

Information Sheet on Ramsar Wetlands

Categories approved by Recommendation 4.7 of the Conference of the Contracting Parties.

1. Date this sheet was completed/updated:

October 2002

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Designation date

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Site Reference Number

2. Country:

Australia

3. Name of wetland:

NSW Central Murray State Forests

4. Geographical coordinates:

	<i>Latitude</i>	<i>Longitude</i>
Millewa Unit	35°49'03"	144°58'00"
Werai Unit	35°19'28"	144°31'44"
Koondrook Unit	35°43'50"	144°20'04"

5. Altitude:

78–96m AHD (west-east)

6. Area:

84,028 hectares

7. Overview:

The site plays a substantial role in the functioning of the River Murray, is critically important for the retention of native biodiversity in the Riverina bioregion, and contains significant social, cultural and economic resources. It has been managed under multiple use principles including forestry for almost 150 years, making it one of the longest continuously managed natural resources in Australia.

8. Wetland Type:

marine-coastal:	A	B	C	D	E	F	G	H	I	J	K
inland:	L	M	N	O	P	Q	R	Sp	Ss	Tp	Ts
	U	Va	Vt	W	Xf	Xp	Y	Zg	Zk		
man-made:	1	2	3	4	5	6	7	8	9		

Please rank these wetland types by listing from the most to the least dominant:

Xf, Ts, P, N

9. Ramsar Criteria:

1	2	3	4	5	6	7	8
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Please specify the most significant criterion applicable to the site:

Criterion 1

10. Map of site included? Please tick **yes** ✓ -or- **no**.

See Appendix 1.

11. Name and address of the compiler(s) of this form:

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12. Justification of the criteria selected under point 9, on previous page.

Criterion 1: Contains a representative, rare, or unique example of a natural or near-natural wetland type found within the biogeographic region.

The NSW Central Murray State Forests, together with the listed Ramsar wetlands in Victoria (Barmah and Gunbower forests), form the largest complex of tree-dominated floodplain wetlands in southern Australia. The site contains wetland types that are rare within the Riverina bioregion, particularly types *P* (floodplain lake) and *Ts* (floodplain meadows and reed swamps).

The site plays a substantial role in the functioning of the Murray River, particularly in terms of hydrology (flood mitigation), water quality (sediment deposition) and river health (carbon flux and sources of invertebrate inoculum).

These wetlands provide an area of comparatively high water availability and habitat productivity in a semi-arid rainfall zone, owing to the occurrence of regular surface inundation and replenishment of groundwater systems derived from flooding of the River Murray. Their biophysical, environmental and vegetation attributes also largely defines the essential character of the Riverina bioregion.

Criterion 2: Supports vulnerable, endangered, or critically endangered species or threatened ecological communities.

The site provides a habitat network for at least eight globally threatened fauna listed by the World Conservation Union (IUCN 2000). The Australasian Bittern (*Botaurus poiciloptilus*), Superb Parrot (*Polytelis swainsonii*), Silver Perch (*Bidyanus bidyanus*) and Flat-headed Galaxias (*Galaxias rostrata*) are listed as 'vulnerable', and the Regent Honeyeater (*Xanthomyza phrygia*), Swift Parrot (*Lathamus discolor*), Murray Hardyhead (*Craterocephalus fluvialilis*) and Trout Cod (*Maccullochella macquariensis*) are listed as 'endangered' on the IUCN Red List (2000). A number of these species have also been afforded protection under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Under the EPBC Act the Superb Parrot and the Murray Hardyhead are listed as vulnerable and the Swift Parrot, Regent Honeyeater and Trout Cod are listed as endangered.

The site is also known to contain Swamp Wallaby Grass (*Amphibromus fluitans*), which is threatened nationally and is listed as vulnerable under the EPBC Act.

The Central Murray State Forests are ecologically linked through an unbroken riparian corridor along the Murray and Edward Rivers. They are in high

ecological condition and provide arboreal and wetland habitat in landscapes extensively cleared of trees and developed for agriculture. As such, the site contributes significantly to the conservation of globally and nationally threatened species. The site is immediately adjacent to other wetlands included in the Ramsar List of Wetlands of International Importance (Barmah Forest and Gunbower Forest in Victoria) and thus further enhances the viability of threatened flora and fauna species that occur at these Ramsar sites.

