4

Interplay of drivers, levers, components and processes within the wetland types of the system

The many types of freshwater and saline-estuarine wetlands found at this Ramsar site are described in detail with attention given to the ecological components and processes that underpin ecological character.

Q Interplay of drivers, levers, components and processes within the wetland types of the system

The Coorong and Lakes Ramsar site lies at the terminus of the Murray-Darling Basin. It incorporates the freshwater bodies of Lakes Alexandrina and Albert and the more saline lagoons of the Coorong (see Figure 6). It is the only estuary within the Murray-Darling Basin and thus the Murray Mouth is the only connection between this one million square kilometre inland basin and the sea.

The Ramsar site covers an area of approximately 140,500 ha which incorporates 23 different wetland types DFFRUGLQJ WR WKH 5D P VDU &RQYHQWLRQ FODVVLÀFDWLRQ system, see Table 8), existing as a mosaic of fresh to hypersaline habitats variously interconnected across time and space. Ramsar Criterion 1 (see Table 3) seeks to recognise sites that contain '… a representative, rare, or unique example of a natural or near-natural wetland type found within the appropriate bioregion' and the Coorong and Lakes qualify against this criterion in addition to seven of the other eight (see Section 5).

To assist this description of ecological character the Ramsar site has been sub-divided into six units as follows:

Freshwater system units:

- Lake Alexandrina
- Lake Albert
- Tributary wetlands (lower reaches of Finniss River Currency Creek and Tookayerta Creek).

Estuarine-saline system units:

- Murray Mouth and Estuary
- North Lagoon
- South Lagoon.

For each of these six units, maps showing the distribution of wetlands types are provided below. These are then followed by detailed consideration of the types, as they occur within the freshwater units and the estuarine-saline units. Sections 4.1.1 to 4.1.3 provide an overview of the three predominantly freshwater units referred to above. This includes a summary qualitative description of each unit plus a more detailed breakdown of the wetland types found there and the key biological components occurring in that habitat. Similarly, Sections 4.2.1 to 4.2.2 document the estuarine-saline units. Section 5 provides P RUH GHWDLOHG LQIRU P DWLRQ RI WKH 5D P VDU 6LJQLÀFDQW Biological Components that contribute to qualifying this site as a Wetland of International Importance—as summarised initially in Section 3.5.

Table 8 - Wetland types found within the Ramsar site WKH FDVVLÀFDWLRQ V\VWHP XVHG LV WKDW DS SOLHG E\ WKH 5DPVDU &RQYHQWLRQ		
Marine/Coastal wetlands		**Area (ha)**
A	**Permanent shallow marine waters** in most cases less than six metres deep at low tide; includes sea bays and straits	50
D	**Rocky marine shores**; includes rocky offshore islands, sea cliffs	788*
E	**Sand, shingle or pebble shores**; includes sand bars, spits and sandy islets; includes dune systems and humid dune slacks	1,020#
F	**Estuarine waters**; permanent water of estuaries and estuarine systems of deltas	2,200
G	,QWHUWLGDO P XG VDQG RU VDOW ÁDWV	3,142
H	**Intertidal marshes**; includes salt marshes, salt meadows, saltings, raised salt marshes; includes tidal brackish and freshwater marshes	536
I	**Intertidal forested wetlands**; includes mangrove swamps, nipah swamps and tidal freshwater swamp forests	4
J	**Coastal brackish/saline lagoons**; brackish to saline lagoons with at least one relatively narrow connection to the sea	10,128
K	**Coastal freshwater lagoons**; includes freshwater delta lagoons	41
Inland wetlands		
M	**Permanent rivers/streams/creeks**; includes waterfalls	221
N	**Seasonal/intermittent/irregular rivers/streams/creeks**	200
O	**Permanent freshwater lakes** (over 8 ha); includes large oxbow lakes	79,480
P	**Seasonal/intermittent freshwater lakes** RYHU KD LQFOXGHV ÁRRGSODQ OODNHV	120
R	6HDVRQDO LQWHUPLWWHQW VDOLQH EUDFNLVK DOND OLQH OODNHV DQG ÁDWV	1,729
Ss	**Seasonal/intermittent saline/brackish/alkaline marshes/pools**	1,289
Tp	**Permanent freshwater marshes/pools**; ponds (below 8 ha), marshes and swamps on inorganic soils; with emergent vegetation water-logged for at least most of the growing season	4,474
Ts	**Seasonal / intermittent freshwater marshes/pools** RQ LQRUJDQLF VRLOV LQFOXGHV VORX JKV SRWKRODHV VHDVRQDO\ ÁRRGHG meadows, sedge marshes	1,037
W	**Shrub-dominated wetlands**; shrub swamps, shrub-dominated freshwater marshes, shrub carr, alder thicket on inorganic soils	4,875
Xf	**Freshwater, tree-dominated wetlands** LQFOXGHV IUHVKZDWHU VZDPS IRUHVWV VHDVRQDO\ ARRGHG IRUHVWV ZRRGHG VZDPSV on inorganic soils	1,470
Y	**Freshwater springs; oases**	<10
Human-made wetlands		
4	6HDVRQDO\ ÁRRGHG DJULFXOWXUDO OODQG (including intensively managed or grazed wet meadow or pasture)	1,235
6	**Water storage areas**; reservoirs/barrages/dams/impoundments (generally over 8 ha)	1
9	**Canals and drainage channels, ditches**	44

Shaded rows indicate the dominant wetland types within each broad category; marine/coastal, inland, and human-made.

KEY

* Includes 165 ha from Lake Alexandrina (a freshwater part of the system)

\# Includes 6 ha from Lake Alexandrina and 1 ha from Lake Albert (freshwater parts of the system)

Ramsar wetland types not found in the Coorong and Lakes system have not been included in the table.

The total area of wetland types is approximately 114,000 hectares. The balance of the land (approx. 26,000 hectares) within the Ramsar site LV WHUUHVWULDO KDELWDW ZKLFK LV QRW FODVVLÀHG XQGHU WKH 5DPVDU &RQYHQWLRQ VHH 6HFWLRQ IRU D GHVFULSWLRQ RI WKH VLWH ERXQGDULHV

Q 4.1 Freshwater system units

4.1.1 Lake Alexandrina

Qualitative description

Area: approximately 76,000 ha.

Lakes Alexandrina and Albert lie at the terminus of the 5LYHU 0XUUD\ V\VWHP UHFHLYLQJ IUHVKZDWHU LQÁRZV IUR P WKH River Murray, the Eastern Mount Lofty Ranges tributaries, groundwater discharge, local run-off and rainfall on the lakes surface (see Figure 6). The River Murray FRQÁXHQFH ZLWK /DNH $OH[DQGULQD RFFXUV LP PHGLDWH0\ GRZQVWUHD P RI : HOOQJWRQ DQG WKH FRQÁXHQFH RI /DNH Alexandrina and the Coorong is now a highly regulated RQH FRQVLVWLQJ RI D VHULHV RI ÁYH EDUUDJHV FRQQHFWLQJ the various islands in the southern section of the lake. &RQVWUXFWHG LQ WKH V WKH ÁYH EDUUDJHV *RRZD Mundoo, Boundary Creek, Ewe Island and Tauwitcherie) in total contain 593 independently-operated gates. Water is discharged from Lake Alexandrina through the gates in the barrages between lake levels of c. 0.75 and 0.85 m AHD (Australian Height Datum) or over wetland areas adjacent to the barrages when lake levels exceed 0.85 m AHD and thus water overtops or runs around the barrage structures.

Hindmarsh, Mundoo, Ewe and Tauwitcherie Islands lie within the transitional zone between Lake Alexandrina and the Coorong. Reserves around Lake Alexandrina LQF0XGH 7R0GHUR 0XG ,V0DQGV DQG &XUUHQF\ &UHHN *DPH Reserves, otherwise the Lake Alexandrina component of the Ramsar site is mainly open water and Crown Lands (often grazed under licence by adjacent landholders).

Lake levels vary with season, being higher in winter and lower in summer. Actual levels vary considerably due to high variability in River Murray and tributary LQÁRZV DQG F0LP DWLF IDFWRUV VXFK DV UDLQID00 ZLQG WLGHV and evaporation. Historically, the barrages have been RSHUDWHG ZLWK D ¶À00 DQG VSL00· SKL0RVRSK\ WKDW VDZ WKH barrages being opened when lake levels reached 0.85 m AHD (typically in July–August) until the lake level dropped to 0.75 m AHD when the barrages were then closed. In the period between 1981 and 2003, there were seven periods when the barrages were closed continuously for more than 200 days with the longest period being 643 days. A new Barrage Operating Strategy (BOS) is being developed to better utilise water available during low ÁRZ FRQGLWLRQV DQG PLPLF QDWXUD0 ZDWHU UHJLP HV (see *Asset Plan*, DWLBC, 2005).

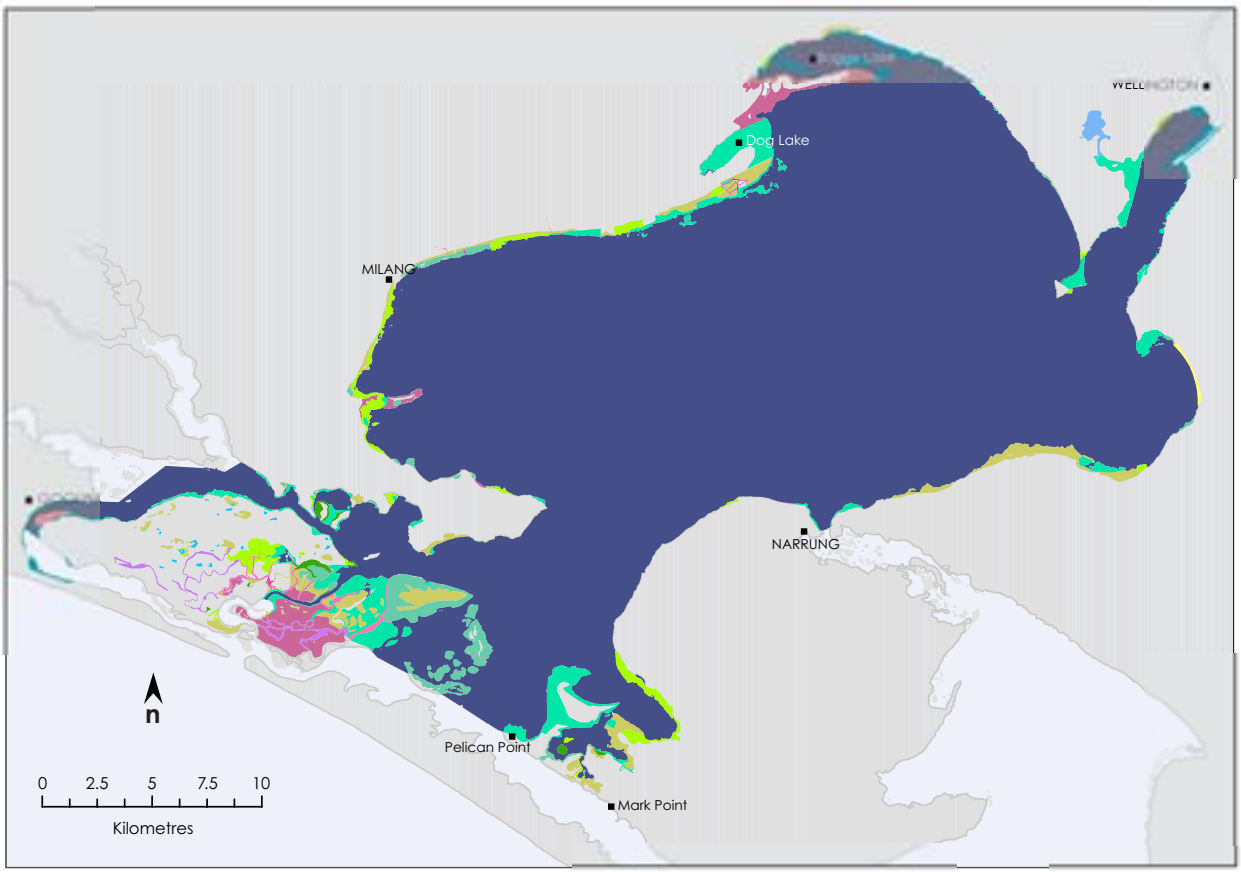
Lake Alexandrina and Lake Albert combined hold */DW P $+' DQG */DW P $+' (DWLBC, 2005). The low points of Lake Alexandrina (and thus the deepest points) occur at approximately -4.0 m AHD. This means that at 0.75 m AHD the deepest areas in the lake are 4.75 m deep. Whilst the 'average' depth is approximately 2.9 m (Baker, 2000), wind action across the lake surface can vary lake levels considerably (average wind speed 28 km/h[1], Bourman et al., 2000).

The lakes are broad and shallow with complex and extensive fringing vegetation and an array of sand and mud islands (Jensen et al., 2000; Seaman, 2003). Much of the fringing vegetation is dominated by *Phragmites australis*, the common reed, with the most FRP S0H[ZHW0DQG ÁRU0 IRXQG QHDU FRQÁXHQFHV channels and drains where the localised water regime is relatively variable.

Freshwater submerged aquatic plant communities were extensive in the lakes system prior to European settlement, spreading for several kilometres out into the lakes (Sim and Muller, 2004). They are now restricted to near-shore, well-illuminated lake habitats, natural FRQÁXHQFHV VXFK DV WKH 5LYHU 0XUUD\²/DNH $0H[DQGULQD FRQÁXHQFH WULEXW0U\ RU ZHW0DQG FRQÁXHQFHV DQG DUHDV such as irrigation channels and drains that mimic natural FRQÁXHQFHV DQG WKXV PD\ SURYLGH ¶ÁRZ·LQ WHUPV RI irrigation pumping or gravity-fed drainage.

The fringing emergent vegetation has been similarly VLP SLÁHG VLQFH LQVW00DWLRQ RI WKH EDUUDJHV DQG WKH creation of static lake levels. Species such as *Phragmites australis* and *Typha domingensis* KDYH ÁRXULVKHG ZKLVW species dependent on variable water regimes (such as *Eleocharis* spp. and *Baumea* spp.) are now restricted to fringing wetlands and tributaries. Many wetlands also support lignum and samphire at the high water mark (behind the reeds) where evaporation provides saline conditions suitable for samphire growth. The hypersaline samphire communities occur at higher elevations, away from the zone inundated by seasonal lake level rise, and contain depressions that often receive run-off from their own mini-catchments and saline groundwater discharge. The freshwater habitats on and immediately surrounding the islands (e.g. Hindmarsh Island) are critical IRU IUHVKZDWHU AVK VXFK DV 0XUUD\ +DUG\KHDG DQG DUH unique in that they provide potential and historical WKURXJK SRLQWV IRU ÁRZV EHWZHHQ /DNH $0H[DQGULQD DQG the Coorong and thus are critical to habitat connectivity DW D VLWH VFD0H 7KH ÁRU0 RI +LQG P DUVK ,V0DQG FRQWDLQV many notable species and there is a range of terrestrial and aquatic habitats on and around the island with high to moderate levels of habitat connectivity.

Disclaimer - Please refer to the beginning of the ecological report for a detailed disclaimer and map data.



