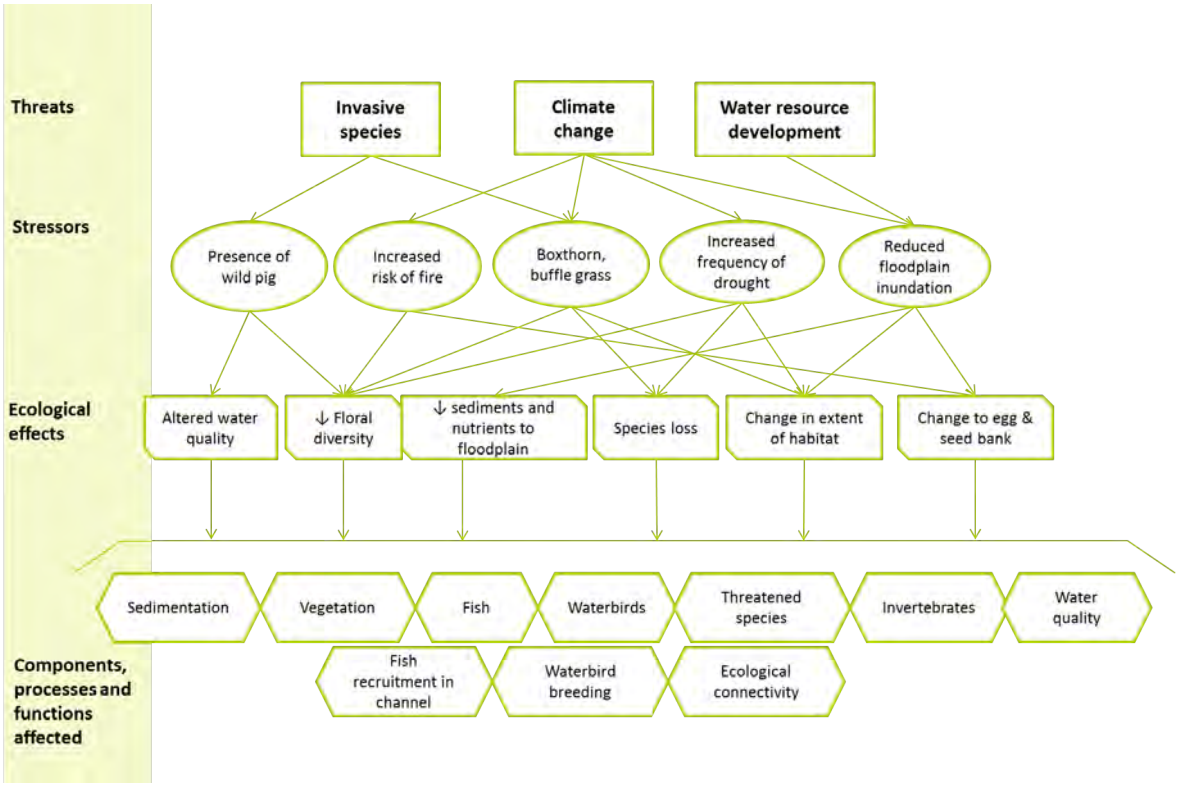


Figure 21: Draft stressor model for Gooraman Swamp.

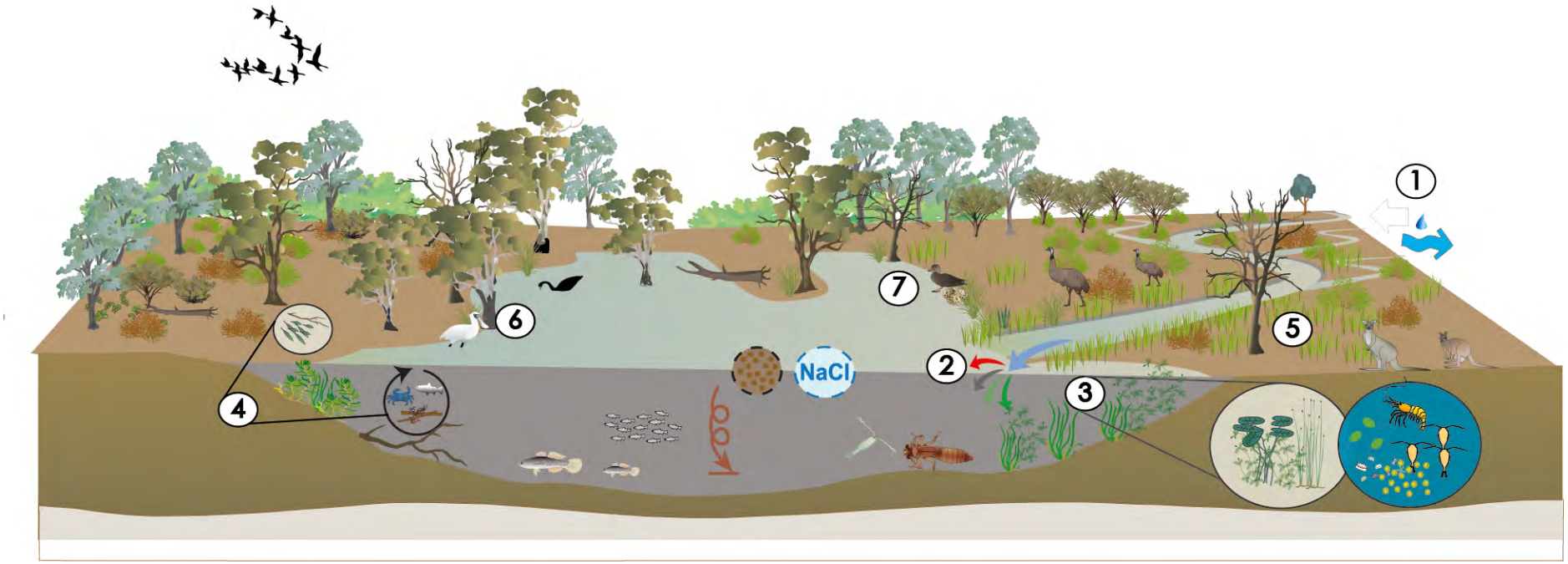
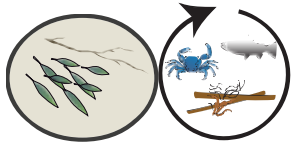


Figure 22: Illustration of ecological character of Gooraman Swamp after filling.

Key to Figure 22:

8. Overbank flows across the floodplain will promote exchange of nutrients between the Culgoa, floodplain and the wetland. It will also promote regeneration in floodplain vegetation, both grasses and woody vegetation.
9. Gooraman Swamp fills predominantly from overland flows from the Culgoa River, but also receives inflows from local runoff and direct rainfall. Connectivity with groundwater is possible, but is a knowledge gap. Overland flows transport nutrients, sediments, and

organic material from the floodplain and upstream sources. Biota are also brought into the system on floodwaters, including plant seeds and propagules, invertebrates and fish.

