

1 Introduction

This description of the ecological character of Myall Lakes Ramsar site was prepared by the Office of Environment and Heritage NSW (OEH) (Table 1) following the *National Framework and Guidance for Describing the Ecological Character of Australia's Ramsar Wetlands* (DEWHA 2008).

1.1 Brief description of the site

The Myall lakes were designated as a wetland of international importance under the Ramsar Convention on Wetlands in 1999 and lies within Myall Lakes National Park, Little Broughton Island Nature Reserve, Gir-um-bit National Park and Corrie Island Nature Reserve.

It is one of the few coastal wetlands systems in NSW that has not been greatly impacted by human activities and is in a relatively healthy condition. It is renowned for its rich biodiversity and complex variety of habitats.

Table 1 Details of the ecological character description of Myall Lakes Ramsar site

Site name	Myall Lakes Ramsar site
Location	In the Hunter (coastal) region of NSW, approximately 75 km north of Newcastle and 30 km south of Forster.
Area	44,612 ha
Geographical Coordinates	Latitude 32° 19' S to 32° 42' S Longitude 152° 02' E to 152° 31' E
Date of listing as a Ramsar site	14 June 1999
Date the description of ecological character applies	1999 (Information gathered since listing has been included where appropriate.)
Management authority	Office of Environment and Heritage Department of Premier and Cabinet NSW
Status of description	This is the first description of the ecological character.
Name of compilers	Dr Peter Scanes, Ms Kirsty Brennan, Mr Brian Leahy, Ms Fiona Miller, Dr Jane Jelbart* and Dr Li Wen Office of Environment and Heritage Department of Premier and Cabinet NSW * now with Umwelt (Australia) Pty Ltd
Date of compilation	July 2011
Reference for Ramsar Information Sheet	Australia 5AU052 www.environment.gov.au/water/wetlands/database/index.html
Reference for management plan	NPWS (2002) DEC (2006)

1.2 Statement of purpose

The description of the ecological character of a Ramsar site forms the baseline for management planning and action, including recommendations for site monitoring to detect negative impacts.

The legal objectives of the ecological character description (ECD) are to:

- assist in implementing Australia's obligations under the Ramsar Convention, as stated in Schedule 6 (Managing wetlands of international importance) of the Environment Protection and Biodiversity Conservation Regulations 2000 (Cwlth):
- describe and maintain the ecological character of the wetlands in a Ramsar site
- formulate and implement planning that promotes:
 - i) conservation of the wetland
 - ii) wise and sustainable use of the wetland for the benefit of humanity in a way that is compatible with maintenance of the natural properties of the ecosystem.
- assist in fulfilling Australia's obligation under the Ramsar Convention to arrange to be informed at the earliest possible time if the ecological character of any wetland in its territory and included in the Ramsar list has changed, is changing or is likely to change as a result of technological developments, pollution or other human interference
- supplement the description of the ecological character contained in the Ramsar Information Sheet submitted to the Ramsar Convention for each listed wetland and collectively form an official record of the ecological character of the site
- assist the administration of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)¹, particularly to:
 - i) determine whether an action has, will have or is likely to have a significant impact on a declared Ramsar wetland in contravention of sections 16 and 17B of the EPBC Act, or
 - ii) assess the impacts that actions referred to the Minister under Part 7 of the EPBC Act have had, will have or are likely to have on a declared Ramsar wetland.
- assist other relevant NSW planning or impact assessment legislation such as the *Environmental Planning and Assessment Act 1979*
- assist any person considering taking an action that may impact on a declared Ramsar wetland in deciding whether to refer the action to the Minister under Part 7 of the EPBC Act for assessment and approval
- inform members of the public who are interested generally in declared Ramsar wetlands to understand and value the wetlands.

From the perspective of management planning and action, the ECD forms the reference for:

- development and implementation of a management plan designed to maintain the ecological character of the site
- design and implementation of monitoring programs to detect change in ecological character and to assess the effectiveness of management actions
- regular evaluation of the results of the monitoring program to assist in site management.

¹ www.environment.gov.au/epbc/index.html

1.3 Relevant legislation and treaties

Australia addresses its obligations under the Convention through the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), the Environment Protection and Biodiversity Conservation Regulations 2000, relevant state legislation, and national, state, territory, and local government wetland policies and natural resource management programs.

1.3.1 NSW legislation and policies

The following NSW legislation and policies are relevant to management of Myall Lakes Ramsar site.

NSW Wetlands Policy 2010

The NSW Wetlands Policy provides a framework for the protection, ecologically sustainable use and management of NSW wetlands. It highlights the importance of protecting and managing wetlands of international importance such as the Myall lakes and other Ramsar sites.

National Parks and Wildlife Act 1974

The *National Parks and Wildlife Act 1974* (NPW Act) provides for the establishment, protection and management of national parks and other conservation reserves in NSW. Under the Act a plan of management for Myall Lakes National Park is required to be prepared and updated on a regular basis.

Threatened Species Conservation Act 1995

The *Threatened Species Conservation Act 1995* provides for the listing and conservation of threatened plants and animals and of endangered ecological communities in NSW. There are 11 plant species, 46 animal species and two ecological communities listed under the Act which have been recorded in the Ramsar site.

Marine Parks Act 1997

The *Marine Parks Act 1997* provides for the establishment and management of marine parks in NSW. The lakes and estuarine waters of the Ramsar site are included in Port Stephens – Great Lakes Marine Park, and are subject to a zoning plan under the Act which determines where activities such as commercial and recreational fishing are permitted.

Fisheries Management Act 1994

The *Fisheries Management Act 1994* (FM Act) regulates commercial and recreational fishing in NSW. Commercial fishing in the Ramsar site includes prawning in the lower Myall River, with eel trapping and mesh netting for fish in those parts of the lakes outside the marine park's sanctuary zones.

Protection of the Environment Operations Act 2000

The *Protection of the Environment Operations Act 2000* aims to minimise the impacts of air, water and noise pollution and wastes on the environment of NSW. The Act regulates activities such as the discharge of untreated sewage effluent and of wastes from intensive agricultural production, and runoff from timber harvesting and road construction on lands and in waters within the catchment of the Myall lakes.

