

Information Sheet on Ramsar Wetlands (RIS) – 2009-2012 version

Categories approved by Recommendation 4.7 (1990), as amended by Resolution VIII.13 of the 8th Conference of the Contracting Parties (2002) and Resolutions IX.1 Annex B, IX.6, IX.21 and IX. 22 of the 9th Conference of the Contracting Parties (2005).

1. Name and address of the compiler of this form:

Roger Jaensch, Wetlands International - Oceania, on behalf of the Western Australian Department of Conservation & Land Management (DCLM), in 1998. Updated by DCLM staff in 2000 and 2003, and by Claire Farrell and Barbara Cook on behalf of Department of Environment and Conservation (DEC) in 2009.

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Designation date

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Site Reference Number

All inquiries should be directed to Michael Coote, DEC, 17 Dick Perry Avenue, Technology Park, Kensington, Western Australia 6983, (Tel: +61-8-9219-8714; Fax: +61-8-9219-8750; email: Michael.Coote@dec.wa.gov.au).

2. Date this sheet was completed/updated:

September 2009

3. Country:

Australia

4. Name of the Ramsar site:

Muir-Byenup System, Western Australia

5. Designation of new Ramsar site or update of existing site:

This RIS is for (tick one box only):

a) Designation of a new Ramsar site ; or

b) Updated information on an existing Ramsar site

6. For RIS updates only, changes to the site since its designation or earlier update:

a) Site boundary and area

The Ramsar site boundary and site area are unchanged:

or

If the site boundary has changed:

i) the boundary has been delineated more accurately ; or

ii) the boundary has been extended ; or

iii) the boundary has been restricted**

and/or

If the site area has changed:

- i) the area has been measured more accurately ; or
- ii) the area has been extended ; or
- iii) the area has been reduced**

** **Important note:** If the boundary and/or area of the designated site is being restricted/reduced, the Contracting Party should have followed the procedures established by the Conference of the Parties in the Annex to COP9 Resolution IX.6 and provided a report in line with paragraph 28 of that Annex, prior to the submission of an updated RIS.

b) Describe briefly any major changes to the ecological character of the Ramsar site, including in the application of the Criteria, since the previous RIS for the site:

- A ninth Ramsar Criterion was added in 2005 after the 9th Meeting of the Conference of the Contracting Parties. During the preparation of the ECD an assessment of the Muir-Byenup System Ramsar site against each of the nine Ramsar Criteria was undertaken. The justification for each criterion has been revised and two new criteria (1 and 3) have been added.
- Since listing in 2001 there have been a number of changes to the Byenup Lagoon System, within the Ramsar site. The changes relate to aquatic invertebrate communities composition, distribution of some fish species and condition of fringing vegetation. These changes may be due to increased salinity levels, however, as mean annual salinity has not been statistically different over the long term (1978-2008) the changes may be within natural variation. It should be noted that these changes may also be a result of sampling effort and further investigation is required.

7. Map of site:

a) A map of the site, with clearly delineated boundaries, is included as:

- i) a **hard copy** (required for inclusion of site in the Ramsar List): ✓
- ii) an **electronic format** (e.g. a JPEG or ArcView image) ✓;
- iii) a **GIS file providing geo-referenced site boundary vectors and attribute tables** ✓.

b) Describe briefly the type of boundary delineation applied:

The boundary of the Ramsar site includes part of the Lake Muir Nature Reserve 31880, which is vested in the Conservation Commission of Western Australia and managed by the Department of Environment and Conservation.

The boundary of the Ramsar site includes the parts of Nature Reserve 31880 that is the part of lot 13201 of plan 240193 south of Muirs Highway's southern road reserve boundary and includes all of lots 12567, 12988, 13200, 13202 of plan 240193, lot 12561 of plan 208115, lots 12566 and 12568 of plan 211868, lot 12991 of plan 175123 and lot 13065 of plan 210271.

The parts of Nature Reserve 31880 excluded from the Ramsar site on the western shore are lot 2237 of plan 128508 and lot 9247 of plan 140779 and lot 12694 of plan 208995 on the northern boundary of Muirs Highway road reserve. Also excluded from the Ramsar site are road reserves PIN 11624987, 11585969, 11733346, 11624444, 11624443, 11733347 and 11733348.