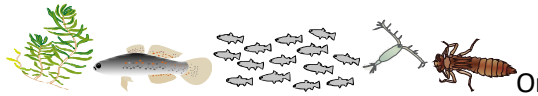
10.  Floodplain systems and intermittent wetlands display a typical boom and bust cycle of seed germination and egg hatching from the seed and egg banks respectively, resulting in a plant and animal community typical of an intermittent semi-arid zone floodplain wetland, with short term high productivity and temporary water specialists.
11.  The dominant food web is detrital based on the floodplain and in the wetland, with large inputs of organic matter accumulated on the dry wetland bed in between flood events aiding the boom of production when water arrives. The woody debris and leaves provide also provide important structural habitat for invertebrates.
12.  Overland flooding promotes floodplain vegetation growth, particularly grasses, along the Culgoa floodplain surrounding the Gooraman Swamp which in turn supports grazing animals and foraging areas for important cultural foods such as emu and kangaroo.
13.  Presence of water supports a diversity of waterbirds, most likely predominantly ducks, grebes, swan, spoonbills, ibis and rails and crakes.
14.  Flooding may support breeding of waterbirds, most likely duck species. Some colonial nesting species may use the wetland but they are likely to only be in small numbers.

Water quality and physical processes characteristic of overland flows in Gooraman Swamp include:

Salinity is low  and turbidity low to moderate, largely reflect levels of the source water. Salinity levels will increase as the wetland dries, some  sedimentation will occur in the wetland and on the floodplain. 

Overbank flows promote transport and dilution of carbon both to and from the floodplain, which contribute to productivity both in-stream and off-stream.

Biological processes characteristic of fully inundated Gooraman Swamp include:


Once full, water remains in the wetland for over a year and supports a productive and complex aquatic ecosystem, with features characteristic of boom and bust ecosystems. Aquatic macrophytes establish from the seed bank and also arrive as propagules from inflows from the Culgoa. Invertebrates hatch from the soils on wetting and establish both micro and macroinvertebrate communities which in turn support a fish.


Periodic flooding of the wetland sustain River Red Gum trees, promoting regeneration in and around the edges of the wetland. Larger floods reaching to the Black Box woodlands are less frequent and water remains on the floodplain for less time.

Combined these components and process represent the ecological character of Gooraman Swamp after flooding.

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5 APPENDIX 1: ATLAS OF NSW WILDLIFE: TOOGIMBIE AND WEILMORINGLE FLORA AND FAUNA SPECIES LISTS

The following species lists were obtained from the Atlas of NSW Wildlife on the 24th March 2016: http://www.environment.nsw.gov.au/atlaspublicapp/UI_Modules/ATLAS_/atlasreport.aspx#

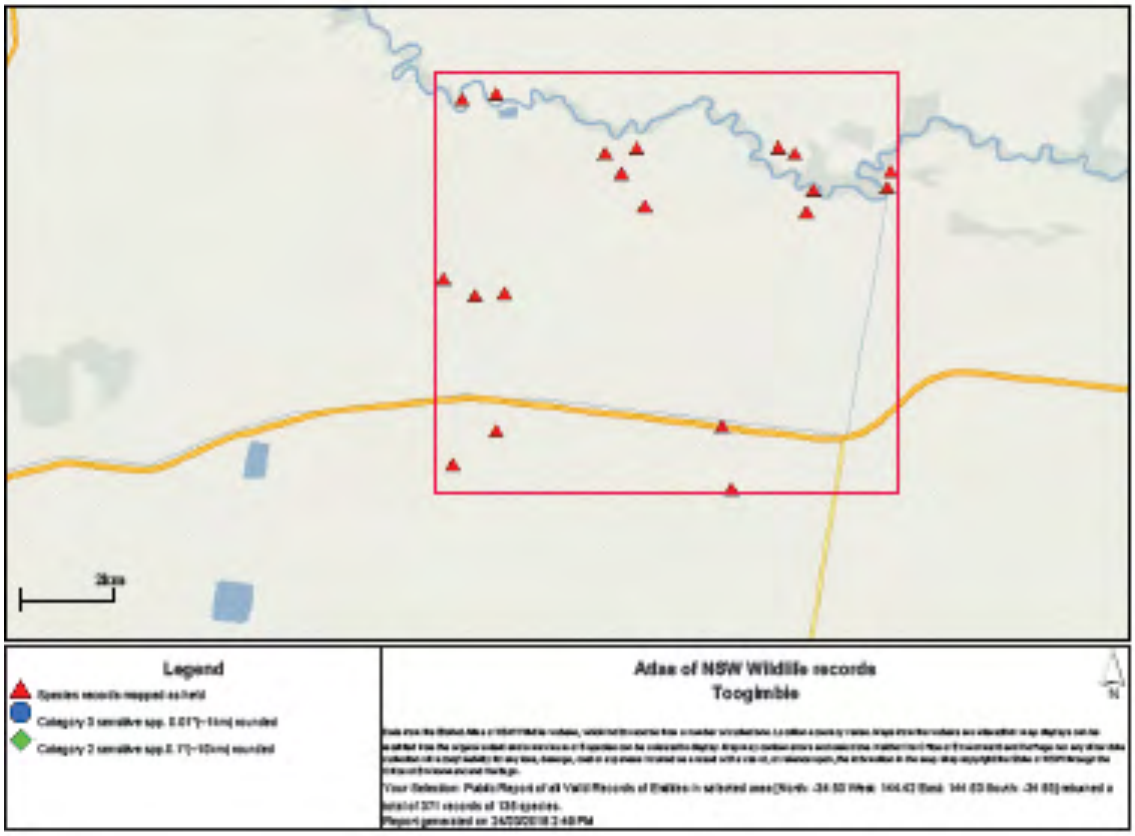

Table 17: Flora and fauna species recorded at Toogimbie IPA (from Atlas of NSW Wildlife, accessed 30 March 2016)

Kingdom	Class	Family	Species Code	Scientific Name	Exotic	Common Name	NSW status
Animalia	Reptilia	Scincidae	2519	*Menetia greyii*		Common Dwarf Skink	P
Animalia	Reptilia	Agamidae	2177	*Pogona barbata*		Bearded Dragon	P
Animalia	Aves	Casuariidae	0001	*Dromaius novaehollandiae*		Emu	P
Animalia	Aves	Anatidae	0211	*Anas gracilis*		Grey Teal	P
Animalia	Aves	Anatidae	0212	*Anas rhynchotis*		Australasian Shoveler	P
Animalia	Aves	Anatidae	0208	*Anas superciliosa*		Pacific Black Duck	P
Animalia	Aves	Anatidae	0202	*Chenonetta jubata*		Australian Wood Duck	P
Animalia	Aves	Columbidae	0034	*Phaps chalcoptera*		Common Bronzewing	P
Animalia	Aves	Pelecanidae	0106	*Pelecanus conspicillatus*		Australian Pelican	P
Animalia	Aves	Ardeidae	0189	*Ardea pacifica*		White-necked Heron	P
Animalia	Aves	Ardeidae	0188	*Egretta novaehollandiae*		White-faced Heron	P
Animalia	Aves	Threskiornithidae	0182	*Platalea flavipes*		Yellow-billed Spoonbill	P
Animalia	Aves	Accipitridae	0224	*Aquila audax*		Wedge-tailed Eagle	P
Animalia	Aves	Accipitridae	0232	*Elanus axillaris*		Black-shouldered Kite	P
Animalia	Aves	Accipitridae	0228	*Haliastur sphenurus*		Whistling Kite	P
Animalia	Aves	Falconidae	0239	*Falco berigora*		Brown Falcon	P
Animalia	Aves	Falconidae	0240	*Falco cenchroides*		Nankeen Kestrel	P
Animalia	Aves	Cacatuidae	0273	*Eolophus roseicapillus*		Galah	P
Animalia	Aves	Psittacidae	0284	*Platycercus elegans flaveolus*		[Yellow Rosella]	P
Animalia	Aves	Tytonidae	9923	*Tyto javanica*		Eastern Barn Owl	P
Animalia	Aves	Alcedinidae	0326	*Todiramphus sanctus*		Sacred Kingfisher	P

