

Lake Conjola Artificial Reef Project Statement of Environmental Effects

Department of Primary Industries, Fisheries

4 April 2008

Statement of Environmental Effects

Prepared for

Department of Primary Industries, Fisheries

Prepared by

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Executive Summary

This document constitutes a Statement of Environmental Effects (SEE) for the NSW Department of Primary Industries - Fisheries (DPI) that was conducted to assess the potential environmental impact of the proposed placement of an artificial reef in Lake Conjola on the south coast of NSW.

The DPI has a program of artificial reef development aimed at creating quality recreational fishing opportunities by providing additional fishing locations. There are existing projects located at Lake Macquarie, St Georges Basin and Botany Bay, all at various stages of colonisation by aquatic flora and fauna.

This project comprises the placement of 'Reef Balls' within the estuarine environment of Lake Conjola. These structures are specifically designed for this purpose and are built from a modified concrete aggregate formulated to be attractive to benthic flora and aquatic fauna. The process of placing the reef balls in the lake is designed to create minimum environmental disturbance.

Other sites where similar artificial reefs have been established have displayed positive environmental outcomes to date and monitoring of these sites is ongoing. The Lake Conjola site will also have a monitoring program established with the objective of determining the effectiveness of the reef and identifying any environmental impacts, both positive and negative. Should negative impacts be identified, the fallback position will be removal of the reef for which there is a contingency plan in place.

The SEE does not identify any significant negative environmental impacts that may eventuate during or following commissioning of the reef and identifies a number of positive impacts that have been identified at other similar artificial reef sites. The SEE indicates that the proposed artificial reef will not require additional mitigation or design changes due to environmental constraints.

1.0 Introduction

1.1 Overview

Artificial reefs have been defined as “any material purposely placed in the marine environment to influence physical, biological, or socio-economic processes related to living marine organisms” (Sutton and Bushnell, 2007). Up to 40 countries around the world have constructed artificial reefs (Baine, 2001). Objectives for the deployment of artificial reefs include the enhancement of recreational and commercial fishing, coastal protection and mitigation of habitat loss and damage (Seaman and Jensen, 2000).

The materials used to build artificial reefs vary and have evolved considerably over time. A variety of ‘waste’ material has historically been used in artificial reef construction. These are collectively known as ‘materials of opportunity’, which have included discarded automobile tyres, scuttled ships, concrete pipes, railway cars, and surplus military equipment. However, the use of specially designed prefabricated reef structures is now used in many countries including Japan and Korea, who are considered world leaders in artificial reef technology (Kim, 2001; Sutton and Bushnell, 2007). Primarily made from concrete or steel, ‘design specific’ structures have been demonstrated to be more appropriate in achieving specific fisheries management objectives (Sherman *et al.* 2002).

Artificial reefs are believed to enhance the productivity of designated areas by providing substrate for the settlement and subsequent growth of marine organisms and can play an important role in providing food and refuge for juveniles of commercially and recreationally important species (Pollard and Mathews, 1985). With improved designs and structural integrity, artificial reefs may contribute significantly to environmental and fish habitat enhancement (Branden *et al.*, 1994).

There has been considerable debate over the effectiveness of artificial reefs to produce more fish, rather than just attracting existing fish to a new location. This has become known as the ‘attraction-production question’. Attraction is simply defined as the net movement of individuals (e.g. fish) from natural to artificial habitats; whereas a simplified definition of production is the change in biomass over time (Carr and Hixon, 1997). In reality, it is a very complex question and extensive research has failed to provide a definitive answer (Grossman *et al.*, 1997; Pickering and Whitmarsh, 1997; Osenberg *et al.*, 2002).

The benefit of artificial reefs on fish stocks will likely depend on the management objectives of their use (Lindberg, 1997). Although artificial reefs may have the potential to increase a fishers catch, management strategies have been implemented by all Australian state fisheries agencies to regulate fishing. These regulations can be varied to prevent overfishing and to ensure that targeted species are not taken before they are sexually mature (Branden *et al.*, 1994). However, the impact of artificial reefs on fish stocks is not clearly understood and requires further scientific study (Branden *et al.*, 1994).

1.2 History of Artificial Reef Use in NSW

There have been at least four detailed reviews of artificial reefs in Australia (Pollard and Mathews, 1985; Kerr, 1992; Branden *et al.*, 1994; Coutin, 2001). Collectively these reviews detail the development of Australian artificial reef design, construction, deployment and monitoring from 1965 to 2001. The main purpose of artificial reefs in Australia is for recreational fishers and divers (Branden *et al.*, 1994) and historically, materials of opportunity (waste material) have been the main materials used in their construction (Pollard, 1989; Kerr, 1992).

In NSW, the use of artificial reefs began in 1966, with the deployment of a series of artificial reefs in Lake Macquarie using car bodies and tyres (Pollard and Mathews, 1985; Pollard, 1989). Augmentation of these reefs continued in the 1970’s with additional reefs constructed in Batemans Bay, Port Stephens and Port Hacking using car tyres (Coutin, 2001). In addition to these tyre and car body reefs,

up to 12 vessels were scuttled beginning in the mid 1970's to create single-component artificial reefs in NSW coastal waters, beginning with the retired ferry, the 'Dee Why', in 1976 (Pollard and Mathews, 1985; Pollard, 1989; Coutin, 2001).

From the mid 1980's, lack of funding and increasingly stringent environmental legislation meant that artificial reef construction in NSW effectively ceased until the introduction of the general recreational fishing fee in 2001, when funds became available for the further investigation of the use of artificial structures as a fisheries enhancement tool.

1.3 Need for an Artificial Reef Program

The Department of Primary Industries – Fisheries (DPI) manages recreational fishing under the *Fisheries Management Act 1994* (FM Act) within both inland and ocean waters of NSW out to 200 nautical miles from the coast. A primary objective of the FM Act is “to conserve, develop and share the fishery resources of the State for the benefit of present and future generations”. Further objectives under the FM Act include promoting “ecologically sustainable development, including the conservation of biological diversity” and promoting “quality recreational fishing opportunities”.

The NSW DPI Artificial Reef Program is consistent with these objectives as it aims to create new, high-quality fishing areas through the deployment of artificial reefs. The artificial reefs provide alternative fishing grounds that may divert fishing effort from natural, existing heavily fished locations. Accordingly, the Department is proposing to deploy additional artificial reefs in a variety of new estuaries. The Program is funded by the Recreational Fishing Trust by funds raised from Recreational Fishing Licence fees.

Since 2005, artificial reefs have been deployed and used for scientific research by the DPI within Lake Macquarie, St Georges Basin and Botany Bay. These were installed as part of the initial pilot stage of the project and have been subject to monitoring since installation to gauge their effectiveness and ecological impacts. So far, they have been considered successful at providing habitat for aquatic life and are therefore being considered for other locations.

Lake Conjola is a Recreational Fishing Haven where local user groups have expressed considerable interest in having an artificial reef deployed in the lake to enhance the recreational fishery. Following community consultation and detailed site inspections by DPI staff, a small site has been identified as potentially suitable for artificial reef deployment. The proposed new reef will provide an additional artificial reef study site, allowing DPI to build on its understanding of the possible benefits of artificial reefs.

1.4 Project Objectives

The deployment of an artificial reef within Lake Conjola by the NSW DPI, has the following objectives:

- Identify a suitable site for the construction of an artificial reef, such that is an effective fisheries enhancement tool, while limiting, and mitigating, any possible negative effects;
- Provide additional fishing opportunities for recreational anglers by providing an alternative to existing sites within the lake; and
- Provide scope for relevant and valuable monitoring opportunities, to increase the scientific knowledge of artificial reefs and the natural environment.

This Statement of Environmental Effects (SEE) outlines the proposal, the deployment and monitoring methodology, and potential environmental impacts. It includes a:

- Detailed description of the site and the project;
- Details of the NSW DPI Artificial Reef Program in NSW and current monitoring results and findings;
- Environmental assessment of the proposal based on the existing environment and currently available information; and
- Outline of the proposed monitoring program and mitigation measures.

2.0 Project Description

2.1 Site Location

Lake Conjola is located within the Shoalhaven Local Government Area (LGA) north of Ulladulla. The catchment area of the lake covers an area of approximately 145 km² and the lake itself has a waterway area of 6 km². Approximately 95% of Lake Conjola's catchment remains undeveloped and mostly forested within National Parks and Reserves.

The entrance to the estuary sits at the northern end of Conjola Beach and is mostly open. The village of Lake Conjola is located on the south eastern side of the estuary inlet, with Manyana located to the north. The lake is a declared Recreational Fishing Haven and is a popular holiday destination and excellent boating waterway (Department of Natural Resources, 2008).

The reef is planned to be deployed in the area bounded by the following marks (WGS84):

- 35° 15.632'S 150° 28.313'E
- 35° 15.628'S 150° 28.330'E
- 35° 15.668'S 150° 28.320'E
- 35° 15.664'S 150° 28.344'E

The proposed artificial reef site is located west of the innermost extent of the tidal delta associated with the estuary inlet. The inlet is some 3 km long separating the main lake from the ocean. The inlet is shallow with an average channel depth of the order of 1 m and extensive intertidal muddy sand flats. Depths within the estuary itself range up to 10 metres deep.