Criterion 4: Supports plant and/or animal species at a critical stage in their life cycles, or provides refuge during adverse conditions.

The site provides refuge for mobile and sedentary fauna during environmentally stressful periods. It also provides sources of migrants capable of dispersing into less productive areas during favourable conditions, as it is an area of comparatively high water availability and habitat productivity in a semi-arid rainfall zone.

The site provides a habitat network for 13 species listed in migratory bird agreements between Australia, and Japan (JAMBA) and China (CAMBA). These species are Painted Snipe (*Rostratula benghalensis*), Great Egret (*Ardea alba*), Cattle Egret (*Ardea ibis*), Sharp-tailed Sandpiper (*Calidris acuminata*), Greenshank (*Tringa nebularia*), Marsh Sandpiper (*Tringa stagnatilis*), Latham's Snipe (*Gallinago hardwickii*), White-throated Needletail (*Hirundapus caudacutus*), Forked-tailed Swift (*Apus pacificus*), Glossy Ibis (*Plegadis falcinellus*), Caspian Tern (*Hydropogone caspia*), Red-necked Stint (*Calidris ruficollis*) and White-bellied Sea-Eagle (*Haliaeetus leucogaster*) (see Appendix 2).

Criterion 5: Regularly supports 20,000 or more waterbirds.

The site, together with the adjacent existing Ramsar sites in Victoria (Barmah Forest and Gunbower Forest), regularly supports more than 20,000 waterbirds (eg. Mattingley 1908, Barrett 1931, Chesterfield *et al.* 1984, Maher 1993, Leslie and Ward in press).

In 2000/01, there were 5508 pairs of 13 species of waterbirds recorded in Millewa Forest and greater than 10,000 pairs of ibis (two species) recorded in Barmah Forest. That is 31,000 adult birds plus at least 62,000 young (93,000 birds in total) for 2000/01. This figure does not include waterfowl or solitary nesters such as White-faced Herons. The total waterbird census for 2000/01 for Barmah-Millewa would have exceeded 100,000 individuals (D. Leslie pers. comm.).

Waterbird breeding in the Barmah-Millewa Forest was recorded 32 times during 1905 to 1997, and at the 1994 level of water development is predicted to occur four times each decade on average (Leslie 2001). In 1998 and 2000 environmental flows were used to extend the duration of natural floods. The reinstatement of the natural flow regime has resulted in tremendous responses in the regeneration of vegetation and bird breeding, with some bird species coming back after a 30-year absence (Leslie and Ward 2002).

Criterion 8: An important source of food for fishes, spawning ground, nursery and/or migration path on which fish stocks, either within the wetland or elsewhere, depend.

The site, when inundated with floodwater, provides a cue for fish migration and enhances the ability of native fish to spawn and recruit. Tagged fish have been recorded moving large distances from the site (up to 300 km upstream and 900 km downstream), which is indicative of pre- and post-spawning behaviour (McKinnon 1997).

13. General location:

The site is composed of three discrete but interrelated units in south-central New South Wales, Australia (Appendix 1). The distance (and bearing) from the municipality of Deniliquin to the centres of each of these units is 33km (S) for the Millewa Unit, 46km (NW) for the Weraï Unit, and 62km (WSW) for the Koondrook Unit. The municipality has an administrative area of 13,000 hectares and a population of 8,100.

14. Physical features:

Geology and geomorphology: The site is situated within the Riverina Plain, which is the depositional environment formed by a network of prior streams, ancestral streams and modern rivers that have been active over the past 65 million years. The geology consists of Quaternary fluvial and aeolian sediments that contain a high proportion of silts and clays. The Plain remains an aggrading depositional feature but the rate has diminished since the middle Pleistocene Epoch, when uplifts and erosion of the headwater area of the Murray River climaxed. Phases of erosion have also taken place in geological time, corresponding to climatic changes associated with glacial oscillations in the northern hemisphere. Uplift of the Cadell Fault between 30,000 and 13,000 years BP had a major influence on the landscape and ecological development of the area. The scarp extends approximately 60 kilometres north-south between Deniliquin and Echuca, and is downthrown 5–15 metres to the east. It was responsible for the deflection of the Murray River northwards along the present course of the Edward River (Bowler 1978, Barberis 1983).