Kingdom	Class	Family	Species Code	Scientific Name	Exotic	Common Name	NSW status
Animalia	Aves	Meropidae	0329	*Merops ornatus*		Rainbow Bee-eater	P
Animalia	Aves	Maluridae	0529	*Malurus cyaneus*		Superb Fairy-wren	P
Animalia	Aves	Maluridae	0536	*Malurus lamberti*		Variegated Fairy-wren	P
Animalia	Aves	Maluridae	0535	*Malurus leucopterus*		White-winged Fairy-wren	P
Animalia	Aves	Acanthizidae	0463	*Gerygone fusca*		Western Gerygone	P
Animalia	Aves	Acanthizidae	0465	*Smicrornis brevirostris*		Weebill	P
Animalia	Aves	Pardalotidae	0976	*Pardalotus striatus*		Striated Pardalote	P
Animalia	Aves	Meliphagidae	0646	*Philemon citreogularis*		Little Friarbird	P
Animalia	Aves	Meliphagidae	0645	*Philemon corniculatus*		Noisy Friarbird	P
Animalia	Aves	Meliphagidae	0625	*Ptilotula penicillatus*		White-plumed Honeyeater	P
Animalia	Aves	Campephagidae	0424	*Coracina novaehollandiae*		Black-faced Cuckoo-shrike	P
Animalia	Aves	Pachycephalidae	0408	*Colluricincla harmonica*		Grey Shrike-thrush	P
Animalia	Aves	Pachycephalidae	0401	*Pachycephala rufiventris*		Rufous Whistler	P
Animalia	Aves	Artamidae	0547	*Artamus cyanopterus*		Dusky Woodswallow	P
Animalia	Aves	Artamidae	0544	*Artamus personatus*		Masked Woodswallow	P
Animalia	Aves	Artamidae	0700	*Cracticus nigrogularis*		Pied Butcherbird	P
Animalia	Aves	Artamidae	0705	*Cracticus tibicen*		Australian Magpie	P
Animalia	Aves	Corvidae	0930	*Corvus coronoides*		Australian Raven	P
Animalia	Aves	Corvidae	0954	*Corvus mellori*		Little Raven	P
Animalia	Aves	Monarchidae	0415	*Grallina cyanoleuca*		Magpie-lark	P
Animalia	Aves	Petroicidae	0381	*Petroica goodenovii*		Red-capped Robin	P
Animalia	Aves	Hirundinidae	0360	*Petrochelidon ariel*		Fairy Martin	P

Kingdom	Class	Family	Species Code	Scientific Name	Exotic	Common Name	NSW status
Animalia	Aves	Nectariniidae	0564	*Dicaeum hirundinaceum*		Mistletoebird	P
Animalia	Aves	Motacillidae	0647	*Anthus novaeseelandiae*		Australian Pipit	P
Animalia	Mammalia	Dasyuridae	1050	*Planigale gilesi*		Paucident Planigale	P
Animalia	Mammalia	Phalangeridae	1113	*Trichosurus vulpecula*		Common Brushtail Possum	P
Animalia	Mammalia	Macropodidae	1265	*Macropus giganteus*		Eastern Grey Kangaroo	P
Animalia	Mammalia	Macropodidae	1275	*Macropus rufus*		Red Kangaroo	P
Animalia	Mammalia	Macropodidae	T085	*Macropus sp.*		kangaroo / wallaby	P
Animalia	Mammalia	Molossidae	1324	*Austronomus australis*		White-striped Freetail-bat	P
Animalia	Mammalia	Molossidae	9044	*Mormopterus "Species 4" (big penis)*			P
Animalia	Mammalia	Molossidae	T299	*Mormopterus petersi*		Inland Free-tailed Bat	
Animalia	Mammalia	Vespertilionidae	1349	*Chalinolobus gouldii*		Gould's Wattled Bat	P
Animalia	Mammalia	Vespertilionidae	1351	*Chalinolobus morio*		Chocolate Wattled Bat	P
Animalia	Mammalia	Vespertilionidae	1335	*Nyctophilus geoffroyi*		Lesser Long-eared Bat	P
Animalia	Mammalia	Vespertilionidae	1334	*Nyctophilus gouldi*		Gould's Long-eared Bat	P
Animalia	Mammalia	Vespertilionidae	1364	*Scotorepens balstoni*		Inland Broad-nosed Bat	P
Animalia	Mammalia	Vespertilionidae	1379	*Vespadelus vulturnus*		Little Forest Bat	P
Animalia	Mammalia	Muridae	1412	*Mus musculus*	*	House Mouse	
Animalia	Mammalia	Canidae	1532	*Vulpes vulpes*	*	Fox	
Animalia	Mammalia	Bovidae	1518	*Bos taurus*	*	European cattle	
Animalia	Mammalia	Bovidae	1521	*Capra hircus*	*	Goat	
Plantae	Flora	Aizoaceae	11185	*Tetragonia tetragonioides*		New Zealand Spinach	
Plantae	Flora	Amaranthaceae	6478	*Alternanthera denticulata*		Lesser Joyweed	

Kingdom	Class	Family	Species Code	Scientific Name	Exotic	Common Name	NSW status
Plantae	Flora	Amaryllidaceae	3537	*Calostemma purpureum*		Garland Lily	
Plantae	Flora	Apiaceae	1109	*Daucus glochidiatus*		Native Carrot	
Plantae	Flora	Asphodelaceae	3531	*Bulbine bulbosa*		Bulbine Lily	
Plantae	Flora	Asteraceae	1273	*Arctotheca calendula*	*	Capeweed	
Plantae	Flora	Asteraceae	1347	*Calotis scabiosifolia*		Rough Burr-daisy	
Plantae	Flora	Asteraceae	7929	*Calotis scabiosifolia var. scabiosifolia*			
Plantae	Flora	Asteraceae	8559	*Chrysocephalum apiculatum*		Common Everlasting	
Plantae	Flora	Asteraceae	1400	*Cirsium vulgare*	*	Spear Thistle	
Plantae	Flora	Asteraceae	8913	*Hedypnois rhagadioloides subsp. cretica*	*	Cretan Weed	
Plantae	Flora	Asteraceae	1542	*Isoetopsis graminifolia*		Grass Cushion	
Plantae	Flora	Asteraceae	8919	*Rhodanthe corymbiflora*		Small White Sunray	
Plantae	Flora	Asteraceae	1661	*Senecio glossanthus*		Streaked Poverty Bush	
Plantae	Flora	Asteraceae	1690	*Sonchus oleraceus*	*	Common Sowthistle	
Plantae	Flora	Asteraceae	1714	*Vittadinia gracilis*		Woolly New Holland Daisy	
Plantae	Flora	Boraginaceae	1751	*Echium plantagineum*	*	Patterson's Curse	
Plantae	Flora	Brassicaceae	1841	*Rapistrum rugosum*	*	Turnip Weed	
Plantae	Flora	Caryophyllaceae	1980	*Sagina apetala*	*	Annual Pearlwort	
Plantae	Flora	Chenopodiaceae	2098	*Chenopodium nitrariaceum*		Nitre Goosefoot	
Plantae	Flora	Chenopodiaceae	2114	*Enchylaena tomentosa*		Ruby Saltbush	
Plantae	Flora	Chenopodiaceae	2119	*Maireana aphylla*		Cotton Bush	
Plantae	Flora	Chenopodiaceae	2127	*Maireana decalvans*		Black Cotton Bush	
Plantae	Flora	Chenopodiaceae	2140	*Maireana pentagona*		Hairy Bluebush,	