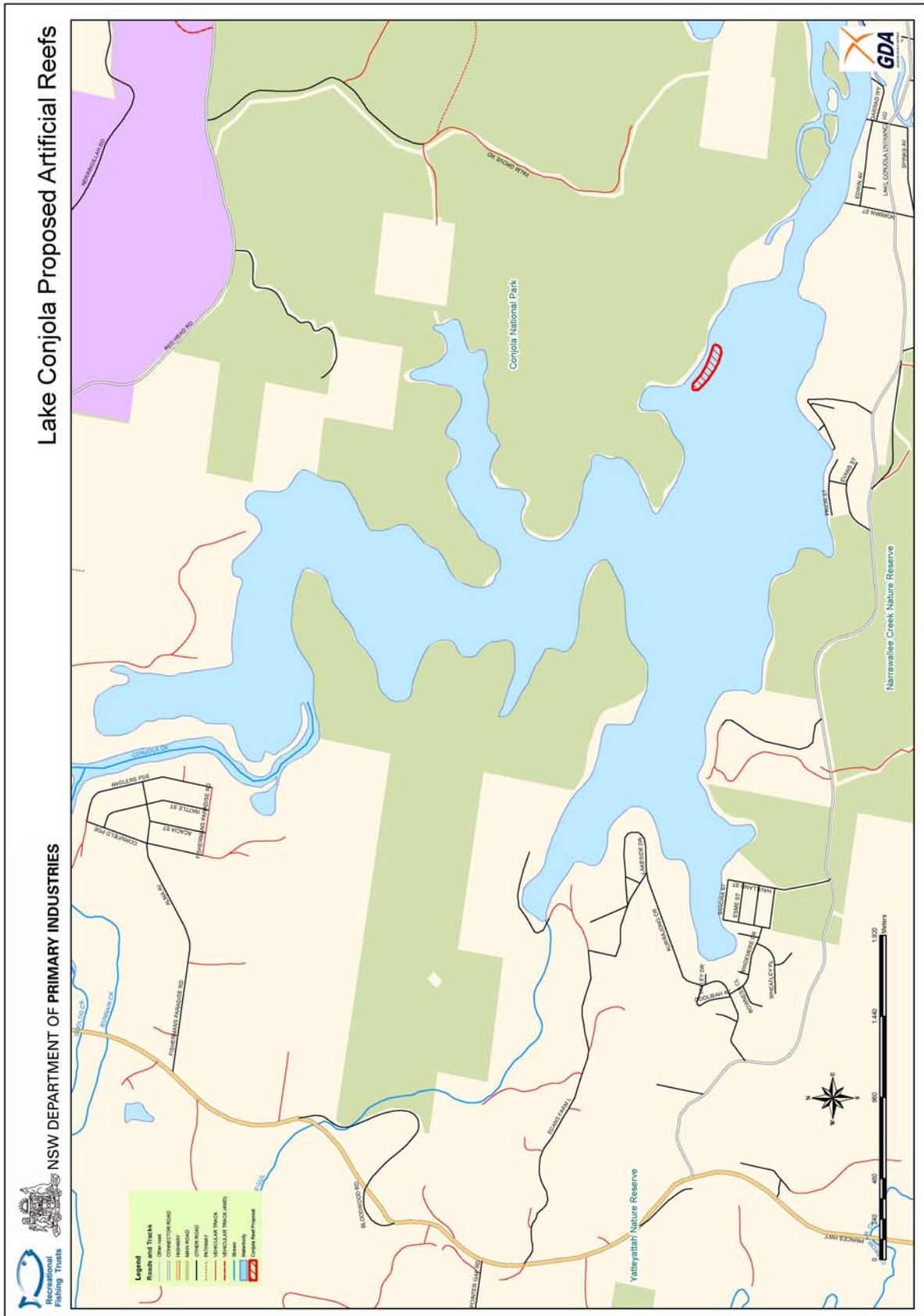
A preliminary site investigation in Lake Conjola has been conducted by DPI staff. These investigations have included the identification of existing habitat in the vicinity of the proposed artificial reef site, and benthic sampling to determine lakebed suitability. The proposed site (see Figure 1) was found to have existing medium to coarse sand sediments and no existing seagrass habitat in water depths of 5 to 8 metres. The lake bed in this area is very similar to that of previously deployed NSW DPI artificial reefs such as Lake Macquarie and St Georges Basin. These site characteristics are ideal as they will enable the placement of the reef ball modules on a stable base, while limiting turbidity, and enabling successful diver and video monitoring of the site.

2.2 Consultation

DPI has held three information evenings regarding the proposed artificial reef in Lake Conjola. These occurred at the Lake Conjola Fishing Club in October 2007, at the Basin Lure and Fly Fishing Club in November 2007, and at the Shoalhaven City Council's Natural Resource Floodplain Management Committee in April 2008. Attendees to the meeting provided very useful anecdotal information regarding potential sites for the placement of the proposed artificial reef and additional site considerations for other popular lake activities including sailing and water-skiing.

Following the information nights, further site inspections were carried out by DPI to determine the final proposed location. An artificial reef information mail out (which included a project information pack with maps and project descriptions) was used to gain further feedback from two related fishing clubs (Milton Ulladulla and Archer Fishing Clubs). Consultations with relevant public authorities such as the Department of Lands and NSW Maritime and will be conducted by DPI prior to the deployment of the reefs.

Figure 1 – Proposed Artificial Reef Location



2.3 Reef Design

The reefs will be constructed using artificial reef modules known as 'Reef Balls'. Reef balls are individually cast concrete artificial habitat modules. The additives added to the concrete mix during construction aim to increase the strength of the module while lowering pH levels to encourage growth of marine plants and settlement of other organisms (Figure 2).

Figure 2 – Extensive growth on NSW DPI Lake Macquarie artificial reef 23 months after deployment



Figure 3 – Fish life on NSW DPI Lake Macquarie artificial reef



The moulds are produced by a patented system developed by the Reef Ball Development Group in the United States. The Reef Balls are hollow cement hemispheres with numerous smaller holes over the surface allowing the egress of fish and other invertebrates (Figure 3 and Figure 4). Over 500,000 Reef Balls have been deployed worldwide in over 3,200 projects.

Figure 4 – Fish life on one of six small Lake Macquarie artificial reefs deployed by NSW DPI in December 2005



Research suggests that Reef Balls create substantial fish, invertebrate and marine plant habitat, with Reef Balls shown to reach 80% or more of the natural species diversity and population densities of nearby natural reef systems within just a few years (Reef Ball Foundation). Encrusting algae and invertebrates ensure the reefs eventually reach a stage where they are unrecognisable from their original form (Figure 2).

The artificial reef in Lake Conjola is proposed to consist of 400 Reef Balls of varying sizes (Table 1), 200 of which will consist of Mini-Bay balls. 100 of each of the Bay and Pallet Balls will also be used. The configuration of the reef will consist of the 200 Mini-bay Balls arranged uniformly, with a Bay or Pallet Ball alternatively interspersed amongst the Mini-bay Balls (Figure 5).

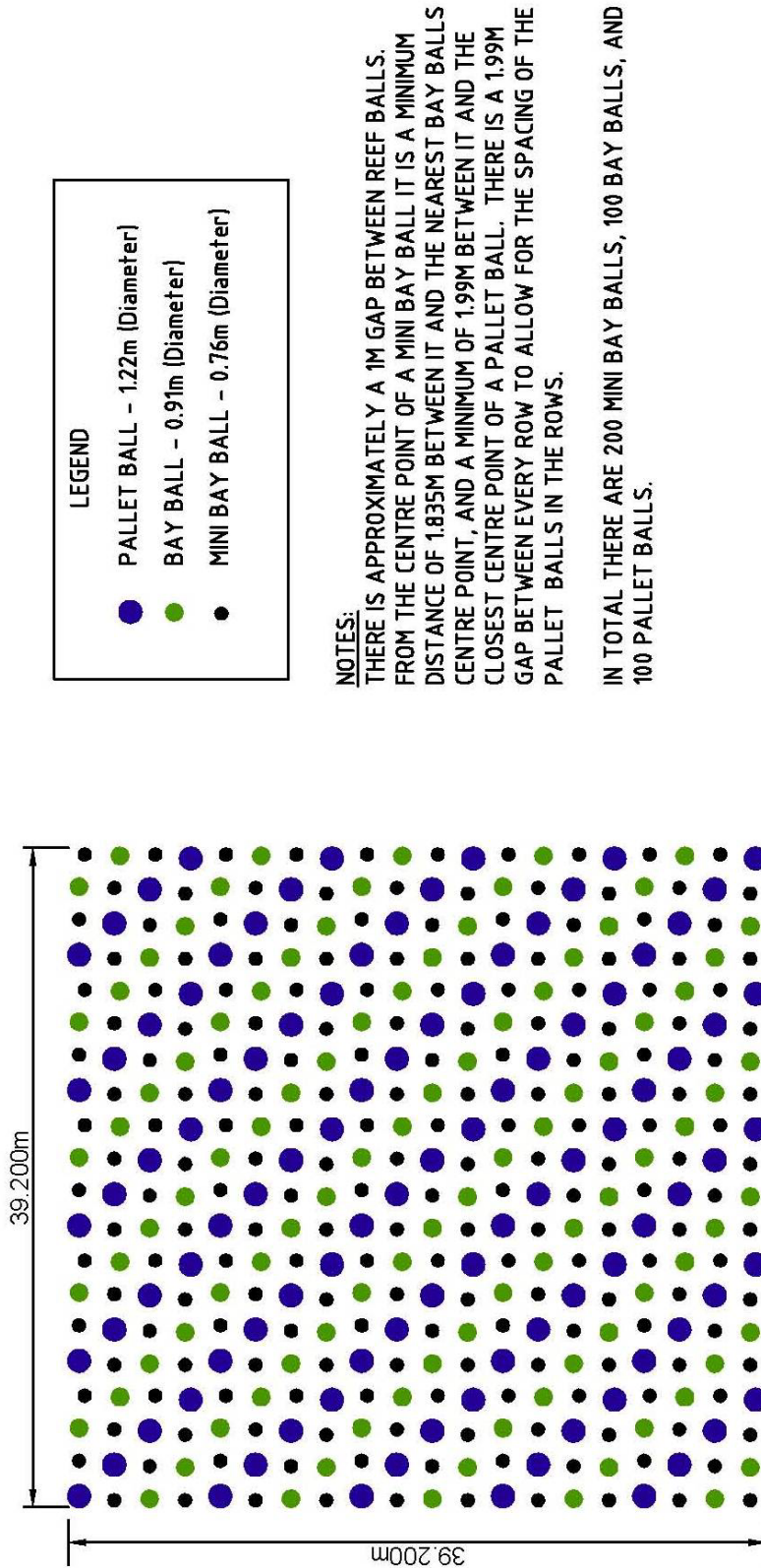
Table 1 – Dimensions of Reef Ball sizes proposed for the Lake Conjola artificial reef

	Width	Height	Footprint	Spaced Footprint	Weight	Number to be used
	(m)	(m)	(m ²)	(m ²)	kg	
Pallet Ball	1.22	0.88	1.17	4.93	682 - 1000	100
Bay Ball	0.91	0.61	0.65	3.65	170 – 341	100
Mini-bay Ball	0.76	0.53	0.45	3.1	68 – 91	200

Total area of the lake bed which will be covered by the Reef Balls themselves will be 272 m². NSW DPI experience has indicated that the ideal spacing between each Reef Ball is approximately 1 metre. Therefore, including the spacing in the calculation, the total reef extent will be approximately 1478m² as follows:

Mini-Bay Balls and spacing: 200 @ 3.1 m² = 620 m²
 Bay Balls and spacing: 100 @ 3.65 m² = 365 m²
 Pallet Balls and spacing: 100 @ 4.93 m² = 493 m²
 Total Area of Artificial Reef = 1478 m²

Figure 5 – Proposed layout of Reef Balls



2.4 Deployment

The reef ball modules will be delivered to Lake Conjola by truck from their construction site in Sydney, NSW. The reef ball modules will be loaded onto a barge for transportation to the artificial reef site at a predetermined and pre-approved loading site (eg boat ramp). Deployment will occur outside of peak usage times for the lake, such as weekends, school and public holidays.