8. Geographical coordinates (latitude/longitude, in degrees and minutes):

Latitude: 34° 26' S to 34° 32' S

Longitude: 116° 43' E to 116° 49' E

9. General location:

The Muir-Byenup System Ramsar site is located primarily in the Shire of Manjimup and to a lesser extent the Shire of Cranbrook (local authorities) in the State of Western Australia (population ca. 1.9 million). Lake Muir is 55 km east-south-east of the town of Manjimup (population ca. 4,300).

The Ramsar site comprises the area of Nature Reserve 31880 south of Muirs Highway. Named wetlands in the Ramsar site include Lake Muir, Byenup Lagoon, Tordit-Gurup Lagoon, Poorginup Swamp, Neeranup Swamp, Coorinup Swamp and Wimbilup Swamp. Freehold land and gazetted road reserves enclosed by the Ramsar site boundary are not part of the Ramsar site.

10. Elevation: (in metres: average and/or maximum & minimum)

Average 170-180 metres Australian Height Datum

11. Area: (in hectares)

10,631 ha (of which approximately 7,000 ha is wetland).

12. General overview of the site:

The Ramsar site comprises a suite of partly inter-connected lakes and swamps of varied size (up to 4,600 ha), salinity (saline to fresh), permanence (permanent to seasonal) and substrate (peat and inorganic), in an internally-draining catchment. The peat based wetlands are rare in Western Australia (Department of Environment and Conservation 2008). The open lakes are used for moulting by thousands of Australian Shelduck (*Tadorna tadornoides*) and for drought refuge by tens of thousands of other waterbirds. The sedge/shrub dominated swamps support an important population of Australasian Bittern (*Botaurus poiciloptilus*) and threatened orchids (*Caladenia harringtoniae*, *Caladenia christineae* and *Diuris drummondii*). Key fauna at the Ramsar site includes, six of the eight endemic south-western Australian freshwater fish species and 32 endemic macroinvertebrate species. Vegetation communities of the wet flats are among the few remaining in non-coastal parts of south-western Australia and the Ramsar site has some of the largest natural sedgeland in Western Australia. The vegetation of the Ramsar site is highly diverse; a total of 649 indigenous flora have been recorded in Nature Reserve 31880, with at least 600 within the Ramsar site (Gibson and Keighery 1999).

13. Ramsar Criteria:

Tick the box under each Criterion applied to the designation of the Ramsar site. See Annex II of the *Explanatory Notes and Guidelines* for the Criteria and guidelines for their application (adopted by Resolution VII.11). All Criteria which apply should be ticked.

1 • 2 • 3 • 4 • 5 • 6 • 7 • 8 • 9
 ✓ ✓ ✓ ✓ ✓ ✓

14. Justification for the application of each Criterion listed in 13 above:

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.

Justification: The Ramsar site is an excellent example of a wetland complex in a relatively undisturbed condition in the South-West Coast Australian Drainage Division (Environment Australia 2001). The peat based wetlands within the site are rare in Western Australia (Department of Environment and Conservation 2008; Environment Australia 2001) and they are also recognised as the most outstanding example in south-western Australia (Wetland Research and Management 2005).

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

Justification: The Ramsar site supports a number of species listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Populations of three wetland dependent orchids *Caladenia christineae*, *Caladenia harringtoniae* and Tall Donkey Orchid (*Diuris drummondii*) occur on the margins of Lake Muir and elsewhere in the Ramsar site. These orchids are listed as Vulnerable under the EPBC Act and inhabit seasonally inundated areas or wetland margins.

The Ramsar site supports the freshwater fish species Balston's Pygmy Perch (*Nannatherina balstoni*), which is listed as Vulnerable under the EPBC Act. The Ramsar site also supports the Australasian Bittern (*Botaurus poiciloptilus*), which is listed as Endangered under the IUCN Red List. In Western Australia, the Australasian Bittern population is now much restricted, with the largest concentration thought to occur within the Ramsar site (IUCN 2008).

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.

Justification: Peat and primary saline wetlands at the site support endemic species and populations of plant and animal species important for maintaining the biodiversity of the South-West Coast Australian Drainage Division.

