

Information Sheet on Ramsar Wetlands (RIS)

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).

This Ramsar Information Sheet has been converted to meet the 2009 – 2012 format, but the RIS content has not been updated in this conversion. The new format seeks some additional information which could not yet be included. This information will be added when future updates of this Ramsar Information Sheet are completed. Until then, notes on any changes in the ecological character of the Ramsar site may be obtained from the Ecological Character Description (if completed) and other relevant sources.

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.

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Designation date

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Site Reference Number

All inquiries should be directed to:

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2. Date this sheet was completed/updated:

November 2003

3. Country:

Australia

4. Name of the Ramsar site:

The precise name of the designated site in one of the three official languages (English, French or Spanish) of the Convention. Alternative names, including in local language(s), should be given in parentheses after the precise name.

Muir – Byenup System, Western Australia

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

Muir – Byenup System was designated on 5 January 2001. The previous RIS was dated 2000.

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:

7. Map of site:

Refer to Annex III of the *Explanatory Note and Guidelines*, for detailed guidance on provision of suitable maps, including digital maps.

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:

e.g. the boundary is the same as an existing protected area (nature reserve, national park, etc.), or follows a catchment boundary, or follows a geopolitical boundary such as a local government jurisdiction, follows physical boundaries such as roads, follows the shoreline of a waterbody, etc.

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

Provide the coordinates of the approximate centre of the site and/or the limits of the site. If the site is composed of more than one separate area, provide coordinates for each of these areas.

Latitude: 34° 26' S to 34° 33' S; Longitude: 116° 38' E to 116° 49' E

9. General location:

Include in which part of the country and which large administrative region(s) the site lies and the location of the nearest large town.

The Muir-Byenup System is 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. 4300).

The Muir-Byenup System comprises the portion of Nature Reserve 31880 that is south of Muirs Highway. Named wetlands in the Site include Lake Muir, Byenup Lagoon, Tordit-Gurup Lagoon,

Poorginup Swamp, Neeranup Swamp, Coorimup Swamp and Wimbalup Swamp. Freehold land and gazetted road reserves enclosed by the Ramsar Site boundary are not part of the Ramsar Site. Parts of the western shoreline of Lake Muir are outside the Reserve and Ramsar Site (but see item 25).

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

170-180 m (Australian Height Datum)

11. Area: (in hectares)

10 631 ha (of which approximately 7000 ha is wetland)

12. General overview of the site:

Provide a short paragraph giving a summary description of the principal ecological characteristics and importance of the wetland.

The Site comprises a suite of partly inter-connected lakes and swamps of varied size (up to 4600 ha), salinity (saline to fresh), permanence (permanent to seasonal) and substrate (peat and inorganic), in an internally-draining catchment. The open lakes are used for moulting by thousands of Australian Shelduck *Tadorna tadornoides* and for drought refuge by tens of thousands of other ducks while the sedge/shrub-dominated swamps support an important population of Australasian Bittern *Botaurus poiciloptilus*, and threatened orchids. Vegetation communities of the Site's wet flats are among the few remaining in non-coastal parts of South-Western Australia and the Site has some of the largest natural sedgelands in Western Australia.

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.

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

Provide justification for each Criterion in turn, clearly identifying to which Criterion the justification applies (see Annex II for guidance on acceptable forms of justification).

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

Three wetland-dependent orchids that are formally recognised as nationally vulnerable, and at least one other wetland plant species that may soon be so recognised, occur at the Site in appreciable numbers. These plants mainly occur on seasonally inundated areas or wetland margins, which have been extensively cleared for agriculture elsewhere in South-Western Australia.

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

The open lakes of the Site regularly support moulting by thousands of Australian Shelducks; this is one of the most important moulting sites for shelducks in South-Western Australia. Lake Muir is used as a drought refuge by tens of thousands of waterbirds (see criterion 5).

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

Up to 51,000 waterbirds have been counted at the Site (at Lake Muir, when full). The annual data on water depth suggest conditions are suitable for use by 20,000 waterbirds at least several times within a 25 year period, which in the context of wetland availability in Western Australia is considered sufficient evidence of regular use by 20,000 waterbirds.