The modules will then be individually deployed at the proposed location from the barge using a crane and a team of three commercially certified divers (Figure 6). This will ensure the correct placement of each individual module, limiting unnecessary turbidity issues and enabling a high level of control over the deployment process.

Pending approval of the proposal from all consenting authorities and the meeting of all statutory obligations, deployment of the artificial reef is anticipated to take approximately 10 days.

Figure 6 – Installation of Reef Balls by barge in St Georges Basin



2.5 Proposed Monitoring Program

The reefs will be monitored quarterly using a similar methodology previously employed at the other estuarine locations. The monitoring will be conducted using both diver census and baited underwater video (BUV), to assess fish recruitment and environmental effects such as sedimentation. Catch monitoring in association with local anglers and fishing clubs will also be employed to assess catch composition and angler CPUE.

Further detail on the monitoring program is provided in Chapter 6.2.

3.0 Current NSW DPI Artificial Reefs Program

3.1 Existing Reefs

The DPI has deployed a series of small, design-specific artificial reefs in three NSW estuaries to increase fish habitat and improve recreational fishing opportunities (Table 2). These reefs were part of a pilot study with long term monitoring to determine best practice procedures for artificial reef construction, deployment, placement, and monitoring while assessing the structures effectiveness as a recreational fisheries enhancement tool. The effects of the artificial reefs have been monitored in detail both pre and post-deployment using a combination of baited underwater video (BUVs) and diver surveys. Monitoring has shown the reefs to be effective in providing habitat for estuarine species, including those targeted by recreational fishers.

Table 2 – Existing NSW DPI Artificial Reefs

Location	Deployment Date	Monitoring Start	Monitoring Completion	No. and Size of Reef
Lake Macquarie	December 2005	September 2005	December 2007	3 x 50 ball reefs 3 x 10 ball reefs
Botany Bay	June 2006	March 2006	June 2008	6 x 30 ball reefs
St Georges Basin	February 2007	November 2007	February 2009	6 x 30 ball reefs

This pilot study has provided DPI with a highly successful model and proven design for the deployment of artificial reefs in barren areas of NSW coastal estuaries. Using Reef Ball technology developed in the United States, DPI has gained an excellent understanding of artificial reef design and management (see further detail on Reef Balls below). Reef Balls are individually cast design-specific concrete artificial habitat modules (Figure 7) that have been used in over 3,200 projects world-wide (Reef Ball Foundation). The main benefit of using design-specific individual modules is that the modules can be moved and located elsewhere or removed completely from the water if required.

Figure 7 – Typical Reef Ball module showing hollowed construction (image courtesy of the Reef Ball Foundation)



3.2 Reef Performance

DPI has monitored the existing artificial reefs in Lake Macquarie, Botany Bay and St Georges Basin before and after deployment. Using a combination of BUVs and diver surveys, data on species present, species density, individual sizes and seasonality has been collected.

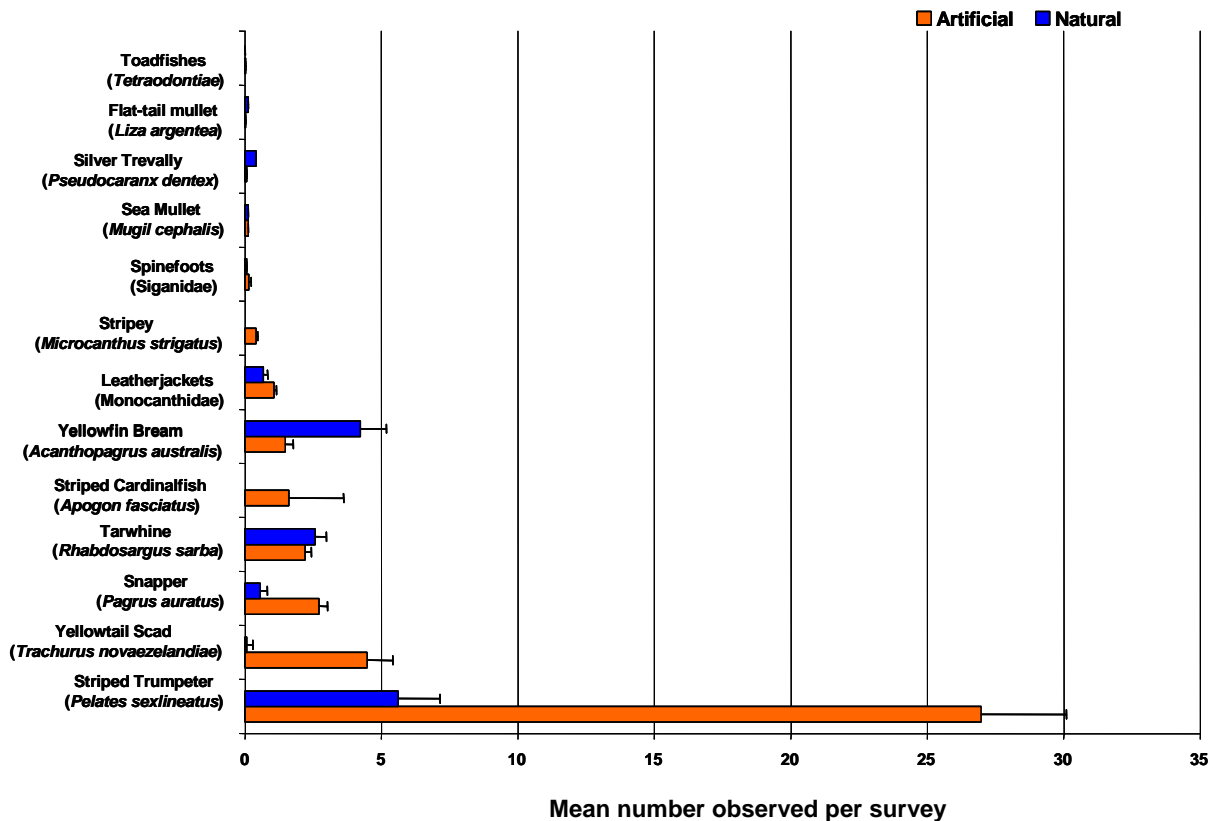
Results from the two years of post deployment monitoring from Lake Macquarie have illustrated the high diversity of fish species found on the artificial reefs. Up to 42 species of fish have so far been identified (Table 3). The species found include resident, reasonably sedentary species such as striped cardinalfish, gloomy octopus, striped catfish and moray eels, but the artificial reefs also attract more transient species such as highfin amberjack, yellowtail kingfish, silver trevally, yellowfin bream and snapper.

Table 3 – List of species recorded on Lake Macquarie NSW DPI Artificial Reefs

Species	Diver Survey	BRUV
Striped Cardinalfish (<i>Apogon fasciatus</i>)	✓	✓
Striped Trumpeter (<i>Pelates sexlineatus</i>)	✓	✓
Yellowtail Scad (<i>Trachurus novaezelandiae</i>)	✓	✓
Snapper (<i>Pagrus auratus</i>)	✓	✓
Tarwhine (<i>Rhabdosargus sarba</i>)	✓	✓
Yellowfin Bream (<i>Acanthopagrus australis</i>)	✓	✓
Striped catfish (<i>Piotosus lineatus</i>)	✓	
Fanbelly Leatherjacket (<i>Monacanthus chinensis</i>)	✓	✓
Stripey (<i>Microcanthus strigatus</i>)	✓	✓
Silver Biddies (<i>Gerreidae</i>)	✓	✓
Trumpeter Whiting (<i>Sillago maculata</i>)	✓	✓
Yellowfin Leatherjacket (<i>Meuschenia trachylepsis</i>)	✓	✓
Silver Trevally (<i>Pseudocaranx dentex</i>)	✓	✓
Diamondfish (<i>Monodactylus argenteus</i>)	✓	
Moray Eels (<i>Muraenidae</i>)	✓	
Eastern Fortescue (<i>Centrapogon australis</i>)	✓	
Silver Sweep (<i>Scorpius lineolate</i>)	✓	✓
Toadfishes (<i>Tetraodontia</i>)	✓	✓
Sixspine Leatherjacket (<i>Meuschenia freycinenti</i>)	✓	✓
Spinefoots (<i>Siganidae</i>)	✓	
Gobies (<i>Gobiidae</i>)	✓	
Whiting (<i>Siganidae</i>)	✓	✓
Luderick (<i>Girella tricuspidate</i>)	✓	✓
Gloomy Octopus (<i>Octopus tetricus</i>)	✓	✓
Estuary Catfish (<i>Cnidoglanis macrocephalus</i>)	✓	
Three-bar Porcupinefish (<i>Dicotylichth punctulatus</i>)	✓	✓
Longfin Bannerfish (<i>Heniochus acuminatus</i>)	✓	
Mado (<i>Atypichthys strigatus</i>)	✓	✓
Giant Trevally (<i>Caranx ignobilis</i>)	✓	✓
Pineapplefish (<i>Cleidopus gloriamaris</i>)	✓	
Ocellate Butterflyfish (<i>Parachaetodon ocellatus</i>)	✓	
Maori Wrasse (<i>Ophthalmolepis lineolatus</i>)	✓	
Magpie Morwong (<i>Cheilodactylus vestitus</i>)	✓	
Bluestriped Goatfish (<i>Upeneichthys lineatus</i>)	✓	✓
Bartail Goatfish (<i>Upeneus tragula</i>)	✓	✓
Ocean Jacket (<i>Nelusetta ayraudi</i>)	✓	✓
Longsnout Flounder (<i>Ammoteretis rostratus</i>)	✓	✓
Highfin Amberjack (<i>Seriola dumerili</i>)	✓	✓
Blackspot Goatfish (<i>Parupeneus spilurus</i>)		✓
Stout Longtom (<i>Tylosurus gaviatoides</i>)		✓
Stingrays (<i>Dasyatidae</i>)		✓
Batfishes (<i>Ephippidae</i>)		✓

A large difference in the species composition between artificial and natural reefs in Lake Macquarie has been observed (Figure 8). Artificial reefs attract higher numbers of striped trumpeter, yellowtail scad, snapper, cardinalfish and stripeys. Natural reefs seem to attract higher densities of yellowfin bream and silver trevally. The yellowfin bream data, however, is confounded by one natural reef site that has an unusually high population of yellowfin bream. The reason for the difference in composition may be attributable to succession of the artificial reef to a natural state and different natural alga associated with the Reef Balls.