Source - SA DEH, Russell Seaman 2006

Figure 8 - Map of Lake Alexandrina showing the various wetland types

Key to wetland types	
D	**Rocky marine shores**; includes rocky offshore islands, sea cliffs
E	**Sand, shingle or pebble shores**; includes sand bars, spits and sandy islets; includes dune systems and humid dune slacks
M	**Permanent rivers/streams/creeks**; includes waterfalls
N	**Seasonal/intermittent/irregular rivers/streams/creeks**
O	**Permanent freshwater lakes** (over 8 ha); includes large oxbow lakes
P	**Seasonal/intermittent freshwater lakes** RYHU KD LQF XGHV ÁRRGS DLQ DNHV
R	6HDVRQD LQHU P LWHQ VDLQH EUDFNLVK DND LQH DNHV DQG ADV
Ss	**Seasonal/intermittent saline/brackish/alkaline marshes/pools**
Tp	**Permanent freshwater marshes/pools**; ponds (below 8 ha), marshes and swamps on inorganic soils; with emergent vegetation water-logged for at least most of the growing season
Ts	**Seasonal/intermittent freshwater marshes/pools** RQ LQRU J DQLF VRLV LQF XGHV VRX J KV SRVKRHV VHDVRQD \ ARRGHG P HDGR Z V sedge marshes
W	**Shrub-dominated wetlands**; shrub swamps, shrub-dominated freshwater marshes, shrub carr, alder thicket on inorganic soils
Xf	**Freshwater, tree-dominated wetlands** LQF XGHV IUHVK Z D HU V Z D P S IRUHVV VHDVRQD \ ARRGHG IRUHVV Z RRGHG V Z D P S V on inorganic soils
4	6HDVRQD \ ARRGHG D J ULFX XUD DQG (including intensively managed or grazed wet meadow or pasture)
9	**Canals and drainage channels, ditches**

4.1.2 Lake Albert

Qualitative description

Mainly Crown Lands. Area: 16,800 ha approximately.

Lake Albert lies to the south east of Lake Alexandrina Narrung Narrows, a narrow channel between Point Malcolm and Narrung Peninsula, connects the two lakes. The channel is only c. 230 m wide whilst the causeway that meets the ferry at this site is c. 280 m long, suggesting that the original connection between the Lakes was in the order of c. 500 m wide.

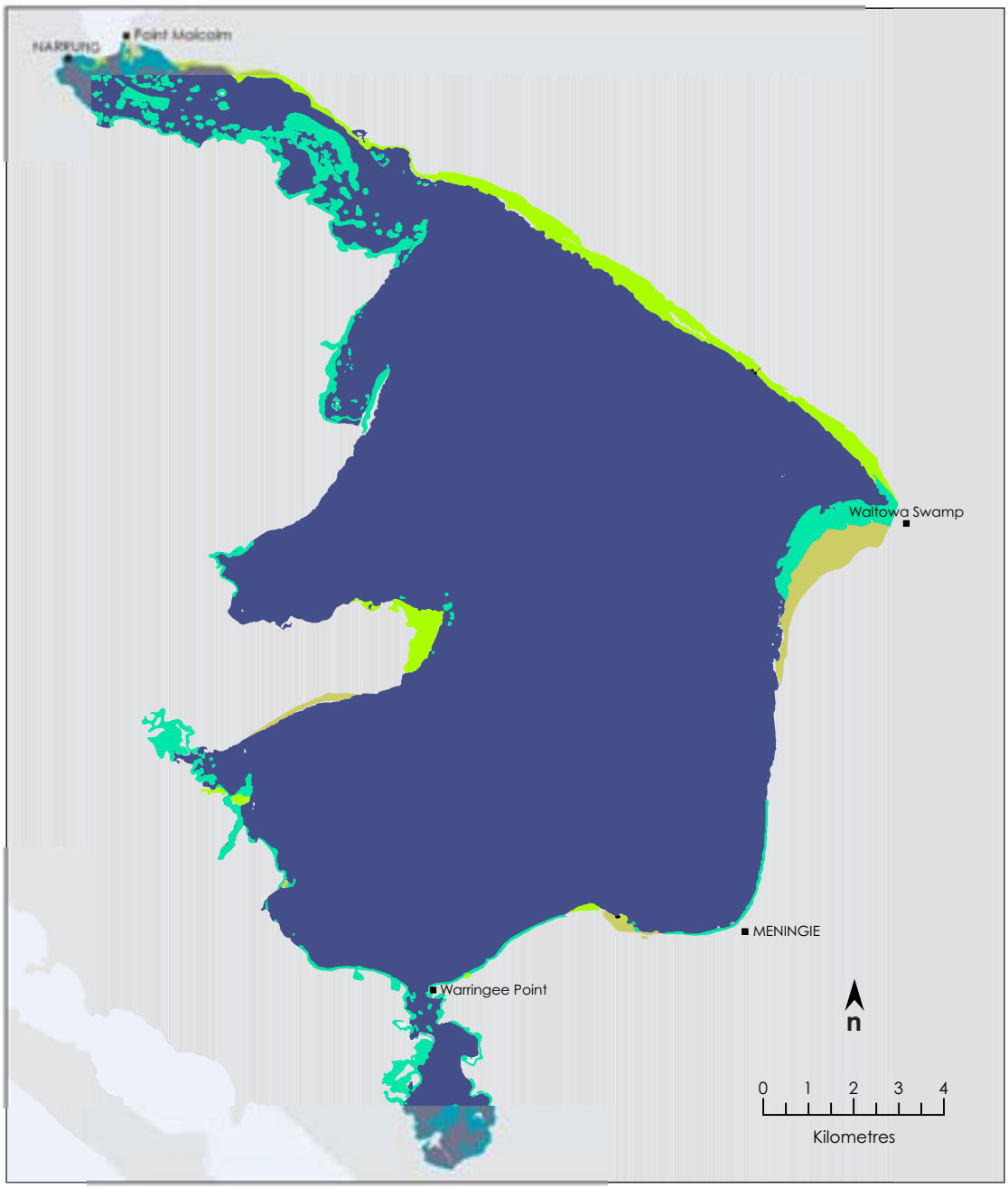
/DNH $0EHUW GRHV QRW KDYH D WKUXJK ÁRZ FRQQHFWLRQ WR the Coorong and thus represents a local, inland terminus RI WKH 5LYHU 0XUUD\ V\VWHP ,W RQ\ UHFHLYHV LQÁRZ WKURXJK the Narrows channel from Lake Alexandrina with its 0RFD0LQSXWV FRQÀQHG WR RYHUDQG UXQ RII IR0RZLQJ UDLQ and groundwater discharge during winter when rainfall rapidly converts to run-off and recharge. Lake levels rise in winter and fall in summer in accord with the levels in Lake Alexandrina, although factors such as wind direction and speed, water extraction rates and local rainfall to evaporation rates also affect Lake Albert water levels.

The groundwater table is shallow and saline under P XFK RI /DNH $0EHUW·V ÁRRGS0DL Q DQG WKXV JURXQGZDWHU discharge creates seasonal and permanent salt-water marshes in depressions or swales around the lake edge. In general, it is more saline than Lake Alexandrina and reaches conductivities of 3,000 EC at the end of periods RI 0RZ ULYHU ÁRZ 7KH 0DNHV KDYH D YHU\ 0RQJ IHWFK (distance of lake surface in-line with prevailing winds) and water can wash backwards and forwards between the two lakes depending on wind direction and speed and resultant wave action. The two lakes combined KR0G * / DW P $+ ' DQG * / DW P $+ ' (DWLBC, 2005). The lowest, and thus the deepest, point in Lake Albert is at -1.7 m AHD.

Lake Albert acts as a sink for salt and sediment from 5LYHU 0XUUD\ LQÁRZV RYHUDQG UXQ RII JURXQGZDWHU and lakeshore erosion. The slow-moving water allows for deposition of silts and sediments particularly at the southern end of the lake, where extensive siltation is reducing water depth and topographical diversity. This will ultimately promote the growth of reeds and riparian species and decrease the submerged wetland habitat. However, in so doing this sedimentation could result in more high quality island habitat and provide opportunities for *Ruppia* spp. growth, replacing beds from the Coorong and increasing habitat availability for nesting swans and ducks.

Lake Albert is a broad and shallow waterbody which supports remnant patches of **DKQLD ÁX P* and extensive, KLJK0\ VLJQLÁFDQW *Phragmites australis* and *Typha domingensis* reedbeds. These provide excellent sheltered KDEWDW IRU D UDQJH RI AVK DQG RWKHU YHUWHEUDWH VSHFLHV as well as long-term rookery sites for ibis, spoonbill and cormorants (EconSearch 2004a). Waltowa Swamp LV D VLJQLÀFDQW ZHW0DQG FR P S0H[FRQQHFWHG WR /DNH $0EHUW DW KLJK ZDWHU 0HYH0V WKDW VXS SRUWV D UDQJH RI ÁRUD LQF0XGLQJ VLJQLÀFDQW RUFKLGV UHHGV 0LJX P VD P SKUH DQG freshwater marshes.

3ULRU WR (XUSHDQ VHWW0H P HQW /DNH $0EHUW ZDV VLJQLÁFDQW0\ fresher than today and supported extensive submerged aquatic plant beds and diverse emergent macrophyte communities that fringed the lakeshore (Sim and Muller, 2004). Submerged aquatic plants are now restricted in range to sheltered, littoral habitats.



Disclaimer - Please refer to the beginning of the ecological report for a detailed disclaimer and map data.

Source - SA DEH, Russell Seaman 2006

Figure 9 - Map of Lake Albert showing the various wetland types

Key to wetland types	
E	**Sand, shingle or pebble shores**; includes sand bars, spits and sandy islets; includes dune systems and humid dune slack
O	**Permanent freshwater lakes** (over 8 ha); includes large oxbow lakes
R	6HDVRQDO LQWHU P LWWHQW VDOLQH EUDFNLVK DOND LQH ODNHV DQG ADW
Ss	**Seasonal/intermittent saline/brackish/alkaline marshes/pools**
Tp	**Permanent freshwater marshes/pools**; ponds (below 8 ha), marshes and swamps on inorganic soils; with emergent vegetation water-logged for at least most of the growing season
W	**Shrub-dominated wetlands**; shrub swamps, shrub-dominated freshwater marshes, shrub carr, alder thicket on inorganic soils
9	**Canals and drainage channels, ditches**

4.1.3 Tributary wetlands

Qualitative description

Tributary wetlands associated with three Eastern Mount Lofty Ranges streams: Finniss River, Tookayerta Creek and Currency Creek. Area: 1,488 ha approximately.

The Eastern Mount Lofty Ranges (EMLR) contain 13 VWUHD P V AYH RI ZKLFK GLVFKDUJH LQWR /DNH $0H[DQGULQD namely Currency Creek, Tookayerta Creek, Finniss River, Angas River and Bremer River. These streams gain water from catchments that vary in rainfall from 350 mm to 850 mm annually, and from aquifers in the hills and across WKH SUDLQV UHFKDUJHG E\ VWUHD P ÁRZ DQG UDLQ LQÀOWUDWLRQ The lower reaches of the Finniss River, Tookayerta Creek and Currency Creek lie within the Ramsar site but the Angas and Bremer Rivers are outside the boundary.

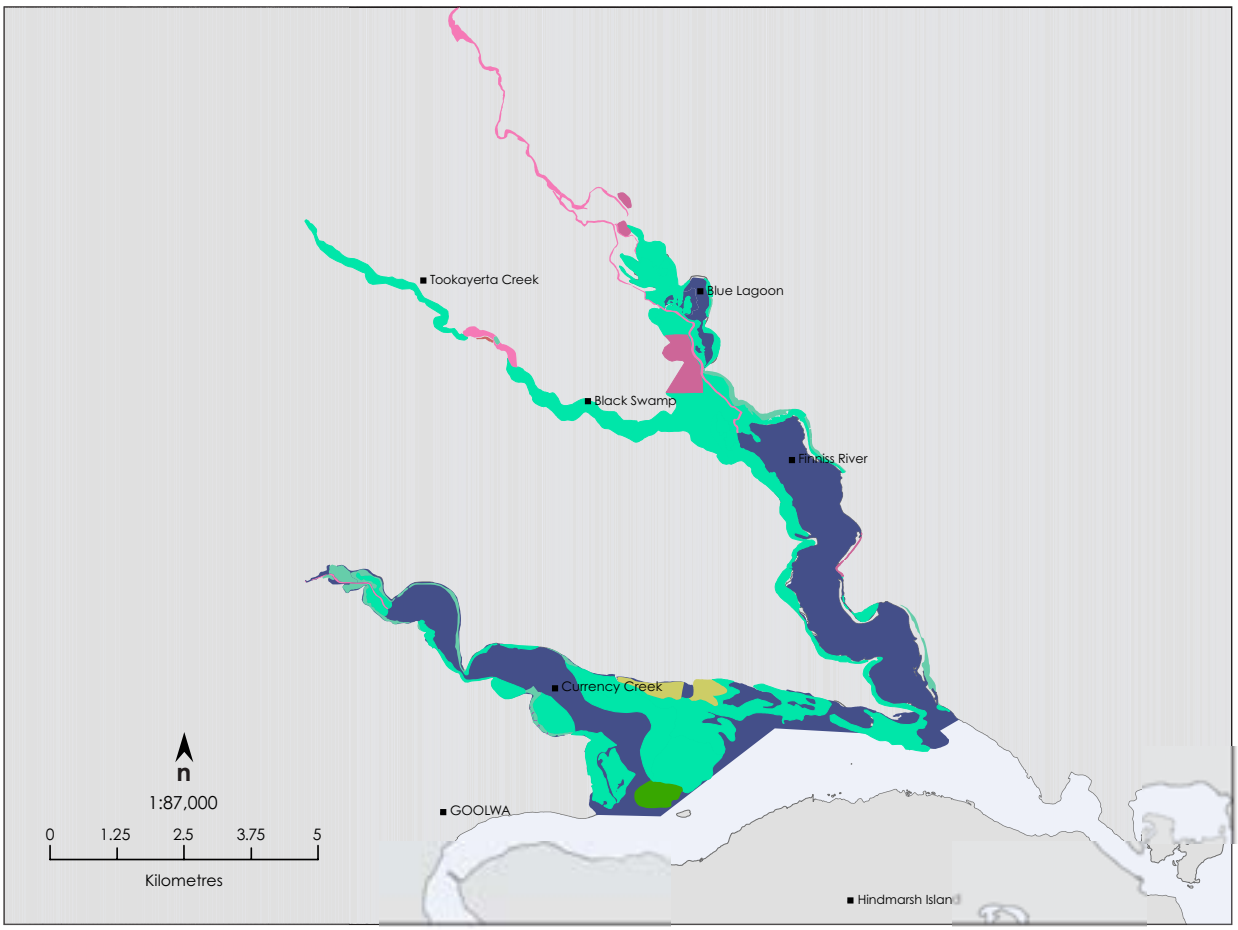
Flow was permanent in most of these streams prior to (XUSHDQ VHWWOH P HQW ZLWK VX P P HU EDVHARZ EHLQJ provided by groundwater discharge and wetland drainage (ABWMC, 2004). In modern times, only the Finniss River, Currency Creek and Tookayerta Creek can EH FRQVLGHUHG ¶SHU P DQHQW· DWKRXJK ÁRZ P D\ VWRS IRU several weeks in summer depending on local climatic conditions and extraction rates (RMCWMB, unpub. data). Water resource development was capped at 30% of winter run-off by the *5LYHU 0 XUUD\ &DWFK P HQW : DWHU Management Plan* in 2003 and Notices of Prohibition and Intent to Prescribe were issued under the *: DWHU 5HVRXUFHV Act 1997* in October 2003.