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

At least five, possibly in the order of 10 Australasian Bitterns occur regularly and possibly breed in the sedge swamps of the Site, which constitutes more than 1% of the South-Western Australian population. The Site 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 this globally threatened species.

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

Name the relevant biogeographic region that includes the Ramsar site, and identify the biogeographic regionalisation system that has been applied.

a) biogeographic region:

Jarrah Forest

b) biogeographic regionalisation scheme (include reference citation):

Interim Biogeographic Regionalisation for Australia (IBRA) Version 5.1 (Cummings and Hardy 2000).

16. Physical features of the site:

Describe, as appropriate, the geology, geomorphology; origins - natural or artificial; hydrology; soil type; water quality; water depth, water permanence; fluctuations in water level; tidal variations; downstream area; general climate, etc.

The Byenup Muir System is an unusual complex of wetland types, and includes a large lake (Lake Muir: 4600 ha), smaller lakes and swamps (notably Byenup Lagoon, Tordit-Gurup 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 component wetlands are terminal drainage basins. Lake Muir is seasonal, often dry in autumn: maximum depth recorded since 1978 is 1.3 m (November 1988) and the September mean is 0.78 m. Byenup Lagoon is permanent: maximum depth recorded is 2.6 m (September 1991) and the September mean is 2.3 m. Some of the other component wetlands are permanent or near-permanent, though peaty Poorginup Swamp frequently shows little or no surface water, and the minor swamps and broad flats are inundated or waterlogged only in winter-spring.

Water quality, Lake Muir: salinity ranges from 96 parts per thousand (March 1982) to 0.6 ppt (November 1990) with a September mean of 10.1 ppt (n=12); water pH ranges from 6.2 to 9.7; and the water is colourless. Water quality, Byenup Lagoon: salinity ranges from 42 ppt (March 1988) to 1.4 ppt (November 1988) with a September mean of 3.2 ppt (n=15); and water pH varies from 7.4 to 9.3. Other component wetlands such as Tordit-Gurup Lagoon and Poorginup Swamp are less saline or fresh, some are more acidic and some have brown coloured water.

Water data are from monitoring by the Department of Conservation & Land Management.

Median and mean annual rainfall at Rocky Gully (29 km east of Lake Muir) are 723 mm and 715 mm respectively, mostly falling in May-September. Annual evaporation is about 1300 mm.

17. Physical features of the catchment area:

Describe the surface area, general geology and geomorphological features, general soil types, and climate (including climate type).

The System is situated in the 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 palaeodrainage 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. Some of the component wetlands, and a swamp that is outside the Site and is subject to peat mining, drain into Lake Muir. Substantial parts of the surface catchments of most of the component wetlands are cleared. Little is yet 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). These are currently under investigation.

18. Hydrological values:

Describe the functions and values of the wetland in groundwater recharge, flood control, sediment trapping, shoreline stabilization, etc.

The Site's wetlands possibly contribute to maintenance of groundwater in surrounding areas, but 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. These are currently under investigation.

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:

Provide further description, as appropriate, of the main habitats, vegetation types, plant and animal communities present in the Ramsar site, and the ecosystem services of the site and the benefits derived from them.

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

Most of the other component 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 huegelii*, and at Poorginup Swamp *Leptocarpus scariosus*, *B. vaginalis* and *Gahnia trifida* also occur. The dominant wetland tree is *Melaleuca raphiophylla*. *Melaleuca lateritia*, *Astartea fascicularis* and *Agonis juniperina* occur in some wetlands. (Halse *et al.* 1993; Lane *et al.* 1996; N. Gibson pers. comm.).

Surrounding areas mainly support open-forest dominated by eucalypts, or are cleared.

The flora and vegetation units of Lake Muir Nature Reserve, and other nearby Nature Reserves, have been extensively surveyed and mapped. A total of 649 indigenous flora taxa were recorded in the Reserve and it has been estimated (N. Gibson pers. comm.) that at least 600 taxa occur within the Ramsar Site. This is a rich flora for such a small area. The reasons for such diversity probably relate to complexes of soil types and hydrological patterns found over short distances. The complex of vegetation patterning is related to these patterns, particularly period of inundation and quality of groundwater, and also to fire history. Structural vegetation mapping showed a complex mosaic of almost 30 vegetation types within the Site (Gibson & Keighery, 1999; Gibson and Keighery, 2000).