Figure 8 – Comparison of densities and species observed using BUVs on NSW DPI Artificial Reefs and natural reefs within Lake Macquarie



3.3 Independent Assessment of Reef Performance

The University of Newcastle has conducted an independent assessment of diversity, abundance and catch rates for the Lake Macquarie artificial reefs. This study compared the populations of fish on the NSW DPI artificial reefs to the natural reefs located in Lake Macquarie. This data was collected 8 months subsequent to deployment. The preliminary data in this section is extracted from a draft version of the scientific manuscript “Artificial reefs: Do they provide similar CPUE to anglers when compared to natural reefs in a recreational fishing haven, Lake Macquarie NSW?” (Stephen Clair unpublished data).

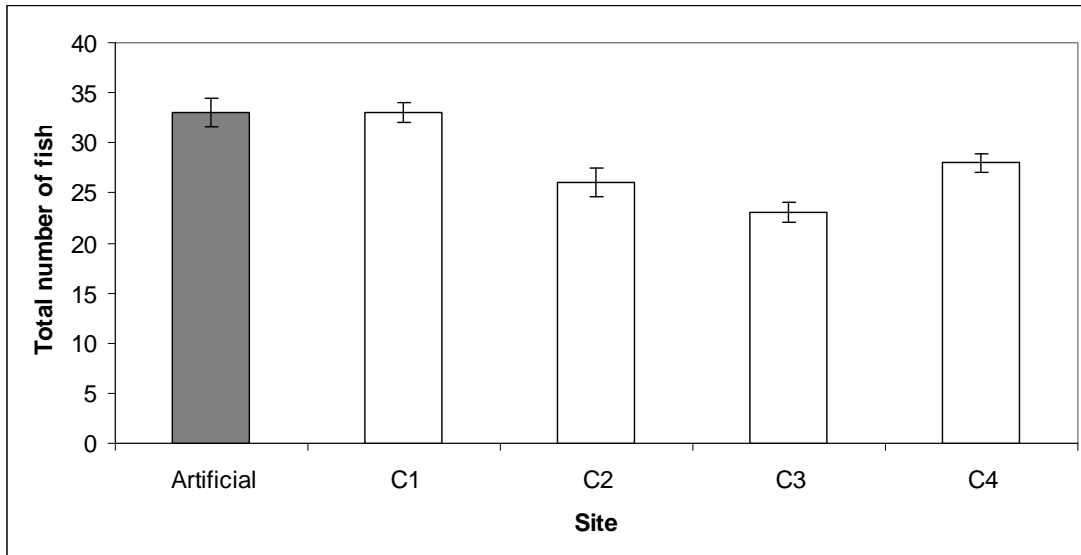
3.3.1 Methodology

The six artificial reefs in Lake Macquarie were considered as one unit. This artificial reef treatment was compared to four control (natural) reef sites, carefully chosen to replicate the treatment site in terms of area and depth. Reefs were sampled by line fishing for one hour per day, with sampling order randomised to avoid confounding effects of time of day, tides etc. All fishing gear was standardised, with fishing conducted from a boat drifting over the site.

3.3.2 Results

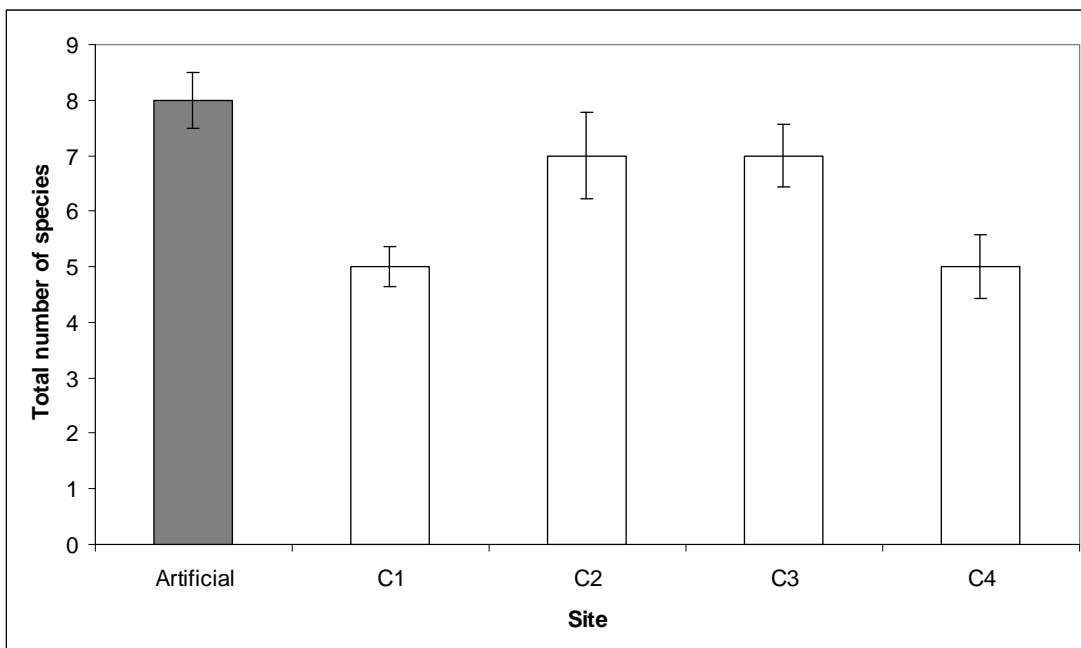
Preliminary results of the independent survey indicated that the total abundance of fish caught at Lake Macquarie differed at artificial and control reef sites. The artificial reef and control site 1 both produced 33 fish, with control site 3 producing only 23 fish for the same 7 day sampling period (Figure 9).

Figure 9 – Total abundance of fish caught at Lake Macquarie on artificial reefs and control sites



The total diversity found on reefs in Lake Macquarie was observed to be highest on the artificial reefs with 8 species recorded. Control sites recorded between 5 and 7 species for the same sampling period (Figure 10).

Figure 10 – Total number of species recorded during sampling at Lake Macquarie artificial reefs and control sites



Total Catch Per Unit Effort (CPUE) was comparable amongst all sites with an average of around 4 fish per hour at artificial and control reefs (Figure 11). Catch per unit effort of legal sized fish, however, was highest at the artificial reef sites with an average of one legal sized fish caught per hour, with control sites having a CPUE of 0.25-0.6 (Figure 12).

Figure 11 – Total CPUE for Lake Macquarie, comparing artificial reef and control sites

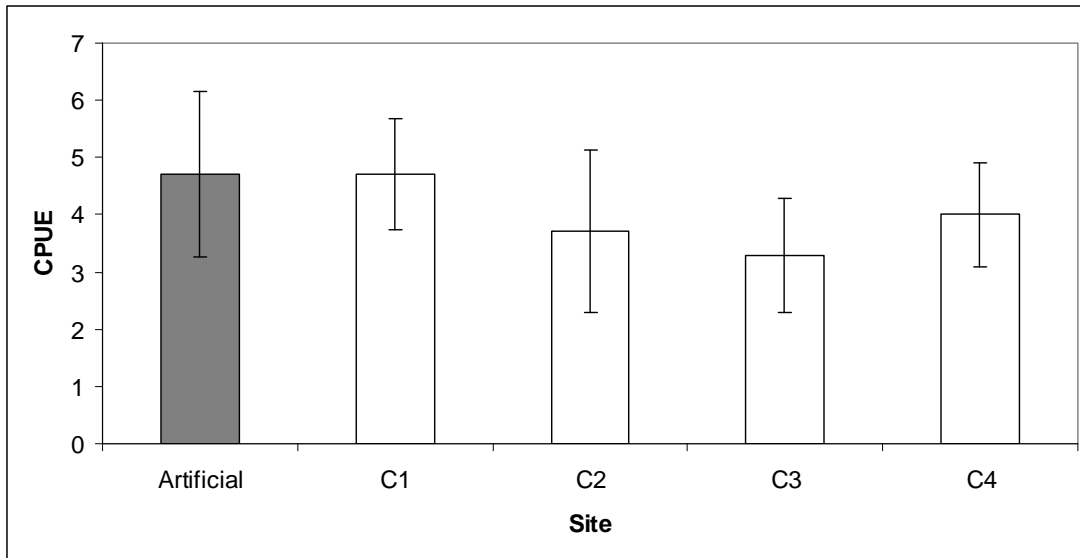
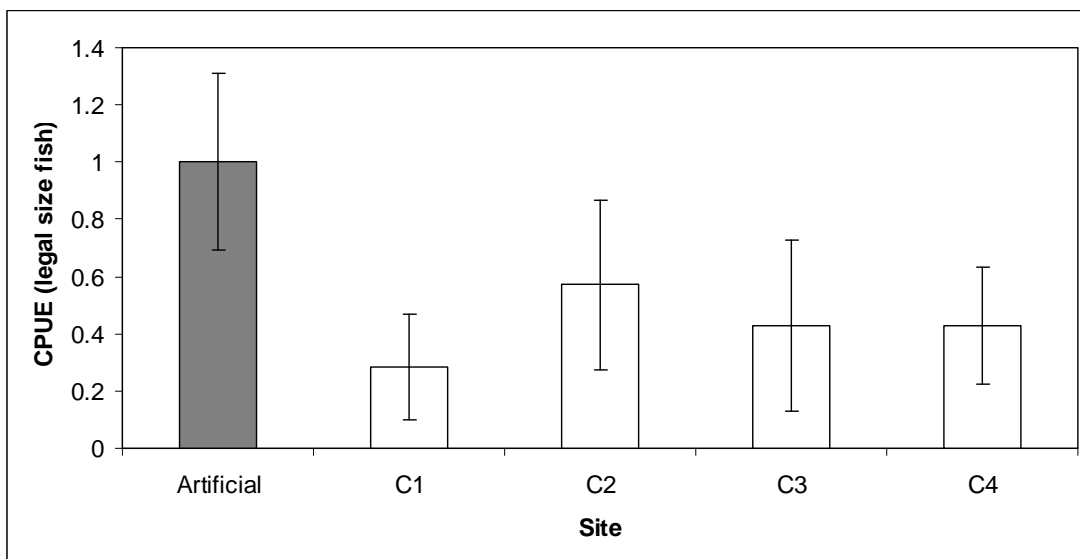


Figure 12 – CPUE of legal sized fish at Lake Macquarie artificial and control reef sites



3.3.3 Summary

Monitoring has indicated that the artificial reefs program has met its objectives and has been a success. By placing artificial reefs in previously barren areas, new diverse habitat for fish and invertebrates has been created. There has been succession of algae on the artificial reefs with extensive marine plant growth on the surface of the Reef Balls, suggesting that the materials used in construction are appropriate for the conditions. Colonisation of the reefs was almost instant, with fish observed inhabiting the reef balls within 2 days. Initially, just a few individuals were present, however the population of fish recorded has been increasing the longer monitoring has continued. Not only do the reefs support a large number of fish, but the diversity is extensive with at least 42 species of fish so far identified.