Kingdom	Class	Family	Species Code	Scientific Name	Exotic	Common Name	NSW status
						Slender Fissure-weed	
Plantae	Flora	Chenopodiaceae	2165	*Scleroblitum atriplicinum*		Purple Goosefoot	
Plantae	Flora	Chenopodiaceae	7656	*Sclerolaena muricata var. semiglabra*		Black Rolypoly	
Plantae	Flora	Chenopodiaceae	6750	*Sclerolaena stelligera*		Star Copperburr	
Plantae	Flora	Convolvulaceae	2220	*Convolvulus erubescens*		Pink Bindweed	
Plantae	Flora	Euphorbiaceae	8560	*Chamaesyce drummondii*		Caustic Weed	
Plantae	Flora	Fabaceae (Faboideae)	2922	*Medicago polymorpha*	*	Burr Medic	
Plantae	Flora	Fabaceae (Faboideae)	2923	*Medicago praecox*	*	Small-leaved Burr Medic	
Plantae	Flora	Fabaceae (Faboideae)	2926	*Medicago truncatula*	*	Barrel Medic	
Plantae	Flora	Fabaceae (Mimosoideae)	3843	*Acacia oswaldii*		Miljee	
Plantae	Flora	Geraniaceae	3141	*Erodium cicutarium*	*	Common Crowfoot	
Plantae	Flora	Geraniaceae	3142	*Erodium crinitum*		Blue Crowfoot	
Plantae	Flora	Geraniaceae	3156	*Geranium solanderi*		Native Geranium	
Plantae	Flora	Goodeniaceae	3181	*Goodenia fascicularis*		Mallee Goodenia	
Plantae	Flora	Goodeniaceae	3194	*Goodenia pusilliflora*			
Plantae	Flora	Haloragaceae	7455	*Haloragis glauca f. glauca*			
Plantae	Flora	Lamiaceae	3453	*Teucrium racemosum*		Grey Germander	
Plantae	Flora	Malvaceae	3657	*Malva parviflora*	*	Small-flowered Mallow	
Plantae	Flora	Malvaceae	3664	*Sida corrugata*		Corrugated Sida	
Plantae	Flora	Malvaceae	3674	*Sida trichopoda*		High Sida	
Plantae	Flora	Nyctaginaceae	6841	*Boerhavia dominii*		Tarvine	
Plantae	Flora	Oxalidaceae	4621	*Oxalis perennans*			

Kingdom	Class	Family	Species Code	Scientific Name	Exotic	Common Name	NSW status
Plantae	Flora	Plantaginaceae	4690	*Plantago cunninghamii*		Sago-weed	
Plantae	Flora	Poaceae	10379	*Austrostipa scabra subsp. falcata*		Rough Speargrass	
Plantae	Flora	Poaceae	4780	*Avena fatua*	*	Wild Oats	
Plantae	Flora	Poaceae	4833	*Chloris truncata*		Windmill Grass	
Plantae	Flora	Poaceae	5012	*Hordeum leporinum*	*	Barley Grass	
Plantae	Flora	Poaceae	5032	*Lolium perenne*	*	Perennial Ryegrass	
Plantae	Flora	Poaceae	14322	*Rytidosperma setaceum*		Small-flowered Wallaby-grass	
Plantae	Flora	Poaceae	5177	*Sporobolus caroli*		Fairy Grass	
Plantae	Flora	Poaceae	13475	*Walwhalleya proluta*			
Plantae	Flora	Polygonaceae	14542	*Duma florulenta*		Lignum	
Plantae	Flora	Polygonaceae	5304	*Rumex tenax*		Shiny Dock	
Plantae	Flora	Solanaceae	6081	*Solanum esuriale*		Quena	

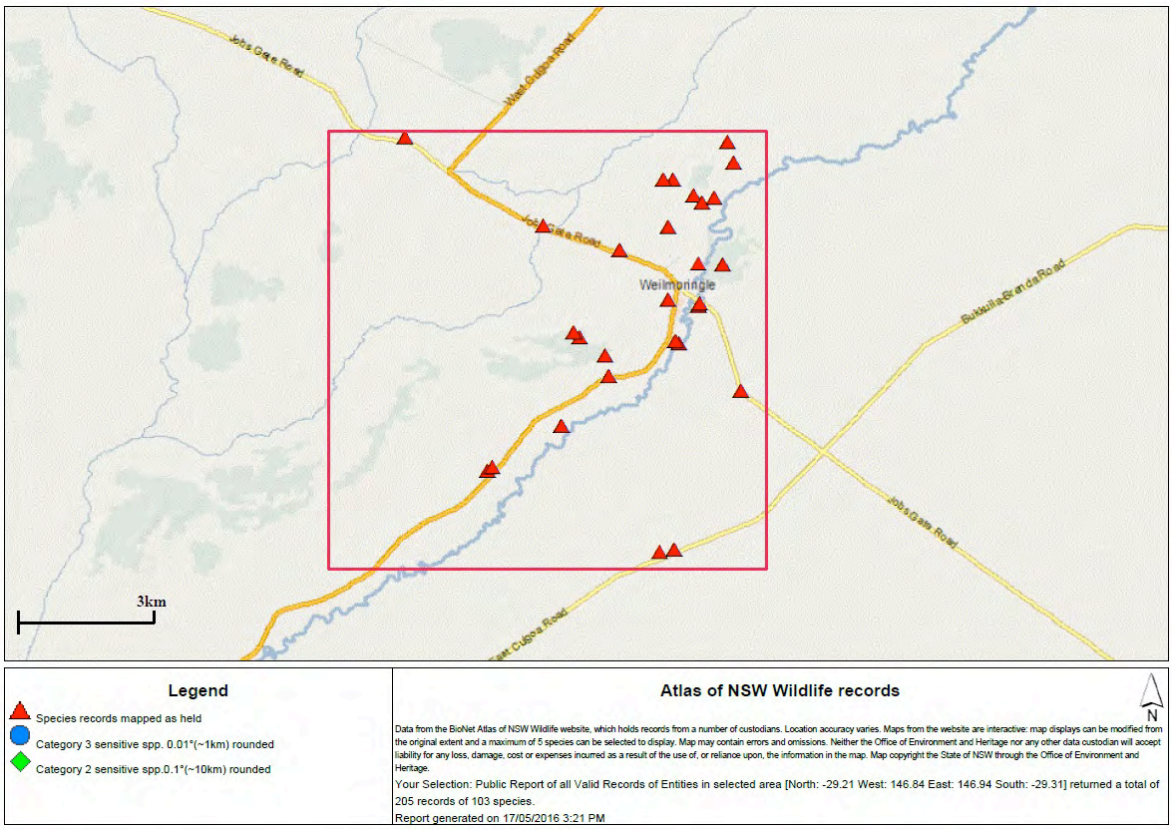

Table 18: Flora and fauna species recorded at Weilmoringle (from Atlas of NSW Wildlife, accessed 30 March 2016)