*DXJLQJ VWDWLRQV RQ &XUUHQF\ &UHHN DQG WKH 5LYHUV Finniss, Angas and Bremer show that median winter UXQRII HTXDWHV WR */ ' : /%& +\GV\V GDWD +RZHYHU SHDN LQÁRZV DUH OLNHO\ WR H[FHHG */LI H[WUDSRODWHG to include Tookayerta Creek, the whole annual cycle and parts of the catchments that are ungauged but FRQWULEXWH ÁRZ

The terminal reaches of the Finniss River and Tookayerta Creek, below Tuckers Ford on the Finniss River arm, are structurally diverse, supporting dense and diverse wetland ÁRUD UDQJLQJ IUR P 5LYHU 5HG *X P DQG UHHG OLQHG channels to swamps and peat bog freshwater marsh DUHDV 7KLV ZHWDQG V\VWH P VXSSRUWV VLJQLÀFDQW IDXQD such as Mount Lofty Ranges Southern Emu-wren (see Section 5.1.3) and pygmy perches (see Section 5.5.1), and receives generally large but variable discharge from the Finniss River and Tookayerta Creek (via Black Swamp) catchments. The patterns of release are relatively natural LQ WHU P V RI WL P LQJ IUHTXHQF\ DQG GXUDWLRQ RI ÁRZV DWKRXJK ÁRZ UDWHV DQG H[WHQW RI LQXQGDWLRQ KDYH EHHQ UHGXFHG &DSWXUH RI ÁRZV LQ WKH KHDGZDWHUV P D\ GHOD\ WKH RQVHW RI ÁRZV LQ GU\ \HDUV ZKHQ GD P V WDNH VHYHUD0 ZHHNV RU P RQWKV WR À00 EHIRUH XSSHU UHDFKHV SURYLGH ARZ *URXQGZDWHU LQÁRZV DFURVV WKH SUDLQV FRQWHUDFW WKLV WR D FHUWDLQ H[WHQW E\ VXVWDLQLQJ ÁRZV RYHU VX P P HU RU LQWLDWLQJ HDU\ DXWX P Q ÁRZV LQ GU\ \HDUV RU P RUH intensely developed sub-catchments. Water quality is generally fresh with a tannic stain and high transparency, SDUWLFXODU\ LQ DUHDV GLUHFW\ UHFHLYLQJ VWUHD P ÁRZ

&XUUHQF\ &UHHN EHJLQV DV D QDUURZ 5LYHU 5HG *X P OLQHG rocky channel broadening to a wetland habitat, and ÀQD0\ RSHQ ZDWHU DV SDUW RI /DNH $0H[DQGULQD ,W LV characterised by permanently inundated channels and wetlands, although the lower section is known to dry in response to strong winds pushing the creek water into Lake Alexandrina and disconnecting the creek and lake habitats (Wedderburn and Hammer, 2003).

,Q D UHFHQW ÀVK VXUYH\ RI ÁYH VLWHV ZLWKLQ &XUUHQF\ &UHHN submerged vegetation was observed to be generally sparse but notably more abundant in the lower reaches. Water quality only varied slightly, with salinity higher upstream (Wedderburn and Hammer, 2003). Mount Lofty Ranges Southern Emu-wren populations are thought to be locally extinct from Currency Creek wetlands primarily due to habitat fragmentation (reduced connectivity) and/or adverse changes in water regime (see Section 5.1.3).



Disclaimer - Please refer to the beginning of the ecological report for a detailed disclaimer and map data.

Source - SA DEH, Russell Seaman 2006

Figure 10 - Map of the tributary wetlands of Lake Alexandrina showing the various wetland types

Key to wetland types	
M	**Permanent rivers/streams/creeks**; includes waterfalls
O	**Permanent freshwater lakes** (over 8 ha); includes large oxbow lakes
Ss	**Seasonal/intermittent saline/brackish/alkaline marshes/pools**
Tp	**Permanent freshwater marshes/pools**; ponds (below 8 ha), marshes and swamps on inorganic soils; with emergent vegetation water-logged for at least most of the growing season
Ts	**Seasonal/intermittent freshwater marshes/pools** RQ LQRU J DQLF VRLV LQFXGHV VRX J KV SRWKRLHV VHDVRQDO\ ARRGHG P HDGR Z V sedge marshes
Xf	**Freshwater, tree-dominated wetlands** LQFXGHV IUHVKZ DWHU VZ D P S IRUHVWV VHDVRQDO\ ARRGHG IRUHVWV ZRRGHG VZ D P SV on inorganic soils
4	6HDVRQDO\ ARRGHG D J ULFXOXUDO DQG (including intensively managed or grazed wet meadow or pasture)
6	**Water storage areas**; reservoirs/barrages/dams/impoundments (generally over 8 ha)
9	**Canals and drainage channels, ditches**

: HWDQG W\ SHV DQG 5D P VDU 6L J QLÀFDQW %LRR J LFD &R P SRQHQWV Z LWKLQ WKH IUHVK Z DWHU system units (organised alphabetically by Ramsar type code)

Type D: Rocky marine shores ...

7UDIÀF OL J KW DVVHVV P HQW

The ecological roles of this wetland type are poorly understood, it has limited areal extent and the rocky shores are threatened by cattle grazing, therefore a precautionary approach of rating this type as under threat has been applied. If it is found that this habitat is critical habitat for Ramsar RU RWKHU VL J QLÀFDQW EL RWD LW VKRXG EH FKDQ J HG to 'amber' unless habitat condition and threat assessment at the time shows otherwise.

Ramsar wetland types	**D**	**Rocky marine shores**; includes rocky offshore islands, sea cliffs
Units where found	Lake Alexandrina	
Estimated areal extent in 2005 (ha)	171	
Description(s)	Not marine but inland remnants of ancient shorelines. The rocky shorelines of Lake Alexandrina contain more than 50% cover of strew (stones) on the beaches and have cliff areas comprising of exposed calcrete outcrops. Typically the vegetation is dominated by exotic grasses that are degraded by cattle grazing and trampling. These rocky areas are located along the: • eastern shore of Lake Alexandrina below Wellington (Poltalloch Plains) • southern edge of Point Sturt • in patches along lakeshore between Clayton and Point Sturt.	
Key biological components supported and how	The relative importance of this habitat type in supporting ecological communities is not known but it is likely to be DQ L P SRUWDQW QHVWLQ J VLWH IRU VR P H EL UG VSHFLHV DQG WKH FR P SOH[VKRUHOLQHV DUH OLNHO\ WR EH L P SRUWDQW IRU ÀVK DQG other aquatic biota. Rocky outcrops on Point Sturt contain notable plant species including orchids.	
Limit of acceptable change—rationale	DUHDO H[WHQW ³ WKHUH LV UHODWLYH\ OLWWOH DUHD RI WKLV W\ SH DQG ZKOH WKH IXO HFRORJ LFD UROHV DUH \HW WR EH GHÀQHG an LAC of 5% is applying the precautionary approach.	

Type E: Sand, shingle or pebble shores

7UDIÀF OLJKW DVVHVV P HQW

Only 1 ha of this wetland type remains and thus this type is extremely vulnerable to loss from the Ramsar site. It is an important part of habitat YDULDEOOW\ DQG FRQQHFWLYLW\ *LYHQ LWV ORFDWLRQ on the lakeshore near a major township, it is considered to be under immediate and extreme threat from a range of direct and indirect anthropogenic factors.

Ramsar wetland types	**E**	**Sand, shingle or pebble shores**; includes sand bars, spits and sandy islets; includes dune systems and humid dune slacks
Units where found	Lake Albert	
Estimated areal extent in 2005 (ha)	1	
Description(s)	Patches of sandy shoreline occur on the banks of Lake Albert on the western side of Meningie.	
Key biological components supported and how	Opportunistic habitat for waders, roosting site for pelicans and other waterbirds.	
Limit of acceptable change—rationale	0% (areal extent)—there is little area remaining, and it provides habitat diversity for waterbirds in particular.	

Type M: Permanent rivers/streams/creeks

Ramsar wetland types	M	**Permanent rivers/streams/creeks**; includes waterfalls	
Units where found	Lake Alexandrina (islands)		Tributaries
Estimated areal extent in 2005 (ha)	135		81
Description(s)	Natural and constructed channels on Hindmarsh ,VODQG DORZ IRU WKURXJK ÁRZ RI ZDWHU IUR P /DNH Alexandrina to the Coorong thereby connecting fresh and estuarine-saline habitats when lake levels are high. Holmes Creek has two main entrances (one P RGLÀHG QDWXUDO DQG RQH FRQVWUXFWHG FKDQQHO DQG RQH P DLQ RXWHW : DWHU FDQ ÁRZ LQ IUR P /DNH Alexandrina into a series of blind channels with very KLJK KDEWDW YDXXH 7KH ÁRZ SDWWHUQV LQ WKH FKDQQHOV are complex and highly dependent on wind and head differences between the groundwater, Lake Alexandrina, the channels and the Coorong. Mundoo Barrage fords Holmes Creek, below which the watercourse is known as Mundoo Channel. Seasonal LQÁX[HV RI VDOLQH JURXQGZDWHU SURYLGH YDLDWLRQ LQ VWUHD P VDOLQLW\ DQG UHYHUVH ÁRZ RI VHD ZDWHU LQWR IUHVK channels upstream of the barrages can occur during storm surges. ¶ : \QGJDWH· QRZ RZQHG E\ 6$ *RYHUQ P HQW DQG managed by SA DEH, is a 1088 ha property (covering approximately 22% of Hindmarsh Island). Hunters &UHHN ÁRZV WKURXJK WKH : \QGJDWH SURSHUW\ Boundary Creek and Fishtrap Creek are permanent channels that transect Mundoo Island.		Three permanent streams enter Lake Alexandrina EHWZHHQ 0LDQJ DQG *RRZD 7KHVH VWUHD P V DUH the Finniss River, Currency Creek and Tookayerta &UHHN ,QÁRZ HVWL P DWHV YDU\ IUR P ² */ SHU \HDU 1% ÁRZV P D\ EH VLJQLÀFDQW\ KLJKHU LQ YHU\ ZHW years). Dam capture rates are approaching 30% of winter run-off and are delivered in a pattern that KDV QRW EHHQ VLJQLÀFDQW\ DWHUHHG E\ ZDWHU UHVRXUFH development (DWLBC, 2004). Currency Creek has WKH 0HDVW UHULDE0H ÁRZV RI WKH WKUHH VWUHD P V DQG KDV recently become more ephemeral in nature.)URZ TXDQWLÀFDWLRQ LQ SUR JUHVV E\ ' : /%& DQG SAMDB NRM Board.
Key biological components supported and how	The complex nature of the habitat provided by the network of streams, channels and drains on Hindmarsh ,VODQG FR P EOQHG ZLWK WKURXJK ÁRZ DQG FORVH proximity to the Murray Mouth Estuary provides high habitat value for waterbirds (Jensen et al., 1996) and for most of the sites biota at some stage. ¶ : \QGJDWH· LQFOXGHV KDEWDW IRU &DSH %DUUHQ *HHVH (Rare in SA—see Section 5.5.1) and 27 other JAMBA and CAMBA bird species (see Section 5.4). There is limited, but controlled cattle grazing and cropping on ¶ : \QGJDWH· WR SURYLGH IRRG IRU &DSH %DUUHQ *HHVH which utilise the close-cropped or grazed pastures that are browning off (Seaman pers. comm.). Cattle grazing occurs to the water's edge on Mundoo Island. $ S SUR[LP DWH0\ KDII WKH ÁVK VSHFLHV IRXQG LQ WKH Lower Murray occur in these habitats, including Murray Hardyheads and Yarra pygmy perch. Dunn's Lagoon and the drains on 'Wyndgate' are particularly LP SRUWDQW 0RZ ÁRZ UHIXJLD IRU QDWLYH ÁVK &RUH 0 XUD\ Hardyhead populations are located on and around Hindmarsh Island (Wedderburn and Hammer, 2003). (see Section 5.6.1). .H\ ZHWDQG ARUD DVVH P EOD J HV DUH 7HD WUHH woodlands, samphire shrublands, freshwater sedgelands and brackish herb- and sedge-lands (Typha and Phragmites dominated), providing diverse and highly connected habitats.		The termini of these tributaries form extensive freshwater wetlands, including Black Swamp, Blue Lagoon and other EPBC-listed Fleurieu Swamps, (see Section 5.1.2) stretching from approximately 10 km VRXWK RI 0LDQJ WR N P QRUWK RI *RRZD 7KH UHOD WLYH0\ QDWXUDO SDWWHUQV LQ ÁRZ IUR P WKH SHU P DQHQW WULEXWDULHV provides habitat for a range of aquatic plants. The ÁRUDO DVVH P EOD J HV LQ WKHVH ZHWDQGV DUH KLJK0\ GLYHUVH ranging from submerged aquatic plants to silky tea tree, red gums and lignum and as such supports a ZLGH UDQJH RI VLJQLAFDQW IDXQD LQFOXGLQJ 6RXWKHUQ Emu-wren and Southern Pygmy Perch (see Sections 5.1.3 and 5.6.1, respectively). This wetland type is the only one within the Ramsar site WR FRQWDLQ 5LYHU 5HG *X P V JURZLQJ DURQJ WKH VLGHV RI the tributary channels and wetlands.	
Limit of acceptable change—rationale	2% (areal extent)—there is relatively little area, this is a vulnerable type and plays important ecological roles. 0% (habitat connectivity)—habitats with fresh, variable water regimes are critical for connections across time and space.		

» continued »

Type M: Permanent rivers/streams/creeks

7UDIAF OLJKW DVVHVV P HQW

This wetland type is considered to be under extreme threat and highly vulnerable. This rating is based on the combined factors of the high ecological value of this wetland type and immediate risks of damage from anthropogenic factors such as land and water resource development. The variable water regimes and habitats available in these wetland types support under-represented species assemblages and 5D P VDU 6LJ QLÀFDQW %LRURJ LFDO &R P SRQHQWV Combined with other island habitats and the Murray Mouth Estuary these wetlands are the 'jewel in the crown' of the modern Ramsar site.

Type N: Seasonal intermittent/rivers ...

7UDIÀF OLJKW DVVHVV P HQW

Similar to Type M above, Type N wetlands are also considered to be under immediate threat and extremely vulnerable to land and water resource development. These channels are critical connectors of various habitats and vital for maintaining the ecological functionality of the island habitats.

Ramsar wetland types	N	Seasonal/intermittent/irregular rivers/streams/creeks
Units where found	Lake Alexandrina (islands)	
Estimated areal extent in 2005 (ha)	200	
Description(s)	: LQWHU UDLQID RQ +LQG P DUVK ,VDQG SHUFRDWHV WKURXJK WKH VDQGKLOV DQG FRQVHTXHQW\ GLYHV VWUHD P ÁRZ DQG GLVFKDUJ H RI JURXQG ZDWHU LQWR GHSUHVVLRQV RQ WKH ÁDW 7KLV FUHDWHV DQQXD F\FUHV RI LQXQGDWLRQ RI DQG ÁRZ WKURXJK D FR P SUH[QHWZRUN RI LQWHU P LWWHQW VWUHD P V IUHVKZDWHU ZHWDQGV VD P SKLUH FKDQQHOV DQG P XGÁDWV thereby providing habitat connectivity across a wide range of habitat types, time and space.
Key biological components supported and how	6D P SKLUH FKDQQHOV ZLWK RSHQ DUHDV RI P XGADW WKDW UHFHLYH ARZ GXULQJ ZLQWHU DQG GU\ RII RYHU WKH VX P P HU P RQWKV WKURXJK EUDFNLVK WR VDLQH FRQGLWLRQV RFFXU DFURVV WKH +LQG P DUVK ,VDQG ADWV *Melaleuca halmatuorum* trees are sparse and are being planted around some of these samphire areas to increase habitat value. These habitats are considered important to the natural hydrological regime on Hindmarsh Island maintaining habitat FRQQHFWLYLW\ DQG GLYHUVLW\ RQ WKH LVDQGV ZKLFK LQ WXQ VXS SRUWV VLJ QLÀFDQW HFRURJ LFDO FR P P XQLWLHV 7KH VHDVRQDO and intermittent nature of these habitats may mean they play a key role in the delivery and cycling of sediments and nutrients, however this is a knowledge gap. Moreover, because the habitats of Hindmarsh Island connect fresh conditions of the lake to estuarine-saline conditions of the estuary and Coorong lagoons, they represent the last remnants of these transitional habitats that were irreversibly damaged by the construction of the barrages. As such, species that depend on variable water regimes which are not provided in the greater lake environment can reside and breed on and around Hindmarsh Island.	
Limit of acceptable change—rationale	2% (areal extent)—there is relatively little area, this is a vulnerable type and plays important ecological roles. 0% (habitat connectivity)—important wetland type in Hindmarsh Island assemblage.	