The reef has also been a success in terms of enhancing recreational fishing opportunities. After eight months, the abundance, diversity, and catch rates of recreational species are as good as or better than control sites at Lake Macquarie. This independent data strengthens NSW DPI information that the reefs are successful and are making a measurable positive contribution to the environment of Lake Macquarie.

4.0 Statutory Approvals

4.1 Commonwealth Legislation

4.1.1 Environment Protection and Biodiversity Conservation Act 1999

The *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) is administered by the Department of the Environment, Water Heritage and the Arts (DEWHA). The EPBC Act is focused on the protection of matters of national environmental significance which are defined as:

- World Heritage properties
- National Heritage places
- Wetlands of international importance
- Threatened species and ecological communities
- Migratory species
- Commonwealth marine areas
- Nuclear actions (including uranium mining)

In addition to the above, the EPBC Act also includes provisions to protect the environment of Commonwealth land.

The DEWHA Protected Matters database was searched on 6 February 2008. A point search on the site coordinates, plus a 10 kilometre buffer, was conducted. Within this area, the database indicates that the following matters of NES are present:

- 43 Threatened species
- 41 Migratory species

Other matters protected by the EPBC Act in the area include:

- Commonwealth Lands – 2
- Register of the National Estate – 6
- Listed Marine Species – 54
- Whales and other Cetaceans – 12
- State and Territory Reserves – 5
- Regional Forest Agreements - 1

A review of the above protected matters and consideration of likely impacts on threatened species was undertaken and it is concluded that no significant impact to matters of NES will occur as a result of the proposal.

4.2 NSW Legislation

4.2.1 Environmental Planning and Assessment Act 1979

The *Environmental Planning and Assessment Act 1979* (EP&A Act) establishes the framework under which environmental planning instruments (state environmental planning policies, regional environmental plans and local environmental plans) are prepared. These instruments guide and control development within the state of NSW and provide the basis for determining whether development is acceptable in a given location given the objectives for the area and the social, economic, and environmental impacts of the proposal.

The EP&A Act contains three pathways under which development can be assessed and approved:

- Part 3A – major infrastructure or developments of state significance
- Part 4 – any development that requires consent under an environmental planning instrument and is not subject to assessment under Part 3A or Part 5
- Part 5 – where a proposal does not require development consent and is being carried out by a public authority, an environmental assessment must be prepared and approved prior to the activity being carried out.

The proposed development, whilst being carried out by a public authority (the NSW DPI), requires development consent under the Shoalhaven Local Environmental Plan 1984 and is therefore subject to Part 4 of the EP&A Act. The proposal therefore requires the submission of a development application to Shoalhaven City Council, accompanied by a SEE, for their consideration prior to granting of consent.

The purpose of this SEE is to assess the environmental impacts of the proposal in accordance with Section 79C of the EP&A Act which requires the consent authority to consider:

- Any statutory requirements and planning instruments
- The likely impacts of the development on both the natural and built environments and social and economic impacts in the locality
- The suitability of the site for development
- Any public or other submissions
- The public interest

4.2.2 Fisheries Management Act 1994

The objectives of the *Fisheries Management Act 1994* (FM Act) are to:

- Conserve fish stocks and key fish habitats
- Conserve threatened species populations and ecological communities of fish and marine vegetation
- Promote ecologically sustainable development – including the conservation of biological diversity
- Promote viable commercial fishing and aquaculture industries
- Promote quality recreational fishing opportunities
- Appropriate share fisheries resources between the users of those resources
- And provide social and economic benefits for the wider community of NSW.

The Recreational Fishing Licence Fee program is implemented under the provisions of the FM Act, with funds raised going to the Recreational Fishing Trust. The purpose of the Trust under the FM Act is to invest in projects that enhance or manage recreational fishing, involve research into fish and their ecosystems, or ensure compliance with fishing regulatory controls. The Artificial Reefs Program is funded by the Trust with the dual objective of enhancing recreational fishing opportunities and contributing to the conservation of fish stocks and natural habitats.

The FM Act also serves to protect threatened species and acts in conjunction with the threatened species provisions of the EP&A Act. Aquatic species or communities listed under the Schedules 4 or 5 of FM Act

4.2.3 Water Management Act 2000

Under the *Water Management Act 2000*, permits are required for 'controlled activities' which are defined as:

- a) the erection of a building or the carrying out of a work (within the meaning of the EP&A Act), or
- b) the removal of material (whether or not extractive material) or vegetation from land, whether by way of excavation or otherwise, or
- c) the deposition of material (whether or not extractive material) on land, whether by way of landfill operations or otherwise, or
- d) the carrying out of any other activity that affects the quantity or flow of water in a water source.

Carrying out of a controlled activity without a permit issued under Clause 90 of the Act is an offence. However, Clause 39A of the Water Management (General) Regulation 2004 exempts public authorities and local councils from obtaining a controlled activity permit in relation to all controlled activities they carry out in, on or under waterfront land.

Department of Primary Industries (Fisheries) is a public authority under the definitions of the Act and therefore is exempt from obtaining a controlled activity approval for the proposal. Furthermore, the proposal is consistent with guidelines published by the Department of Water and Energy for In-stream works. The proposal:

- Does not impact on the riparian corridor;
- Will not alter the existing hydraulic, hydrologic, and geomorphic functions of the waterway; and
- Will be monitored to ensure no scour, bed degradation, or adverse ecological impacts occur.

4.2.4 Crown Lands Act 1989

Under the *Crown Lands Act 1989* it is an offence to “erect a structure”, “interfere with any substance”, or “deposit or leave on public land any matter of a prescribed class” without a licence or lease granted under the Act. Lake Conjola is defined as ‘public land’ and therefore the Minister for Crown Lands may issue a licence or lease under the Act following consideration of an environmental assessment.

The NSW DPI will consult with the Department of Lands and obtain the necessary licences prior to deployment of the artificial reef.

4.3 Environmental Planning Instruments

4.3.1 Shoalhaven Local Environmental Plan 1985

The Shoalhaven Local Environmental Plan 1985 (LEP) provides guidelines in accordance with the EP&A Act for the orderly development and management of land use within the Shoalhaven Local Government Area. The LEP includes over twenty-three objectives, of which the following are most relevant to the proposal:

- (m) *to encourage appropriate forms of tourism which are sensitive to and compatible with the natural and cultural environments of the City;*
- (o) *to ensure the protection of important natural and cultural environments*
- (p) *to ensure that development achieves the water quality or river flow objectives of groundwater, rivers, estuaries, wetlands and other water bodies*
- (s) *to avoid, mitigate or remedy the adverse effects of development on the environment*

The proposed artificial reef site is shown as uncoloured on the Shoalhaven LEP maps. Clause 35A requires that development of such land cannot be carried out without development consent of Council. In addition to this, the LEP adopts the *Environmental Planning and assessment Model Provisions 1980*, under which, development below the high water mark on the bed of a waterway cannot be carried out without development consent.

4.3.2 State Environmental Planning Policy No. 71 (Coastal Protection)

State Environmental Planning Policy No. 71 (Coastal Protection) (SEPP 71) applies to the Coastal Zone of NSW and aims to protect and manage the natural, cultural, recreational, and economic attributes of the NSW coast.

SEPP 71 requires that a consent authority (in this instance, Shoalhaven City Council) consider sixteen matters when determining a development application for development on land within the Coastal Zone. These have been considered as part of this environmental assessment and include the following matters of particular relevance to the proposal:

- the aims of SEPP 71
- the suitability of development given its type, location and design and its relationship with the surrounding area,
- measures to conserve fish (within the meaning of Part 7A of the Fisheries Management Act 1994) and marine vegetation (within the meaning of that Part), and their habitats
- measures to reduce the potential for conflict between land-based and water-based coastal activities,
- measures to protect the cultural places, values, customs, beliefs and traditional knowledge of Aboriginals,
- likely impacts of development on the water quality of coastal waterbodies,

Under the SEPP, the proposal is considered to be “significant coastal development” which is defined as being development within 100 metres below mean high water mark of the sea, a bay, or an estuary. Consequently, a copy of the development application must be forwarded to the Director-General within 2 days of the development application being lodged with Council. Council must not determine the development application within 28 days after a copy of the application is received by the Director General, during which time the Director-General may specify additional matters to be taken into consideration by council in its assessment.

4.3.3 State Environmental Planning Policy (Infrastructure) 2007

The aim of the SEPP (Infrastructure) is to facilitate effective delivery of infrastructure across NSW through:

- Improving regulatory certainty and efficiency through a consistent planning regime for infrastructure
- Providing flexibility in the location of infrastructure
- Allowing for efficient development, redevelopment or disposal of surplus government owned land
- Identifying the environmental assessment category into which different types of infrastructure falls
- Identifying matters to be considered in the assessment of development adjacent to particular types of infrastructure development
- Providing for consultation with relevant public authorities about certain development during the assessment process or prior to development occurring.

DPI understands that under SEPP (Infrastructure) 2007, waterway or foreshore management activities may be permitted without consent if carried out by a public authority and if the development conforms to one of the three definitions below:

- a) riparian corridor and bank management, including erosion control, bank stabilisation, resnagging, weed management, revegetation and the creation of foreshore access ways, and
- b) instream management or dredging to rehabilitate aquatic habitat or to maintain or restore environmental flows or tidal flows for ecological purposes, and

- c) coastal management and beach nourishment, including erosion control, dune or foreshore stabilisation works, headland management, weed management, revegetation activities and foreshore access ways.

However, the proposed artificial reef is not adequately described by these definitions. The intention of the proposed artificial reefs is to provide a fisheries enhancement tool and not an aquatic habitat rehabilitation tool. Therefore, this approach will not be pursued and it is considered that development consent is required.

4.3.4 Illawarra Regional Environmental Plan No 1

The aim of the Illawarra Regional Environmental Plan (REP) is to “*maximise the opportunities for the people of the region and the State to meet their individual and community economic and social needs*”.

The REP includes the following objectives with respect to coastal lands, wetlands and other water bodies:

- a) *to protect beach systems and conserve their scenic, recreation and natural values,*
- b) *to maintain and improve public access to waterways, lakes and the sea front, and*
- c) *to protect the productive ecosystems and natural habitats of the region’s estuaries, wetlands, lakes and lagoons and their scenic attributes.*

The proposal is consistent with these objectives and in particular will assist in enhancing the productivity of the waterway and reduce existing pressure on natural fish habitats of Lake Conjola.