Origins: The site owes its existence to the tectonic, climatic, aeolian, fluvial and lacustrine activities that have taken place during the Quaternary Period.

Hydrology: The Murray River is the principal river in the Murray-Darling Basin, Australia (Appendix 1). Rainfall and runoff is generally low and erratic in the basin, producing a mean annual discharge of only 10,090 gigalitres (GL; 10⁹ litres) in 1894–1993 (Walker *et al.* 1995). Two large reservoirs located in the Murray catchment above Albury provide a secure water supply for agriculture; Dartmouth Dam (commissioned 1979; capacity 4000 GL) and Hume Reservoir (1936; 3040 GL). Yarrowonga Weir (1939; 120 GL) and Torrumbarry Weir (1924: 38GL) on the Murray River, and Stevens Weir (1935; 9GL) on the Edward River, enable water to be diverted by gravity into channels supplying irrigation areas in Victoria and New South Wales (Jacobs 1990). The site is fed by anabranch systems originating from the Murray River, including the Edward River and Gulpa Creek. The existence of the

dominant wetland type (floodplain forest) depends on floodwater contributions to the soil water balance, as rainfall alone is not sufficient to sustain a forest structure (Bacon *et al.* 1993 a, b).

Soil type and chemistry: Surface soils generally range from coarse to very fine alluvia. Deep profiles show stratified layers varying from fine clays to coarse sands and gravels, reflecting changes to the discharge and bedload of streams through geological time.

Water quality: Most physico-chemical parameters for the Murray River downstream of Yarrawonga are deemed acceptable for slightly disturbed lowland rivers in south-east Australia. The 90th percentile values for electrical conductivity, pH and turbidity (77 μ S/cm, 7.7 pH units and 27 NTU respectively) do not exceed ANZECC (2000) trigger values. However, the median value for total nitrogen (0.56 mg/L) and the 90th percentile for total phosphorus (0.09 mg/L) exceed the ANZECC (2000) trigger values.

Depth, fluctuations and permanence of water: The site is for the most part an ephemeral wetland, with permanent water restricted to rivers and deeper oxbow lagoons and channels within the floodplain. The water regime is predominantly governed by the flow regime of the Murray River. (NB. A distinction is made between flow regime and water regime, as water regime variables such as depth can be manipulated by non-flow options). Depth of inundation is highly variable according to topographic position, peak discharge and flood duration but is generally within the range 0.5–1.5 metres. Under natural flow conditions, periods of inundation of 3–6 months duration generally occurred 6–8 times each decade between June and December.

Tidal variations: There are no tidal variations.

Catchment area: The area of the Murray Catchment is 35,170 square kilometres.

Downstream area: The Lower River Murray floodplain is located downstream of the site, which includes other Ramsar listed wetlands (Hattah-Kulkyne Lakes, The Coorong and Lakes Alexandrina and Albert).

Climate: The climate at Deniliquin is semi-arid, with hot summers (January mean daily maximum 32.5°C) and cool winters (July mean daily minimum 3.4°C). Mean annual rainfall is 408mm, with mean winter and summer rainfall totals of 113mm and 85mm respectively (Bureau of Meteorology 2002).

15. Hydrological values:

Floods mobilise River Red Gum litter in the form of particulate and dissolved organic carbon into the riverine food web (Glazebrook and Robertson 1999). Linkages between the site and adjacent river channels during flood also provide a storage capacity of between 400 to 550 GL. The heavy clay soils of the floodplain are largely impermeable, and soil saturation during flood is largely achieved through extensive deep cracks that develop in upper soil profile in summer. Groundwater, where present within nine metres of the surface, is generally restricted to confined aquifer systems that are believed to be connected to the main river systems. Localised groundwater recharge also occurs during floods from exposed lens surfaces (FCNSW 1987). The modern rate of floodplain sedimentation is in the order of 7 mm/10 years compared to the assumed long-term background rate of 3 mm/10 years (Kenyon 2001).