Water Management Act 2000

The *Water Management Act 2000* provides for the preparation of water sharing plans to ensure the equitable sharing of water resources for urban, industrial and agricultural purposes and for the benefit of the community and the environment. The Water Sharing Plan for the Lower North Coast Unregulated and Alluvial Water Sources, which includes the streams and rivers and the groundwater in the catchment of the Ramsar site and the Myall lakes, was adopted in 2009.

1.3.2 International agreements and conventions

Migratory shorebirds use the East Asian – Australasian Flyway, which stretches from New Zealand and Australia, through south-east Asia, China and Japan, and north to Siberia and Alaska. International agreements and conventions that protect bird species known to use the flyway include:

- Agreement between the Government of Australia and the Government of Japan for the Protection of Migratory Birds in Danger of Extinction and their Environment (JAMBA)²
- Agreement between the Government of Australia and the Government of the People's Republic of China for the Protection of Migratory Birds and their Environment (CAMBA)³
- Agreement between the Government of Australia and the Government of the Republic of Korea for the Protection of Migratory Birds and their Environment (ROKAMBA)⁴
- Convention on the Conservation of Migratory Species of Wild Animals (the Bonn Convention)⁵
- Convention on Biological Diversity⁶
- Asia-Pacific Migratory Waterbird Conservation Strategy 2001–2005.⁷

1.4 Approach taken in this ecological character description

This report has been compiled to meet the requirements of the *National Framework and Guidance for Describing the Ecological Character of Australia's Ramsar Wetlands* (DEWHA 2008), which requires presentation of:

- a general description of the site
- a baseline description of the components, processes and services of the site around the time of Ramsar listing (1999)
- definition of the critical components, processes and services of the site
- setting of limits of acceptable change for the critical components, processes and services, and nomination of indicators to measure change
- identification of changes in ecological character within the site since 1999
- a summary of knowledge gaps and recommendations for monitoring
- key communication messages for the site.

Myall Lakes Ramsar site was gazetted in 1999 to correspond with the then boundaries of Myall Lakes National Park, Little Broughton Island Nature Reserve and Corrie Island Nature Reserve. Myall Lakes Ramsar site is centred around the large open-water fresh to brackish lakes system, with other wetland types either directly connected (such as fringing wetlands around lakes, riverine wetlands upstream of lakes, tidal wetlands downstream of lakes) or located nearby (perched dune wetlands). These linked wetlands, with the supporting terrestrial habitat, will be referred to as the Myall lakes throughout the ECD. The marine coast of Myall Lakes National Park is part of the Ramsar site, and has also been addressed in this ECD.

Since 1999 the Fame Cove section of Myall Lakes National Park has been gazetted as part of Gir-umbit National Park, and there have been a number of additions to Myall Lakes National Park (Figure 3). While the new additions to the national park do not form part of the Ramsar site, some are inextricably linked to the site and its values and are relevant to this ECD.

² www.austlii.edu.au/au/other/dfat/treaties/1981/6.html

³ www.austlii.edu.au/au/other/dfat/treaties/1988/22.html

⁴ www.aph.gov.au/HOUSE/committee/jsct/27february2007/treaties/korea_nia.pdf

⁵ www.cms.int/

⁶ www.cbd.int/

⁷ www.environment.gov.au/biodiversity/migratory/publications/asia-pacific/index.html

Areas that have been referred to in this ECD, even though they are not part of the Ramsar site, are listed below. It is anticipated that an application may be made to include all or some of these areas into the Ramsar site in the future.

- 1 In 2001 Myall Lakes National Park was extended to low tide, whereas the previous gazettal was to high tide, and it now includes all the sandy and rocky marine shores of Myall Lakes National Park and the estuarine areas of Fame Cove and Myall River.
- 2 In 2005 additional lands on Myall River were gazetted as part of the national park; this includes estuarine tidal flats and habitats such as mangroves, saltmarshes and associated fringing forest.
- 3 The upper and lower Myall River, where it traverses the national park, is not part of the Ramsar site (this includes estuarine waters and macrophyte beds).
- 4 Corrie Island Nature Reserve and Little Broughton Island Nature Reserve are gazetted to high tide; the region between mean low tide and mean high tide is Crown land. These areas include sand spits, sand shores, rocky shores and intertidal flats.

In summary, Myall Lakes Ramsar site consisted of 44,612 ha of conservation reserves at the time of listing in 1999.

2 General description

2.1 Site characteristics

The Myall lakes are four interlinked water bodies that originally (prior to European settlement) probably had ecologies that were fundamentally similar, but differed in detail due to the effects of salinity. The water bodies are, in order of increasing salinity, Myall Lake, Boolambayte Lake, Two Mile Lake and Bombah Broadwater. Myall River upstream of Bombah Broadwater is brackish below the township of Bulahdelah and becomes freshwater just upstream of Bulahdelah.

The Myall lakes have been recognised as having natural values of high conservation significance, including a largely unmodified catchment. A review of coastal lakes in NSW in 2002 concluded that the Myall lakes require significant protection in order to restore and preserve their critical natural ecosystem processes (Healthy Rivers Commission 2002). The dominant feature of the site is the large interconnected lakes system which covers an area of 10,000–15,000 ha (the range is due to varying water levels). The two large lakes – Myall Lake in the north, and Bombah Broadwater in the south – are connected by two smaller lakes – Two Mile Lake and Boolambayte Lake. The lower Myall River links the lakes to the Tasman Sea via Port Stephens (Figure 1).

The lakes system is bounded by high sand dunes on the coast and older, flatter dunes to the west which support a range of wetlands interconnected with the lakes and river systems. There are fringing wetlands around the margins of the lakes and tidal wetlands from the lower Myall River to the Tasman Sea. The perched freshwater wetlands are located between the eastern shores of Myall Lake and the coastal dunes, and over 40 km of ocean beaches and headlands are part of the Ramsar site.

In addition to the four main lakes, Nerong Creek, sections of the upper and lower Myall River, Boolambayte Creek, the estuarine environments of Fame Cove inlet and Corrie Island in Port Stephens, and Broughton Island and Little Broughton Island offshore are part of the Ramsar site. The site includes approximately 30% of the catchment surrounding the lakes, which includes significant terrestrial habitats and extends through hills to the west to approximately 30 km inland from the coastline.



Figure 1 Corrie Island and confluence of Myall River with Port Stephens

Because of the extensive waterways, dune systems and beaches, Myall Lakes Ramsar site is one of the most frequently visited national parks in NSW. It is within a comparatively short distance of a number of population centres and offers a range of recreational opportunities.