The site includes 21 'priority taxa' listed by the Western Australian Department of Environment and Conservation (DEC), including endemic plant taxa *Eryngium* sp. Lake Muir and *Tribonanthes* sp. Lake Muir. *Astartea* sp. Lake Muir is also endemic to the site. The majority of the population of *Wurmbea* sp. Cranbrook also occurs at the Ramsar site.

The Muir-Byenup System Ramsar site supports six of the eight endemic south-western Australian freshwater fish species including; the Western Pygmy Perch (*Edelia vittata*), Balston's Pygmy Perch (*Nannatherina balstoni*), Nightfish (*Bostockia porosa*), Western Minnow (*Galaxias occidentalis*), Black-striped Minnow (*Galaxiella nigrostriata*) and Mud Minnow (*Galaxiella munda*). The Ramsar site also supports a number of important macroinvertebrate taxa, including 32 endemic taxa (Storey 1998).

Criterion 4: A wetland should be considered internationally important if it supports plant and animal species at a critical stage in their life cycles, or provides refuge during adverse conditions.

Justification: The Muir-Byenup System Ramsar site supports thousands of Australian Shelducks (*Tadorna tadornoides*) during their moulting phase. The Ramsar site supports breeding of Little Bittern (*Ixobrychus minutus*), Spotless Crake (*Porzana tabuensis*), Australasian Bittern, Black Swan (*Cygnus atratus*) and Eurasian Coot (*Fulica atra*). The Ramsar site is also used as a drought refuge by tens of thousands of waterbirds and supports 10 species identified under international migratory agreements (CAMBA, JAMBA, ROKAMBA, and CMS).

Criterion 5: A wetland should be considered internationally important if it regularly supports 20,000 or more waterbirds.

Justification: Up to 52,000 waterbirds (1989) have been counted at Lake Muir during periods of high water levels. Although there is no comprehensive data available on waterbird numbers since 1989, it is likely that the Ramsar site is still capable of regularly supporting more than 20,000 waterbirds as there has been no major change in water depth or salinity. Annual data on water depth, over a 25 year period, suggests that conditions were suitable for use by 20,000 waterbirds at least several times over this period.

Criterion 6: A wetland should be considered internationally important if it regularly supports 1% of the individuals in a population of one species or sub-species of waterbird.

Justification: The Ramsar site supports at least five, and possibly up to 10, Australasian Bitterns, which exceeds the 1% population thresholds for south-western Australia (Wetlands International 2006). Although, no comprehensive counts have been made since 1991, there has been no major change in water quality or wetland vegetation at the site, suggesting that conditions remain suitable to support 1% of the south-western Australian population. The site also contains the core component of a wider suite of wetlands that constitutes one of the five remaining refuges for the south-western Australian population of Australasian Bitterns.

15. Biogeography (required when Criteria 1 and/or 3 and /or certain applications of Criterion 2 are applied to the designation):

a) biogeographic region:

South-West Coast Australian Drainage Division

b) biogeographic regionalisation scheme:

Australian Drainage Divisions, National Land & Water Resources Audit (Commonwealth of Australia 2000)

16. Physical features of the site:

The Muir-Byenup System Ramsar site contains an unusual complex of wetland types and includes: Lake Muir (4,600 ha); and the Byenup Lagoon System, comprising of smaller lakes and swamps (notably Byenup Lagoon, Tordit-Gurrup Lagoon and Poorginup Swamp: each 140-690 ha) and inter-connected flats, all of which are natural wetlands. Lake Muir and most of the other wetlands are terminal drainage basins.

Lake Muir is seasonal, often dry in autumn (dry for 9 out of 10 years between 1998-2008) with the maximum depth recorded since 1978 at 1.3 m. Lake Muir is a naturally saline wetland and acts as a shallow evaporating basin.

Byenup Lagoon is permanent with the maximum depth recorded at 2.6 m. Some of the other wetlands are permanent or near-permanent, though peaty Poorginup Swamp usually shows little or no surface water, and the minor swamps and broad flats are inundated or waterlogged only in winter and spring. Poorginup Swamp is fresh and the other wetlands range from brackish to saline, with increased salinity in summer. Byenup Lagoon, Tordit-Gurrup Lagoon and Poorginup Swamp are peat swamps, formed by climatic conditions, very slow water movement and a shallow lake basin, and strongly influence water quality and provide a very effective filter and buffering capacity (Department of Environment and Conservation 2008). Poorginup Swamp is acidic and the other wetlands have a pH ranging from 7-9.