16. Ecological features:

The site plays a substantial role in biodiversity retention in the Riverina bioregion as it contains high quality wetland habitats and a significant proportion of the species adapted to lowland river and floodplain environments in the Murray-Darling Basin (see Appendices 3 and 4).

The site contains three broad vegetation types that provide a wide variety of ecosystem services and habitats for fauna:

(1) Riparian herblands: Grasses, rushes, sedges and forbs dominate the lowest portions of the floodplain that are devoid of trees. Most herbland species also occur throughout the riverine forests as they tolerate a wide range of water regimes. However, zonation patterns are generally evident with changes in species dominance sometimes occurring over distances as short as two metres. A common transition in species dominance from wet to increasingly dry environments is Water Ribbons (*Triglochin dubium*), Giant Rush (*Juncus ingens*), Moira Grass (*Pseudoraphis spinescens*) to Common Spike-rush (*Eleocharis acuta*). The composition, structure and distribution of the herblands have been altered by past livestock grazing practices, river regulation, suppression of wildfire and cessation of Aboriginal burning practices since the 1850s. While this broad vegetation type is relatively free of introduced plant species, the invasive Arrowhead (*Sagittaria graminea*) has an expanding distribution. Living and detrital biomass in the herblands provides energy and substrate for benthic and littoral aquatic invertebrates that are prey for fish. The herblands also provide nesting and feeding habitat for waterbirds, including the Australasian Bittern (*Botaurus poiciloptilus*) which is considered vulnerable globally (IUCN 2000).

(2) Riverine forest and woodland: River Red Gum (*Eucalyptus camaldulensis*) is the dominant floodplain tree species. Its distribution, regenerative capacity, size potential and growth form is related to the water regime, which in turn is governed by small changes in topographic relief. Water regime is also the major determinant of understorey composition, with Warrego Summer-grass (*Paspalidium jubiflorum*) and Terete Culm-sedge (*Carex tereticaulis*) being common ground flora in wetter and drier sites respectively. River Red Gum is absent from the lowest portions of the floodplain, attains its best development in areas that receive flooding of 3–6 months duration 6–8 times each decade, and is replaced by Black Box (*Eucalyptus largiflorens*) woodland on more highly elevated sites that are rarely flooded. The structure of River Red Gum stands has changed due to river regulation, timber harvesting and altered fire regimes. River regulation, livestock grazing and to a lesser extent altered fire regimes have also changed the understorey composition. The ground flora of drier sections of the floodplain have a higher proportion of introduced species, particularly annual herbs in the family Poaceae, than areas that receive more regular flooding. The shrub layer, where present, is generally restricted to Silver Wattle (*Acacia dealbata*) or Dwarf Cherry (*Exocarpus strictus*). Cavities occurring in the stem and branches of River Red Gum provide den and nest locations for arboreal mammals and birds, including waterfowl. Colonial and solitary nesting waterbirds, such as the Great Egret (*Ardea alba*) and White-faced Heron (*Ardea novaehollandiae*), also build stick nests in River Red Gum. Organic carbon, derived from River Red Gum litter, plays a major role in

wetland and riverine food webs.

(3) **Plains woodland:** Elevated areas within the site that very rarely or never flood contain a higher variety of tree species, including Grey Box (*Eucalyptus microcarpa*), Yellow Box (*Eucalyptus melliodora*), White Cypress Pine (*Callitris glaucophylla*), Murray Pine (*Callitris gracilis* subsp. *murrayensis*) and Bulloak (*Allocasuarina luehmannii*). Adjacent agricultural land has been substantially cleared of these species, and the remaining woodlands within the site generally have a disturbed understorey due to past livestock and rabbit grazing. The plains woodlands are assumed to be unimportant in terms of river health, as they do not form part of the floodplain. They are, however, highly significant in terms of providing refuge for terrestrial fauna during major floods, being representative of depleted or rare vegetation communities within the Riverina bioregion, and providing habitat for threatened woodland birds such as Gilberts Whistler (*Pachycephala inornata*) and Hooded Robin (*Melanodryas cucullata* subsp. *cucullata*).