The ecology of the Myall lakes is complex and poorly understood. The limits of our understanding consist of observations and inferences from correlated patterns of distribution. However, the physiochemical water characteristics and the distributions of macrophytes and algae have been described in some detail (Dasey et al. 2004).

Prior to European settlement the lakes would probably have all been mostly clear water, with low nutrient and chlorophyll concentrations and dominated by benthic macrophytes. The types of macrophytes would have differed among the lakes due to exposure to salinity (Dasey et al. 2004; DECC 2007a).

It is assumed that, prior to European disturbance of the system, macrophytes in Myall Lake and Boolambayte Lake would have been similar, with seasonally fluctuating dominance between annual macrophytes such as charophytes (algae from the Characeae family, mainly *Chara fibrosa* and *Nitella hyalina*) and *Najas*; Two Mile Lake and Bombah Broadwater would have had fewer *Najas* and tended to be dominated by charophytes and the perennial seagrass *Ruppia* (Sainty and Jacobs 1981, 2003).

The macrophyte beds form an important resource for macroinvertebrate, avian and fish fauna in the lakes. The annual macrophytes which dominate the Myall lakes vegetation are also thought to be the major source of material for gyttja, which is a key feature and is believed to have a considerable influence on the presence and distribution of many other biota.

The associated fringing wetlands are much more strongly associated with terrestrial flora, and consist largely of low-lying lands which are inundated when lake levels rise due to tidal forcing during spring tides, high flows from the catchment or increased groundwater levels. The perched dune wetlands of The Moors and other unnamed systems form in the interdune swales along the eastern margin of the Ramsar site, and are influenced by groundwater and partly by sea levels (Peter Myerscough 2010, pers. comm.). They are also dominated by terrestrial vegetation and would be used by a range of avian and amphibian fauna.

Intertidal wetlands consist of unconsolidated tidal flats composed of sands and muds, usually backed by mangroves and saltmarsh. These areas provide important foraging for resident and migratory shorebirds. The open ocean beaches and dunes also provide extensive inter- and supratidal habitat for resident and migratory shorebirds. The terrestrial forests in the hills and dunes surrounding the wetlands provide habitat for a wide range of biota, including many threatened species, and are a natural buffer around the lakes.

The marine coast has some rocky headlands and extensive dunes and open beaches, which are used by many migratory birds and other shorebirds, including threatened species such as the little tern. The offshore islands have some beach and rocky intertidal habitat, as well as the supratidal regions of the islands. They are influenced primarily by prevailing weather, the existing vegetation on the islands and the surrounding marine waters.

2.2 Location and regional context

The centre of Myall Lakes Ramsar site is approximately 75 km north-east of Newcastle and 30 km south of Forster on the lower north coast of NSW, between the coastal sand barrier and the hills around the township of Bulahdelah. The site is largely contained within the catchment of Myall River, whose tributaries are the Crawford River, Boolambayte Creek and Nerong Creek, with a small area of the site in the estuarine part of the Karuah River catchment (Figure 12). The Ramsar site is located in the South East Coast Drainage Division, and the lakes and estuarine parts of the site are in the Manning Shelf Bioregion under the Interim Marine and Coastal Regionalisation of Australia (Environment Australia 1998).

The prevailing climate is warm and temperate with a maritime influence. Summers are warm to hot and humid, winters are cool to mild. Rainfall is typical of a temperate coastal region.

The site covers 44,612 ha and is in terrestrial and marine conservation reserves. It contains the only remaining example of a large coastal brackish lake system on the NSW coast that has not been greatly modified by human activity. Figure 2 shows the boundaries of Myall Lakes Ramsar site.

Although the site is protected in national parks, nature reserves and a marine park, 70% of the surrounding catchment is freehold land and state forest (Figure 3). Land use in the catchment greatly influences water quality in the lakes system and potentially threatens the ecological character of the site.

The catchment plays a critical role in maintaining the water quality of the Ramsar site, in particular the lakes system. The Myall lakes catchment has a total area of 780 km², with approximately 30% protected in Myall Lakes National Park, 18% managed for timber production in state forests and 52% freehold land (comprising a variety of agricultural and urban land use). The dominant land use in the catchment is summarised in Table 2 (Figure 4).

The largest subcatchment, which comprises 47% of the total catchment area, drains via the Myall and Crawford rivers and flows into Bombah Broadwater (Figure 12). While much of this subcatchment is forested, it has large areas of mostly extensive agriculture, urban areas at Bulahdelah and Nerong and, at the time of listing, had some intensive agricultural practices (dairy and poultry) (Figure 4).

The next largest subcatchment drains into Boolambayte Lake via Boolambayte Creek, and is also predominantly forested with significant areas of agricultural land (beef grazing) in the low lying areas of the subcatchment. The smaller subcatchments around the periphery of Myall Lake are forested with the exception of the Shinglers Creek catchment and the urban area at Bungwahl. Other inputs of water into the lakes are from direct rainfall and groundwater drainage from the sand mass on the eastern shore.

Table 2 Land use in the Myall lakes catchment

Land use ¹	Area (ha)	Catchment area (%)
Conservation	49,203	31.5
Forestry	29,912	19.2
Grazing	18,246	11.7
Residential – rural residential, rural living	2,321	1.5
Transport (i.e. roads) ²	876	0.6
Marsh/wetland (on private land)	591	0.4
Residential – urban	396	0.2
Plantation ²	144	<0.1
Intensive animal production ²	30	<0.1
Cropping ²	8	<0.1
Other minimal use ³	54,299	34.8
Total	156,026	100

Adapted from Bureau of Rural Sciences (2006)

1 Land use is classified according to the Australian Land Use and Management (ALUM) classification (Bureau of Rural Sciences 2006).

2 Areas of catchment occupied by land use such as roads, intensive animal production (e.g. poultry) and cropping are too small or too dispersed to be shown in Figure 4.

3 This includes large areas of private land covered by native vegetation, and areas classified as 'rehabilitation' (approximately 1712 ha).