17. Physical features of the catchment area:

The Ramsar site overlies the Proterozoic Albany-Fraser Orogen, in alluvial/lacustrine deposits and peat (peat to 4 m thick) overlying granite and gneiss, in broadly undulating country. The broad plain on which most of the wetlands occur has had a complex geological history. The area has been subject to several

marine incursions while most of the soils are of Tertiary or Quaternary age and represent infilling of blocked paleodrainage systems (Chakravartula and Street, 1999).

Water is derived from a surface catchment that covers about 38,400 ha, mainly from minor seasonal streams up to about 5 km long. Lake Muir is a major sink for groundwater and surface water in the region (Smith 2003). Very infrequent overflow from Lake Muir drains southwest through swamps into the Deep River (Smith 2003). Inflow surface water is channelled into Lake Muir from the north and east. From the north, water enters via artificial channels, associated with peat mining activities (Department of Conservation and Land Management 2003), which run beyond Red Lake through Coverup Swamp (Smith 2003). On the eastern side of Lake Muir inflow enters at Mulgarnup Bridge fed by the Mulgarnup Swamp complex (Smith 2003).

Flows into the Mulgarnup Swamp complex, from under the Muirs Highway, originate from three distinct sources; Pindicup Creek, Decampo Creek and Noobijup Creek (Smith 2003). The Mulgarnup Swamp complex is also fed by Byenup Lagoon, which overflows to the north annually when full (Smith 2003), although Mulgarnup Swamp itself is bypassed (R. Hearn, pers. com.). Byenup Lagoon is fed by average to wet years overflow from southern Tordit-Gurup Lagoon and Neeranup Swamp (Smith 2003).

Substantial parts of the surface catchments of most of the wetlands are cleared. Little is known on the interactions between the shallow and deep groundwater systems in the area and the interaction of these with the surface water systems, hence the potential for impacts on conservation values of the wetlands.

18. Hydrological values:

Surface water area and depth of wetlands in south-west Western Australia varies seasonally, with water levels rising in winter and spring and falling in summer and autumn (Lane and Munro 1982). Depending on rainfall, evaporation and groundwater connectivity, wetlands in the catchment of the Ramsar site are either; permanent or ephemeral, naturally fresh, naturally saline or seasonally alternating (Smith 2003). These wetlands can belong to groundwater systems overlying poorly conductive clays or they may be 'windows' to deeper regional aquifers, depending on their position in the landscape (Smith 2003).

The Ramsar site possibly contributes to the maintenance of groundwater in surrounding areas, however little is known on the interactions between shallow and deep groundwater systems and groundwater interactions with surface water systems (Department of Conservation and Land Management 2003). Smith (2003) suggested that due to permeable lake floor sediments and/or large areal extent, Muir-Byenup lakes were likely to have groundwater flow-through regimes, although some could exhibit seasonal discharge or recharge regimes.

19. Wetland Types

a) presence:

Circle or underline the applicable codes for the wetland types of the Ramsar "Classification System for Wetland Type" present in the Ramsar site. Descriptions of each wetland type code are provided in Annex I of the *Explanatory Notes & Guidelines*.

Marine/coastal: A • B • C • D • E • F • G • H • I • J • K • Zk(a)

Inland: L • M • N • Q • P • Q • R • Sp • Ss • Tp • Ts • U • Va •
Vt • W • Xf • Xp • Y • Zg • Zk(b)

Human-made: 1 • 2 • 3 • 4 • 5 • 6 • 7 • 8 • 9 • Zk(c)

b) dominance:

List the wetland types identified in a) above in order of their dominance (by area) in the Ramsar site, starting with the wetland type with the largest area.

R, U, O, Ts, Tp, W, Xf

20. General ecological features:

The Muir-Byenup System Ramsar site is floristically diverse; a total of 649 indigenous flora taxa have been recorded in Nature Reserve 31880, with at least 600 species within the Ramsar site (Gibson and Keighery 1999). This diversity is probably due to complexes of soil types and hydrological patterns, which are found over short distances and are reflected in vegetation patterning (Gibson and Keighery 1999). Structural vegetation mapping showed a complex mosaic of almost 30 vegetation types within the Ramsar site (Gibson & Keighery, 1999; Gibson and Keighery, 2000).