Type O: Permanent freshwater lakes

Ramsar wetland types	O	**Permanent freshwater lakes** (over 8 ha); includes large oxbow lakes	
Units where found	Lake Alexandrina	Lake Albert	Tributaries
Estimated areal extent in 2005 (ha)	62,040	17,369	71
Description(s)	Lakes Alexandrina and Albert are vast open water bodies with sandy beaches and pockets of reeds. Wetland complexes adjoin the open water, WKH P RVW VLJQLÀFDQW RI ZKLFK RFFXU DW FRQÁXHQFHV ZLWK WKH 5LYHU 0 XUUD\ between the two lakes, with the EMLR tributaries and the island streams. The open areas of the lakes once supported diverse plant communities which extended for several kilometres out into the lake (pre-European VHWWOH P HQW 7KHVH KDYH VLQFH EHHQ VL P SÀHG WKURXJK WKH P DLQWHQDQFH of static water levels in the lakes, lakeshore erosion and reduced light availability from increased turbidity. Submerged plants are now restricted to the near-shore, wetland and channel areas.		The waters of Lake Alexandrina mix with the EMLR tributary ÁRZ VLQ WKH]RQH ,Q JHQHUD these areas represent the best fresh, submerged vegetation habitat in the Ramsar site in terms of species diversity and abundance, primarily because of the variable water regime and good quality water SURYLGHG E\ WULEXWDU\ LQÁRZV These localised variations in water regime are critical for some species assemblages, habitat connectivity and for providing drought refuge. Some of the submerged aquatic plants now considered extinct in the lakes themselves still occur in the tributaries.
Key biological components supported and how	Fringing lakeshore habitats are important for a range of fauna, but they are believed to be depauperate in species such as *Baumea* spp., that rely on YDULDEOH ZDWHU UH J L P HV IRU J UR ZWK DQG UHSURGXFWLRQ * DQI DQG WKXV DUH P RVW\ FRQÀQHG WR WKH WULEXWDU\ LQÁXHQFHG DUHDV 5LYHU 0 XUUD\ FRQÀQHG KDV VHYHUDO GUDLQV EDFNZDWHUV DQG IUHVKZDWHU lagoons and includes Pomanda Island, an area of extensive reedbeds that dries when river/lake levels are low (e.g. Wedderburn and Hammer, 2003) which also supports these less common species. Areas containing variable water regime dependent emergent plants from the *Eleocharis*, *Schoenoplectus*, *Baumea* or *&\SHUXV* genera and/or submerged plants from the *Vallisineria*, *&KDUD*, *Nitella*, *Ottelia*, *Villarsia* and *Potamogeton* genera are now under-represented in the lake environment. *Ottelia ovalifolia* appears to be locally extinct (Mallen, van der Wielen, Hammer and Muller, obs.). Submerged aquatic plants are critical habitat for a range of small- and OD U J H ERGLHG QDWLYH AVK /DNH $OEHUW KDV D P RUH UHVWULFWHG UDQJH RI IUHVKZDWHU AVK VSHFLHV WKDQ /DNH $OH[DQGULQD VSHFLHV 7DEOH Wedderburn and Hammer, 2003) see Section 5.6.1) although the open water areas of the lakes were not adequately sampled for safety reasons. 7KLV GLIIHUHQFH LQ AVK GLYHUVLW\ LV OLNHO\ WR EH LQGLFDWLYH RI WKH P RUH UHVWULFWHG submerged vegetation cover, higher salinities and the lack of connectivity WR VRXUFHV RI YDULDEOH LQÁRZV VXFK DV WKH WULEXWDULHV SURYLGH IRU /DNH Alexandrina) in Lake Albert compared to Lake Alexandrina. The relative importance of the open water habitat of the main lake body for sustaining ecological communities has not been well studied, with the majority of surveys having focused on the near shore, more highly productive areas. For example Wedderburn and Hammer (2003) did not sample the open water sections of the lakes, and felt that this may have LQÁXHQFHG WKH GDWD UHFRUGHG LQ WKH VXUYH\ IRU VR P H ÀVK VSHFLHV ZKLFK prefer this habitat.		These areas are important as habitat for a wide range of fauna. They are believed to contain species such as *Baumea* spp., *Eleocharis* spp., *Schoenoplectus pungens* and *&\SHUDFHDH* that are now under-represented in the lakes units. These plants rely on variable water regime for growth and UHSURGXFWLRQ * DQI cited in DWLBC, 2005) which is provided for by EMLR tributary LQÁRZV 7KH SÔDQW VSHFLHV RI these wetlands are declining in cover and are threatened by reduced water regime YDULDEÔLW\ DQG VKLIWV LQ LQÁRZ seasonality by water resource development.
Limit of acceptable change—rationale	5% (areal extent)—these areas play important ecological roles. 0% (Tributaries water regime—see Section 6.6 also)—the patterns and volumes of EMLR tributaries need to be maintained to maintain these habitats.		

Type O: Permanent freshwater lakes

7UDIÅF OL JKW DVVHVV P HQW

Type O wetlands are abundant in the Ramsar site but those with clear, cool water, as in the Tributaries unit, are rare and under extreme threat from water resource development and increasing lake turbidity levels. Fringing lake habitats support species assemblages that once extended much further into the lake and thus are important and extremely vulnerable remnants. The turbidity of the main lake bodies needs to be below 90 NTU and the abundance and health of variable water regime-dependent biota higher for the rating to be 'green'.

Type P: Seasonal /intermittent freshwater lakes

7UDIÅF OL JKW DVVHVV P HQW

The wetlands are important remnants of the pre-European lower River Murray system that support RSBC and other species of note. They are considered to be under extreme threat and highly vulnerable because of relatively small area, location near areas of intensive human activities and capacity to support under-represented ecosystem components and processes.

Ramsar wetland types	P	Seasonal/intermittent freshwater lakes RYHU KD LQFXGHV ÁRRGSODLQ DNHV
Units where found	Lake Alexandrina	
Estimated areal extent in 2005 (ha)	120	
Description(s)	: HWDQG FR P SOH[HV WKDW ÀO DW KLJKHU DNH OHYHOV RFFXU QHDU WKH 5LYHU 0 XUD\ FRQÁXHQFH 3HOFDQ /DJ RRQ LV WKH DU J HVW DQG IDOV LQWR WKH 7\SH 3 FDWHJ RU\ ,W OLHV WR WKH VRXWKZ HVW RI : HOOQ J WRQ DQG FRQWDLQV H[WHQVLYH P XGÁDWV with extensive but degraded fringing vegetation (reeds and sedges). The catchment for Pelican Lagoon is grazed, cropped and contains a dairy on the eastern edge. Pelican Lagoon itself is used as a point for water extraction. It is connected to the River Murray by a channel that is maintained and is one of a few wetlands in Lakes region that could have pool level connection to the River Murray.	
Key biological components supported and how	Habitat connectivity between wetland and the River Murray important in supporting ecological communities associated with this habitat type and providing connectivity between a range of diverse habitats important IRU ZDWHUEOGV 7KH UHOLDQFH RQ WRSRJUDSK\ DW WKH FRQÁXHQFH DQG OLYHU ÁRZV IRU ZDWHU UHJL P H YDOLDEOW\ P HDQV that this habitat type is not common in the very static environs of Lake Alexandrina and thus it is core habitat for species reliant on variable water regimes. Considered critical bird habitat for waterbirds, waders and waterfowl (Paton, 2000) (see Section 5.4) and given ephemeral nature also likely to be important for turtles, frogs and yabbies.	
Limit of acceptable change—rationale	2% (areal extent)—there is relatively little area, this is a vulnerable type and plays important ecological roles. KDEWDW FRQQHFWLYLW\ ³ L P SRUWDQW RFDWLRQ QHDU FRQÁXHQFHV DQG WKXV FRQQHFWLRQ EHWZHHQ HSKH P HUDO DQG permanent habitats.	

Type Ss: Seasonal/intermittent saline/brackish ...

Ramsar wetland types	Ss	Seasonal/intermittent saline/brackish/alkaline marshes/pools	
Units where found	Lake Alexandrina	Lake Albert	Tributaries
Estimated areal extent in 2005 (ha)	15	241	48
Description(s)	7KLV ZHWODQG W\SH LV GHÀQHG DV EHLQJ VLPLODU WR 7\SH : EHUR Z EXW GRPLQDWHG E\ VDOLQH GHSUHVVLRQV VDOLQDV DQG typically supports samphire vegetation. The key determinants for samphire vegetation are salinity levels, which result from the competing processes of rainfall, run-off, evaporation and saline groundwater inputs creating hypersaline soils and standing water. The mosaic of habitats thus created are considered critical habitat assemblages that are vital for effective habitat connectivity (see Section 6).		
	Polltaloch Plains (near Wellington), Hindmarsh Island and Mundoo Island have the greatest concentration of these salinas in /DNH $OH[DQGULQD *URXQGZDWHU levels vary considerably on Hindmarsh Island, being highest in winter following storm events. *URXQGZDWHU WHQGV WR EH VDOLQH 2 SSW DQG AOOV GHSUHVVLRQV RQ WKH ADWV IRU PLQJ VD P SKLUH fringed salinas and lined channels. Mundoo Island contains patches that are wet all year (due to higher groundwater table and more FKDQQHO LQAXHQFH WKDQ +LQG P DUVK Island) and support more diverse and abundant reeds and sedges.	: LWKLQ /DNH $OEHUW WKHUH DUH AYH areas of seasonal saline marshes, WKH ODUJHVW DQG P RVW VLJQLAFDQW LV Waltowa Swamp on the eastern edge of the lake. This represents a series of separate salina basins, interconnected at high lake levels with each other and Lake Albert. Lignum and reeds occur in areas where freshwater inputs support fresher patches of soil and thus a wetter water regime.	Samphire and samphire-lignum communities associated with high elevation basins or depressions occur on the peninsula between Currency Creek and Finniss River, behind extensive reedbeds along the lake margin. These communities typically receive VLJQLAFDQW IUHVKZDWHU UXQ RII as well as groundwater inputs during winter and spring which accumulates in the depressions. The water evaporates over summer through brackish to saline conditions providing a range of habitats and physico-chemical environs over time and space. The salinity regime of individual depressions is affected by water regime and rates of evaporation on a seasonal basis.
Key biological components supported and how	7KLV KDELWDW LV LP SRUWDQW DV IHHGLQJ KDELWDW IRU P LJUDWRU\ ZDGHUV ZDWHUIRZO DQG ZDWHUEUGV DQG DIWHU ÁRRGLQJ biota that could opportunistically utilise inundated brackish wetlands for breeding and feeding (EarthTech, 2003 and MDBC, 2003). 7KH GHSUHVVLRQV WKDW VHDVRQDOO\ ÀOO DQG GU\ IRU P LP SRUWDQW P XGÁDWV LQ VSULQJ DQG VX P P HU		
	The Poltalloch Plains area is considered critical habitat for waterfowl, waders, waterbirds (Wetland Types W, Ss) by Paton (2000) (see Section 5.4).	The high degree of interconnectedness of this site and the diversity of wetland ARUD HQKDQFH LWV FDSDFLW\ WR support a diverse range of plants and animals. Sand dunes are often intersperse a with the salinas providing protected KDELWDW IRU VLJQLAFDQW ARUD VXFK as *Pterostylis arenicola,* Sandhill greenhood orchid and *Thelymitra epipactoides*, Metallic sun-orchid. (see Section 4.4.1). 7KH *RRUZD WR : HOOQJWRQ /RFDO Action Planning group is currently preparing Discussion Paper on Waltowa Swamp. This wetland is connected to but outside the Ramsar site.	
Limit of acceptable change—rationale	2% (areal extent)—there is relatively little area, this is a vulnerable type and plays important ecological roles. 0% (habitat availability)—connections between habitats of varying salinities, in good condition, across time and space are considered critical, particularly connections with wetland types Tp, O, W, Xf and Ss.		

Type Ss: Seasonal/intermittent saline/brackish ...

7UDIAF OLJKW DVVHVV P HQW

This is an important wetland type in the freshwater units assemblages that connect various other wetland types. They are under threat from grazing and altered water regime. These habitats are also considered extremely vulnerable because they occur at the top of the seasonal variations in groundwater levels and thus are vulnerable to reduced hydraulic pressure and also because of trampling of brittle vegetation and pugging of anoxic soils by cattle.

Type Ts: Seasonal freshwater marshes

7UDIAF OLJKW DVVHVV P HQW

Once the dominant type, these wetlands are considered to be under extreme threat because they are high-elevation wetlands dependent RQ YDULDEOH ÁRZV DQG ÁRRGV 7KH\ DUH DOVR considered vulnerable because they connect important habitats and support ecological processes and components that are dependent RQ YDULDEOH ZDWHU UHJLP H DQG ÁRRGLQJ

Ramsar wetland types	Ts	**Seasonal/intermittent freshwater marshes/pools** on inorganic soils; includes sloughs, potholes, VHDVRQDOO\ ÁRRGHG P HDGRZV VHGJH P DUVKHV	
Units where found	Lake Alexandrina		Tributaries
Estimated areal extent in 2005 (ha)	941		96
Description(s)	Seasonal freshwater marshes occur on the Holmes &UHHN ÁRRGSODLQ RQ /RQJ ,VODQG DQG LQ D VWULS DORQJ the shore of Lake Alexandrina from Milang north to the Mouth of the Bremer River. These wetland areas AO LQ ZLQWHU ZKHQ ODNH OHYHOV ULVH WKHQ EHFR P H disconnected from the lake acting as nurseries for frogs and turtles. Vegetation is dominated by emergent reeds and sedges as for wetland Type Tp. +RO P HV &UHHN ÁRRGSODLQ FRQWDLQV D FR P SOH[RI KLJK elevation wetland areas. Inundation occurs in winter when lake levels approach approximately 0.8 m AHD. Similarly, Long Island contains areas with seasonal freshwater marshes. The area of lakeshore from Milang north past the Mouths of the Angas and Bremer Rivers is described by Thompson (1986 cited in EarthTech, 2003) as an almost continuous series of temporary and permanent wetlands stretching for 5–6 km each side of Milang.		' XLQJ SHULRGV RI KLJK ARZ V LQ WKH WULEXWDULHV DQG RU ARRGLQJ LQ WKH ODNHV WKH DUHDV RI ZHWODQG LQXQGDWHG DURXQG WKH WULEXWDU\ FRQÁXHQFHV LQFUHDVHV 7KHVH higher level wetland communities blend with the wetland assemblages that require more permanent water (and thus occur down-gradient) to complete the gradation from terrestrial plant communities to obligate aquatic communities.	
Key biological components supported and how	6HDVRQDO IUHVKZDWHU P DUVKHV FDQ VXSSRUW VLJQLÅFDQW ecological communities with many species of invertebrates and plants being adapted to the wetland having a dry period. Seasonal freshwater marshes can be highly productive systems and are often important feeding habitat for waterbirds. $URXQG /DNH $OH[DQGULQD WKHVH DUHDV DUH ÀOOHG LQ winter then become disconnected from the lake and are considered especially important for frogs and turtles that feed on the abundant insects. Habitat connection to permanent inundated wetlands and channels and drains (e.g. Hindmarsh Island and Angas and Bremer irrigation channels) provides a wide range of water regimes to which different species are adapted, and effectively extends the wetland habitats. The area of this habitat W\SH VXJJHVWV WKDW LW SURYLGHV D VLJQLÅFDQW FRQWULEXWLRQ to the diversity of the ecological communities of Lake Alexandrina.		Species such as *Acacia retinodes*, Swamp Wattle and *Leptospermum lanigerum,* Woolly Tea-tree are contained within this wetland type (EarthTech, 2003). Obligate aquatic plants include *Triglochin procerum*, Water ribbons, *&HUDWRSK\OXP* spp., Hornwort, *charaphytes* and *Myriophyllum* spp., Water Milfoil. A range of orchids, daises, ferns and grasses, including Silver Daisy-bush, *Olearia pannosa* var. *pannosa*, that are otherwise underrepresented in South Australia also occur here within or adjacent to Tookayerta Creek. The Finniss Estuary is considered critical bird habitat for waterfowl, waterbirds and the Mount Lofty Southern Emu-wren (Paton, 2000) based on the birds dependence on seasonal wetlands. Currency Creek is also considered critical bird habitat for waterfowl and waterbirds (Paton, 2000; Seaman, unpublished data), although Southern Emu-wren has not been sighted in Currency Creek in recent times, suggesting the local population may have died out (see Sections 5.4 and 5.1.3, respectively).	
Limit of acceptable change—rationale	5% (areal extent)—this type plays important ecological roles. KDEWDW DYDUDEOW\ ³ RQFH GR P LQDQW W\SH QR Z UHVWULFWHG WR FRQÁXHQFHV &ULWLFDO IRU KDEWDW FRQQHFWLYW\ DQG 5D P VDU 6LJQLÅFDQW %LRORJLFDO &R P SRQHQWV		