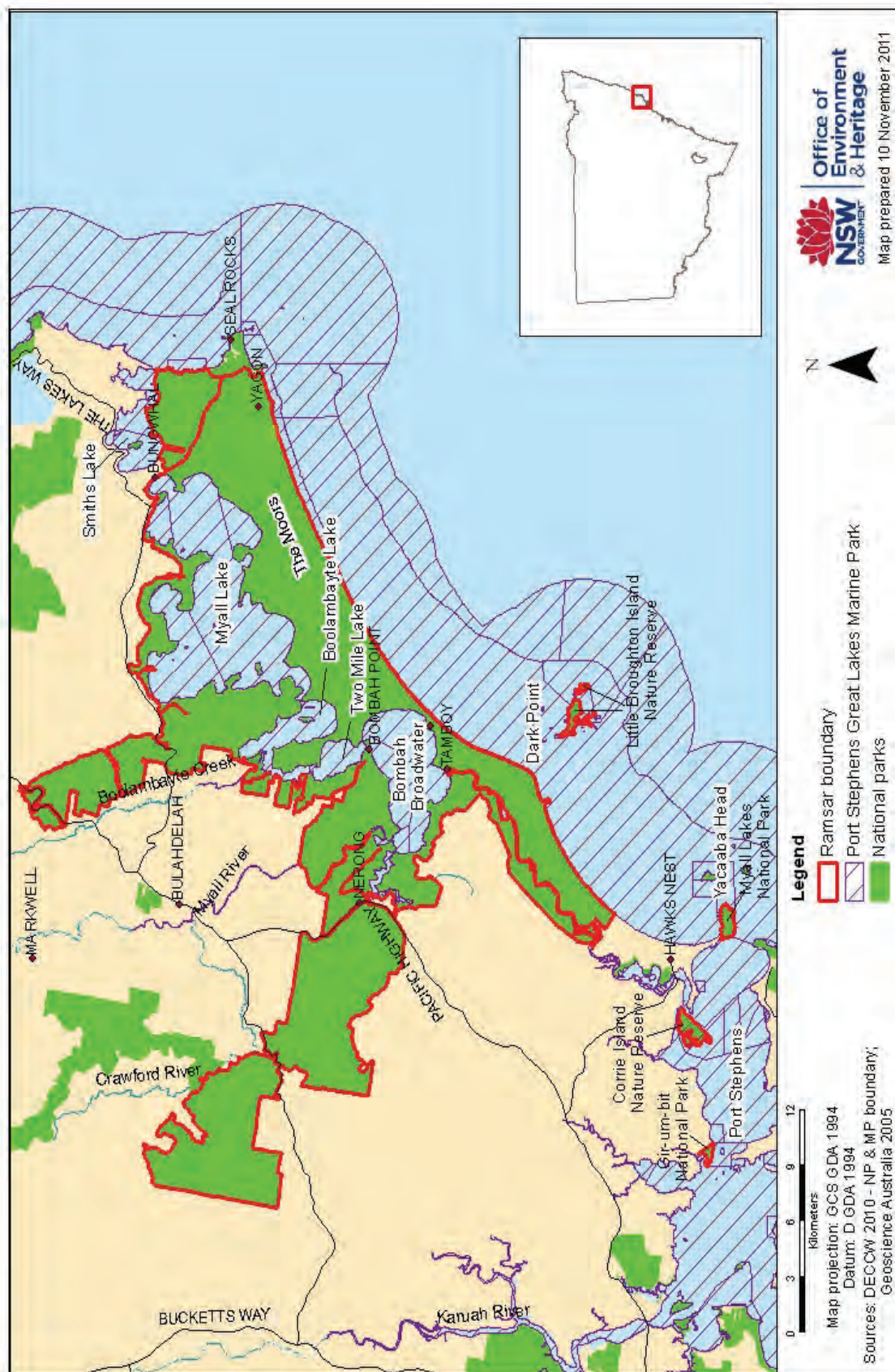
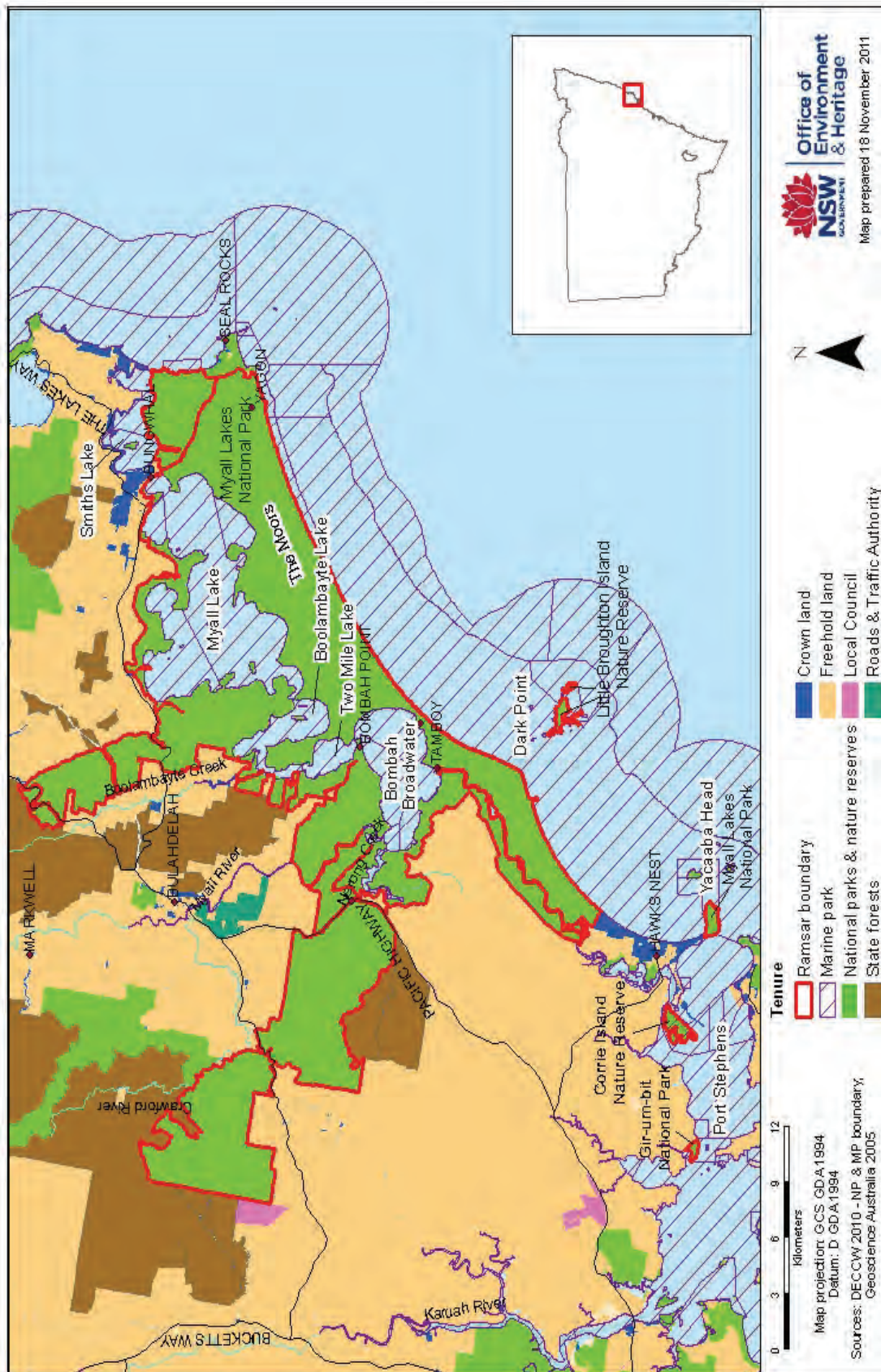