Kingdom	Class	Family	Species Code	Scientific Name	Exotic	Common Name	NSW status	Comm. status
Animalia	Reptilia	Agamidae	2822	*Lophognathus burnsi*		Burns' Dragon	P	
Animalia	Reptilia	Agamidae	2177	*Pogona barbata*		Bearded Dragon	P	
Animalia	Aves	Burhinidae	0174	*Burhinus grallarius*		Bush Stone-curlew	E1,P	
Animalia	Aves	Climacteridae	8127	*Climacteris picumnus victoriae*		Brown Treecreeper (eastern subspecies)	V,P	
Animalia	Aves	Pomatostomidae	8388	*Pomatostomus temporalis temporalis*		Grey-crowned Babbler (eastern subspecies)	V,P	
Animalia	Aves	Petroicidae	0377	*Microeca fascinans*		Jacky Winter	P	

Kingdom	Class	Family	Species Code	Scientific Name	Exotic	Common Name	NSW status	Comm. status
Animalia	Mammalia	Phascolarctidae	1162	*Phascolarctos cinereus*		Koala	V,P	V
Plantae	Flora	Aizoaceae	11185	*Tetragonia tetragonioides*		New Zealand Spinach		
Plantae	Flora	Amaranthaceae	1057	*Amaranthus macrocarpus*		Dwarf Amaranth		
Plantae	Flora	Amaranthaceae	1081	*Ptilotus polystachyus var. polystachyus*		Long Tails		
Plantae	Flora	Apiaceae	10871	*Eryngium paludosum*		Long Eryngium		
Plantae	Flora	Apocynaceae	1164	*Alstonia constricta*		Quinine Bush		
Plantae	Flora	Asphodelaceae	3532	*Bulbine semibarbata*		Wild Onion		
Plantae	Flora	Asteraceae	ASTRC	*Asteraceae indeterminate*	*	Daisies		
Plantae	Flora	Asteraceae	1342	*Calotis hispidula*		Bogan Flea		
Plantae	Flora	Asteraceae	1347	*Calotis scabiosifolia*		Rough Burr-daisy		
Plantae	Flora	Asteraceae	1438	*Epaltes cunninghamii*		Tall Nut-heads		
Plantae	Flora	Asteraceae	9690	*Euchiton sphaericus*		Star Cudweed		
Plantae	Flora	Asteraceae	12766	*Leiocarpa brevicompta*		Flat Billy-buttons		
Plantae	Flora	Asteraceae	1573	*Minuria integerrima*		Smooth Minuria		
Plantae	Flora	Asteraceae	1576	*Myriocephalus rhizocephalus*		Woolly-heads		
Plantae	Flora	Asteraceae	11144	*Polycalymma stuartii*		Poached Eggs		
Plantae	Flora	Asteraceae	VITT	*Vittadinia spp.*		Fuzzweed		
Plantae	Flora	Asteraceae	7130	*Xanthium occidentale*	*	Noogoora Burr		
Plantae	Flora	Campanulaceae	1938	*Wahlenbergia stricta*		Tall Bluebell		

Kingdom	Class	Family	Species Code	Scientific Name	Exotic	Common Name	NSW status	Comm. status
Plantae	Flora	Capparaceae	1942	*Apophyllum anomalum*		Warrior Bush		
Plantae	Flora	Chenopodiaceae	2087	*Chenopodium auricomum*		Queensland Bluebush		
Plantae	Flora	Chenopodiaceae	7916	*Chenopodium desertorum subsp. desertorum*		Desert Goosefoot		
Plantae	Flora	Chenopodiaceae	2098	*Chenopodium nitrariaceum*		Nitre Goosefoot		
Plantae	Flora	Chenopodiaceae	6528	*Dissocarpus biflorus var. cephalocarpus*		Many-horned Cpperburr		
Plantae	Flora	Chenopodiaceae	2111	*Einadia nutans*		Climbing Saltbush		
Plantae	Flora	Chenopodiaceae	2114	*Enchylaena tomentosa*		Ruby Saltbush		
Plantae	Flora	Chenopodiaceae	2122	*Maireana brevifolia*				
Plantae	Flora	Chenopodiaceae	2127	*Maireana decalvans*		Black Cotton Bush		
Plantae	Flora	Chenopodiaceae	2145	*Maireana schistocarpa*				
Plantae	Flora	Chenopodiaceae	2155	*Malacocera tricornis*		Soft Horns		
Plantae	Flora	Chenopodiaceae	2161	*Rhagodia spinescens*		Thorny Saltbush		
Plantae	Flora	Chenopodiaceae	2165	*Scleroblitum atriplicinum*		Purple Goosefoot		
Plantae	Flora	Chenopodiaceae	2169	*Sclerolaena bicornis*		Goathead Burr		
Plantae	Flora	Chenopodiaceae	7243	*Sclerolaena bicornis var. bicornis*				
Plantae	Flora	Chenopodiaceae	2170	*Sclerolaena birchii*		Galvinized Burr		
Plantae	Flora	Chenopodiaceae	2172	*Sclerolaena calcarata*		Redburr		
Plantae	Flora	Chenopodiaceae	2176	*Sclerolaena decurrens*		Green Copperburr		

Kingdom	Class	Family	Species Code	Scientific Name	Exotic	Common Name	NSW status	Comm. status
Plantae	Flora	Chenopodiaceae	2185	*Sclerolaena muricata*		Black Rolypoly		
Plantae	Flora	Cupressaceae	6379	*Callitris glaucophylla*		White Cypress Pine		
Plantae	Flora	Cyperaceae	2351	*Cyperus bifax*		Downs Nutgrass		
Plantae	Flora	Cyperaceae	2418	*Eleocharis pallens*		Pale Spike Sedge		
Plantae	Flora	Euphorbiaceae	8560	*Chamaesyce drummondii*		Caustic Weed		
Plantae	Flora	Fabaceae (Faboideae)	3092	*Trigonella suavissima*		Coopers Clover		
Plantae	Flora	Fabaceae (Mimosoideae)	3731	*Acacia cambagei*		Gidgee		
Plantae	Flora	Fabaceae (Mimosoideae)	3770	*Acacia excelsa*		Ironwood		
Plantae	Flora	Fabaceae (Mimosoideae)	3788	*Acacia harpophylla*		Brigalow		
Plantae	Flora	Fabaceae (Mimosoideae)	3832	*Acacia murrayana*		Murray's Wattle		
Plantae	Flora	Fabaceae (Mimosoideae)	3872	*Acacia salicina*		Cooba		
Plantae	Flora	Fabaceae (Mimosoideae)	3879	*Acacia stenophylla*		River Cooba		
Plantae	Flora	Goodeniaceae	3183	*Goodenia glauca*		Pale Goodenia		
Plantae	Flora	Goodeniaceae	3194	*Goodenia pusilliflora*				
Plantae	Flora	Haloragaceae	7455	*Haloragis glauca f. glauca*				
Plantae	Flora	Lobeliaceae	1922	*Pratia concolor*		Poison Pratia		
Plantae	Flora	Loranthaceae	7922	*Amyema miraculosum*				