The site is adjacent to Ramsar listed wetlands in Victoria (Barmah Forest and Gunbower Forest) and thus enhances the viability of at least 28 flora and fauna species that are listed under Victorian but not NSW threatened species legislation. It provides a habitat network for at least 27 fauna species listed under NSW threatened species legislation, and 38 fauna species listed under Victorian threatened species legislation (see Appendix 2).

The site has been recorded as containing or as likely to contain at least 21 (60%) of the 35 species of native freshwater fish species predicted to occur in the Murray-Darling Basin (Harris and Gehrke 1997, McKinnon 1997, Allen *et al.* 2002) (see Appendix 4) and more than 4000 aquatic invertebrate species. The site includes part of the aquatic community in the natural drainage system of the lower Murray River catchment, listed as an endangered ecological community under the NSW *Fisheries Management Act 1994*.

17. Noteworthy flora¹:

The site is known to contain one nationally threatened plant species, Swamp Wallaby Grass (*Amphibromus fluitans*) and a further seven plant species of conservation significance at a State level. These are Austral Pillwort (*Pilularia novae-hollandiae*), Boree (*Acacia pendula*), Common Joyweed (*Alternanthera nodiflora*), Emu-foot (*Cullen tenax*), Western Boobiella (*Myoporum montanum*), Sandalwood (*Santalum lanceolatum*) and Lilac Darling Pea (*Swainsona phacoides*) (see Appendix 2).

While there are no recognised endemic species, the site contains particularly good examples of riparian herblands, riverine forest and woodland, and plains woodland, owing to their size, condition, composition and connectivity. The site contains ancillary rare (Murray Pine woodland) and depleted (Grassy Box woodland) terrestrial vegetation communities. A comprehensive list of flora species occurring within the site is provided in Appendix 3.

18. Noteworthy fauna:

Eight globally threatened fauna species have been recorded within the site including Swift Parrot (*Lathamus discolor*), Regent Honeyeater (*Xanthomyza phrygia*), Australasian Bittern (*Botaurus poiciloptilus*), Superb Parrot (*Polytelis swainsonii*),

Trout Cod (*Maccullochella macquariensis*), Silver Perch (*Bidyanus bidyanus*), Murray Hardyhead (*Craterocephalus fluviatilis*) and Flathead Galaxias (*Galaxias rostrata*) (see Appendix 2). The Swift Parrot is also endangered nationally and the Superb Parrot is vulnerable nationally, as listed under the *Environment Protection and Biodiversity Conservation Act, 1999* (EPBC Act).

The site provides important breeding habitat for two of these threatened species, Australasian Bittern and Superb Parrot. The Australasian Bittern breeds in the riparian herblands when favourable spring floods occur. During 2000/01 flood, the site supported internationally significant numbers of this cryptic species (12 adult breeding birds, plus young). The Superb Parrot, which breeds annually within the Millewa Unit, has an estimated breeding population of 55–65 pairs. A further 51 species are of conservation significance at national and State levels or are listed migratory species (Appendix 2). A comprehensive list of fauna species occurring within the site is provided in Appendix 4.

The site holds a high proportion of the population of White-bellied Sea-eagles (*Haliaeetus leucogaster*) in the Riverina bioregion, a highly dispersed sedentary species of conservation concern (Clunie 1994). The Sea-eagle is a listed migratory species (EPBC Act) and is endangered in Victoria (*Flora and Fauna Guarantee Act, 1988*).

19. Social and cultural values:

The site is a major factor in the social and economic profiles of the rural townships of Koondrook (Victoria), Barham (NSW) and Mathoura (NSW). Current Aboriginal custodians are the Yota Yota Local Aboriginal Land Council (covering the Millewa Unit and the eastern portion of the Koondrook Unit) and the Deniliquin Local Aboriginal Land Council (covering the Weraï Unit and the western portion of the Koondrook Unit). Evidence of Aboriginal occupation includes scarred trees, burials, shell middens and oven mounds (Craib 1990, Lyons undated). Places of European significance that illustrate the phases of pastoral settlement, timber getting and river navigation are also located within the site.

The site is important for sustainable forestry as well as recreation and education. The site is currently used for timber harvesting, apiculture, fishing, bird watching and scientific study.