Figure 2 Myall Lakes Ramsar site boundary



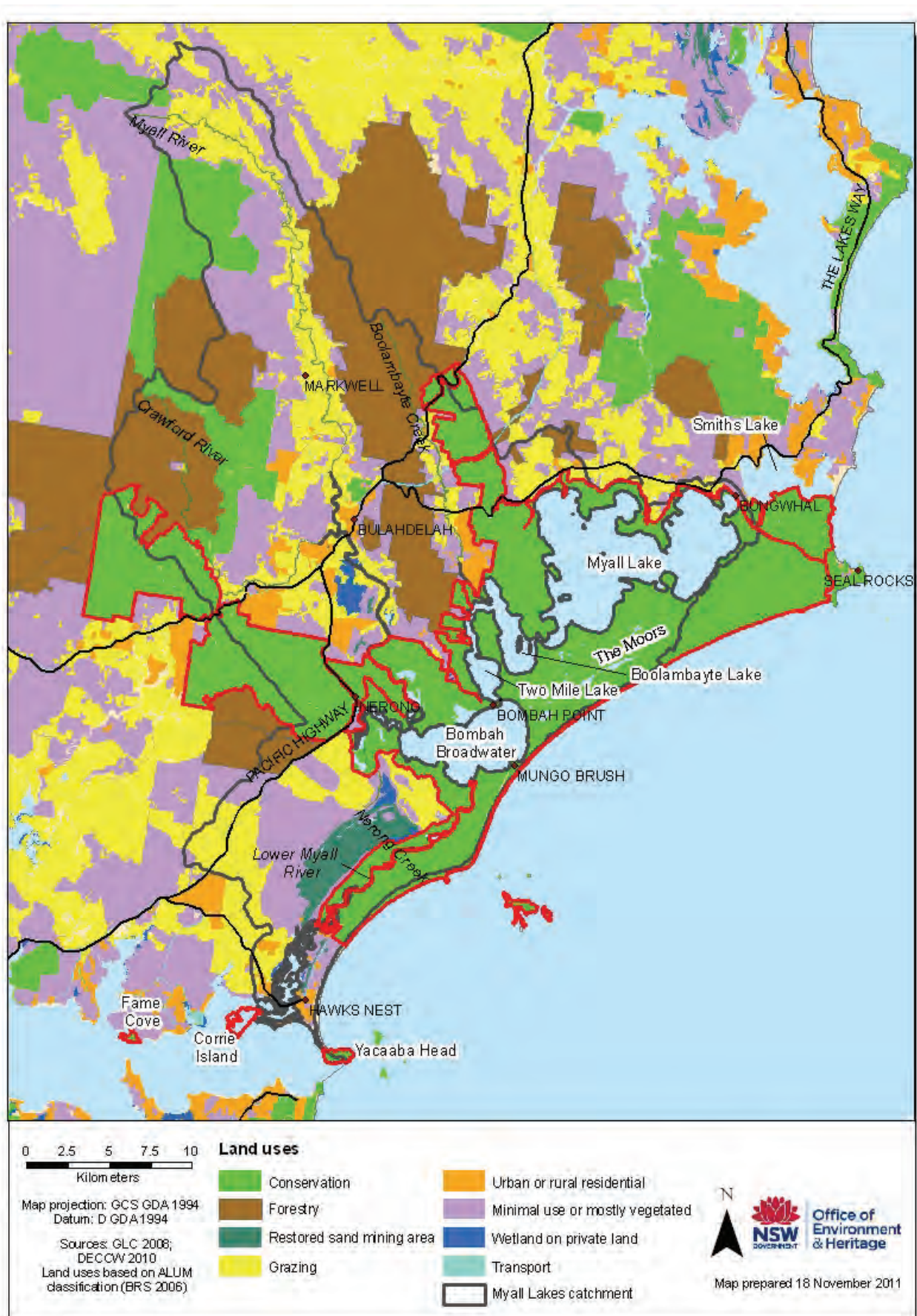


Figure 4 Major land use in the Myall lakes catchment

2.3 Land tenure

Myall Lakes Ramsar site is comprised of national park (Myall Lakes National Park and part of Gir-um-bit National Park) and nature reserve (Little Broughton Island Nature Reserve and Corrie Island Nature Reserve), which are protected under the NPW Act and managed by OEH. The waterways of the Ramsar site are included within the Port Stephens – Great Lakes Marine Park, protected under the Marine Parks Act.

2.4 Ramsar criteria

Myall Lakes Ramsar site was listed as meeting the pre-1999 Ramsar criteria 1a, 1c, 2a and 3b (equating to the current Ramsar criteria 1, 2 and 3):

- Criteria 1a and 1c: criteria for representative, natural or near-natural wetlands, and for a wetland which plays a substantial hydrological, biological or ecological role in ecosystem functioning
- Criterion 2a: general criterion based on plants or animals, including rare and threatened species
- Criterion 3b: specific criterion for a wetland supporting substantial numbers of waterfowl from particular groups.

The current criteria met by the Ramsar site are described below.

Criterion 1: A wetland should be considered internationally important if it contains a representative, rare, or unique example of a natural or near-natural wetland type found within the appropriate biogeographic region.