Lake Muir supports a narrow zone of open-scrub, sedgeland and low shrubland. The dominant low shrubs are the samphires *Sarcocornia quinqueflora* and *Tecticornia lepidosperma*, the wetland scrub is dominated by the tall shrubs *Melaleuca viminea* and *M. cuticularis* and there is some *M. rhabdophylla*. Other wetland plants near the lake margins include *Lepidosperma effusum*, *Gabnia trifida*, *Schoenus submicrostachyus* and *Wilsonia backhousei*.

Most of the other lakes and swamps support extensive sedgeland and fringing or scattered areas of low closed-forest or closed-scrub, while open-heathland over open-sedgeland occurs on the wet flats. Major areas of sedgeland are dominated by *Baumea articulata*; commonly associated species are *Baumea* spp. and *Triglochin huegii*, and at Poorginup Swamp *Meeboldina scariosa*, *B. vaginalis* and *Gabnia trifida* also occur. The dominant wetland tree is *Melaleuca rhabdophylla*. *Melaleuca lateritia* and *Astartea leptophylla*, and *Taxandria juniperina* occur in some wetlands. (Halse *et al.* 1993; Lane *et al.* 1996; N. Gibson pers. com.).

The Ramsar site provides important breeding habitat for waterbirds and is also used as a drought refuge. The Ramsar site is considered a centre of endemism as it supports six of the eight endemic south-western Australian freshwater fish species and a number of important endemic macroinvertebrate taxa.

21. Noteworthy flora:

Three species of wetland-dependent orchids *Caladenia christineae*, *Caladenia barringtoniae* and *Diuris drummondii* occur at the margins of Lake Muir and elsewhere in the Ramsar site (Halse *et al.* 1993; Lane *et al.* 1996, R. Hearn pers. com.). These species are listed as Vulnerable under the EPBC Act. 21 other species listed by DEC as priority taxa have also been recorded within the Ramsar site including, *Styloidium rhipidium*, *Wurmbea* sp. Cranbrook and *Eryngium* sp. Lake Muir.

22. Noteworthy fauna:

49 waterbird species have been recorded within the Ramsar site and 10 of these species are listed under international migratory bird agreements. Up to 52,000 waterbirds were recorded on Lake Muir in March 1989 and the most abundant species were Pacific Black Duck (*Anas superciliosa*), Grey Teal (*Anas gracilis*) and Eurasian Coot. Lake Muir is a migration stop-over site for small numbers of shorebirds, notably Red-necked Stint (*Calidris ruficollis*). The Ramsar site supports breeding of Little Bittern, Spotless Crake, Australian Bittern, Black Swan and Eurasian Coot. The Ramsar site is regularly used in spring by thousands of Australian Shelduck during their moulting phase – the site is considered one of the most important moulting sites for Australian Shelduck in south Western Australia.

Sedge dominated wetlands provide important habitat for Australasian Bitterns (Department of Conservation of Land Management 2003) which are listed as Endangered at the global level under the IUCN Red List (2008). Possibly ten Australasian Bitterns, are supported by these wetlands, and behaviour suggests that breeding occurs at the site (Department of Conservation of Land Management 2003). The latest south-western population estimate for the Australasian Bittern is 500 birds (Wetlands International 2006), therefore the Ramsar site exceeds the 1% population threshold for this species. The

Muir-Byenup System Ramsar site is one of the five remaining refuges for the south-western Australian population of Australasian Bitterns.

Fish surveys undertaken in 1996/97 indicate that the Ramsar site supports six of the eight endemic south-western Australian freshwater species including; Western Pygmy Perch, Balston's Pygmy Perch, Nightfish, Western Minnow, Black-stripe Minnow, and the Mud Minnow (Storey 1998). Balston's Pygmy Perch is listed as Vulnerable under the EPBC Act, and Black-stripe Minnow and Mud Minnow are listed as Lower Risk/near threatened on the IUCN Red List. Of the wetlands surveyed (Byenup Lagoon, Tordit-Gurru Lagoon, Mulgarnup Swamp, Geordinup Swamp and Poorginup Swamp), Poorginup Swamp had the greatest number (five) of native species. Mulgarnup Swamp recorded four native species. The two least frequently encountered native species, Black-stripe Minnow and Mud Minnow, were found only at Poorginup Swamp and one other wetland outside the site. All six fish species occurred within the Ramsar site; no species were restricted to it.