20. Land tenure/ownership:

(a) Site. The tenure of the site is Crown Land, which is dedicated as State Forest under the New South Wales *Forestry Act 1916* for the purposes of timber production and other matters in the public interest. The site is managed by the Forestry Commission of New South Wales, a corporation solely constituted under the *Forestry Act 1916*, trading as State Forests of New South Wales (SFNSW).

(b) Surrounding area. Tenure of the surrounding land is predominantly freehold title. Parcels of public land other than State forest also adjoin the site in New South Wales, which are managed by the NSW Department of Land and Water Conservation. The southern boundaries of the Millewa and Koondrook units form part of the State border, and mostly adjoin

public land managed by the Victorian Department of Natural Resources and Environment.

21. Current land use:

- (a) Site.** Current land uses within the site include recreation, timber harvesting, Aboriginal and European cultural heritage, biodiversity conservation, education, livestock grazing, water supply, flood mitigation, apiculture, fishing, scientific study and military exercise. Timber harvesting is the main commercial use. There is also commercial fishing of carp (*Cyprinus* spp.) and yabbies (*Cherax* spp.). There are no permanent human residences within the site.
- (b) Surroundings/catchment.** Irrigated and dryland cereal cropping and pastures are the main land uses surrounding the site. Other adjacent land uses include horticulture, private native forestry and residential development. The population in NSW local government areas immediately adjacent to the site (Deniliquin, Conargo/Windouran, Murray and Wakool) is around 20,000. The population in the NSW Murray catchment is around 110,000 (Singh 2000).

22. Factors (past, present or potential) adversely affecting the site's ecological character, including changes in land use and development projects:

- (a) Site.** Most European land uses have altered the ecological character of the site to a lesser or greater extent. The main factors that have existed in the past but have been substantially addressed include river regulation (external to the site), and water management, livestock grazing, forestry and fishing activities within the site. Aboriginal uses also undoubtedly had an impact on the ecological character of the site, but these influences are considered part of the natural (pre-European) landscape. The main factors that are ongoing and require further remedial attention include recreational activities, introduced flora and fauna species, native herbivore grazing pressure and altered fire regimes. Factors having the potential to develop in the future include rising groundwater levels and salinity, further introductions of non-indigenous flora and fauna, eutrophication and climate change. Floodplain sedimentation as a result of natural and anthropogenic inputs also has the capacity to significantly alter the ecological character of the site in the longer term.
- (b) Around the site.** The surrounding irrigation areas have a bearing on the water regime of the site and water quality entering the site due to ancillary development (river regulation, surface drainage schemes) and water ordering procedures (rain rejection flows). The high level of tree clearing in surrounding areas also means that the site shoulders much of the responsibility for biodiversity retention in the Riverina bioregion.

23. Conservation measures taken:

Environmental Management System: Management of the environmental, social and economic values of the site is outlined in the 1987 Management Plan for the Murray

Management Area (FCNSW 1987). As the delivery of integrated natural resource management has evolved rapidly at state and national levels in the past decade, tactical plans and actions that more closely reflect the aspirations of government and society have superseded many areas of the Plan. Examples of completed and ongoing conservation measures are summarised below.

Flow regime management: Modifications to the natural flow regime of the Murray River to provide a secure water supply have led to extensive vegetation changes and a reduction to the diversity and abundance of wetland fauna within the site (eg. Leslie 2001). Serious attempts to address these issues by reinstating a more natural flow regime commenced in 1990. Measures that have been undertaken include:

- (i) provision of an environmental water allocation of 100GL for the Barmah-Millewa Forest in 1993;
- (ii) release of the 100 GL for the Barmah-Millewa Forest in 1998;
- (iii) assessment of State water sharing arrangements, including protocols for the use of the 100 GL allocation, completed in Victoria (Murray Water Entitlement Committee 1997, 1999) and New South Wales (Murray Lower Darling Community Reference Committee 2002);
- (iv) release of 340 GL for the Barmah-Millewa Forest in 2000/01 (Barmah-Millewa Forum 2001); and
- (v) transfer of 25.5 GL from the Murray River to the Edward River for trial flooding of the Werai Unit in 2001 (Green 2001).

The final outcomes of many of these processes remain subject to negotiations between governments and community stakeholders.