The Myall lakes are a relatively unmodified large coastal brackish lake system. The main streams flowing into the lakes (Myall River and Boolambayte Creek) are free of dams and mostly free of weirs. Consequently the water level changes in the lakes are considered to be close to natural and represent a rare example of near-natural flow regimes in the South East Coast Drainage Division. The coastal wetland types in the Ramsar site are representative of near-natural wetlands in the Manning Shelf Bioregion, and include marine subtidal aquatic beds, intertidal marshes, and intertidal forested wetlands (mangroves). The range of wetlands, combined with the adjoining near-natural terrestrial ecosystem, provides a complex variety of habitats and a rich biodiversity.

The Myall lakes are significant because they:

- represent a unique association of at least 18 Ramsar wetland types, ranging from fresh to marine waters, with the entire association covering an extensive area with minimal structural and hydrological disturbance, and supporting ecosystems and processes in near-natural condition
- are one of the two largest brackish–freshwater barrier estuaries in the South East Coast Drainage Division, and are an excellent, near-natural representative example of this wetland type in the bioregion
- contain a unique co-existence of deep and shallow water macrophytes and gyttja.

The site met Criterion 1 at the time of listing and continues to do so.

Criterion 2: A wetland should be considered internationally important if it supports vulnerable, endangered, or critically endangered species or threatened ecological communities.

Myall Lakes Ramsar site supports five wetland-dependent species which are listed as nationally threatened under the EPBC Act, or listed as internationally threatened in the IUCN Red List of Threatened Species (IUCN 2010). They are:

- Australasian bittern (*Botaurus poiciloptilus*): endangered, EPBC Act; IUCN Red List
- Freycinet's frog (*Litoria freycineti*): vulnerable, IUCN Red List
- green and golden bell frog (*Litoria aurea*): vulnerable, EPBC Act; IUCN Red List
- green-thighed frog (*Litoria brevipalmata*): endangered, IUCN Red List
- stuttering frog (*Mixophyes balbus*): vulnerable, EPBC Act.

Australasian bittern (*Botaurus poiciloptilus*)

The Australasian bittern prefers wetlands with dense vegetation, including sedges, rushes and reeds. This species generally prefers freshwater wetlands, although it also uses dense saltmarsh vegetation in estuaries and flooded grasslands (DECC 2006).

This species was originally recorded in the Ramsar site between 1977 and 1980 (Atlas of NSW Wildlife). It is now occasionally seen in the Ramsar site and is listed as endangered under the EPBC Act and in the IUCN Red List.

Freycinet's frog (*Litoria freycineti*)

Freycinet's frog is found in heaths, paperbark swamps and forest habitats in coastal areas from central NSW to south-eastern Queensland (Cogger 2000).

There are 23 records of Freycinet's frog in the Ramsar site between 1974 and 2008 (Atlas of NSW Wildlife). It is listed as vulnerable in the IUCN Red List.

Green and golden bell frog (*Litoria aurea*)

The green and golden bell frog lives in large, permanent, open-water swamps or ponds that have a variable water level and dense vegetation, bulrushes (*Typha* spp.) or spikerushes (*Eleocharis* spp.) (DECC 2006).

There are several populations of the green and golden bell frog in the Ramsar site: at Mungo Brush, on The Moors, on Broughton Island, and at Neranie Bay in Myall Lake (Susanne Callaghan 2010, pers. comm.). The population on Broughton Island is believed to be free of chytrid fungus affecting populations of the species on the mainland (Susanne Callaghan 2010, pers. comm.). It is listed as vulnerable under both the EPBC Act and in the IUCN Red List.

Green-thighed frog (*Litoria brevipalmata*)

The green-thighed frog occurs in a range of habitats from rainforest and moist eucalypt forest to dry eucalypt forest and heath, typically in areas where surface water gathers after rain (DECC 2006). It is found in isolated localities along the coast and ranges from just north of Wollongong to south-east Queensland (DECC 2006; Cogger 2000).

There are eight records of the green-thighed frog from the Ramsar site between 1995 and 1996 (Atlas of NSW Wildlife). It is listed as endangered in the IUCN Red List.

Stuttering frog (*Mixophyes balbus*)

The stuttering frog is found in rainforest and wet, tall open forest in the foothills and escarpment on the eastern side of the Great Dividing Range from southern Queensland to north-eastern Victoria. It breeds in streams during summer after heavy rain, and lays its eggs on rock shelves or shallow riffles in small, flowing streams (DECC 2006).

Between 1993 and 2001 there were nine recorded sightings of the stuttering frog in the Ramsar site; however, there is no data to estimate the population size and habitat extent (Atlas of NSW Wildlife). It is listed as vulnerable under the EPBC Act.

The site met Criterion 2 at the time of listing and continues to do so.

Criterion 3: A wetland should be considered internationally important if it supports populations of plant and/or animal species important for maintaining the biological diversity of a particular biogeographic region.

The Ramsar site's large area (44,612 ha) supports a rich biodiversity and contains a range of undisturbed terrestrial vegetation communities and wetland types. As a consequence it supports a diversity of terrestrial plants and animals in the South East Coast Drainage Division and aquatic plants and animals in the Manning Shelf Bioregion.

Many groups of bird species are represented in the Ramsar site, such as pelicans (Pelicanidae), cormorants (Phalacrocoracidae), grebes (Podicipedidae), swans and ducks (Anatidae), herons, egrets, bitterns, ibises and spoonbills (Ciconiiformes), plovers and lapwings (Charadriidae), and wetlands-related raptors (Accipitridae and Falconidae).

The site provides a wide range of intertidal habitats for shorebirds, including coastal mudflats, sandy beaches, saltmarshes, brackish marshes, mangroves and swamp forests, as roosting, nesting, breeding, and feeding sites (Lane 1987). The site is important as habitat for migratory birds, with 22 species listed in international agreements (JAMBA, CAMBA and ROKAMBA) recorded in the site (Table 13); these species include the little tern (*Sterna albifrons*), sooty shearwater (*Puffinus griseus*), short-tailed shearwater (*P. tenuirostris*) and wedge-tailed shearwater (*P. pacificus*).

The site's vegetation is particularly diverse, with 946 species of terrestrial flora, two mangrove species and 10 species of submerged aquatic flora, and 10 saltmarsh species expected to occur in the site (Williams et al. 2006; Kelleway et al. 2007; R. Williams 2008, pers. comm.). The terrestrial species occur in a wide range of vegetation communities, from rainforest and wet sclerophyll vegetation to heathland and sand dune vegetation.