Additional surveys in 2003/04 found temporal changes in fish communities, including the absence of several species, since sampling in 1996/97 (Wetland Research and Management 2005). The fish species not recorded in the 2003/04 sampling in the Byenup Lagoon System included; Western Pygmy Perch, Balston's Pygmy Perch, Nightfish and Western Minnow from Mulgarnup Swamp, and Nightfish from Byenup Lagoon (Wetland Research and Management 2005). These changes may be a result of sampling effort or seasonality and may not be permanent, as Balston's Pygmy Perch and Nightfish were again observed within the Ramsar site at Myalgelup Swamp in 2008 (R. Hearn, pers. com.).

A survey of macroinvertebrates by DeHaan (1987) recorded 103 invertebrate taxa in the suite comprising Tordit-Gurru Lagoon, Byenup Lagoon and Poorginup Swamp. These included 11 watermites Hydracarina, six of which (found at Poorginup Swamp) have restricted distributions (e.g. *Pseudohydrphantes doegi*, *Acerella poorginup*) and are of considerable zoogeographic interest. One species, *Huitfeldtia* sp. nov., is the second known species in its genus, the other species occurs in northern Europe and Canada. The crustaceans *Cherax preissii* and *C. quinquecarinatus* also occur at the site.

Storey (1998) surveyed the macroinvertebrate communities of eight wetlands within the Ramsar site in 1996/97 and recorded 32 taxa endemic to south-western Australia. Poorginup Swamp had the greatest number (16) of south-western Australian endemics. Two new species of dytiscid water beetle *Sternopriscus* sp. nov. and *Antiporus pennifolidae* (*Antiporus* Sp. 1 of Storey, 1998) were recorded.

Preliminary identification of macroinvertebrates collected during the 1996/97 survey has revealed a rich and diverse fauna (Storey 1998). At least 78 species of ostracods and copepods were recorded. Of these, six ostracods and one cyclopoid copepod are, to date, only known from the Muir-Unicup area, with two of the ostracods and the cyclopoid being found within the Ramsar site (S. Halse pers. com.). Within the Rotifera there were 11 new records for Western Australia, one new record for Australia and one new species, yet to be described. Within the Cladocera there were two new species and the second record of new, undescribed genus. *Hygrobia watsii* sp. n (Coleoptera: Hygrobidae) found in Byenup Lagoon appears to be restricted to peatland swamps and lakes and is the sixth species in the world in this genus and the fourth in Australia (Hendrich 2001). *Hygrobia watsii* sp. n is a relict species which is likely to be endangered by swamp drainage and increased salinity (Hendrich 2001).

Additional surveys by Storey in 2003/04 indicate that there have been changes in macroinvertebrate community structure since 1996/97 (Wetland Research and Management 2005). Increased salinity in the Byenup Lagoon System wetlands compared with 1996/97 has been correlated with reduced macroinvertebrate species diversity (Wetland Research and Management 2005). However, as differences in mean annual salinity between years from 1978-2008 were not significant, it is possible these changes are not permanent and may also be related to sampling effort.

23. Social and cultural values:

a) Describe if the site has any general social and/or cultural values e.g., fisheries production, forestry, religious importance, archaeological sites, social relations with the wetland, etc. Distinguish between historical/archaeological/religious significance and current socio-economic values:

Recreation and tourism – The bird observatory on Muirs Highway is used for passive nature study/appreciation activities such as bird watching, photography, landscape painting and drawing and writing.

Scientific and educational – The Ramsar site has been monitored for several decades. Peat wetlands, rare in Australia, and primary saline wetlands are found within the site and support scientifically important flora and fauna. The Ramsar site is also of interest for scientific research of past climatic regimes (peat record). Pollen and charcoal fossil records from Byenup Lagoon peat profiles have provided insights into Holocene vegetation and fire history (Dodson and Lu 2000). Analysis of lignite obtained during drilling investigations have also contributed to understanding late Eocene history of the area (Milne 2003). An information bay and interpretive facility at Lake Muir provides conservation education. Education also occurs through the Perup Forest Ecology Centre.