The proposal also meets other objectives of the REP relating to tourism and recreation. The deployment of artificial reefs within Lake Conjola is therefore considered consistent with the REP.

5.0 Environmental Assessment

5.1 Land Use

Lake Conjola is a popular holiday and recreational area. Current activities on the waterway include fishing, sailing, water skiing, canoeing and swimming. The site is adjacent to the Conjola National Park.

The lake bed is Crown Land and administered by the Department of Lands. Consultation with the Department of Lands will be conducted prior to the deployment of the reef balls.

The introduction of the artificial reef is unlikely to have a significant impact on land use in the area. The reef is intended to enhance recreational fishing opportunities within the waterway and the proposed site was selected based on consultation with recreational fishing clubs in the area along with environmental suitability.

The site around the reef is likely to see a concentration of recreational fishing boat traffic following deployment of the reef. These boats will tend to be drifting or travelling at low speed.

The proposed artificial reef is at a depth that will not limit other activities from taking place in the area and will not pose a danger to boats and other water craft.

5.2 Topography, Geology, and Soils

The proposed artificial reef site has been inspected by DPI staff and was found to have existing medium to coarse sand sediments and no existing seagrass habitat. Water depths above the site range from 5 to 8 metres. The bed of the lake in this area is very similar to that of previously deployed NSW DPI artificial reefs within Lake Macquarie and St Georges Basin. These site characteristics are ideal, as they will enable the placement of the reef ball modules on a stable base, while limiting turbidity, enabling successful diver and video monitoring of the site.

Local changes in flow patterns and velocity (refer to Section 5.4) may contribute to minor bed scour, or increased deposition of sediments in the immediate vicinity of the Reef Balls. However this is expected to be minor and limited in extent. Whilst bed scour is possible, it is unlikely given the coarse sandy nature of the bottom sediments and low flow velocities.

The increased use of the area for recreational fishing may result in damage and erosion of the lake bed due to an increase in the number of boats anchoring in that location. It should be noted however that not all boats are expected to use anchors, but may drift or trawl over the site.

Changes to the bed in the vicinity of the reef balls will be monitored and if detrimental impacts are noted, measures to manage boats in the area will be considered in consultation with NSW Maritime. This may include the provision of moorings and prohibition of anchor usage.

5.3 Water Quality

Recent water quality monitoring data for Lake Conjola is published on the Shoalhaven City Council website (Shoalhaven City Council, 2008). There are four monitoring locations within the lake and the overall Water Quality Index for 2006/2007 was classified "Good". Water quality is monitored at four locations within the lake and analysed for dissolved oxygen levels, faecal coliforms, total phosphorus, and total nitrogen. The monitoring data shows that water quality is generally within the adopted guidelines with occasional exceedance.

The deployment of the artificial reef balls has the potential to increase localised water turbidity during placement on the lake bed. This potential impact has been limited to the extent practicable by appropriate site selection and methods of deployment.

The bed of the site consists of medium to coarse sand sediments and the balls will be slowly placed on the bed using a crane operated barge. Each ball will be guided into place by commercially certified divers and in order to operate effectively, they will need to minimise impact of the balls on the lake bed to maintain suitable visibility.

Use of the reefs for recreational fishing activities has the potential to introduce water pollutants such as oils and fuels from boat engines. Litter may also be produced by reef users, however it is not expected that the reefs themselves will contribute to any increase in such water pollutants. Furthermore, such pollution is an offence under the *Protection of the Environment Operations Act 1994*.

5.4 Hydrodynamics

Lake Conjola is a relatively deep barrier estuary with steep valley sides and central basin that formed when sea level rose to drown the pre-existing river valley (Manly Hydraulics Laboratory, 2003). The entrance to Lake Conjola is located between the townships of Lake Conjola and Manyana and consists of an extensive tidal delta of clean marine sand.

The waterway is relatively protected from the ocean by the narrow inlet which is prone to closure during storm events. The inlet and overall lake storage also acts to limit the tidal range of the lake to approximately 20% of the ocean range under typical entrance conditions (Manly Hydraulics Laboratory, 2003). Modelling of the entrance under heavily shoaled conditions by Manly Hydraulics Laboratory indicated that tidal velocities do not exceed 0.5m/s (except near the boat ramp and entrance throat).

Tidal velocities throughout the lake are expected to be lower than the tidal velocities through the entrance delta. However, wind blowing across the lake surface generates surface currents, which in turn set in motion water below the surface. This results in currents circulating throughout the lake in three-dimensions which assists to maintain water quality within the lake by increasing tidal exchange, vertical mixing and oxygenation.

Given the low profile of the Reef Balls compared to the total water column depth, generally low velocities the proposal is not expected to have a negligible impact on circulation patterns within Lake Conjola. Some local disturbance of flows may occur but given the typically weak nature of bottom currents at depth and size of the Lake compared to the reef site, these changes are unlikely to be perceptible.

Monitoring of the site will aim to observe any detrimental impacts to the site as a result of bed scour due to flow changes. Where impacts occur, either re-design of the reef layout, or removal could be considered to address the issue.

5.5 Biodiversity

5.5.1 Aquatic Habitat

The site for the artificial reef has been selected based on depth, substrate and lack of existing habitat (ie rocky reefs, seagrass meadows). Therefore, the substrate of the reef site will not impact on areas generally considered to provide important aquatic breeding, feeding or foraging functions.

The artificial reefs are intended to provide new such habitats for aquatic life within Lake Conjola. Previous studies overseas conducted on artificial reef systems indicate that biodiversity can be greatly increased through the use of Reef Balls. This has been supported by the research conducted to date on the NSW DPI Artificial Reef Program in other, similar, coastal estuaries within NSW.

The Reef Balls will provide a platform for the growth of aquatic algae and plants, as well as provide suitable habitat for fish seeking food and shelter. The reef will potentially provide an excellent breeding ground and should attract a large range of herbivorous and carnivorous fish to the area.

By providing additional aquatic habitat within Lake Conjola, it is predicted that the productivity of the area both in an ecological and fishery sense, will increase.

5.5.2 Seagrasses

Seagrasses are angiosperms that live submerged in estuarine and coastal waters. There are several species of seagrass known to occur within Lake Conjola (Department of Primary Industries, 2008):

- Varieties of Eelgrass (*Zostera Capricornia*, *Z. muelleri* and *Heterozostera tasmanica*); and
- Varieties of Paddleweed (*Halophila ovalis*, and *H. decipiens*).

Seagrass beds are vital to the health of estuaries. They provide a food resource to some water birds and herbivorous fish as well as habitat to a variety of coelenterates, molluscs, crustaceans, polychaete worms and larval, and juvenile and adult fish. Seagrass beds also stabilise shorelines and lake beds – their leaves absorb wave energy and prevent the full force of waves impacting on the sediments and causing erosion.

The protection of seagrasses is seen as an integral part of maintaining ecosystem health and ensuring their ongoing sustainability. The artificial reef has the potential to increase seagrass extent within Lake Conjola as the surface of the Reef Balls may provide suitable sites for seagrass colonisation.

There are currently no seagrass beds at the proposed reef site and therefore the project will not damage existing seagrass habitat through either the deployment of the Reef Balls or indirectly through increased boating and anchor use over the site.

5.5.3 Exotic Species

An infestation of the invasive marine seaweed *Caulerpa taxifolia* exists in the lake. This presents a serious threat to the biological diversity (through smothering of aquatic vegetation), amenity and economic viability of local tourist industries that depend on healthy coastal lakes in the Shoalhaven.

Caulerpa taxifolia is a listed noxious marine vegetation species under the FM Act. It is a green alga with feather-like fronds that can be very fast growing and may overrun other types of aquatic vegetation. It can colonise most kinds of substrates, including rock, sand, mud and seagrass beds and has been found at depths ranging from 1m to over 100m.

The NSW DPI has developed and is implementing a comprehensive control program for the control of *Caulerpa taxifolia*. At present, Lake Conjola is closed to fishing using any type of net (other than a landing net) to minimise its spread, and the NSW DPI is also implementing education campaigns through their website and other methods to educate fishers and the public on how to avoid contributing to the further spread of this pest.

If monitoring reveals that *Caulerpa taxifolia* or other exotic species are colonising the Reef Balls or hindering the objectives of the program, weed control works or decommissioning of the reef may be considered.

5.5.4 Threatened Species

Database searches revealed a number of threatened species under the TSC Act, FM Act, and EPBC Act are known or predicted to occur within 10km of the subject site.

Terrestrial flora will not be impacted as a result of the proposal and therefore no assessment of such species has been conducted.

Whilst the list of threatened species either recorded or predicted to occur in the area is extensive, most are not expected to occur at the site due to its aquatic nature. Generally the likelihood of the remaining aquatic and marine species occurring at the proposed reef site is considered low.

The proposal will not impact on any habitat that is known to be important to threatened species, nor will it directly kill injure or maim any individuals. This combined with the low likelihood of threatened species occurring at the site and the methodology of deployment (crane and commercially certified divers) results in a low risk of any impacts to:

- Threatened species
- Endangered ecological communities
- Endangered populations

Therefore an assessment of significance under the EP&A Act or EPBC Act is not required.

5.6 Climate

Lake Conjola is located within the temperate east coast climate of New South Wales, therefore the climate of the region is characterised as having warm summers and cool winters.

The Bureau of Meteorology's weather monitoring station at Jervis Bay (Point Perpendicular Lighthouse - Station No. 068034) is the closest weather monitoring station to the proposal site with long term averages. The station was operating between 1899 and 2004. The Ulladdulla AWS is closer to the subject site but has been operating less than 20 years.

Based on the summary climate statistics published for Point Perpendicular by the Bureau of Meteorology the area is characterised by maximum annual average temperatures of 23.9° in February and minimum annual averages of 9.2° in July. Rainfall is highest in May with average recordings of 134.1mm and lowest in September with average recordings of 78.9mm. The average annual rainfall at Point Perpendicular is 1242mm. On average wind speeds are highest in the afternoon with November typically recording higher 3pm wind speeds with an average of 22.5km/hr. Morning winds tend to be predominantly southerlies and north westerlies, with afternoon winds being predominantly southerlies and north easterlies.

5.7 Air Quality

A database search of the online National Pollutant Inventory (NPI) database revealed that predominant sources of pollutants within the Shoalhaven LGA includes:

- Food manufacturing
- Mineral, metal and chemical wholesaling
- Paper and paper product manufacturing
- Log sawmilling and timber dressing
- Water supply, sewerage and drainage services

According to the NPI database, the top pollutants by total emissions (kg/year) within the Shoalhaven LGA included the following air pollutants:

- Sulfur dioxide
- Oxides of nitrogen
- Carbon monoxide
- Particulate matter
- Hydrochloric acid
- Fluoride compounds
- Chlorine
- Ammonia
- Volatile organic compounds

However, the level of development within the area is quite low, and the above pollutants are emitted at relatively low levels given the size of the area considered.