Type Tp: Permanent freshwater marshes

Ramsar wetland types:	Tp	**Permanent freshwater marshes/pools**; ponds (below 8 ha), marshes and swamps on inorganic soils; with emergent vegetation water-logged for at least most of the growing season	
Units where found	Lake Alexandrina	Lake Albert	Tributaries
Estimated areal extent in 2005 (ha)	2410	958	1106
Description(s)	Extensive reedbeds fringed both lakes in pre-European times (Sim and Muller, 2004). Distribution has changed over time with variations in lake salinities prior to barrage construction (due to sea water ingression) and altered lake levels since barrage construction. $UHDV QHDU WKH 5LYHU 0XUUD\ DQG WULEXWDU\ FRQÅXHQFHV VXFK DV %RJ J\ Lake, Dog Lake and Tolderol point area and south towards Milang have reedbeds which have persisted since before barrage operations (EarthTech, 2003). The Mouth of Lake Albert referred to as the Narrung Narrows supports extensive reedbeds of *Typha domingensis* and *Phragmites australis*. Static water levels promote growth of these species. The wetland complexes, such as West Kilbride, Waltowa Swamp and Belcanoe, contain extensive reeded areas and abundant submerged vegetation.		The bulk of the Tributary component is made up of wetlands of this type, fringing the tributary wetlands and extending into the water further DURXQG FRQÅXHQFHV 7KLV DUHD has supported freshwater swamp vegetation since before barrage operation. Black Swamp is a freshwater marsh (with areas of peat bog) associated with the Mouth of the Finniss River and Tookayerta Creek, with extensive reedbeds, riparian shrubs and tree species such as *Eucalyptus camaldulensis*, 5LYHU 5HG *X P
Key biological components supported and how	Emergent macrophyte beds are dominated by *Typha domingensis, Phragmites australis and Bolboschoenus medianus*. These plants often form dense stands and allow other species to colonise in the sheltered areas of the reedbeds, for example submerged plants like *8WULFXODUD : RÅD /HPQD 6SURGHOD 1WHHOD* and *&KDUD* and herbland species such as *Triglochin procerum* and *T.striatum*. Species under-represented in the Type O wetlands such as *Baumea* spp., *Eleocharis* spp., *Schoenoplectus pungens* and *&\SHUDFHDH* FDQ EH IRXQG DW FRQÅXHQFHV DQG WULEXWDU\ LQÅXHQFHG DUHDV GXH WR WKHLU UHLDQFH RQ QDWXUDO YDULDWLRQ LQ ZDWHU UHJLPH IRU JURZWK DQG UHSURGXFWLRQ *DQI : KLJVW WKH H[WHQVLRQ RI WKH UHHGEHGV WKURXJKRXW WKH /DNHV SRVW EDUDJH FRQVWUXFWLRQ is well documented (EarthTech, 2003; DWLBC, 2005) there does not appear to be an associated expansion of rookery sites in reedbeds that have developed since the construction of the barrages (EarthTech, 2003). The reedbeds in the permanent freshwater marshes provide important refugia for biota with regard to feeding sites, DUHDV RI SURWHFWLRQ IUR P SUHGDWRUV H J V P D0 ÀVK WDGSRLHV HWF DQG DV EUHHGLQJ DUHDV (DUWK7HFK DQG Pedler and Mallen (2001 cited in EarthTech, 2003) found that the most diverse plant assemblages associated with this habitat type were usually in sites found behind the main lakeshore ranging from shallow depressions to large freshwater swamps, and areas in the Finniss River, Tookayerta Creek and Currency Creek tributaries where wave action was limited.		
	The areas of reedbeds that were recorded as waterbird rookeries pre-barrage construction still exist and support seasonal breeding colonies. Waterbird breeding areas on Lake Alexandrina include: Tolderol Point—Snake Island, Mosquito Point—Boggy Lake area, South of Milang, Kindaruar Corner – Reedy 3RLQW 2SSRVLWH &UD\WRQ ² *RDW ,VDQG *RRVH ,VDQG)LQQLVV 5LYHU Mouth, Currency Creek Mouth, Salt Lagoon islands, Coolindawerh Lagoon, Rat Island and Rushy Island (EarthTech, 2003) (see Section 5.3). Other areas of extensive and dense emergent vegetation include: Loveday Bay, connection between Mud island and long island, Pelican Lagoon, 5LYHU 0XUUD\ FRQÅXHQFH near Wellington and tributary FRQÅXHQFHV	The reedbeds in the Narrung Narrows and other areas have become noted as long term rookery sites for several species of Ibis, Spoonbill and Cormorants. The protected shallow wetland areas on the inshore areas of the reedbeds are important habitat IRU V P D0 ÀVK VSHFLHV 0 '%& (see Section 5.3). In Lake Albert, this habitat is LGHQWLAHG DV FULWLFDO ELUG KDEWDW in the following areas (from Paton, 2000): • Narrung Narrows—waterbirds and ibis (area incorporates Tp, O, W and Ss habitats) • Reedy Point—waterbirds, pelicans (Tp, O) • Waltowa Swamp—waterfowl, waterbirds, waders (Tp, Ss, W) • Waringee Point—waterfowl, waders (Tp, O) (see Sections 5.3 and 5.4). *Phragmites* beds on Lucerne Island and Lake Albert Station also important (MDBC, 2003).	The tributary wetlands provide freshwater habitats that were once more widespread in Lakes Alexandrina and Albert. Mount Lofty Southern Emu-wren (see Section 5.1.3) utilise the wetlands at the termini of Finniss River and Tookayerta Creek for feeding amongst the dense vegetation. *Juncus pallidus*, in particular, is an important food plant providing the birds with insects (Fletcher, 1915). Since land clearance, they have been forced to also utilise the tributary wetlands as nesting sites (Littley and Cutten, 1994 as cited by Kahrimanis et al., 2001). Submerged macrophytes such as *Myriophyllum* sp., Water Milfoil and *&HUDWRSK\0XP GHPHUVXP* Hornwort occur in dense beds throughout this area. These types of macrophytes are critical for spawning and habitat of a range RI REOJDWH IUHVKZDWHU AVK ZKLFK rely on the fresh, cool, clear water (see Section 4.8.1). Emergent and herbland plant species of note include:

» continued overleaf »

Key biological components supported and how (continued)		The entrance to Waltowa Swamp is considered critical habitat IRU WKUHDWHQHG V P DX QDWLYH ÅVK species by Wedderburn and Hammer, (2003) (see Section 5.6.1). Notably Murray Hardyhead was UHFRUGHG IRU WKH ÅUVW WL P H LQ /DNH Albert at this wetland entrance.	*Baumea articulata*, Jointed twig rush; *Blechnum minus*, Soft water fern; *Eleocharis* sp., *&DUH[JDXGLFKDXGLDQD* Fen sedge and *Hydrocotyle pterocarpa* Wing pennywort. *Ottelia ovalifolia* now appears to be extinct from the lake environment and occurs only in dams and in-channel wetlands in the upper Tookayerta Creek and Finniss River catchments. (Mallen, van der Wielen, Hammer and Muller, obs.). Yarra Pygmy Perch, Southern Pygmy Perch and Murray Hardyhead occur here, the latter in the only known population to inhabit extensive freshwater habitats (Wedderburn and Hammer, 2003) (see Section 5.6.1). This area supported Purple Spotted *XGJHRQ 0 XUUD\ 5DLQERZ)LVK and Chanda Perch up until the 1970s (some of the last remnants LQ 6$ /DUJH QDWLYH ÅVK VXFK DV 0 XUUD\ &RG *RGHQ 3HUFK DQG FDWÅVK KDYH DVR EHHQ UHSRUWHG from this area (Rutherford, 1991; Sim et al., 2000 as cited in Wedderburn and Hammer, 2003). Locally abundant submerged aquatic vegetation in the DUHD RI 1RUWK *RRZD beach is believed to be a key component which VXSSRUWV QX P HURXV AVK VSHFLHV surveyed in the area in 2003. In particular hundreds of Flyspecked Hardyhead of all size classes were recorded during the survey at the North *RRZD EHDFK DUHD ³ WKH only stronghold detected in the Lakes for the species (Wedderburn and Hammer, 2003) (see Section 5.6.1). The tributaries also contain the RQ\ VWDQGV RI 5LYHU 5HG *X P V downstream of Wellington. They are restricted to the margins of the tributary wetlands and WKHLU ÅRRGSLDQV DQG DUH GHSHQGHQW RQ WULEXWDU\ ÅRZV and groundwater levels and quality.
Key biological components supported and how	5% (areal extent)—this type plays important ecological roles. 0% (habitat availability)—all aspects of habitat availability considered important for maintaining species assemblages. Maintaining connectivity between Tp, O, W, Xf and Ss types is considered essential.		

Type Tp: Permanent freshwater marshes

7UDIAF OLJKW DVVHVV P HQW

8UJ HQW QHHG WR UHYHUVH WKH VL P SOÀFDWLRQ RI WKH emergent vegetation communities around the lakeshore that has resulted from static regulated lake levels to ensure on-going provision of habitat for RSBC and other species. Diverse emergent and submerged wetland vegetation are considered keystone assemblages for the freshwater units. *LYHQ WKH DERYH SUXV SRRU FXUUHQW FRQGLWLRQ DQG diversity, and high exposure to human activities, these wetland types are considered to be under threat and extremely vulnerable.

Type W: Shrub-dominated wetlands

7UDIAF OLJKW DVVHVV P HQW

Samphire communities cover relatively large areas of both the fresh and estuarine-saline units. They are however under threat from activities such as cattle grazing and alterations to groundwater and surface water dynamics. Although abundant, these wetlands are not given a 'green' rating primarily because of threats from land and water resource development to habitat connectivity between wetlands of this type and types Tp, O, Xf and Ss.

Ramsar wetland types	**W**	**Shrub-dominated wetlands**; shrub swamps, shrub-dominated freshwater marshes, shrub carr, alder thicket on inorganic soils
Units where found	Lake Alexandrina	Lake Albert
Estimated areal extent in 2005 (ha)	2190	525
Description(s)	7KH UHHGEHGV DURXQG WKH ODNH P DUJLQV JUDGH LQWR OLJQX P DQG VD P SKLUH ADWV DV HOHYDWLRQ DQG WKXV GLVWDQFH IUR P WKH ODNH LQFUHDVHV 7KHVH VD P SKLUH DQG OLJQX P ADWV DUH UHODWLYHO\ ADW DQG UHFHLYH UH J XODU IUHVK AXVKHV when the lake level exceeds approximately 0.85 m AHD. Evaporation provides the saline soils needed by the samphire vegetation with intrusions of freshwater provided via static and raised lake levels and wave splash from wind action. Shrub-dominated wetlands in Lake Alexandrina have undergone a number of changes in distribution and condition since European settlement, primarily due to variations in salinity between 1880s and 1940s (sea water intrusions pre-barrages), the higher and more static lake margin post-barrage construction and agricultural land clearance and grazing. They now fringe many parts of the lake, although they are subject to cattle grazing in most areas. This is also the dominant habitat type along the northern edge of Lake Albert associated with the edges of Type Ss and Tp wetlands.	
Key biological components supported and how	Samphire wetlands include low shrubland formations and can be fringed by lignum, native grasses and/or *Melaleuca halmatuorum*, Swamp Paperbark depending on the water regime. The close associations thus made with other plant communities are an important feature of the habitat value of samphire shrublands. Dominant samphire species include *Halosacrcia pergranulata* ssp *pergranulata,* Black Seed Samphire; *Sclerostegia arbuscula*, Shrubby Samphire; *Suaeda australis*, Austral Seablite, and species of *Sarcocornia* (EarthTech, 2003). Refer to Brandle (2002) for listing of additional samphire species. Remnant samphire communities support diverse faunal assemblages. When combined with lignum or paperbarks they become important rookery sites, and also offer sheltered feeding grounds in semi-permanent lagoons (MDBC, 2003). For example, Coolinderwerh Lagoon is a swamp paperbark fringed samphire wetland representing habitat that is now considered very rare in the Lakes. Samphire wetlands Type W occur in a number of areas which are considered as critical habitat for waterbirds (from Paton, 2000): • +LQG P DUVK ,VDQG DQG RWKHU EDUUD J H LVDQGV ³ ZDWHUIR Z ZDGHUV ZDWHUEUGV DQG &DSH %DUUHQ *HHVH LQFXGHV habitat types W, 4) • Milang shore—waterfowl, waders, waterbirds (W, Ts, 4, Tp) • Milang Town—Latham's Snipe (W) • Wellington Point—Darters, waterbirds (W) • Poltalloch—waterfowl, waders, waterbirds (W, Ss) • Yalkuri and Salt lagoon—waterfowl, waders (Tp, W, Xf). • Cormorant nesting site Salt Lagoon Conservation Park, Lucerne Island (W, Xf) (see Sections 5.3 and 5.4) 2WKHU ORFDWLRQV VXS SRUWLQJ : W\SH ZHWDQGV LQFXGH +RP HV &UHHN %RJ J \ &UHHN *RRZD &KDQQH 0XQGRR &KDQQH 0XUD\ 0RXWK 0XG ,VDQG *D P H 5HVHUYH ,VDQG DQG &D\WRQ ³ *RDW DQG *RRVH ,VDQGV 0 '%& 7KH VD P SKLUH ADWV QHDU WKH 0RXWK RI WKH $QJDV DQG %UH P HU 5LYHUV DUH FRQQHFWHG WR RYHUDQG ÁRZ IUR P WKH Angas River in particular, and lie adjacent to other valuable habitats such as submerged vegetation in irrigation FKDQQHOV 5LYHU 5HG *XP VZD P SV RQ WKH %UH P HU 5LYHU ÁRRGSODLQ DQG H[WHQVLYH UHHGEHGV DURQJ WKH ODNHVKRUH	
Limit of acceptable change—rationale	5% (areal extent)—this type plays important ecological roles. 0% (habitat connectivity)—connections between Tp, O, W, Xf and Ss considered essential.	

Type Xf: Freshwater tree-dominated wetlands

7UDIAF OLJKW DVVHVV P HQW

These trees are under extreme threat of local extinction due to their poor current condition at most freshwater remnant sites supported by 5LYHU 0XUUD\ ÁRZV 2QFH D GR PLQDQW ZHWDQG type, the trees, and the species dependent on them (e.g. birds of prey), are considered extremely vulnerable, based on the lack of regular recruitment and their very small areal coverage. Local replanting efforts require additional resources to be truly effective at arresting the decline.