Spiritual and inspirational – The wetlands are spiritually significant for the Noongar people and at least one Aboriginal site occurs within the Ramsar site. The Mulgarnup Swamp complex is known to be an important site for Aboriginal women (R. Hearn pers. com.). European historical sites also exist within the Ramsar site. The Ramsar site is included within the Lake Muir Area site (9556), which is registered on the Register of the National Estate for its high aesthetic values.

b) Is the site considered of international importance for holding, in addition to relevant ecological values, examples of significant cultural values, whether material or non-material, linked to its origin, conservation and/or ecological functioning?

If Yes, tick the box and describe this importance under one or more of the following categories:

- i) sites which provide a model of wetland wise use, demonstrating the application of traditional knowledge and methods of management and use that maintain the ecological character of the wetland:
- ii) sites which have exceptional cultural traditions or records of former civilizations that have influenced the ecological character of the wetland:
- iii) sites where the ecological character of the wetland depends on the interaction with local communities or indigenous peoples:
- iv) sites where relevant non-material values such as sacred sites are present and their existence is strongly linked with the maintenance of the ecological character of the wetland:

24. Land tenure/ownership:

a) within the Ramsar site: The Ramsar site includes areas of A Class Nature Reserve 31880 south of Muirs Highway. This reserve is vested in the Conservation Commission of Western Australia (appointed by the Government of Western Australia) for the purposes of ‘water and conservation of flora and fauna’.

b) in the surrounding area: freehold (privately owned) land, Nature Reserve, special leases for mining, and State Forest. An area of freehold land is enclosed within, but is not part of, the Ramsar site.

25. Current land (including water) use:

a) within the Ramsar site: There is no land use other than nature conservation within the Ramsar site. The bird observatory on Muirs Highway provides facilities for nature based recreation such as passive nature study/appreciation activities including bird watching, photography, landscape painting and drawing and writing.

b) in the surroundings/catchment: Surrounding land uses include: agriculture, predominantly grazing and tree plantations on freehold land; and peat mining north of Lake Muir. Previously, timber was also extracted from surrounding State Forest areas. Human population in the site's surface catchment is in the order of about 20, with a further 8 absentee owners.

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

a) within the Ramsar site: Feral animals have caused land degradation and weed invasion throughout the Ramsar site (Department of Conservation and Land Management 1998). Feral animals known to occur within the site include: foxes, red and fallow deer, cats, dogs, pigs, rabbits, and horses. Methods of control include baiting and trapping programs and opportunistic shooting of foxes, cats, dogs and pigs (Department of Conservation and Land Management 1998). Also, introduced plants such as *Typha orientalis* have appeared in some of the wetlands. Some disturbance of seasonally dry lake bed areas by motor vehicles also occurs at Lake Muir.

Potentially important factors include: eutrophication (algal blooms caused by agricultural fertilisers); salinisation (particularly smaller wetlands adjacent to cleared land); too frequent and/or inappropriate fires (destruction of peat and retardation of regeneration of wetland shrub thickets, especially those used by breeding waterbirds); and drainage works, some of which are releasing acids from acid sulfate soils.

b) in the surrounding area: Factors operating in the site's catchments which potentially may affect the ecological character include salinisation, past catchment drainage and future drainage proposals, and too frequent and/or inappropriate fires. See also Department of Conservation and Land Management (1998), Storey (1998), and Gibson & Keighery (1999).

Another threat is climate change. The Indian Ocean Climate Initiative (2002) have indicated five major changes that have already occurred to the climate in the south west of Western Australia.

27. Conservation measures taken:

a) List national and/or international category and legal status of protected areas, including boundary relationships with the Ramsar site:

The entire Muir-Byenup System Ramsar site is located within Nature Reserve 31880, Western Australia. An area of lake and shoreline (Nelson Location 2198) on the south-western side of Lake Muir has recently been purchased by the Department of Environment and Conservation and has been added to the Lake Muir Nature Reserve (31880).