The general air quality within the LGA is considered to be very good (Shoalhaven City Council, 2008). The report notes that the LGA has relatively low levels of heavy industrial development and the predominant air quality contaminants in the region are generated by motor vehicle emissions, bushfires, solid fuel heaters and landfill.

Minor impacts to air quality may result in the immediate vicinity of the reefs as a result of boat engines. These emissions are not significant in a regional or local sense and no mitigation measures are proposed.

5.8 Noise and Vibration

There are currently no major noise or vibration sources in the area. National Parks are located to the north, and the area is likely to be disturbed intermittently by recreational power boats, particularly on weekends and Public Holidays.

Increased boating in the area may potentially increase boat noise emissions in the immediate vicinity. However, boat speeds will be typically low while fishing, and this increase in the frequency of noise sources will not impact on any sensitive noise receptors.

5.9 Social-Economic Environment

5.9.1 Waterway Navigation

The reefs are expected to be attractive to recreational fishing enthusiasts and therefore have the potential to increase boat traffic in the immediate reef vicinity. If the reef proves particularly popular, some potential adverse impacts include:

- Boating accidents / collisions
- Boating noise
- Over-fishing of the reef

However, it is likely that the attraction of the reef will result in a threshold level of use, above which the users are likely to seek less competition and better amenity at alternative fishing sites. The use of the site can be monitored and controls implemented if required such as implementation of speed zones or the provision of moorings combined with the prohibition of anchor use to limit numbers.

It is noted that the Reef Balls are located at a depth to avoid causing damage to the hulls or keels of boats. The depths at which the Reef balls will be placed ranges from 5 to 8 metres. The Reef Balls

range in height from 0.53 to 0.88 metres, therefore providing a minimum of approximately 4 metres of clearance over the reef. This clearance is in excess of the depth required by the typical recreational vessels likely to be using the area.

5.9.2 Regional Tourism

Lake Conjola is a declared Recreational Fishing Haven, and the area is a popular tourist destination. Recreational fishing is a major activity in the area and the artificial reef will be intended to augment this activity on the lake.

It is estimated that direct expenditure on fishing related items in NSW is in excess of \$550 million dollars (Department of Primary Industries, 2008). Enhancing recreational fishing opportunities within Lake Conjola has the potential to increase local expenditure on fishing related activities and indirectly through other tourism and hospitality services.

5.9.3 Community Engagement

As discussed in Section 2.2, the DPI has consulted with recreational fishing groups regarding the site selection process for the artificial reef. Feedback from the community regarding the reefs has been generally positive.

The DPI also publishes information on its artificial reef program through its website, and will continue to gain feedback from the both the recreational fishing and wider community on the effectiveness of the reef in enhancing to recreational fishing and its impact on other users and the environment.

5.9.4 Heritage

Based on site inspection by the NSW DPI, the proposed reef area is devoid of any former marine structures and consists of a sandy lake bed. Whilst subsurface artefacts are unlikely to occur, no excavation of the lake bed is proposed and the proposal will therefore not impact on any potential subsurface archaeological deposits (if present).

6.0 Environmental Management

6.1 Summary of Mitigations Measures

There are generally only minor negative environmental impacts predicted as a result of the proposal. Therefore, the primary mechanism for the management of any predicted or unexpected environmental impacts is to implement a monitoring program. The program has the dual purpose of ensuring that negative environmental effects are not occurring and to further scientific knowledge regarding the effect of artificial reefs in NSW estuaries.

6.2 Monitoring Program

A quarterly monitoring program of the artificial reef will be implemented using the same methodology applied to the Lake Macquarie, St Georges Basin and Botany Bay sites. The purpose of the monitoring will be to assess the impacts and effectiveness of the reef. The monitoring objectives are to:

- determine the number, size, and species composition of fish assemblages;
- determine differences in the number, size and species composition of fish between artificial reefs and naturally occurring control reef locations;
- detect differences in catch rates and species composition between artificial and naturally occurring reefs;

Before-After-Control-Impact (BACI) assessment designs will be employed to assess relative rates of recruitment and species composition between artificial reefs and control locations over time.

The monitoring programme will also enable visual identification of other reef associated impacts. Potential impacts have been previously discussed in this report, however, due to the lack of data on artificial reefs in Australian waters, these impacts are difficult to quantify.

6.2.1 Sampling

Monitoring will be carried out using baited underwater video (BUV). The use of video as a sampling device has the following advantages:

- allows for non-invasive qualitative and quantitative observations;
- provides remote recording beyond physiological limitations of divers over long periods of time;
- can record a large amount of data quickly;
- removes observer bias and error;
- provides a visual record;
- allows for low-light recording (to study the fish assemblage in low visibility conditions); and
- provides the possibility of accurate metric measurement.

The camera is mounted on a stand and includes a bait holder. Video sequences will be analysed with a real-time counter, and the abundance of each observed species will be recorded. The maximum number of individuals of each species will be recorded as the actual value of relative abundance for each replicate.

6.2.2 Catch Rate Information

Using data supplied by local recreational fishers, an assessment of catch rate, species composition and size composition at the artificial reefs and control locations will be carried out.

6.2.3 Site Condition

It is proposed that a photographic survey will be conducted to assess issues related to gross changes to the condition of the immediate area (i.e. scouring, deposition, anchor damage or waste).

6.2.4 Additional Monitoring and Research Opportunities

The deployment of the proposed artificial reefs also provides a unique and very real potential for organisations external to the NSW DPI, such as universities, to conduct further research on the ecological implications and environmental impacts of artificial reefs in estuaries. The NSW DPI and the Recreational Fishing Trust will encourage separate funding applications for such studies.

6.3 Decommissioning

Experience on the three existing artificial reefs within Lake Macquarie, St Georges Basin and Botany Bay indicate that there is a very low likelihood of the reefs resulting in adverse environmental impact. Generally the artificial reefs have been highly successful and provide a net environmental benefit. Provided this is the case within Lake Conjola, the intention of the project is for the Reef Balls to remain on the lake bed indefinitely.

Whilst unlikely to be required, decommissioning of the reefs will be undertaken if the results of the monitoring indicated that adverse ecological or environmental impacts are occurring following the deployment of the reef. Some examples of impacts that if identified, may require removal of the Reef Balls are:

- Catch rates at unsustainable levels or adverse impacts on biodiversity
- Extensive damage to lake bed or seagrass communities from increased boating activity
- Contribution of the reef to exotic species colonisation or spread
- Excessive deposition of sediment or initiation of bed scouring
- Widespread and negative community feedback

Impacts of decommissioning would be similar to deployment and may include an increase in short term turbidity. Species that had taken residence at the reef would be required to find alternative suitable natural habitats and any juvenile species would be vulnerable to predation until suitable cover was located.

The need for rehabilitation or post-removal monitoring would be decided based on the adverse impacts that had lead to the decision for decommissioning. The Reef Balls are not intrusive into the lake bed and therefore, it is likely that once the Reef Balls had been removed, the site should to return to its pre-existing, natural state within a relatively short period of time and with minimal intervention or rehabilitation.

7.0 Discussion

The proposal to install an artificial reef within Lake Conjola will impact an area of less than 0.02% of the waterway. The site has been selected based on appropriate depths, impact on other lake users, the lack of existing habitat and bed materials to ensure that:

- No existing critical habitat is damaged
- Minimise the risk of turbidity issues during deployment and monitoring
- Minimise risk of erosion and scour
- Minimise conflict with other waterway users
- Maximise the opportunities for study and research into artificial reef systems

No impacts to threatened species or endangered ecological communities or populations are predicted.

Overall, the proposal will result in a net environmental and social benefit, with only minor risks of negative impacts occurring. Through the monitoring program, any negative impacts that do occur can be detected and mitigations measures implemented through regulation of the use of the site or removal of the Reef Balls if necessary. However, the likelihood of these potential negative impacts occurring is low.

The deployment of an artificial reef within Lake Conjola by the NSW DPI, will provide additional fishing opportunities for recreational anglers by providing an alternative to existing sites within the lake. It is expected that by providing additional habitat for aquatic species that the artificial reefs will reduce pressure on natural reefs within the lakes and assist to ensure the long-term sustainability of the area as a Recreational Fishing Haven. The reefs will also provide valuable monitoring opportunities, to increase the scientific knowledge of artificial reefs and the natural environment.

8.0 References

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Appendix A Threatened Species Assessment



Appendix A Threatened Species Assessment

Table 4 – Threatened Species (TSC Act and EPBC Act)

Scientific Name	Common Name	Conservation Status		Habitat	Likelihood
		TSC Act	EPBC Act		
Birds					
<i>Apus pacificus</i>	Fork-Tailed Swift		Mi	Ma	NE
<i>Ardea alba</i>	Great Egret, White Egret		Mi	We, Ma	NE
<i>Ardea ibis</i>	Cattle Egret		Mi	We, Ma	NE
<i>Calidris alba</i>	Sanderling	V	Mi	Ma	NE
<i>Calidris tenuirostris</i>	Great Knot	V	Mi	Ma	NE
<i>Callocephalon fimbriatum</i>	Gang-Gang Cockatoo	V		T	NE
<i>Calyptorhynchus lathamii</i>	Glossy-Black Cockatoo	V		T	NE
<i>Charadrius leschenaultii</i>	Greater Sand Plover	V	Mi	Ma	NE
<i>Charadrius mongolus</i>	Lesser Sand Plover	V	Mi	Ma	NE
<i>Climacteris picumnus</i>	Brown Treecreeper	V		T	NE
<i>Diomedea amsterdamensis</i>	Amsterdam Albatross		E, Mi	Ma	Low
<i>Diomedea antipodensis</i>	Antipodean Albatross	V	V, Mi	Ma	Low
<i>Diomedea dabbenena</i>	Tristan Albatross		E, Mi	Ma	Low
<i>Diomedea exulans</i>	Wandering Albatross	E	V, Mi	Ma	Low
<i>Diomedea gibsoni</i>	Gibson's Albatross	V	V, Mi	Ma	Low
<i>Esacus neglectus</i>	Beach Stone-Curlew	E		Ma	Low
<i>Fregetta grallaria</i>	White-Bellied Storm-Petrel	V		Ma	Low
<i>Gallinago hardwickii</i>	Latham's Snipe, Japanese Snipe		Mi	We	Low
<i>Gygis alba</i>	White Tern	V		Ma	
<i>Haematopus fuliginosus</i>	Sooty Oystercatcher	V		We	Low
<i>Haematopus longirostris</i>	Pied Oystercatcher	V		We	Low
<i>Haliaeetus leucogaster</i>	White-Bellied Sea Eagle		Mi	NS	NE
<i>Hirundapus caudacutus</i>	White-Throated Needletail		Mi	T	NE
<i>Ixobrychus flavicollis</i>	Black Bittern	V		Ma	Low
<i>Lathamus discolor</i>	Swift Parrot	E	E	T	NE
<i>Limicola falcinellus</i>	Broad-Billed Sandpiper	V		Ma	Low
<i>Limosa limosa</i>	Black-Tailed Godwit	V		Ma	Low
<i>Lophoictinia isura</i>	Square-Tailed Kite	V		T	NE
<i>Macronectes giganteus</i>	Southern Giant-Petrel	E	E, Mi	Ma	Low
<i>Macronectes halli</i>	Northern Giant-Petrel	V	V, Mi	Ma	Low
<i>Merops ornatus</i>	Rainbow Bee-Eater		Mi	T	NE
<i>Monarcha melanopsis</i>	Black-Faced Monarch		Mi	T	NE
<i>Myiagra cyanoleucca</i>	Satin Flycatcher		Mi	T	NE
<i>Neophema chrysogaster</i>	Orange-Bellied Parrot	E	CE, Mi	T	NE
<i>Ninox connivens</i>	Barking Owl	V		T	NE