21. Noteworthy flora:

Provide additional information on particular species and why they are noteworthy (expanding as necessary on information provided in 14, Justification for the application of the Criteria) indicating, e.g., which species/communities are unique, rare, endangered or biogeographically important, etc. *Do not include here taxonomic lists of species present – these may be supplied as supplementary information to the RIS.*

Three species of wetland-dependent orchids *Caladenia christineae* ms, *Caladenia harringtoniae* ms and *Diuris drummondii* that occur in appreciable numbers at the margins of Lake Muir and elsewhere in the Site (Halse *et al.* 1993; Lane *et al.* 1996, R.W. Hearn pers. comm.) are listed as “Species that are Vulnerable” (Threatened Species) under the Commonwealth of Australia’s *Environment Protection and Biodiversity Conservation Act 1999*.

Other notable plants that occur in winter-wet swamps at the Site include several species that currently are poorly known and that soon may be declared rare at a State level: *Stylidium ripidium*, *Wurmbea* sp. Cranbrook, and *Caladenia starteorum* ms.

Recently, the flora of Lake Muir Nature Reserve was extensively surveyed and described (Gibson & Keighery 1999). Among the 649 indigenous flora taxa recorded on this Reserve were three rare orchid species (see above) and 19 other “priority taxa” (State supplementary listing of poorly known, or rare but not threatened, taxa). One of these, *Eryngium* sp. Lake Muir, appears to be an endemic taxon to winter-wet clay flats of the Lake Muir area, and currently is known only from the Ramsar Site.

The two large populations of *Euphrasia scabra* within the Site are the only known extant populations for this taxon in Western Australia; and it has been recommended for listing nationally as critically endangered, based on severe population declines in eastern Australia.

During recent surveys of the *Euphrasia scabra* populations a new population of the orchid *Caladenia lodgeana* was found. This species was previously known only from a few restricted populations in the Augusta area, some 150 km to the west (N. Gibson pers. comm.).

The shrublands and forests surrounding Lake Muir contain the only known populations of *Lilaeopsis polyantha* in WA.

The aquatic sedge *Schoenus natans* has recently been de-listed as Declared Rare Flora based on the large population of this taxon in the Ramsar Site and several nearby Nature Reserves; it was previously believed to be restricted to the Swan Coastal Plain.

Tribonanthes sp. Lake Muir, which appears to be a previously unrecognised taxon, also appears to be endemic to winter-wet clay flats of the Ramsar Site and other nearby Nature Reserves.

22. Noteworthy fauna:

Provide additional information on particular species and why they are noteworthy (expanding as necessary on information provided in 14. Justification for the application of the Criteria) indicating, e.g., which species/communities are unique, rare, endangered or biogeographically important, etc., including count data. *Do not include here taxonomic lists of species present – these may be supplied as supplementary information to the RIS.*

Surveys have recorded 23 waterbird species at Lake Muir and 41 at Byenup Lagoon: most are non-migrants. The most abundant species at Lake Muir are Pacific Black Duck *Anas superciliosa* (up to 18,450), Grey Teal *Anas gracilis* (16,000) and Eurasian Coot *Fulica atra* (9630) (all counts in March 1989). Lake Muir is a migration stop-over site for small numbers of shorebirds, notably Red-necked Stint *Calidris ruficollis* (up to 517 in November 1985). A breeding colony of up to 40 pairs of Silver Gull *Larus novaehollandiae* occurs on rock outcrops in Lake Muir; up to 700 birds have been counted. Little Bittern *Ixobrychus minutus* and Spotless Crane *Porzana tabuensis* are among the several waterbirds recorded breeding in the sedge-dominated wetlands.

Lake Muir is regularly used in spring for moulting by thousands of Australian Shelduck. Moulting also occurs on the smaller open lakes, an exceptional concentration of 12,000 shelduck being recorded at Tordit-Gurup Lagoon in December 1982. Muir-Byenup System is one of the most important moulting sites for shelduck in South-Western Australia.