The Ramsar site is included within the Lake Muir Area site (9556), which is registered on the Register of the National Estate.

b) If appropriate, list the IUCN (1994) protected areas category/ies which apply to the site (tick the box or boxes as appropriate):

Ia ; Ib ; II ; III ; IV ; V ; VI

c) Does an officially approved management plan exist; and is it being implemented?: No

d) Describe any other current management practices:

Under the Salinity Action Plan for WA, Lake Muir and associated wetlands have been designated as a “Key Wetlands and Natural Diversity Catchment”. Cooperative management of the catchment, with substantial community participation, is occurring. Besides commercial tree crops (both hardwood and softwood), non commercial plantings of recharge and discharge areas has been undertaken as joint operations between DEC and landowners on private lands to improve water quality impacting downstream on wetlands. Stream flow and water quality monitoring is in place in several locations.

Parts of the eastern and southern shoreline of Lake Muir and Byenup Lagoon have no protected area buffer zones (they are private property) whereas most of the other wetlands within the Ramsar site have protected buffers of at least 100 m wide.

28. Conservation measures proposed but not yet implemented:

A management plan which includes the Muir-Byenup System Ramsar site is in preparation by DEC.

29. Current scientific research and facilities:

- Depth, salinity and nutrient levels are currently being recorded by DEC. These measurements are recorded at least quarterly.
- Waterbird usage was surveyed annually during 1981-91, with an emphasis on bitterns and ducks (Jaensch *et al.* 1988, Jaensch and Vervest 1988, Halse *et al.* 1990). Recent waterbird surveys were undertaken by Peter Taylor on behalf of DEC.
- Intensive surveys of flora and fauna within the site were conducted with funding from Environment Australia Biodiversity Group (Natural Heritage Trust) and the State Government (Salinity Action Plan). Reports on the site’s fish, aquatic macroinvertebrates, physico-chemistry, flora and vegetation have been prepared (Storey 1998 and Gibson & Keighery 1999). The site’s fish, aquatic macroinvertebrates and physico-chemistry were resurveyed in 2003 and 2004.
- Vegetation monitoring plots and/or transects have been established at Tordit-Gurrup, Mulgarnup, Byenup, North Byenup and Geordinup Lagoons, Poorginup Swamp, Lake Muir and two other locations within the Ramsar site (Gibson & Keighery 1999; J. Lane pers. com.). The relationships between water level, salinity and the emergent and fringing vegetation of six of the Muir-Byenup wetlands have been examined by Froend and Loomes (2001). These vegetation transects were resurveyed in 2003.
- Magnetic and radiometric survey data have been collected to improve knowledge of the geology of the area (Chakravartula and Street, 1999). Recently, airborne electro-magnetic survey data has been acquired and borehole geophysical logging undertaken. Geological logging of boreholes was undertaken at the time of drilling and records are due for publication in the near future (R. Hearn pers. com.). Limnological surveys, analysis and mapping will follow with a view to improving knowledge of groundwater and surface water systems.
- The Ramsar site is of interest for scientific research of past climatic regimes (peat record). Pollen and charcoal fossil records from peat profiles in Byenup Lagoon have provided insights into the vegetation and fire history of the site during the Holocene period (Dodson and Lu, 2000; Dodson and Zhou, 2000). Palynological analysis of lignites recovered during drilling investigations has contributed to an understanding of the area during the late Eocene (Milne, 2003).
- A hydrogeological study within the larger catchment area has been initiated and is ongoing with a view to improving knowledge of groundwater and surface water systems, and understanding salt and acid sulfate soils within the landscape (Smith, 2003; New C.E.S., two reports in prep).

30. Current communications, education and public awareness (CEPA) activities related to or benefiting the site:

Current CEPA for the Muir-Byenup System Ramsar site includes:

- Construction of an information bay and interpretive facility at the northern end of Lake Muir was completed during 2002, and an information brochure has been prepared.
- The area is likely to become a target of education through the Perup Ecology Centre, located in the adjacent Perup Nature Reserve.

31. Current recreation and tourism:

There is low level, irregular use for bird watching from the few public access points, e.g. Muirs Highway adjacent to Lake Muir .

32. Jurisdiction:

Territorial: The State Government of Western Australia.

Functional: The Conservation Commission of Western Australia (vesting) and the Western Australian Department of Environment and Conservation (management on behalf of the Conservation Commission of Western Australia).

33. Management authority:

The Donnelly District (based in Pemberton) of the Warren Region, Western Australian Department of Environment and Conservation.

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