Scientific Name	Common Name	Conservation Status		Habitat	Likelihood
		TSC Act	EPBC Act		
<i>Ninox strenua</i>	Powerful Owl	V		T	NE
<i>Pandion haliaetus</i>	Osprey	V	Mi	NS	Low
<i>Petroica rodinogaster</i>	Pink Robin	V		T	NE
<i>Phoebastria fusca</i>	Sooty Albatross	V	V, Mi	Ma	Low
<i>Pterodroma leucoptera leucoptera</i>	Gould's Petrel	E	E, Mi	Ma	Low
<i>Pterodroma neglecta neglecta</i>	Kermadec Petrel (western)	V	V	Ma	Low
<i>Pterodroma nigripennis</i>	Black-Winged Petrel	V		Ma	Low
<i>Puffinus assimillis</i>	Little Shearwater	V		Ma	Low
<i>Puffinus carneipes</i>	Flesh-Footed Shearwater	V	Mi	Ma	Low
<i>Rhipidura rufifrons</i>	Rufous Fantail		Mi	T	NE
<i>Rostratula australis</i>	Australian Painted Snipe	E	V, Mi	We	Low
<i>Sterna albifrons</i>	Little Tern	E	Mi	NS	Low
<i>Sterna fuscata</i>	Sooty Tern	V		Ma	Low
<i>Thalassarche bulleri</i>	Buller's Albatross		V, Mi	Ma	Low
<i>Thalassarche cauta</i>	Shy Albatross	V	V, Mi	Ma	Low
<i>Thalassarche chlororhynchos</i>	Yellow-Nosed Albatross, Atlantic Yellow-Nosed Albatross		Mi	Ma	Low
<i>Thalassarche chrysostoma</i>	Grey-Headed Albatross		V, Mi	Ma	Low
<i>Thalassarche impavida</i>	Campbell Albatross		V, Mi	Ma	Low
<i>Thalassarche melanophris</i>	Black-Browed Albatross	V	V, Mi	Ma	Low
<i>Thalassarche salvini</i>	Salvin's Albatross		V, Mi	Ma	Low
<i>Thalassarche steadi</i>	White-Capped Albatross		V, Mi	Ma	Low
<i>Thinornis rubricollis</i>	Hooded Plover	E		NS	Low
<i>Tyto tenebricosa</i>	Sooty Owl	V		T	NE
<i>Xanthomyza phrygia</i>	Regent Honeyeater	E	E	T	NE
<i>Xenus cinereus</i>	Terek Sandpiper	V	Mi	Ma	Low
Fish					
<i>Prototroctes maraena</i>	Australian Grayling		V	F	NE
Frogs					
<i>Heleioporus australiacus</i>	Giant Burrowing Frog	V	V	T	NE
<i>Litoria aurea</i>	Green And Golden Bell Frog	E	V	T, We	NE
<i>Litoria littlejohni</i>	Littlejohn's Tree Frog, Heath Frog		V	T, We	NE
Mammals					
<i>Arctocephalus forsteri</i>	New Zealand Fur Seal	V		Ma	Low
<i>Arctocephalus pusillus doriferus</i>	Australian Fur Seal	V		Ma	Low
<i>Balaenoptera edeni</i>	Bryde's Whale			Ma	Low
<i>Balaenoptera musculus</i>	Blue Whale	E	E	Ma	Low

Scientific Name	Common Name	Conservation Status		Habitat	Likelihood
		TSC Act	EPBC Act		
<i>Caperea marginata</i>	Pygmy Right Whale			Ma	Low
<i>Chalinolobus dwyeri</i>	Large-Eared Pied Bat, Large Pied Bat		V	T	NE
<i>Dasyurus maculatus maculatus</i> (SE mainland population)	Spot-Tailed Quoll, Spotted-Tail Quoll, Tiger Quoll (SE mainland population)		E	T	NE
<i>Dugong dugon</i>	Dugong	E		Ma	Low
<i>Eubalaena australis</i>	Southern Right Whale	V	E, Mi	Ma	Low
<i>Isodon obesulus obesulus</i>	Southern Brown Bandicoot	E	E	T	NE
<i>Lagenorhynchus obscurus</i>	Dusky Dolphin		Mi	Ma	Low
<i>Megaptera novaeangliae</i>	Humpback Whale	V	V, M	Ma	Low
<i>Miniopterus schreibersii oceanensis</i>	Eastern-Bentwing Bat	V		T	NE
<i>Orcinus orca</i>	Killer Whale, Orca		Mi	Ma	Low
<i>Physeter macrocephalus</i>	Sperm Whale	V	Mi	Ma	Low
<i>Pteropus poliocephalus</i>	Grey-Headed Flying-Fox	V	V	T	NE
<i>Petaurus australis</i>	Yellow-Bellied Glider	V		T	NE
<i>Petrogale penicillata</i>	Brush-Tailed Rock-Wallaby		V	T	NE
<i>Phascolarctos cinereus</i>	Koala	V		T	NE
<i>Potorous tridactylus</i>	Long-Nosed Potoroo	V	V	T	NE
Reptiles					
<i>Chelonia Mydas</i>	Green Turtle	V	V	Ma	Low
<i>Dermochelys coriacea</i>	Leathery Turtle, Leatherback Turtle	V	V, M	Ma	Low
<i>Hoplocephalus bungaroides</i>	Broad-Headed Snake		V	T	NE
Sharks					
<i>Carcharias taurus</i> (east coast population)	Grey Nurse Shark (east coast population)	E	CE	Ma	Low
<i>Carcharodon carcharias</i>	Great White Shark	V	V, Mi	Ma	Low
<i>Rhincodon typus</i>	Whale Shark		V, Mi	Ma	Low

Notes

CE:	Critically Endangered	T:	Terrestrial
E:	Endangered	Ma:	Marine
V:	Vulnerable	We:	Wetland
Mi:	Migratory	NS:	Near shore
		F:	Freshwater

Table 5 – Threatened Species (Fisheries Management Act 1994)

Scientific Name	Common Name	Habitat	Assessment
Endangered Species			
<i>Austrocordulia leonardi</i>	Sydney Hawk Dragonfly	Only recorded in deep shady river pools. Site is outside predicted range.	Not expected
<i>Carcharias taurus</i>	Grey Nurse Shark	Shallow coastal waters, deep gutters around rocky outcrops and reefs.	Low likelihood
<i>Craterocephalus fluviatilis</i>	Murray Hardyhead	Freshwater – lower reaches of Murray River system	Not expected
<i>Maccullochella ikei</i>	Eastern Freshwater Cod	Freshwater – Clarence and Richmond Rivers	Not expected
* <i>Maccullochella macquariensis</i>	Trout Cod	Freshwater – lower reaches of Murray – Darling system	Not expected
<i>Nannoperca oxleyana</i>	Oxleyan Pygmy Perch	Coastal and swampy drainages, streams in Northern NSW to SE Qld	Not expected
<i>Notopala sublineata</i>	River Snail	Free-flowing rivers of the Murray Darling System	Not expected
<i>Pristis zijsron</i>	Green Sawfish	Shallow bays, estuaries and lagoons. Last records :1972 in Northern NSW, 1926 Sydney.	Low likelihood – prefers muddy substrates
<i>Thunnus maccoyii</i>	Southern Bluefin Tuna	Occurs in oceanic waters	Not expected
Endangered Populations			
<i>Mogurnda adspersa</i>	Western population of the purple spotted gudgeon	Western population occurs within the Murray-Darling system	Not expected
<i>Ambassis agassizii</i>	Western population of the olive perchlet	Occurs in the Darling drainage system upstream of Burke	Not expected
Endangered Ecological Communities			
Aquatic ecological community in the natural drainage system of the lower Murray River catchment			Not expected
Aquatic ecological community in the natural drainage system of the lowland catchment of the Darling River			Not expected
Species Presumed Extinct			
<i>Vanvoorstia bennettiana</i>	Bennetts Seaweed	Red algae only previously recorded in Port Jackson	Not expected

Scientific Name	Common Name	Habitat	Assessment
Vulnerable			
<i>Archaeophya adamsi</i>	Adams Emerald Dragonfly	Small freshwater streams in Hawkesbury and Sydney regions	Not expected
<i>Bidyanus bidyanus</i>	Silver Perch	Fast flowing freshwater. Natural population near Torrumbarry Weir in Murray River.	Not expected
<i>Branchinella buchananensis</i>	Buchanans Fairy Shrimp	Temporary saline lakes, north west NSW.	Not expected
<i>Carcharodon carcharias</i>	Great White Shark	Temperate and sub-tropical ocean. Inshore waters near islands, and seal colonies	Not expected
<i>Epinephelus daemeli</i>	Black Cod	Temperate and sub-tropical waters. Rocky reefs, caves or deep (10 – 40 m) ledges	Low likelihood due to lack of reef habitat
<i>Macquaria australasica</i>	Macquarie Perch	Cool freshwater, upper reaches of Murray-Darling system	Not expected
<i>Nannoperca australis</i>	Southern Pygmy Perch	Small, slow flowing freshwater with vegetation cover. Murray and Murrumbidgee Rivers.	Not expected
Marine vegetation			
<i>Nereia lophocladia</i>	Marine Brown Alga	Occurs near Muttonbird Island, Coffs Harbour.	Not expected