Ramsar wetland types	Xf	**Freshwater, tree-dominated wetlands** LQFXGHV IUHVKZDWHU VZDP S IRUHVWV VHDVRQDO\ ÁRRGHG IRUHVWV wooded swamps on inorganic soils	
Units where found	Lake Alexandrina		Tributaries
Estimated areal extent in 2005 (ha)	100		10
Description(s)	*Melaleuca halmatuorum*, Swamp Paperbark distribution in the Lake Alexandrina component of the Ramsar site is very patchy, with stands located at: • Salt Lagoon • Collinderwerh Lagoon • Dunn's Lagoon • +RUP HV &UHHN ARRGSUDLQ • %RJ J\ &UHHN ARRGSUDLQ • fringing salinas (Type Ss) • 'Wyndgate' freshwater channels • +XQWHU &UHHN FRQAXHQFH ZLWK &RRURQJ • &XUUHQF\ &UHHN FRQAXHQFH ZLWK /DNH $UH[DQGULQD Paper-bark primarily occurs in two habitats in Lake Alexandrina: near FRQÁXHQFHV H J +RUP HV DQG +XQWHUV &UHHNV RU ILUQJLQJ VDLQH OD J RRQV (e.g. Coolinderwerah) in association with samphire, native grasses, dunal shrubs and/or reeds depending on water and salinity regimes.		*Melaleuca halmatuorum*, Swamp Paperbark forms ZRRGLDQGV DW WKH FRQAXHQFH of Currency Creek and Lake Alexandrina, on the northern banks. Water regime is highly dependent on lake levels, wind direction and speed.
Key biological components supported and how	*Melaleuca halmatuorum* is the only wetland tree species in the bulk of the Ramsar site given that River Red *X P V DUH UHVWLFWHG WR WKH 7LEXWDULHV &RRLQGHUZ HUK /DJ RRQ DQG 'XQQ·V /DJ RRQ DUH VZ D P S 3DSHUEDUN ILUQJ HG ZHWDQGV UHSUHVHQWLQJ KDEWDW WKDW LV QRZ FRQVLGHUHG YHU\ UDUH LQ WKH UDNHV 7KH ZHWDQG ÁRUD DW WKHVH sites is complex, driven by variation in soil salinity levels and topography. These habitats support diverse faunal assemblages, with the paperbarks being important rookery sites and nesting and foraging grounds for a wide range of waterbirds (Jensen et al., 2000). They also offer sheltered feeding grounds in semi-permanent lagoons (MDBC, 2003) (see Section 5.4). *UHHQZD\ GLVFXVVHV VR P H IXWKHU GLUHFW EHQHÀWV IUR P *Melaleuca halmaturorum*. These include K\GUROR J LFDU DQG HFROR J LFDU EHQHÀWV VXFK DV • LP SURYHG ZDWHU TXDOLW\ DQG FRQWUROOHG VHGLP HQWDWLRQ E\ ÀOWHULQJ VHGLP HQWV • essential cycling of carbon, nutrients and contaminants between rivers and estuaries (food source for heterotrophic micro-organisms and detritivores) • SURYLGH OROQ J OLYHG WH P SRUDU\ DQG SHU P DQHQW KDEWDW IRU D YDULHW\ RI ÁRUD DQG IDXQD LQFXGLQJ URRVWLQJ DQG breeding areas for wildlife particularly colonial nesting birds • SURYLGLQJ D SURWHFWLYH SK\VLFDU EXIIHU DQG ÁRRG PWLJ DWLRQ EHWZ HHQ VKRUHLQHV DQG ZDWHU ERGLHV • act as long-term biomass sinks and drought refugia • provide groundwater recharge areas and thus freshwater source for people and wildlife • provide valuable food sources for migratory birds that rely on nectar during autumn and winter months. *UHHQZD\ 0 : *HWDQGV LQ D 'U\ /DQG 8QGHUVWDQGLQJ IRU 0DQDJH P HQW*, Albury, New South Wales, 29–30. Environment Australia.		
Limit of acceptable change—rationale	2% (areal extent, whole site)—there is relatively little area, this is a vulnerable type and plays important ecological roles. 0% (areal extent, Hindmarsh Island)—critical location and under-represented type 0% (habitat connectivity)—critical connections to types Tp, O, W, Xf and Ss.		

7\SH 6HDVRODQ\ ÁRRGHG DJULFXOWXUDO ODQG

7UDIAF OLJKW DVVHVV P HQW

A 'green' rating has been given to this wetland type because it is not under threat but rather promoted by human activities, particularly by the active management of 'Wyndgate' to provide wetland habitats of this type for Cape Barren *HHVH VHH 6HFWLRQ

Ramsar wetland types	**4** 6HDVRQDQ\ ÁRRGHG DJULFXOWXUDO ODQG (including intensively managed or grazed wet meadow or pasture)	
Units where found	Lake Alexandrina	Tributaries
Estimated areal extent in 2005 (ha)	1175	60
Description(s)	*UDJLQJ DQG FURSSLQJ ODQG RQ +LQG P DUVK DQG Mundoo Islands and on Mosquito Point between Boggy Lake and Dog Lake.	/RZ O\LQJ DJULFXOWXUDO ODQG ZLWKLQ WKH ÁRRGSODLQ RI WKH)LQQLVV 5LYHU SUL P DUO\ XSVWUHD P RI LWV FRQÁXHQFH with Tookayerta Creek is subject to seasonal inundation. The majority of this land is or has been XVHG IRU JURZLQJ ÁRRG RU SLYRW LUUL JDWHG OXFHUQH FURSV Perennial horticulture tends to occur higher on the sandy and limestone rises, out of the wetland area, although vineyards are often planted to break of slope which may be within 100 m of the wetland edge depending on topography.
Key biological components supported and how	Close-cropped or grazed pastures that are drying off are considered important habitat for Cape Barren *HHVH RQ +LQG P DUVK DQG 0 XQGRR LVDQGV (R. Seaman, pers. comm.), thus the DEH-owned property 'Wyndgate' is in part managed to provide WKHVH SDVWXUHV IRU &DSH %DUUHQ *HHVH VHH 6HFWLRQ 5.5.1). Swans may also be utilising 'green pick' on grazing lands as a replacement for main native food plants from the Coorong area that are in severe decline (e.g. *Ruppia* spp.) (see Section 6).	,W LV DVVX P HG WKDW DJULFXOWXUH RQ WKHVH ÁRRGSODLQ DUHDV is not intensive or regular. The greatest impact has EHHQ ODQG FUHDUDQFH DQG ÁRZ P DQLSXODWLRQ LQ WKH past which has lead to reduced habitat extent and connectivity. It may be that the pasture areas provide 'green-pick' for waterbirds particularly in areas where the aquatic plant distribution and abundance has declined and thus native food sources are limited.
Limit of acceptable change—rationale	None indicated as these are not natural wetlands. 1% ¶ : \QGJDWH· SURSHUW\ RQ +LQG P DUVK ,VDQG FRQWDLQV ÁRRGHG DJULFXOWXUDO ODQG P DQDJHG IRU &DSH %DUUHQ *HHVH VHH 6HFWLRQ	

Type 6: Water storage areas

7UDIAF OLJKW DVVHVV P HQW

Dams of this nature are common in the landscape surrounding the Ramsar site, and as are Type 4 wetlands, they are promoted by human activities rather than threatened.

Ramsar wetland types	6	**Water storage areas**; reservoirs/barrages/dams/impoundments (generally over 8 ha)
Units where found	Tributaries	
Estimated areal extent in 2005 (ha)	1	
Description(s)	&XUUHQF\ &UHHN ZLQHU\ KDV D GD P IHG E\ D P HGLX P ÁRZ OHYHO FKDQQHO RULJLQDWLQJ LQ WKH EDQN RI 7RRND\HUWD &UHHN LP P HGLDWHO\ XSVWUHD P RI :LQHU\ 5G FDXVHZD\ 7KLV GD P LV IHG GXULQJ SHULRGV RI P HGLX P VWUHD P ÁRZ DQG spills back into the creek (sometimes via a waterwheel).	
Key biological components supported and how	8QLNHO\ WR SURYLGH DQ\ VLJQLÁFDQW EHQHÁW WR NH\ EURRJLFDO DVVHWV GXH WR V P DO VL]H DQG ORFDWLRQ QH[W WR SHU P DQHQW DQG UHODWLYHO\ RSHQ VHFWLRQ RI 7RRND\HUWD &UHHN 0 D\ EH LQFLGHQWDO KDEWDW IRU V P DO QDWLYH ÁVK DQG obligate aquatic macroinvertebrates.	
Limit of acceptable change—rationale	None indicated as these are not natural wetlands.	

Type 9: Canals and drainage channels, ditches

7UDIAF OLJKW DVVHVV P HQW

Although constructed, these channels are YDXHG IRU SURYLGLQJ IUHVK ÁRZLQJ FUHDU FRRU habitats that are now under-represented at this Ramsar site. These sites support RSBC, particularly V P DU QDWLYH ÀVKHV VHH 6HFWLRQ 7KH \ DUH WKUHDWHQHG E \ GUHGJLQJ LQÀXOLQJ DQG WKH VKXWWLQJ GRZQ RI SXP SV GXLQJ FULWLFDU ÁRZ SHULRGV

Ramsar wetland types	9	Canals and drainage channels, ditches	
Units where found	Lake Alexandrina	Lake Albert	Tributaries
Estimated areal extent in 2005 (ha)	28	1	15
Description(s)	&RQVWUXFWHG FKDQQHOV DUH FRQFHQWUDWHG DW WKH 5LYHU 0 XUUD\ FRQÁXHQFH along the shore of Lake Alexandrina from Milang north to the Mouth of WKH %UH P HU 5LYHU DQG RQ +LQG P DUVK ,VDQG 6R P H FKDQQHOV DUH P RGLÀHG natural channels whilst others have been constructed by evacuating the DNH ÁRRU DQG RU ÁRRGSODLQ 7KH P DLQ SXUSRVH RI P RVW RI WKHVH FKDQQHOV is to feed water to pumps situated at the landward end (50–250 m from lakeshore). Some of the channels on Hindmarsh Island were originally constructed for management of saline groundwater and surface run-off and are generally considered under wetland Type M above. Only a small area of 1 ha of this type of habitat is found within the bounds of Lake Albert. These are located on Lake Albert Station road and on Narrung Peninsula.			Irrigation channels used to deliver Lake Alexandrina or surface tributary water to irrigation pumps occur along the shore near &XUUHQF\ &UHHN *D P H 5HVHUYH
Key biological components supported and how	The key ecological function of irrigation channels in the lakes area is SURYLVLRQ RI IUHVK ARZLQJ ZDWHU KDEWDWV ZKLFK VXSSRUW H[WHQVLYH HGJH habitat and a high complexity of habitat types within close proximity. The irrigation channels which line the Lake Alexandrina from the Mouth of the Bremer River to the Mouth of the Angas River provide a VL P XODWHG IUHVKZDWHU ÁRZ GXH WR SXP SLQJ XS WKH FKDQQHO ZKLFK LQ WXUQ SURYLGHV KDEWDW IRU VXE P HUJHG DTXDWLF SODQWV DQG V P DU QDWLYH ÁVK such as Southern Pygmy Perch. These are considered critical habitats for restoration works by Wedderburn and Hammer, (2003), particularly JLYHQ WKDW ÁRZ UDWHV LQ ERWK WKH $QJDV DQG %UH P HU 5LYHUV KDYH GHFUHQHG in recent decades due to water resource development. Irrigation GUDLQV QHDU WKH 0 XUUD\ FRQÁXHQFH DUH DVR NH\ KDEWDWV DQG DGG WR WKH complexity of habitats in that area (see Section 5.6.1). 7KH FKDQQHOV RQ +LQG P DUVK ,VDQG SURYLGH XQTXH AVK KDEWDW DQG KDYH WKH SRWHQWLDO WR SURYLGH WKURXJK ARZ IUR P WKH DNHV WR WKH &RRURQJ 6HH discussion above under Type M.			These channels tend to support dense stands of submerged aquatic vegetation such as *&HUDWRSK\XX P* spp., Hornwort, charaphytes, *Vallisineria sprialis*, Water ribbons and *Myriophyllum* spp., Water Milfoil and are lined with reeds, mostly *Phragmites* and *Typha*. *LYHQ WKDW WKLV W\SH RI VXE P HUJHG vegetation is under-represented these channels are considered critical habitats for small native ÁVK SDUWLFXDUU\ WKRVH WKDW DUH GHSHQGHQW RQ QDWXUDO ÁRZ patterns) and are considered targets for restoration works by Wedderburn and Hammer, (2003) (see Section 4.8.1).
Limit of acceptable change—rationale	10%—these are not natural wetlands but are considered important habitat because type is now rare in freshwater units.		

Q 4.2 Estuarine–saline system units

4.2.1 Murray Mouth and Estuary

Qualitative description

This component of the Ramsar site includes the Murray 0RXWK IUR P WKH *RRZD %DUDJH WR 3HOLFDQ 3RLQW LQFOXGLQJ WKH *RRZD &RRURQJ DQG 0XQGRR FKDQQHOV (See Figures 6 and 11). Area: approximately 3,400 ha.

3ULRU WR (XUSHDQ VHWWOH P HQW ÁRZV RI 5LYHU 0XUUD\ water out of the Mouth exceeded 2,000 ML per day, more than 95% of the time (Sim and Muller, 2004) and were adequate to maintain an open Murray Mouth. *HR P RUSKRORJLFDO VWXGLHV VKRZ WKDW WKH 0XUUD\ 0RXWK has been open for at least 6,000–7,000 years (Barnett, 1991 and Bourman, expert panel). The location of the Murray Mouth has varied over a range of approximately 6 km during the last 3,000 years and over 1.4 km in the last 160 years (Bourman and Murray-Wallace, 1991).

As DJ Walker (2002) writes:
'According to Barnett (1995) the general layout of the 5LYHU 0XUUD\ 0RXWK ZDV ÀQDOLVHG DURXQG \HDUV DJR when sea level rises and the subsequent formation of sand barriers (Sir Richard and Younghusband Peninsulas) enclosed the Lakes (Alexandrina and Albert) and the Coorong. Based on sediment cores taken in Lake Alexandrina, Barnett was able to provide a description of the lakes over the last 7,000 years … A key conclusion of WKH ZRUN LV WKDW IRU P XFK RI LWV KLVWRU\ WKH ULYHU ÁRZV KDYH EHHQ VXIÀFLHQW WR NHHS WKH /DNHV IUHVK DQG DW D SRRO level that was similar to that maintained by the barrages (pers. comm. Bourman, 2001).'

7KH 0RXWK FORVHG IRU WKH ÁUVW WL P H VLQFH IRU P DWLRQ LQ 1981. Between 2000 and 2002, the Murray Mouth almost closed again and since 9 October 2002 dredges have been operating to pump sand out of two channels (one OHDGLQJ IUR P WKH 0RXWK WR WKH *RRZD FKDQQHO DQG the other to the Coorong) and onto the ocean beach. The dredged channels keep the Mouth open and provide 'fresh', oxygenated sea water to the Coorong lagoons, without which oxygen levels would decline and temperatures would rise to beyond threshold levels for most Coorong biota.

The character of the Murray Estuary is now determined OD U J H\ E\ VHDZDWHU LQÁRZV DQG RXWÁRZV ZLWK SHULRGV RI IUHVKZDWHU LQÁRZV IUR P WKH 5LYHU 0XUUD\ UH J XODWHG by the barrages (MDBC, 2005). The Murray Mouth is a tidal inlet restricted by the accumulation of dune P DWHULDO RQ WKH ÁDQNLQJ VSLWV RI 6LU 5LFKDUG 3HQLQVXOD DQG Younghusband Peninsula (Bourman and Harvey, 1983 cited in MDBC, 2002). It is located in the high-energy environment of the Southern Ocean, with deposition of sediment (sand) inside the Mouth a function of tidal DFWLRQ FRXQWHUEDODQFHG E\ RXWÁRZV IUR P WKH 0XUUD\ over the barrages and water levels in the estuary area. The area is highly dynamic. Single storm events can shift massive amounts of sand (MDBC, 2002). The location, size and shape of the Mouth and the adjacent estuary are YDULDEOH GLFWDWHG E\ D FR P ELQDWLRQ RI ULYHU ÁRZV WLGDO ÁRZV DQG RFHDQ DQG FRDVWDO SURFHVVHV -HQVHQ HW DO 2000; MDBC, 2002). River regulation and water resource development of the River Murray catchment, resulting LQ UHGXFHG ULYHU ÁRZ DW WKH 0RXWK DQG WKH FRQVWUXFWLRQ of the barrages has lead to a progressive silting of the 0XUUD\ 0RXWK 7KH FDSDFLW\ RI WLGDO ÁRZV WR WUDQVSRUW sand into the Mouth area is a power function of the tidal YHORFLW\ VR HYHQ OR Z RU V P DOO ULYHU ÁRZV KDYH WKH SRWHQWLDO to reduce the sediment load being carried into the Mouth by the tide (MDBC, 2002). The issue in recent times is the increase in the frequency and duration of periods RI]HUR RU YHU\ OR Z ULYHU ÁRZV ZKLFK DOORZV D JUHDWHU amount of sediment to be transported into the Mouth culminating in the closure of the Mouth in 1981 and its severe constriction since 2001. Whilst there have been restrictions in the Mouth in the past, the severity of the sedimentation in recent times is considered much more severe and likely to persist unless there is intervention 0 '%& 8QWLO ULYHU ÁRZV WKURXJK WKH 0XUUD\ 0RXWK are increased, the system will be reliant on dredging to keep the Mouth open and maintain exchange between the ocean and the Coorong.