The same lakes are also used as drought refuges by large numbers of waterbirds. The highest number of waterbirds counted at Lake Muir was 51,600 in March 1989, an unusually high total following a wet winter in the surrounding district but, together with depth data, indicative of occurrence by more than 20,000 waterbirds from time to time.

The Australasian Bittern has been recorded in four of the component sedge-dominated wetlands and probably also occurs elsewhere in the Site. The Site possibly supports in the order of ten pairs of Australasian Bittern and behaviour suggests that some pairs breed there. This number constitutes more than 1% of the South-Western Australian population: the 1% level is 3 birds (Rose & Scott 1997). The Site 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 this globally threatened (Collar *et al.* 1994) species. The Australasian Bittern is specially protected under State legislation as a species that is “rare or likely to become extinct”.

Recent surveys (Storey 1998) of 27 wetlands (including eight in the Muir-Byenup Ramsar Site) in the adjoining catchments of Lake Muir and Lake Unicup have revealed a total of seven fish species, with six being endemic to South-Western Australia and one introduced. Of the 27 wetlands surveyed, Poorginup Swamp had the greatest number (five) of native species. Mulgarnup Swamp, also within the Site, had four native species. The two least-frequently encountered native species, *Galaxiella nigrostriata* and *G. munda*, were found only at Poorginup Swamp and one other wetland outside the Site. All seven fish species occurred within the Ramsar Site; no species was restricted to it.

A survey of macroinvertebrates by DeHaan (1987) revealed 97 invertebrate taxa in the suite comprising Tordit-Gurup Lagoon, Byenup Lagoon and Poorginup Swamp. These included 11 water mites Hydracarina, six of which (found at Poorginup Swamp) have restricted distributions (e.g. *Pseudohydryphantes 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* occur at the site.

More recently, Storey (1998) has surveyed the macroinvertebrate communities of 27 wetlands (including eight in the Muir-Byenup Ramsar Site) in the adjoining catchments of Lakes Muir and Unicup. A total of 219 taxa was recorded; with 32 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, the former was widespread in the catchments, the latter from Poorginup and another location. Storey also recorded a possible new species of ceinid amphipod *Austrochiltonia* sp.

Another new species of dytiscid *Antiporus mcraeae* has recently been found (Watts and Pinder in press) in the Muir-Unicup area (Kodjinup Swamp, outside the Site) during a biological survey funded under the State Salinity Action Plan (Government of Western Australia, 1996).

Preliminary identification of microinvertebrates collected during Storey's (1998) survey has revealed a rich and diverse fauna. 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 Site (S. Halse pers. comm.). 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. It is considered likely that much-needed taxonomic revision will reveal that the Muir-Unicup collection contains other new cladoceran taxa. South-Western Australia has been shown to have more endemic species and genera of cladocerans than any other region of Australia (R. Shiel pers. comm.).

Unless otherwise indicated, data above are from Jaensch & Vervest 1988, Jaensch *et al.* 1988, Halse *et al.* 1990, Lane *et al.* 1996, R. Hearn pers. comm. and data sets held by the Western Australian Department of Conservation & Land Management.

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:

No information.

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 is the portion of A-Class Nature Reserve 31880 that is south of Muirs Highway. This reserve is vested in the Conservation Commission (appointed by the Government of Western Australia) for the purposes of “Conservation of Flora and Fauna” and “Water”.

b) in the surrounding area:

Surrounding areas include 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 (see map).

25. Current land (including water) use:

a) within the Ramsar site:

There is no land use other than nature conservation within the Ramsar Site. There are no facilities for nature-based recreation and this type of recreation is limited within the Ramsar Site.

b) in the surroundings/catchment:

Freehold land enclosed by and adjoining the Ramsar Site is used for agriculture, notably grazing of domestic sheep and cattle and tree plantations. The mining leases are for extraction of peat. They expire in 2003 and 2004; however one of these tenements has been modified and extended so that low-level mining activity will continue beyond 2004. Timber is extracted from the State Forests. The most important land uses in the catchment are agriculture and forestry (plantations and native forest). 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:

Recently pigs *Sus scrofa* were unlawfully released on the Site. They are causing considerable damage to vegetation and soil. Determined efforts are being made to reduce feral pig numbers by trapping, shooting and poisoning but eradication may be impossible without new technology. Red deer, fallow deer and horses have been illegally released in the area, are breeding, and are causing damage to vegetation in the nature reserves. Action is being taken to remove them. Also, exotic plants such as *Typha orientalis* are appearing in some of the wetlands. Some unlawful disturbance of seasonally dry lake bed areas by motor vehicles 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 sulphate soils. These and other present and potential disturbances and threats have been described in DCLM (1998), Storey (1998) and Gibson & Keighery (1999).