Kingdom	Class	Family	Species Code	Scientific Name	Exotic	Common Name	NSW status	Comm. status
				subsp. boormanii				
Plantae	Flora	Malvaceae	3627	*Abutilon fraseri*		Dwarf Lantern-flower		
Plantae	Flora	Malvaceae	7206	*Malvastrum americanum*	*	Spiked Malvastrum		
Plantae	Flora	Marsileaceae	8803	*Marsilea drummondii*		Common Nardoo		
Plantae	Flora	Myoporaceae	3933	*Eremophila bignoniiflora*		Eurah		
Plantae	Flora	Myoporaceae	7252	*Eremophila deserti*		Turkeybush		
Plantae	Flora	Myoporaceae	3941	*Eremophila latrobei*		Crimson Turkeybush		
Plantae	Flora	Myoporaceae	3944	*Eremophila mitchellii*		Budda		
Plantae	Flora	Myoporaceae	3946	*Eremophila polyclada*		Flowering Lignum		
Plantae	Flora	Myoporaceae	EREM	*Eremophila spp.*				
Plantae	Flora	Myoporaceae	3949	*Eremophila sturtii*		Turpentine Bush		
Plantae	Flora	Myoporaceae	3955	*Myoporum montanum*		Western Boobialla		
Plantae	Flora	Myrtaceae	6360	*Eucalyptus camaldulensis*		River Red Gum		
Plantae	Flora	Myrtaceae	8930	*Eucalyptus coolabah*		Coolibah		
Plantae	Flora	Myrtaceae	8931	*Eucalyptus coolabah subsp. coolabah*				
Plantae	Flora	Myrtaceae	4114	*Eucalyptus largiflorens*		Black Box		
Plantae	Flora	Myrtaceae	10023	*Eucalyptus populnea subsp. bimbil*		Bimble Box		
Plantae	Flora	Myrtaceae	4267	*Melaleuca trichostachya*				

Kingdom	Class	Family	Species Code	Scientific Name	Exotic	Common Name	NSW status	Comm. status
Plantae	Flora	Nyctaginaceae	6841	*Boerhavia dominii*		Tarvine		
Plantae	Flora	Papaveraceae	7115	*Argemone ochroleuca subsp. ochroleuca*	*	Mexican Poppy		
Plantae	Flora	Pittosporaceae	11202	*Pittosporum angustifolium*		Butterbush		
Plantae	Flora	Poaceae	6540	*Cynodon dactylon*		Common Couch		
Plantae	Flora	Poaceae	7485	*Dichanthium sericeum*		Queensland Bluegrass		
Plantae	Flora	Poaceae	6378	*Eragrostis setifolia*		Neverfail		
Plantae	Flora	Poaceae	13449	*Isachne miliacea*				
Plantae	Flora	Poaceae	11388	*Lachnagrostis filiformis*				
Plantae	Flora	Poaceae	5082	*Paspalidium jubiflorum*		Warrego Grass		
Plantae	Flora	Poaceae	5129	*Poa fordeana*		Sweet Swamp-grass		
Plantae	Flora	Poaceae	POAC	*Poaceae indeterminate*	*	Grasses, reeds and bamboos		
Plantae	Flora	Poaceae	5182	*Sporobolus mitchellii*		Rat's Tail Couch		
Plantae	Flora	Polygonaceae	14542	*Duma florulenta*		Lignum		
Plantae	Flora	Polygonaceae	5299	*Rumex crystallinus*		Shiny Dock		
Plantae	Flora	Polygonaceae	5304	*Rumex tenax*		Shiny Dock		
Plantae	Flora	Portulacaceae	5324	*Portulaca oleracea*		Pigweed		
Plantae	Flora	Ranunculaceae	13523	*Myosurus australis*		Mousetail		
Plantae	Flora	Rubiaceae	5653	*Asperula conferta*		Common Woodruff		

Kingdom	Class	Family	Species Code	Scientific Name	Exotic	Common Name	NSW status	Comm. status
Plantae	Flora	Rubiaceae	10203	*Asperula gemella*		Twin-leaved Bedstraw		
Plantae	Flora	Rubiaceae	11943	*Psydrax oleifolia*				
Plantae	Flora	Rutaceae	5800	*Geijera parviflora*		Wilga		
Plantae	Flora	Sapindaceae	7830	*Dodonaea viscosa subsp. angustissima*		Narrow-leaf Hop-bush		
Plantae	Flora	Solanaceae	6040	*Lycium ferocissimum*	*	African Boxthorn		
Plantae	Flora	Solanaceae	6049	*Nicotiana simulans*				
Plantae	Flora	Zygophyllaceae	6349	*Zygophyllum ammophilum*		Sand Twinleaf		
Plantae	Flora	Zygophyllaceae	6350	*Zygophyllum apiculatum*		Common Twinleaf		

6 APPENDIX 2: SPECIES LIST FROM TOOGIMBIE IPA 2002 FAUNA SURVEY

This species list is from Pennay et al. (2002), based on their survey of November 2002. None of the species recorded were listed as threatened.

The number of survey sites (maximum 6) at which a species was recorded gives a rough indication of how widespread the species was across the property; 0 = incidental records only.

BIRDS

Scientific Name	Common Name	No. of survey sites
Dromaius novaehollandiae	Emu	2
Turnix varia	Painted Button-Quail	0
Geopelia placida	Peaceful Dove	1
Phaps chalcoptera	Common Bronzewing	2
Ocyphaps lophotes	Crested Pigeon	0
Gallinula ventralis	Black-tailed Native-Hen	0
Phalacrocorax carbo	Great Cormorant	0
Phalacrocorax sulcirostris	Little Black Cormorant	0
Phalacrocorax varius	Pied Cormorant	0
Phalacrocorax melanoleucos	Little Pied Cormorant	0
Pelecanus conspicillatus	Australian Pelican	0
Platalea flavipes	Yellow-billed Spoonbill	1
Egretta novaehollandiae	White-faced Heron	0
Ardea pacifica	White-necked Heron	1
Anas superciliosa	Pacific Black Duck	0
Aquila audax	Wedge-tailed Eagle	1
Haliastur sphenurus	Whistling Kite	1
Elanus axillaris	Black-shouldered Kite	1
Falco longipennis	Australian Hobby	0
Falco berigora	Brown Falcon	1
Falco cenchroides	Nankeen Kestrel	4
Ninox novaeseelandiae	Southern Boobook	0
Tyto alba	Barn Owl	1
Cacatua tenuirostris	Long-billed Corella	0

Scientific Name	Common Name	No. of survey sites
Eolophus roseicapillus	Galah	6
Platycercus elegans flaveolus	Yellow Rosella	4
Podargus strigoides	Tawny Frogmouth	1
Todiramphus sanctus	Sacred Kingfisher	1
Merops ornatus	Rainbow Bee-eater	1
Hirundo neoxena	Welcome Swallow	0
Petrochelidon ariel	Fairy Martin	1
Petroica goodenovii	Red-capped Robin	3
Pachycephala rufiventris	Rufous Whistler	2
Colluricincla harmonica	Grey Shrike-thrush	3
Grallina cyanoleuca	Magpie-lark	2
Coracina novaehollandiae	Black-faced Cuckoo-shrike	3
Gerygone fusca	Western Gerygone	1
Smicrornis brevirostris	Weebill	2
Acanthiza reguloides	Buff-rumped Thornbill	1
Acanthiza chrysorrhoa	Yellow-rumped Thornbill	1
Malurus cyaneus	Superb Fairy-wren	1
Malurus leucopterus	White-winged Fairy-wren	1
Malurus lamberti	Variegated Fairy-wren	1
Artamus personatus	Masked Woodswallow	3
Artamus cinereus	Black-faced Woodswallow	0
Artamus cyanopterus	Dusky Woodswallow	3
Climacteris picumnus	Brown Treecreeper	0
Dicaeum hirundinaceum	Mistletoebird	2
Plectorhyncha lanceolata	Striped Honeyeater	1
Lichenostomus penicillatus	White-plumed Honeyeater	1
Manorina melanocephala	Noisy Miner	1
Philemon corniculatus	Noisy Friarbird	1
Philemon citreogularis	Little Friarbird	2
Anthus australis	Richard's Pipit	2
Corcorax melanorhamphos	White-winged Chough	1