A large variety of habitats are represented in the Murray Mouth and Estuary component ranging from freshwater marshes to intertidal forested wetlands. Recreation in WKH IRU P RI ERDWLQJ ÀVKLQJ VZL P PLQJ DQG FD P SLQJ is concentrated in this component of the Coorong and Lakes because of relatively easy access and close proximity to Adelaide. This is the only estuary in the Murray-Darling Basin and the only natural exit for catchment water and mobilised sediments and salts.

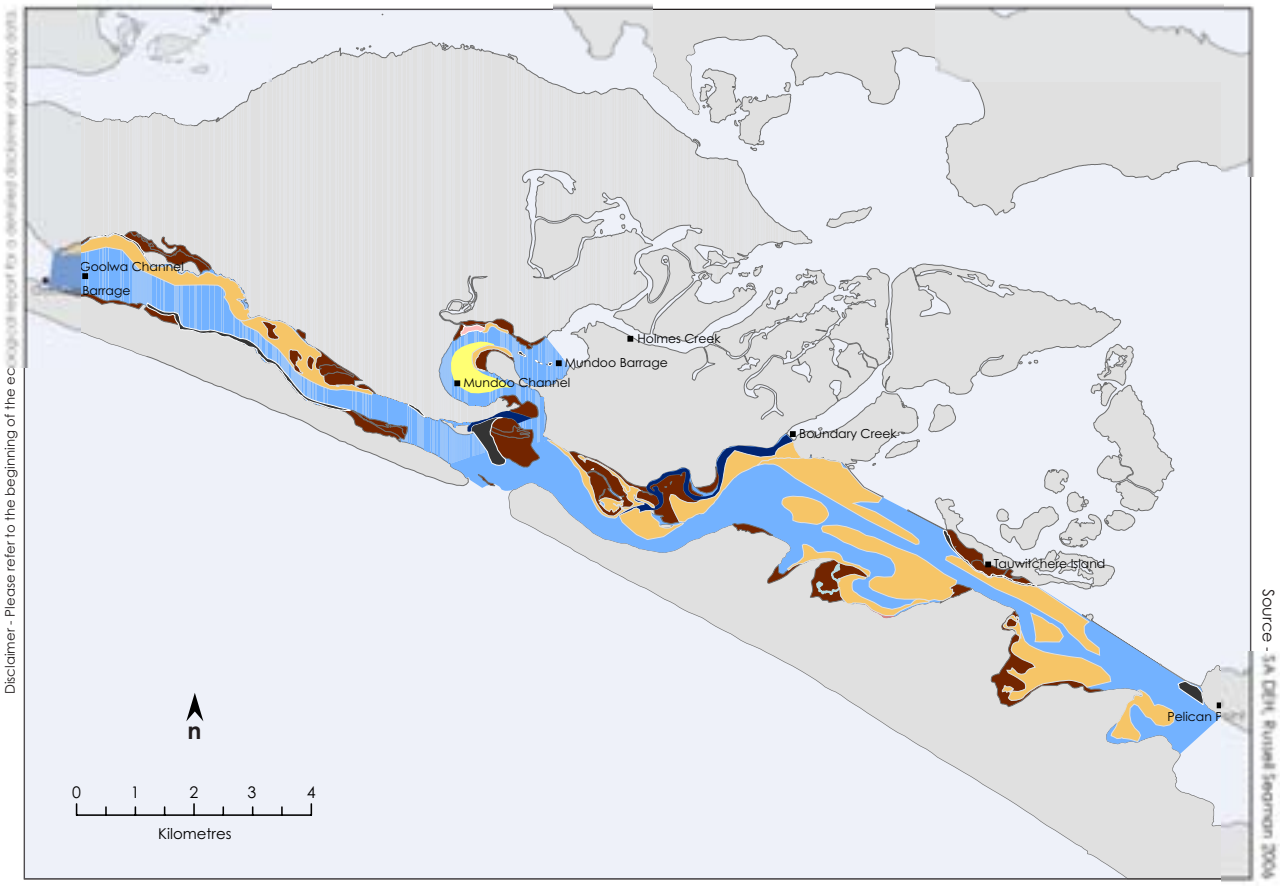


Figure 11 - Map of the Murray Mouth and Estuary showing the various wetland types

Key to wetland types	
A	**Permanent shallow marine waters** in most cases less than six metres deep at low tide; includes sea bays and straits
D	**Rocky marine shores**; includes rocky offshore islands, sea cliffs
E	**Sand, shingle or pebble shores**; includes sand bars, spits and sandy islets; includes dune systems and humid dune slacks
F	**Estuarine waters**; permanent water of estuaries and estuarine systems of deltas
G	,QWHUWLGDO P XG VDQG RU VDOW ÀDWV
H	**Intertidal marshes**; includes salt marshes, salt meadows, saltings, raised salt marshes; includes tidal brackish and freshwater marshes
I	**Intertidal forested wetlands**; includes mangrove swamps, nipah swamps and tidal freshwater swamp forests
J	**Coastal brackish/saline lagoons**; brackish to saline lagoons with at least one relatively narrow connection to the sea
K	**Coastal freshwater lagoons**; includes freshwater delta lagoons

4.2.2 North Lagoon

Qualitative description

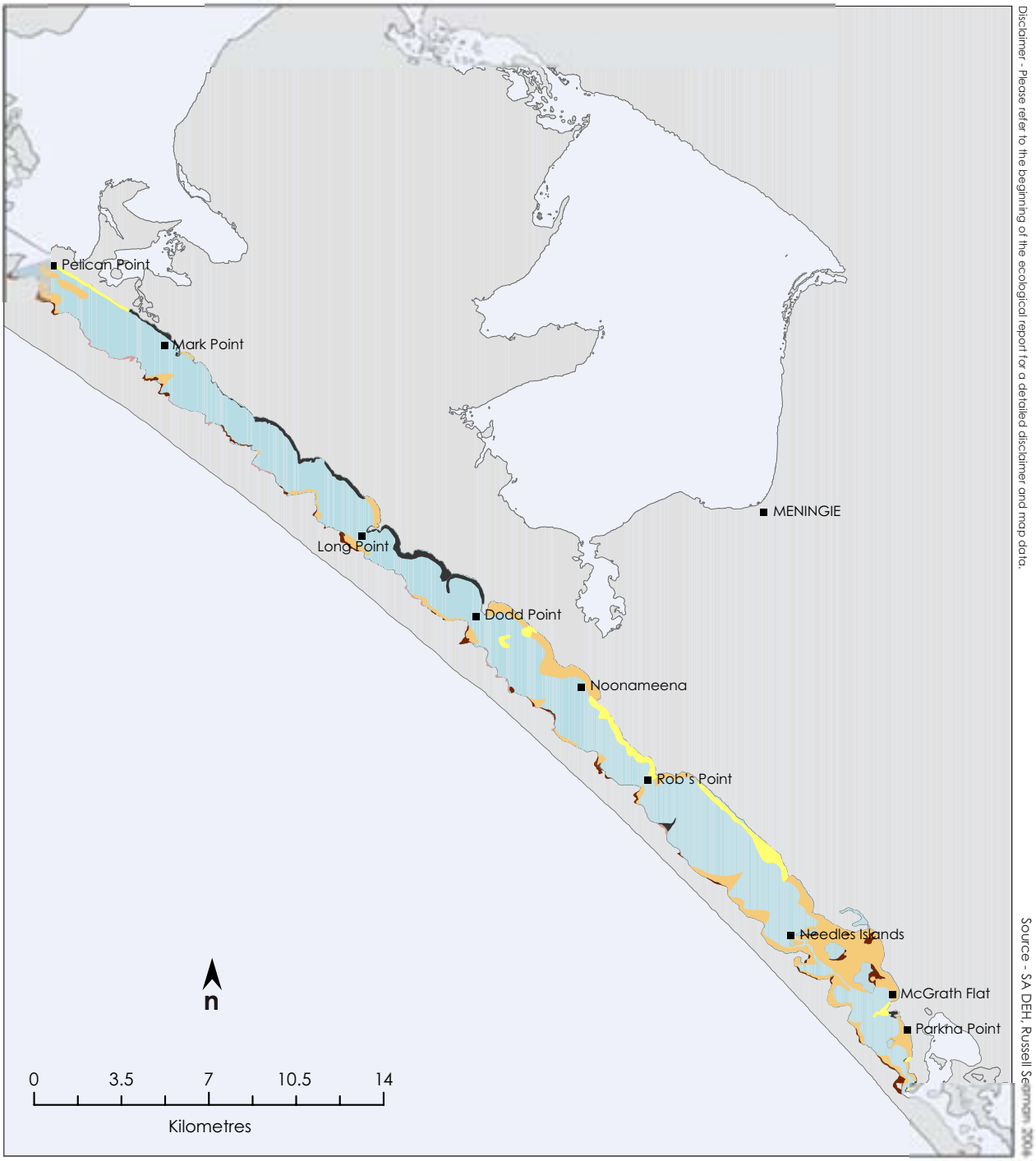
A long coastal lagoon stretching from Pelican Point to Parnka Point. Approximately 50 km long with an average width of <3 km. Area: approximately 11,069 ha.

7KH 1RUWK /DJRRQ P D\ EH FDVVLÀHG DV HVWXDULQH VDOLQH ZLWK VDOLQW\ FRQWUROOHG E\ IUHVKZDWHU LQÁRZV SUL P DULO\ from the Tauwitcherie Barrage), tidal exchange through WKH 0XUUD\ 0RXWK HYDSRUDWLRQ DQG LQÁRZV RI K\SHUVDOLQH water from the South Lagoon (Lamontagne, et al., 2004). 5DLQIDOO RQ WKH OD J RRQ LWVHOI FDQ DOVR EH VLJQLÀFDQW $V a consequence of these factors, the North Lagoon has a salinity gradient with lower salinity in the northwest (as OR Z DV SSW GXULQJ WL P HV RI IUHVKZDWHU LQÁRZ DQG KLJKHU salinity towards the Needles and the connection to the 6RXWK /DJRRQ XS WR SSW GXULQJ OR Z ÁRZ SHULRGV Horizontal salinity gradients can form in the water FROX P Q VXJ J HVWLQJ VWUDWLÀFDWLRQ XQGHU FHUWDLQ FRQGLWLRQV *HGGHV 7KH KLJKHVW UHDGLQJV LQ WKH 1RUWK /DJRRQ were in March 1982 (up to 65 ppt) and January 2003 (up to 90 ppt), both periods were preceded by Murray Mouth closure (1981) and severe constriction (2001) and OROJ SHULRGV RI EDUUDJH FORVXUH *HGGHV /DUJH volumes of fresh water are required to lower the salinity JUDGLHQWV VLJQLÀFDQW\ IROORZLQJ OROJ SHULRGV RI EDUUDJH closure because of the large volumes of water held in the Coorong lagoons and the high salinities reached through evaporation in the intervening months/years.

Although the North Lagoon is a permanent waterbody, the area of inundation varies both diurnally and VHDVRQDOO\ ZLWK WKH WLGH DQG LQÁRZV UHVXOWLQJ LQ WKH H[SRVXUH RI P XGÁDWV DQG LQWHUWLGDO P DUVKHV DORQJ WKH shoreline (Boon, 2000). This area provides important habitat for a large number of waterbirds, including migratory shorebirds, which are recorded in high numbers during spring and summer (Oborne, 2003). The permanent waters of the North Lagoon once contained extensive beds of submerged vegetation, dominated by *Ruppia megacarpa*. Large numbers of waterfowl consumed the leaves, seeds and turions of the *Ruppia* ZKLFK DOVR SURYLGHG SK\VLFDO KDELWDW IRU ÀVK and aquatic invertebrates (Oborne, 2003). In addition, the submerged vegetation provided much of the detritus in the North Lagoon, and as such, this habitat SURYLGHV WKH IRRG VRXUFH IRU GHWULWYRUHV VXFK DV ÁVK DQG macroinvertebrates. In recent years, these beds of *R. megacarpa* have been lost and the more salt tolerant *R. tuberosa* is colonising from the South Lagoon (Nichols, 2005).

Under natural conditions, the North Lagoon was dominated by tidal input of marine water and River 0XUUD\ LQSXWV DW LWV QRUWKHUQ HQG *HOO DQG +D\QHV The construction of the barrages in the 1930s–1940s has resulted in a severe reduction in the area of estuarine habitat in the North Lagoon and disrupted the transition between fresh and saltwater conditions (Jensen et al., 2000). This is evidenced by the decline LQ P DULQH LQÁXHQFH VLQFH WKH V DQG D VL P XOWDQHRXV LQFUHDVH LQ WXUELGLW\ *HOO DQG +D\QHV 6DLQH WR hypersaline conditions (equal or greater than sea water) now dominate the North Lagoon, and as such much RI WKH HVWXDULQH ORZHU WKDQ VHD ZDWHU DGDSWHG ARUD and fauna is no longer present. Fish populations have declined due to the reduction in estuarine area, as many species are dependant on estuarine salinities to trigger reproduction and recruitment. Only scattered remnants of *Melaleuca halmatuorum*, Swamp Paperbark, occur in this component (no forest areas) and they are not considered a dominant wetland type. The reduction in reedbed habitat has reduced habitat suited to waders. In addition, constrictions at the Murray Mouth have lead WR D GHFUHDVH LQ ÁXVKLQJ ZKLFK KDV QHJDWLYH LP SDFWV RQ submerged vegetation and promotes conditions more suitable for phytoplankton growth (Jensen et al., 2000). The loss of these keystone submerged plant assemblages will ultimately mean the loss of dependent fauna. Once aquatic plants are lost from a system, an 'alternate steady state' can be reached where algae dominate SUL P DU\ SURGXFWLRQ ,I WKLV RFFXUV LW LV YHU\ GLIÀFXOW WR move back to a plant-dominated system even if IUHVKZDWHU ÁRZV DUH UHWXUQHG 6FKHIIHU HW DO Davis et al., 2003).

7KH FRQVWUXFWLRQ RI WKH EDUUDJHV LQ ***the 1930s–1940s has resulted in a severe*** *UHGXFWLRQ LQ WKH DUHD RI HVWXDULQH KDELWDW* ***in the North Lagoon and disrupted the transition between fresh and saltwater*** *FRQGLWLRQV*



Disclaimer - Please refer to the beginning of the ecological report for a detailed disclaimer and map data.

Source - SA DEH, Russell Seaman 2004

Figure 12 - Map of the North Lagoon showing the various wetland types

Key to wetland types	
D	**Rocky marine shores**; includes rocky offshore islands, sea cliffs
E	**Sand, shingle or pebble shores**; includes sand bars, spits and sandy islets; includes dune systems and humid dune slacks
G	,QWHUWLGDO P XG VDQG RU VDOW ÁDWV
H	**Intertidal marshes**; includes salt marshes, salt meadows, saltings, raised salt marshes; includes tidal brackish and freshwater marshes
J	**Coastal brackish/saline lagoons**; brackish to saline lagoons with at least one relatively narrow connection to the sea
K	**Coastal freshwater lagoons**; includes freshwater delta lagoons

4.2.3 South Lagoon

Qualitative description

A long, narrow coastal lagoon extending from Parnka Point to 42 Mile Crossing, comprising the southern most arm of the Coorong. Area: approximately 9,440 ha.