In the past, proposed commercial extraction of peat from Tordit-Gurru Lagoon was opposed by the Western Australian Department of Conservation & Land Management and others and was subsequently not approved by Government.

b) in the surrounding area:

Factors operating in the Site’s catchments which potentially may affect the Site’s ecological character include salinisation, past catchment drainage and future drainage proposals, and too frequent and/or inappropriate fires. See also DCLM (1998), Storey (1998), and Gibson & Keighery (1999).

27. Conservation measures taken:

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

In particular, if the site is partly or wholly a World Heritage Site and/or a UNESCO Biosphere Reserve, please give the names of the site under these designations.

The Nature Reserve was established in 1973.

The entire Site is included on the Register of the National Estate.

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 Conservation & Land Management and has been added to the Lake Muir Nature Reserve.

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?:

A Draft Management Plan for the Reserve (and nearby Perup and Unicup Reserves) was released for public comment late in 1998 (DCLM, 1998).

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 the Western Australian Department of Conservation & Land Management 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:

e.g. management plan in preparation; official proposal as a legally protected area, etc.

Measures proposed under the Salinity Action Plan include further planting of trees (including commercial plantations) on freehold land as a strategy to reduce dryland salinity in the Lake Muir catchment. Proposals to divert high salt water flows away from freshwater systems at critical times are being investigated.

A Recovery Catchment Management Plan is being prepared. A new draft management plan for the area, together with nearby Perup and Unicup Nature Reserves, is soon to be finalised. It is proposed to change the purpose of the land to National Park.

There is potential to extend the Ramsar Site in the future, following consultation with land managers, to include Nature Reserves and possibly other government land (e.g. some Water & Rivers Commission land) to the north of Muirs Highway.

29. Current scientific research and facilities:

e.g., details of current research projects, including biodiversity monitoring; existence of a field research station, etc.

Depth, salinity and other water quality parameters of Lake Muir, Byenup Lagoon, Tordit-Gurru Lagoon and Poorginup Swamp have been measured by the Department of Conservation & Land Management at least twice each year since the late 1970s.

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).

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 will be resurveyed in 2003 and 2004.

Vegetation monitoring plots and/or transects have been established at Tordit-Gurru, 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. comm.). 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). Limnological surveys, analysis and mapping will follow with a view to improving knowledge of groundwater and surface water systems. "Salt mapping" will allow synthesis into a model to facilitate planning of future management of the area, particularly (high water use) tree and agricultural crops on adjoining lands, to maintain conservation values of the wetland system.

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, participation and awareness (CEPA) activities related to or benefiting the site:

e.g. visitors' centre, observation hides and nature trails, information booklets, facilities for school visits, etc.

Construction of an information bay and interpretive facility at the northern end of Lake Muir was completed during 2002, and an informative 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:

State if the wetland is used for recreation/tourism; indicate type(s) and their frequency/intensity.

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:

Include territorial, e.g. state/region, and functional/sectoral, e.g. Dept of Agriculture/Dept. of Environment, etc.

Territorial: The State Government of Western Australia.

Functional: The Conservation Commission (vesting) and the Western Australian Department of Conservation & Land Management (management on behalf of the Conservation Commission).

33. Management authority:

Provide the name and address of the local office(s) of the agency(ies) or organisation(s) directly responsible for managing the wetland. Wherever possible provide also the title and/or name of the person or persons in this office with responsibility for the wetland.

The Donnelly District (based in Pemberton) of the Warren Region, Western Australian Department of Conservation & Land Management.

34. Bibliographical references:

Scientific/technical references only. If biogeographic regionalisation scheme applied (see 15 above), list full reference citation for the scheme.

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