Scientific Name	Common Name	No. of survey sites
Cracticus nigrogularis	Pied Butcherbird	3
Gymnorhina tibicen	Australian Magpie	4
Corvus coronoides	Australian Raven	5
Corvus mellori	Little Raven	2
Pardalotus striatus	Striated Pardalote	3
Passer domesticus	House Sparrow	0
Sturnus vulgaris	Common Starling	0

BATS[#]

Scientific Name	Common Name	No. of survey sites
Nyctinomus australis	White-striped Freetail-bat	1
Nyctophilus gouldi	Gould's Long-eared Bat	1
Nyctophilus geoffroyi	Lesser Long-eared Bat	2
Chalinolobus gouldii	Gould's Wattled Bat	1
Chalinolobus morio	Chocolate Wattled Bat	1
Scotorepens balstoni	Inland Broad-nosed Bat	1
Vespadelus vulturnus	Little Forest Bat	4
Mormopterus sp. (big penis)		0
Mormopterus sp. (little penis)		0

[#] Note that analysis of ultrasonic recordings is yet to be completed. Hence, additional species may have been recorded from the property.

OTHER MAMMALS

Scientific Name	Common Name	No. of survey sites
Tachyglossus aculeatus	Short-beaked Echidna	1
Planigale gilesi	Paucident Plaigale	1
Trichosurus vulpecula	Common Brushtail Possum	2
Macropus giganteus	Eastern Grey Kangaroo	4
Macropus fuliginosus	Western Grey Kangaroo	1
Macropus rufus	Red Kangaroo	2
Mus musculus	House Mouse	2

Scientific Name	Common Name	No. of survey sites
Oryctolagus cuniculus	Rabbit	0
Lepus capensis	Brown Hare	0
Vulpes vulpes	Fox	1
Capra hircus	Goat	1

REPTILES AND FROGS

Scientific Name	Common Name	No. of survey sites
Linnodynastes tasmaniensis	Spotted Grass Frog	0
Crinia parinsignifera	Plains Froglet	0
Litoria peronii	Peron's Tree Frog	0
Diplodactylus tessellatus	Tessellated Gecko	2
Pogona barbata	Eastern Bearded Dragon	2
Pogona vitticeps	Central Bearded Dragon	1
Varanus varius	Lace Monitor	1
Cryptoblepharus carnabyi	Shiny-palmed Shinning-skink	1
Menetia greyii	Common Dwarf Skink	1
Morethia boulengeri	South-eastern Morethia Skink	1
Trachydosaurus rugosus	Shingleback	0
Morelia spilota variegata	Carpet Python	0
Pseudonaja textilis	Eastern Brown Snake	1

7 APPENDIX 3: EUAHLAYI TOTEMISM AND THE ECO-SYSTEMS.

Prepared by Michael Ghillar Anderson

Ghurriebhurrah (translated means; people of the '**Ghurrie'**) Ghurrie, is native orchid which is found in the fork of the Red Box and Goodoo-rroo, yellow box trees. Ghurrie, is the on the high grounds which never gets flooded, while the Doodoo-rroo, is below this country on the river edges. It also connects to both the Mirri-yhar, lignum; and Murroo- ghoo, Bibblar, that is, the Bibble Box and Belah trees.

The head of this totemic group is the 'Emu'.

The sub-totems of this mob (Ghurrie) are presented in Table 19.

Table 19: Groups and sub-totems of the Ghurrie.

Euahalayi name	Common name	Known western common names and species	Habitat preference	Comments
Fish				
Good-do	Murray Cod (fish)	Murray cod (*Maccullochella peelii*)	Obligate aquatic	River specialist, responds to floods and rising water for spawning and movement
Ingar	Crayfish	Most likely the yabby (*Cherax destructor*)	Wetland dependent	Yabby - River and wetland opportunistic species. Omnivore/ scavenger. No known flooding requirements.
Boomool	Shrimp	Several possible species	Obligate aquatic	
Gumbarl	Silver Bream	Silver perch?(*Bidyanus bidyanus*)	Obligate aquatic	River specialist, flood spawner
Birds and Insects				
Moogra-bhar	The big Black and white Magpie, referred to in some case as the magpie geese.	Magpie geese (*Anseranas semipalmata*)	Wetland dependent	Prefers floodplains and swamps, herbivore grazing on aquatic plants and grasses. Males larger than females; they move around the landscape in the dry season.
Bhi-yhar-mull	Black Swan	Black Swan (*Cygnus atratus*)	Wetland dependent	Herbivore grazing on aquatic plants and grasses. Likes deeper wetlands to

Euahalayi name	Common name	Known western common names and species	Habitat preference	Comments
				breed, often building nests from aquatic plants.
Eerin	Little night Owl	Eastern barn owl and barking owl found in the district	Terrestrial	Woodland species
Beer-won	Native swallow	Up to six spp of woodswallow in the district	Terrestrial	Woodland species
Bullar-bullar	Butterfly's	Lepidoptera	Terrestrial	
Trees				
Gidghee	An acacia	Possibly (*Acacia cambagei* 'ringed')	Terrestrial	Woodland species
Dtheen-yee	Ironbark	Several possible species	Terrestrial	Woodland species
Guthar	Quandong	Quandong (*Santalum acuminatum*)	Terrestrial	Woodland species
Grew-wee	Fruit bearing tree like a Quandong	Emu apple (*Owenia acidulal*)	Terrestrial	Woodland species
Nyew-un	Wild melon	Paddymelon (*Cucumis* sp.)	Terrestrial	Woodland species
Yarran	Big River Red Gum by the river's edge	River red gum (*Eucalyptus camaldulensis*)	Wetland dependent	Woodland species, requires inundation to set seed and germinate
Plants				
Binnar-mayah	Big Salt bush	*Atriplex* spp.	Terrestrial	Grassland and woodland species
	Mitchell grass	*Astrebia* spp.	Terrestrial	Grassland and woodland species
Spiritual				
Ghar-whar-ghoo	The water spirit, Featherless Emu, who lives in the Wurrumboorrool (Milky Way) belongs to this group (eco-system).	No equivalent		

Euahalayi name	Common name	Known western common names and species	Habitat preference	Comments
Dtheeli-why	Sacred fire	No equivalent		

Mirri-yhar; Lignum.

The head of this clan group is Bhee-wee (large yellow and black stripped goanna [the Gomeroi (Kamilaroi) refer to him as Mung-gwen-garli].

The sub-totems of this group are presented in Table 20

Table 20: Group and sub-totems of the Mirri-yhar.