Water regime management: Additional measures to reinstate a more natural water regime using non-flow (mostly civil engineering) options also commenced in 1990. Key developments include;

- (i) initiation of a research project investigating the effect of different water regimes on floodplain ecosystems in 1990 (Bacon *et al.* 1993 a, b; Robertson *et al.* 2001);
- (ii) preparation of water management plans for the Koondrook and Millewa units (Wyatt 1992, Leslie and Harris 1996); and
- (iii) preparation and implementation of rehabilitation plans for the Gulpa Creek, Moira Lake and Edward River wetlands (Lugg 1994, Leslie and Lugg 1994, Rodda and Leslie 1997).

A number of these projects have been driven by joint agency/community groups, including the NSW Murray Wetlands Working Group (formed in 1992) and the Barmah-Millewa Forum (1994).

Plains woodland rehabilitation: A rehabilitation program was initiated in 1992 to encourage tree and shrub regeneration in high conservation value woodlands adjoining the floodplain. Since that time, livestock grazing has been deferred from approximately 3,000 hectares, direct seeding using local provenance seed has occurred over 500 hectares and almost 6,000 tubestock seedlings have been planted. Low rabbit numbers are also being maintained through cooperative programs involving 1080 (sodium fluoroacetate) baiting, warren destruction, and release of myxomatosis (Type species *Myxoma virus*) and the rabbit calicivirus (Type species *Rabbit hemorrhagic disease virus*). A

strategic livestock grazing program was also implemented in 2001 (Leslie 2002).

Timber harvesting: Harvesting of sawlogs from the floodplain forests aims at achieving ecological sustainability. Progress towards achieving and demonstrating that aim is continuously reviewed. Recent conservation measures that have been incorporated into the planning and implementation of forest operations include:

- (i) establishment of biodiversity benchmarking and permanent monitoring sites;
- (ii) conducting targeted pre-logging surveys for threatened species;
- (iii) application of soil erosion mitigation guidelines;
- (iv) adoption of complete tree marking by experienced SFNSW personnel;
- (v) introduction of forest management intent zoning aligned to IUCN 'Protected Area' categories;
- (vi) cultural heritage surveys;
- (vii) application of prescriptions for threatened species conservation under licence arrangements with NSW National Parks and Wildlife Service (which includes provisions for such factors as habitat and recruit habitat tree retention);
- (viii) development of a River Red Gum Timber Industry Strategy that embraces the principle of ecologically sustainable forest management;
- (ix) adoption of silvicultural practices that integrate biodiversity and wood production objectives;
- (x) periodic inventory assessments and measurements of growth to re-calculate sustainable sawlog supply levels; and
- (xi) post-logging surveys to assess the adequacy of residual stocking, arboreal habitat and regeneration.

Threatened species and ecological community recovery: Changes to flow and water regime have been introduced to ameliorate threats to Superb Parrot nest trees and reinvigorate the breeding habitat of the Australasian Bittern. Altered livestock grazing practices and vegetation enhancement programs have also improved the habitat of the Superb Parrot and Gilberts Whistler. Inappropriate floodplain structures have been progressively removed or upgraded to facilitate fish passage.

Livestock grazing: A review of livestock grazing practices in State forests was undertaken during 1999-2000 in response to changing community attitude towards grazing on public land (Leslie 2002). The purpose of the review was to find innovative ways to integrate conservation and production objectives over large spatial scales. A community and scientific panel identified a tactical grazing system that represented a considerable change from the traditional practices of set stocking and continuous grazing. Other measures were recommended to remove the drivers for exploitative grazing, reward a custodial grazing ethic and recover the debt of past grazing practices. A major commitment to monitoring and research was also advocated to inform future management decisions.

Aboriginal participation in natural resource management: Ecological burns that aim to manage the distribution of Giant Rush at Moira Lake have included Aboriginal participants. SFNSW is also developing an indigenous plant nursery with the Yota Yota Local Aboriginal Land Council to provide tubestock for biodiversity enhancement projects within the site.