There is also a diversity of animal species, with 298 bird, 46 mammal, 44 fish, 37 reptile and 29 amphibian species recorded in the Ramsar site (Atlas of NSW Wildlife) (Appendices 1–4). Many of the site's animals are found in a wide range of wetland types, including estuarine waters, intertidal forested wetlands, coastal freshwater lagoons, permanent rivers, streams or creeks, freshwater tree dominated wetlands, and shrub-dominated wetlands.

The site met Criterion 3 at the time of listing and continues to do so.

2.5 Wetland types

Myall Lakes Ramsar site has 18 different wetland types as defined by the Ramsar Convention classification system. These wetlands are a mosaic of fresh to brackish and saline habitats interconnected across time (driven by hydrology) and space (determined by geomorphology).

Because of the large number of wetland types in Myall Lakes Ramsar site, the wetlands have been grouped (on the basis of similar functions) in this ECD (Table 3). The locations of the wetland groups are shown in Figure 5.

Table 3 Wetland types and groups

Ramsar wetland type*	Ramsar code	Wetland group
Permanent shallow marine waters	A	Group 1: Marine coast
Marine subtidal aquatic beds	B	
Rocky marine shores	D	
Sand, shingle or pebble shores	E	
Estuarine waters	F	Group 2: Mangroves and intertidal flats
Intertidal mud or sand flats	G	
Intertidal marshes	H	
Intertidal forested wetlands	I	
Coastal brackish/saline lagoons	J	Group 3: Brackish waters
Coastal freshwater lagoons	K	
Permanent rivers/streams/creeks	M	Group 4: Rivers, creeks and streams
Seasonal/Intermittent rivers/streams/creeks	N	
Permanent freshwater marshes/pools	T _p	Group 5: Freshwater and fringing wetlands
Seasonal/Intermittent freshwater marshes/pools	T _s	
Shrub dominated wetlands	W	
Freshwater tree dominated wetlands	X _f	

* Ramsar wetland classification system (DEWHA 2010)

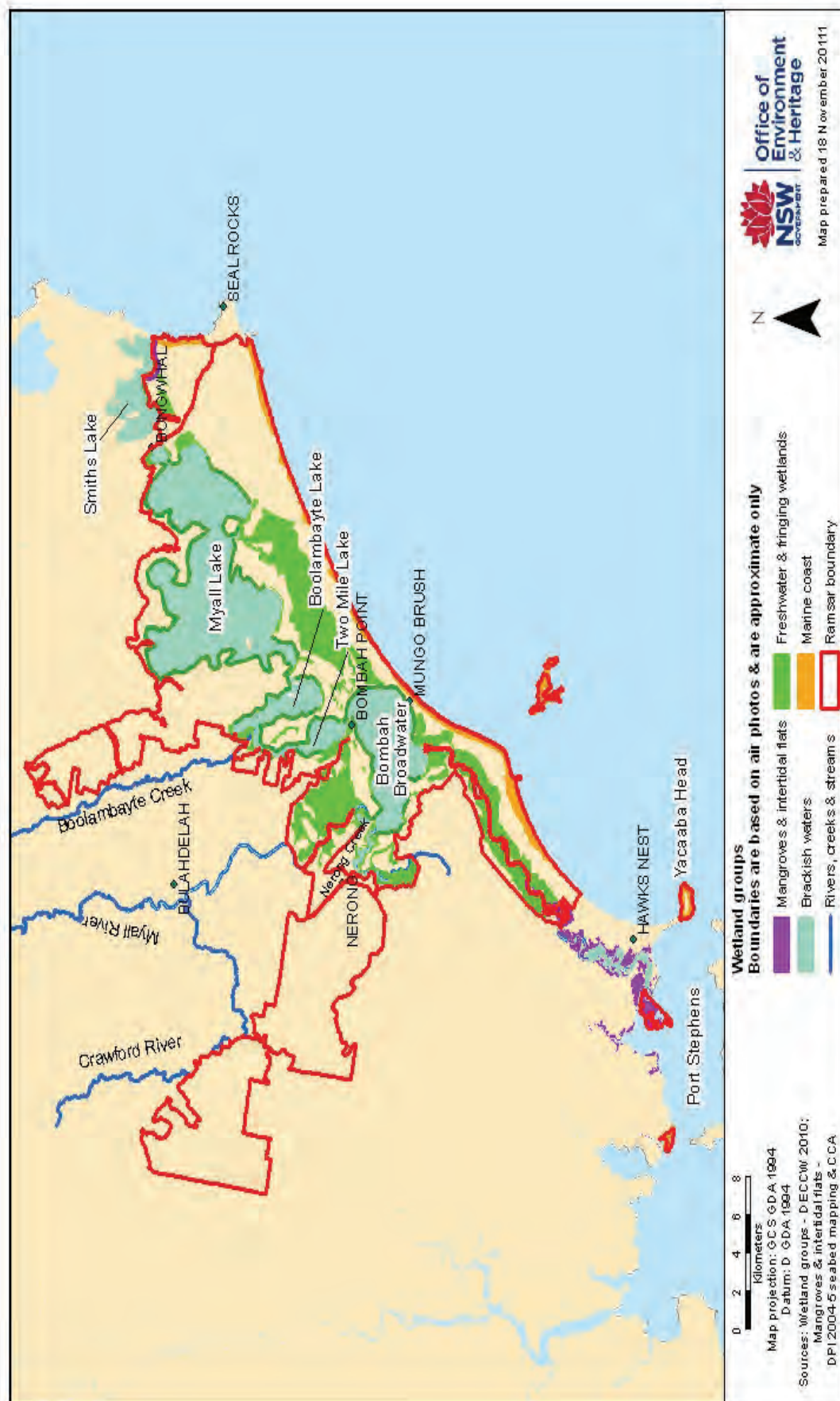


Figure 5 Wetland groups

A brief description of each wetland group is provided below, along with their respective estimated areas and locations in the Ramsar site. A short summary of the ecosystem components, processes and services associated with each wetland group is also provided. Further information on the components and processes can be found in section 3. Ecosystem services are discussed in section 4. Threats to each wetland group are also listed and discussed in section 8.