Euahalayi name	Common name	Known western common names and species	Habitat preference	Comments
Fish				
Gay –gay	Cat fish	Catfish, eel-tailed catfish (*Tandanus tandanus*)	Obligate aquatic	Found in slow moving streams as well as lakes and wetlands. Juveniles will congregate together but adults tend to be solitary – can live up to 8 years.
Tucki	Boney bream also known as Silver bream (not edible for many)	Bony bream (*Nematalosa erebi*)	Obligate aquatic	Prefer slow moving streams, can tolerate turbid conditions but are sensitive to low levels of oxygen.
Birds and insects				
Ghoorree-quin-quin	Butcher bird	Butcher bird (*Cracticus* sp.)	Terrestrial	Woodland species
Ghoo-ghoo-rrah-ghar-ghar	Kookaburra	Laughing Kookaurra (*Dacelo novaeguineae*)	Terrestrial	Woodland species occurring in family groups. Laughing call marks boundary of territories, feed predominantly on terrestrial prey items. Not wetland dependent.
Dtheen-bee	Divers	Cormorants, darter?	Wetland dependent	Piscivores require deep water typically above 1m to feed.
Birroo-birroo	Sand pipers	Scolopacidae	Wetland dependent	Sandpipers are a large family of shorebirds with many species also includes curlews and snipe. Wood sandpiper, curlew sandpiper, Latham's snipe and marsh sandpiper occur at Narran

Euahalayi name	Common name	Known western common names and species	Habitat preference	Comments
				Lakes, so these may be a general group
Dtheegun-boyer	Soldier bird	Noisy Miner (*Manorina melanocephala*)	Terrestrial	Woodland species, not wetland dependent.
Weedar	Bower Bird	Several spp, may be the regent bowerbird?	Terrestrial	Woodland species
Moorreegoo	Black Ibis	Glossy ibis? (*Plegadis falcinellus*)	Wetland dependent	
Bollon	White crane	Possibly one of the egrets?, possibly the Eastern great egret (*Ardea modesta*)	Wetland dependent	
Noodle-noodle	Whistling duck	Plumed whistling duck (*Dendrocygna eytoni*)	Wetland dependent	Feeds at night on grasslands, breeds in grasslands, congregates on wetland edges during the day.
Moonun-googy-goo-we	Horse fly	Tipulidae?, crane fly, March fly/ blue bottle?	Terrestrial	
Moonin	Mosquito	*Ades* spp.	Wetland dependent	Wetland dependent for immature phase of life history – need to know if both adult and nymphs are important.
Reptile				
Gulghurrar	Water lizard	Australian water dragon (*Intellagama lesueurii*)	Wetland dependent	Arboreal in riparian areas and floodplains, but capable of swimming and staying underwater for up to 90 minutes.
Trees				
Ghurray	Native pine	Native pine (*Callitris* sp.)	Terrestrial	
Gweebit	Native type passion fruit		Terrestrial	
Mooloolwerh	A shrub with creamy flowers		Terrestrial	

Euahalayi name	Common name	Known western common names and species	Habitat preference	Comments
Goodooga	Big yam		?	Unclear if terrestrial or aquatic – different plants.
	Curly Mitchell grass	Curly Mitchell grass (*Astrebla lappacea*)	Terrestrial	Terrestrial but can be found on floodplains.
Poison extracts from trees				
Guddee-boon-doo	Bitter bark	Bitterbark , Quinine bush, Australian fever bark, fever bark (*Alstonia constricta*)	Terrestrial	Occurs in eucalypt and acacia woodlands.
Boonburr	Sap of the black wattle	*Acacia* spp. Several species are called black wattle	Terrestrial	
Death				
Dtalinghar	Native fuschsia	Common name for several plants	Terrestrial	Not known to be wetland dependent.

Murroo- ghoo, Bibblar, that is, the Bibble Box and Belah trees (twin sisters)

The two senior totemic figure heads for this clan group are Ghoo-you (Bandicoot) and Moodthi (opossum).

The totemic group names of this clan are presented in Table 21

Table 21: Groups and sub-totems of the Murroo-ghoo, Bibblar.

Euahalayi name	Common name	Known western common names and species	Habitat preference	Comments
Fish and Water animals				
Why-amber	Turtle		Wetland dependent	
Mungghee	Pipi type Muscle		Obligate aquatic	
Reptiles and insects				
Moondo	Wasp		Terrestrial	
Goo-you	king Brown snake	King brown snake (*Pseudechis australis*)	Terrestrial	Prefers mulga habitats but can be found in a range of habitats – not wetland dependent.
Murgar-moogar-wee	Scrub Spider		Terrestrial	
Bay-yer	Green ant	Green ant, green-head ant (*Rhytidoponera metallica*)	Terrestrial	Terrestrial, scavengers and predators.
Doo-you-wee	red-black meat ant		Terrestrial	
Dthayar-minnar	Small carpet snake		Terrestrial	
Birds				
Doommar	top knot pigeon		Terrestrial	Woodland species
Gwenee-boo	Robin redbreast		Terrestrial	Woodland species
Munghee-wurray-wurray-mul	Seagull		Wetland dependent	Opportunistic use of aquatic habitat but will also use terrestrial environments

Boondoon	kingfisher		Wetland dependent	
Trees and shrubs				
Eurah	Dog Wood		Terrestrial	
Bingar-wingul	Needle bush		Terrestrial	
	Never fail grass		Terrestrial	
Gibboon	small yam		?	
Bumble	*Capparis mitchellianni*	Wild orange (*Capparis mitchellianni*)	Terrestrial	
Illay	Hop Bush		Terrestrial	
Mirri	Wild Current bush		Terrestrial	
Birrar	Whitewood		Terrestrial	
Animals				
Biggi-billar	Porcupine (Echidna)	Echidna (*Tachyglossus aculeatus*)	Terrestrial	Terrestrial
Other				
Guig-ghar	Ant-beds		Terrestrial	

Nyoongarbhurrah; People of the Kurrajong Tree (*Brachychiton populneus*).

The head totem for this clan group is the Dthoolung-gay-yar (Bilbi) {now extinct in the Euahlayi 'Dthouri' (country/land)

The groups and sub-totems of this Nyoongarbhurrah are presented in Table 22

Table 22: Groups and sub-totems of the Nyoongarbhurrah.

Euahalayi name	Common name	Known western common names and species	Habitat preference	Comments
Reptiles and other				
Ooboon	Blue tongue lizard	Blue tounge lizard (*Tiliqua*)	Terrestrial	Terrestrial
Dthoo-you	Red belly black snake	Red bellied black snake (*Pseudechis porphyriacus*)	Wetland dependent	Wetland dependent for main prey which is frogs.
Bouy-you-gar	Centipedes	Needs to be discussed	Terrestrial	Terrestrial
Dthoo-you-gurar	Myall earth worm		Terrestrial	
Dthurrinbandi	Large green frog(known as the Croaking frog)		Wetland dependent	
Birds and Insects				
Oooyan	Curlew		Wetland dependent	
Bouy-you-doorinillee	Grey Crane		Wetland dependent	
Dirree-ree-ree	Willy Wagtail		Terrestrial	
Plants and Shrubs				
Millan	Sour top (Onion like. Is poison if not soaked in water for 24 hours)		Terrestrial	
Fish and Shell fish				
Wee	Small guppy or mud fish found on open land waters		Obligate aquatic	

Euahalayi name	Common name	Known western common names and species	Habitat preference	Comments
Ghurree-yhar	Crocodile	??	Obligate aquatic	
Wah-R	Shells of muscles		Obligate aquatic	

Clan and totem relationships provided by Michael Ghillar Anderson	Known western common names and species	Habitat preference
Associated Totemic group **Bow-dhar -The Red Kangaroo, is not a relation but uses all bhurrah (peoples country). He is connected to all lands and like the weather Bhurrah (people), is NOT claimed by any of the totemic groups. He travels over all country however. And his clan group can be married into all totemic groups. Yet he is a very dominant figure in the totemic world.**	Red kangaroo (*Macropus rufus*)	Terrestrial