24. Conservation measures proposed but not yet implemented (at April 2002):

Environmental Management System: The Management Plan for the Murray Management Area is being replaced by a Regional Ecologically Sustainable Forest Management (ESFM) Plan as part of the Native Forest Management System (NFMS). The NFMS is a system developed by SFNSW to ensure that ecologically sustainable forest management practices are applied systematically, rigorously and consistently throughout the SFNSW native forest estate (SFNSW 2000). The NFMS is the system through which commitments made internationally (eg. Ramsar, the Montreal process), nationally (eg. the National Forest Policy Statement) and at a State level (eg. Catchment Management Blueprints) will be delivered and reported upon. The ESFM Plan will encompass 12 key topics: protected areas; forest values; social and economic development; sustainable timber supply; harvest planning and implementation; forest health; tourism and recreation; water and flow regimes; cultural heritage; other forest uses (eg. grazing, apiary, noxious and environmental weed and feral animal control, education); consultation, monitoring and reporting; and five year strategic overview.

Flow regime management: Water sharing arrangements being developed by the States of South Australia and Queensland, and a Murray-Darling Basin-wide environmental flow strategy being prepared by the Murray-Darling Basin Commission, may significantly influence the total volume of water available for environmental flows and the flow release decision rules.

Water regime management: Major civil engineering projects have been proposed to reinstate more natural water regimes to the Koondrook Unit and in the Moira Lake and Edward River wetlands. It is also proposed to more fully develop and implement water management plans for the Werai and Koondrook units.

25. Current scientific research and facilities:

Research, monitoring and investigation projects that are current (or have been recently completed but not published) include:

Organisation/individual	Project title
Murray-Darling Freshwater Research Centre	The effect of flow on lowland river productivity Billabong-river interactions during high flows
Arthur Rylah Institute for Environmental Research	Movement and habitat use of radio-tagged carp in the Murray River Targeting spawning habitats to control carp populations

Museum of Victoria	Impact of flow regulation structures on fish in the Barmah-Millewa Forest River Red Gum invertebrate biodiversity
Cooperative Research Centre for Freshwater Ecology	Impact of flooding on river metabolism Micro-invertebrate response to water regime changes in the Barmah-Moira Lakes
Charles Sturt University, James Cook University and State Forests of NSW	Domestic stock, grazing and riparian zones: research for best practice management of land and water in inland rivers
University of Wollongong and State Forests of NSW	Ground calibration of River Red Gum health associated with airborne video imagery
University of Melbourne	Preliminary palynological assessment of the Moira Lakes
Land Victoria	Digital elevation modelling of the Barmah-Millewa Forest
Theiss Environmental Services	Hydrographic monitoring of the Barmah-Millewa Forest
Paula Ward	Monitoring of frog response to flooding in the Barmah-Millewa Forest
Ecosurveys Pty Ltd and State Forests of NSW	Bushbird monitoring in the NSW Central Murray State Forests Waterbird monitoring in the NSW Central Murray State Forests
Sinclair Knight Merz	Assessment of options for improved management of rainfall rejection, river fresh and other discharges into the River Murray upstream of the Barmah-Millewa Choke

26. Current conservation education:

The site provides a focal point for environmental flow and wetland research and management issues in the Murray-Darling Basin. Publicly available information on these and other conservation-related topics is provided by agencies and community groups using various media, including posters, pamphlets, reports, CD-ROMS, internet, radio and television. The site is regularly used for education purposes by school groups, and was recently (2002) included in a youth forum on managing the Barmah-Millewa Forest. Interpretive walkways and a waterbird observatory established in the Millewa Unit also have significant conservation education components.

27. Current recreation and tourism:

A camping holiday on the shaded banks of a lowland river is a quintessential Australian experience, as it combines four icons of Australian folklore—the Murray River, River Red Gums, bush camping and Murray Cod (*Maccullochella peelii*). The high recreational and tourism values of the site largely stem from these associations, which are realised through the availability of public access to the Murray River. The forests provide an important backdrop to the river setting by establishing a sense of isolation in a semi-natural bushland environment. Nature study, and Aboriginal and European cultural heritage, are also important tourism attractions. Befitting the values for which the site is esteemed, there are no formal camping areas and few structured tourist attractions within the site.

28. Jurisdiction:

Territorial: Government of New South Wales
Functional: State Forests of NSW (land and vegetation)
NSW Department of Land and Water Conservation (water)
NSW Fisheries (fishery)

29. Management authority:

State Forests of NSW

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