- **Group 1: Marine coast**

Ramsar wetland types: A, B, D, E

Where found: Port Stephens, Fame Cove, Corrie Island, Little Broughton Island, Yacaaba Head, Broughton Island, Myall coastline and beaches (Figure 6)

Estimated area: 730 ha

Description: Permanent shallow waters associated with Fame Cove and Corrie Island; seagrass beds of the Myall River and Bombah Broadwater; rocky shores associated with the Myall coastline, Yacaaba Head and Broughton and Little Broughton islands; sandy shores including beaches, dunes and Corrie Island

Ecological components and processes: Rocky and sandy shores; nationally threatened species; shorebirds

Services supported: Physical habitat and biodiversity; nationally threatened species; shoreline stabilisation and protection; fisheries production; recreation and tourism; cultural heritage

Threats: Loss of habitat and changed vegetation types due to clearing, disturbance by human intrusion, predation and competition by introduced species



G Mason

Figure 6 Wetland type group 1: marine coast – Yagon Gibber Headland and Treachery Beach

- **Group 2: Mangroves and intertidal flats**

Ramsar wetland types: F, G, H, I, B

Where found: Corrie Island, Smiths Lake shoreline, lower Myall River, Fame Cove (Figure 7)

Estimated area: 200 ha

Description: Intertidal sand and mudflats at Corrie Island and Smiths Lake; mangroves and saltmarsh in the lower Myall River and Fame Cove

Ecological components and processes: Intertidal mudflats and sandflats, saltmarsh, forested swamp (mangroves) and seagrass beds; migratory shorebirds; tidal flushing; salinity regime



P Scanes

Figure 7 Wetland type group 2: mangroves and intertidal flats

Services supported: Physical habitat and biodiversity; nationally threatened species; priority wetland species; ecological connectivity; shoreline stabilisation and protection; fisheries production; maintenance of fishery productivity

Threats: Loss of habitat; changed vegetation types due to clearing, disturbance by human intrusion, predation and competition by introduced species

- **Group 3: Brackish waters**

Ramsar wetland types: J, K

Where found: Bombah Broadwater, Two Mile Lake, Boolambayte Lake and Myall Lake (Figure 8)

Estimated area: 10,300 ha

Description: Large relatively undisturbed brackish to freshwater lake system connected to the sea by the lower Myall River via Port Stephens. Includes Myall Lake, Boolambayte Lake, Two Mile Lake and Bombah Broadwater. Located in embayment between hills to the west and coastal dune system to the east.

Ecological components and processes: Submerged and emergent aquatic vegetation; waterbird habitat and drought refuge; oligotrophic clear water; maintenance of hydrological processes and nutrient cycling; habitat for fish, macroinvertebrates, plankton and gyttja.

Services supported: Hydrological processes; physical habitat and biodiversity; primary production and food webs; nationally threatened species; ecological connectivity; natural or near-natural wetland ecosystems; maintenance of hydrological regimes; fisheries production; recreation and tourism.

Threats: Loss of habitat and changed vegetation types due to increased loads of nutrients and sediments from catchment clearing, algal blooms, disturbance by human intrusion, predation and competition by introduced species, changed lake levels from changed rainfall patterns, climate change and sea level rise.

- **Group 4: Rivers, creeks and streams**

Ramsar wetland types: M, N

Where found: Myall River, Boolambayte Creek, upper catchment (Figure 9)

Estimated area: 500 ha

Description: Myall River, Boolambayte Creek, Nerong Creek and their tributaries (permanent and ephemeral creeks and streams).



G Mason

Figure 8 Wetland type group 3: brackish waters – Neranie Headland and Myall Lake

Ecological components and processes: Wet sclerophyll, she-oak and paperbark forests; habitat for amphibians and freshwater fish (freshwater parts of upper Myall River and Boolambayte Creek); seagrasses; habitat for euryhaline and estuarine fish species (brackish parts of lower Myall River).

Services supported: Hydrological processes; physical habitat and biodiversity; habitat for nationally threatened wetland species; ecological connectivity; maintenance of hydrological regimes.

Threats: Loss of riparian vegetation and changed in-stream vegetation types due to clearing, algal blooms, disturbance by human intrusion, predation and competition by introduced species, changed flow patterns from changed rainfall patterns, climate change and sea level rise.

- **Group 5: Freshwater and fringing wetlands**

Ramsar wetland types: K, W, X_{fr}, T_{pr}, T_{sr}, 7, 9

Where found: The Moors; extensive wetlands adjoining lakes system; between upper Myall River and northern shore of Bombah Broadwater; along both sides of the lower Myall River downstream of Bombah Broadwater (Figures 9, 10, 11)

Estimated area: 6000 ha

Description: The Moors – coastal heath swamps occupying low-lying areas in the Eurunderee sand mass; coastal swamp forests dominated by paperbarks and swamp mahogany and by casuarinas along the lake margins.

Ecological components and processes: Emergent vegetation; *Melaleuca-Casuarina* fringe forest, wet heath forest, swamp forest and coastal heath swamps.

Services supported: Hydrological processes; habitat and biodiversity; gyttja; nationally threatened wetland species; ecological connectivity; natural or near-natural wetland ecosystems; maintenance of hydrological regimes; recreation and tourism.

Threats: Loss of habitat and changed vegetation types due to clearing, disturbance by human intrusion, predation and competition by introduced species, changed water levels from changed rainfall patterns, climate change and sea level rise.



S Thompson

Figure 9 Wetland type group 4: rivers, creeks and streams – Myall River (top right) and wetland type group 5: freshwater and fringing wetlands (centre)



F Miller

Figure 10 Wetland type group 5: freshwater and fringing wetlands – The Moors



F Miller

Figure 11 Wetland type group 5: freshwater and fringing wetlands – Bombah Broadwater

2.6 Terrestrial ecosystems

Myall Lakes Ramsar site also contains a wide variety of terrestrial habitats which comprise over 60% of the site's area and contribute to its ecological value.

Keith (2004) identified 11 terrestrial vegetation formations that are expected to occur in Myall Lakes Ramsar site. The exact locations of these formations have not yet been mapped. Each vegetation formation will have an associated faunal community.

The vegetation formations indicated by Keith (2004) are three classes of dry sclerophyll forest, coastal valley grassy woodlands, maritime grasslands, two classes of heath, two classes of rainforest and two classes of wet sclerophyll forest.

The terrestrial ecosystems provide an important buffer around the wetlands and a vegetation corridor that connects to Smiths Lake and Wallis Lake to the north of the Ramsar site.