The South Lagoon of the Coorong is a saline-hypersaline permanent waterbody that is connected to North Lagoon by a narrow channel at the northwest end. Water levels vary seasonally by approximately 0.9 m (Lamontagne et al., 2004), being higher in winter and lower in summer, resulting in the seasonal exposure of H[WHQVLYH DUHDV RI P XGÁDWV ZKLFK SURYLGH IRUDJLQJ and nesting habitat for large numbers of waterbirds. At its southern end, the South Lagoon grades through an annually drying section into a series of shallow and ephemeral salt lakes (Boon, 2000). Salinity in the South /DJRRQ LV FRQWUROOHG E\ LQÁRZV IUR P WKH 1RUWK /DJRRQ rainfall on the lagoon surface, evaporation, openness RI WKH 0 XUUD\ 0 RXWK DQG KLVWRULFDO LQÁRZV RI IUHVK ZDWHU from groundwater via soaks and the South East of South Australia via Salt Creek. These latter two inputs have EHHQ UHGXFHG VLJQLÀFDQWO\ VLQFH (XUSHDQ VHWWOH P HQW due to drainage, land clearance (altering groundwater recharge) and localised water resource development.

8QGHU QDWXUDO FRQGLWLRQV P DULQH ÁXVKLQJ VWURQJO\ LQÁXHQFHG WKH 6RXWK /DJRRQ DWKRXJK OHVV IUHTXHQWO\ RU to a lesser extent than the North Lagoon. Areas at the southern end of South Lagoon may have occasionally become hypersaline prior to European settlement but show biota indicative of regular freshwater inputs presumably from the South East rather than the River Murray. The South Lagoon became more turbid perhaps as early as the beginning of European settlement and more saline after 1940 with further increases in salinity DIWHU * HOO DQG +D\QHV

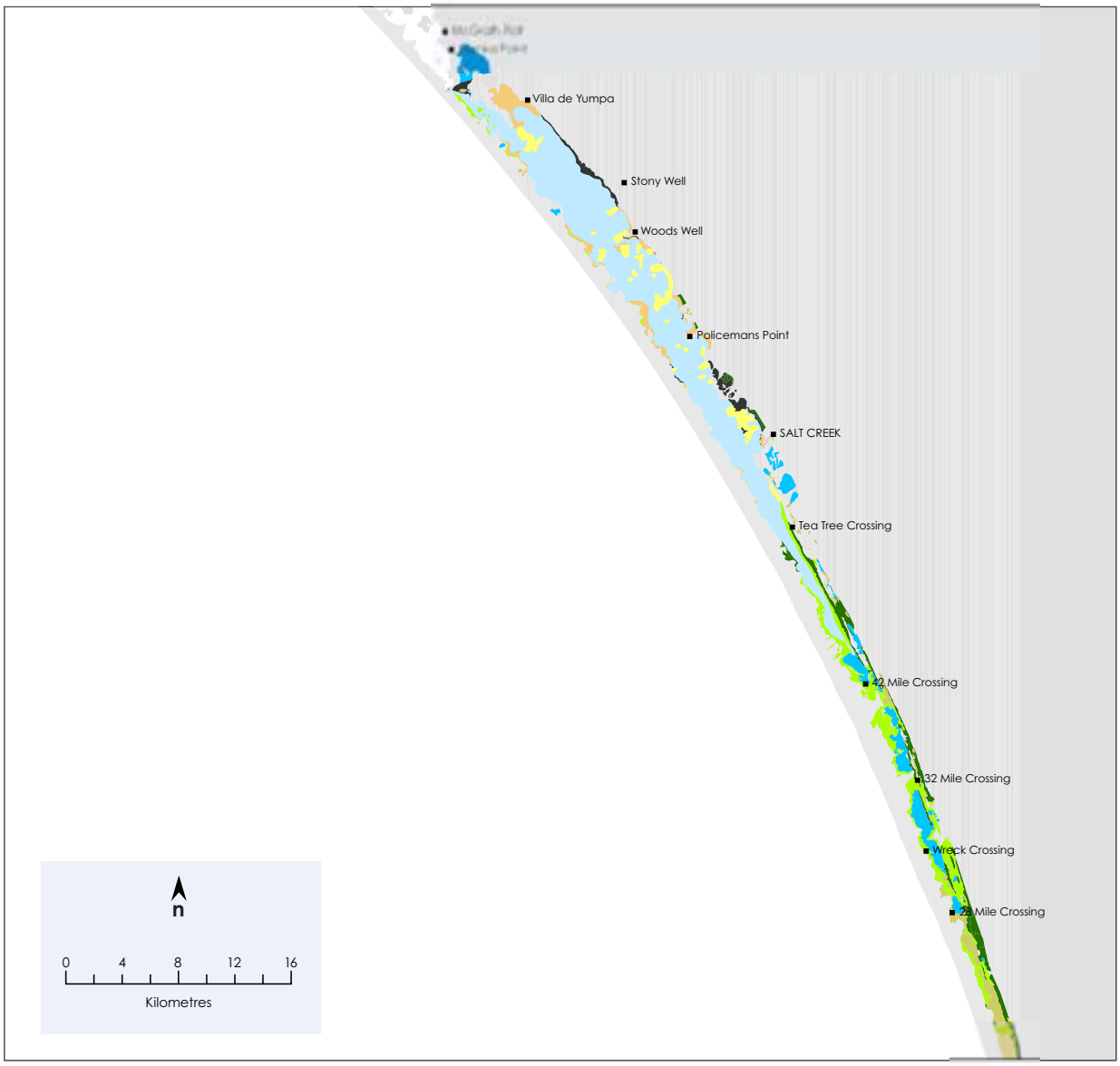
5LYHU 0 XUUD\ LQÁRZV KDYH OLWWOH GLUHFW LQÁXHQFH RQ WKH water quality of the South Lagoon but indirectly affect it via North Lagoon water quality and inputs such as salt and silt accumulating in the lagoons. River Murray ÁRZV DVR LQGLUHFWO\ L P SDFW RQ WKH 6RXWK /DJRRQ E\ keeping the Murray Mouth open and thus maintaining connectivity between the lagoons and the Southern Ocean. If the connection to the sea is lost or constricted, the volumes of water that enter the Coorong exceed that which leave the Coorong on any given tidal cycle. Therefore water levels in the Coorong lagoons increase, GUZQLQJ RXW P XGÁDWV DQG FDXVLQJ P DUR FKDQJHV to ecological processes such as denying access to P XGÁDWV E\ ZDGHUV : DWHU WH P SHUDWXUHV DQG VDOLQLWLHV also increase with evaporation over summer creating a VWUDWLÀHG ZDWHU FROX P Q WKDW EHFR P HV SRRU LQ GLVVROYHG oxygen. Such a scenario is devastating to all biota of the Coorong lagoons and prevention of these physico-chemical conditions has been the primary purpose of dredging the Murray Mouth to maintain oceanic exchange since 2001.

As a consequence of the interactions of the above drivers and levers, the South Lagoon has a salinity gradient with lower salinity in the northwest (as low as SSW GXULQJ WL P HV RI IUHVKZDWHU LQÁRZ DQG KLJKHU salinity towards the southern end and the boundary of WKH 1DWLRQDO 3DUN XS WR SSW GXULQJ 0RZ ÁRZ SHULRGV The highest readings in the South Lagoon were in recorded in March 1983, 1984 and 1985 (up to 140 ppt) and January 2003 (up to 110 ppt), both periods were preceded by Murray Mouth closure (1981) or severe constriction (2001) and long periods of barrage closure * HGGHV 2QFH VXFK H[WUH P HO\ KLJK VDOLQLW\ OHYHOV are reached, large volumes of fresh water are required WR OR ZHU WKH VDOLQLW\ JUDGLHQWV VLJQLÀFDQWO\ DQG ÁXVK RXW the accumulated silts and salts. Meanwhile, irreversible changes can occur to the ecological character of the salinised wetland because salinity and turbidity levels and sedimentation rates exceed the thresholds for many ecosystem components and processes.

Historically, the submerged annual plant *Ruppia tuberosa* dominated these areas, and is the primary diet of a number of waterbirds (Oborne, 2003). During spring as water levels recede, *Ruppia tuberosa* sets seeds and retreats to its underground organs (turions). When water levels rise again in autumn and winter, seeds and turions germinate and sprout (Jensen et al., 2000) and grow to match the rising water levels, forming blankets WKDW ÁRDW RYHU WKH ZDWHU VXUIDFH DQG SURYLGH FRYHU IRU fauna when in dense stands. Other submerged aquatic plants such as *Lamprothamnion* sp. once made up a VLJQLÀFDQW SURSRUWLRQ RI WKH VXE P HUJHG EOR P DVV LQ WKHVH plant beds but are now considered locally extinct in the Coorong lagoons. Recent surveys, recorded only sparse shoots of *Ruppia tuberosa* and the biota in general was considered to be extremely depauperate (see Section 5.4). Coupled with the loss of other intertidal habitats, this has impacted on waterbird populations that relied on these habitats and food sources for feeding and/or nesting (see Section 6.3–Keystone species). Redirected groundwater and surplus surface water from the Upper South East Drainage Scheme may be a source of fresh LQÁRZV IRU WKH 6RXWK /DJRRQ 7KHVH ÁRZV DUH FXUUHQWO\ capped at 40,000 ML per annum on a 10 year rolling average. This cap is currently under review by the &RP P RQZHDOWK * RYHUQP HQW DQG P D\ VRRQ EH YDULHG

6XFK IUHVKZDWHU LQÁRZV P D\ EH RI EHQHÀW WR WKH GHFOLQLQJ submerged vegetation of the South Lagoon provided that the water is of good quality. Decreased tidal H[FKDQJH DQG AXVKLQJ KDV DVR UHVXOWHG LQ DQ LQFUHDVH in turbidity and nutrients in the South Lagoon, impacting negatively on submerged vegetation and favouring of phytoplankton (Lamontagne et al., 2004).

Murray Mouth closure 1981



Disclaimer - Please refer to the beginning of the ecological report for a detailed disclaimer and map data.

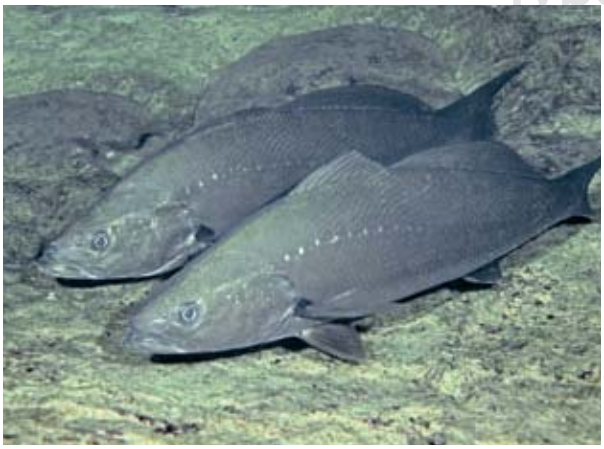
Source - SA DEH, Russell Seaman 2006

Figure 13 - Map of the South Lagoon showing the various wetland types

Key to wetland types	
D	**Rocky marine shores**; includes rocky offshore islands, sea cliffs
E	**Sand, shingle or pebble shores**; includes sand bars, spits and sandy islets; includes dune systems and humid dune slacks
G	,QWHUWLGDO P XG VDQG RU VDOW ADWV
J	**Coastal brackish/saline lagoons**; brackish to saline lagoons with at least one relatively narrow connection to the sea
M	**Permanent rivers/streams/creeks**; includes waterfalls
R	6HDVRQDO LQWHU P LWWHQW VDOLQH EUDFNLVK DUNDLQH UDNHV DQG ADWV
Ss	**Seasonal/intermittent saline/brackish/alkaline marshes/pools**
W	**Shrub-dominated wetlands**; shrub swamps, shrub-dominated freshwater marshes, shrub carr, alder thicket on inorganic soils
Xf	**Freshwater, tree-dominated wetlands** LQFXGHV IUHVKZ DWHU VZ D P S IRUHVWV VHDVRQDO\ ARRGHG IRUHVWV ZRRGHG VZ D P SV on inorganic soils
Y	**Freshwater springs; oases**

: HWDQGV W\ SHV DQG 5D P VDU VLJ QLÀFDQW EL RR J LFD FR P SRQHQWV ZLWKLQ WKH HVWXDULQH VDOLQH system units (organised alphabetically by Ramsar type code)

Type A and Type F wetlands.



7UDIÀF OLJKW DVVHVV P HQW

Estuarine waters once dominated the whole Coorong, Murray Mouth and Estuary area and are now restricted to just those times and places ZKHUH IUHVKZDWHU LQÁRZV DUH JUHDW HQRXJK WR UHGXFH VDOLQLWLHV WR VLJQLÀFDQW\ EHORZ WKDW RI VHD water. Consequently, this wetland type now acts as refuge for estuarine species and is considered extremely vulnerable. It is also considered to be XQGHU H[WUH P H WKUHDW IUR P RQ JRLQJ ORZ ÁRZV from the River Murray causing increasing salinity and turbidity and effective loss of estuarine conditions.

Ramsar wetland types	**A**	**Permanent shallow marine waters** in most cases less than six metres deep at low tide; includes sea bays and straits
	F	**Estuarine waters**; permanent water of estuaries and estuarine systems of deltas
Units where found	Murray Mouth and Estuary	
Estimated areal extent in 2005 (ha)	A = 50, F = 2200	
Description(s)	Permanent, shallow waters that once would have alternated between fresh estuarine and saline conditions 0 '%& EXW DUH QRZ GR P LQDWHG E\ VHD ZDWHU GXH WR ORZ ULYHU ÁRZV DQG GUHGJLQJ RI FKDQQHOV FUHDWLQJ permanent connection to the sea.	
Key biological components supported and how	Estuarine waters provide habitat for many marine species during a part of their lifecycle (Jensen et al., 2000). For example juvenile stages of Mulloway are reliant on access to protected marine or estuarine waters for UHFUXLW P HQW LQWR WKH DGXOW RFHDQ GZHOLQJ SRSXODWLRQV DQG DGXOW AVK UHO\ RQ WKH HVWXDU\ IRU UHJXODU EDWKLQJ WR rid themselves of marine parasites. Submerged aquatic plant species recorded in the past include *Ruppia* spp., *Lamprothamnium* (Oborne, 2003) and *Lepilaena* (Boon, 2000). Seagrasses (*Zostera* and *Heterozostera*) have also been recorded. The current extent of submerged plants and seagrasses is unknown, although recent work GRQH E\ WKH 8QLYHUVLW\ RI $GHODLGH 0 *HGGHV KDV VKRZQ VLJQLÀFDQW UHGXFWLRQ LQ DUHDV RI *Ruppia* at long term monitoring sites (see Sections 5.4 and 6.3). The submerged aquatic plant beds provide foraging for waterfowl such as swans and ducks (Oborne, 2003). The estuarine water column also provides habitat for phytoplankton and macroinvertebrates such as amphipods DQG FRSHSRGV %UDQGH DQG \HDU URXQG KDEWDW IRU HVWXDULQH AVK H J %DFN %UHD P *UHHQEDFN)RXQGHU DQG 6 P DO 0 RXWKHG +DUG\KHDG VHH 6HFWLRQ DQG WKXV IHHGLQJ JURXQGV IRU LQYHUWHEUDWH DQG AVK HDWLQJ waterbirds.	
Limit of acceptable change—rationale	5% (areal extent)—this plays important ecological roles.	

Type D: Rocky marine shores

7UDIÀF OLJKW DVVHVV P HQW

This wetland type is ecologically important. The rocky, intertidal pools and shores are under threat of loss from smothering due to the high rates of sedimentation occurring in the Coorong. Vulnerability is considered high because of the relatively thin tidal band occupied by this type and the relatively low areal extent.

Ramsar wetland types	**D**	**Rocky marine shores**; includes rocky offshore islands, sea cliffs	
Units where found	Murray Mouth and Estuary	North Lagoon	South Lagoon
Estimated areal extent in 2005 (ha)	40	226	351
Description(s)	Isolated patch of rocky inland shores of approximately 40 ha in the Mundoo Channel comprised of exposed calcrete outcrops.	A thin band of rocky shoreline occurs along the north western shoreline of North Lagoon.	Isolated patches of inland rocky shorelines occur in the northern part of South Lagoon.
Key biological components supported and how	Rocky marine shores of this nature are important in stimulating production of macroinvertebrates and algae, which thrive in the warm pools which establish in between tides. Such systems are important areas for nutrient cycling and for providing macroinvertebrates and algae to seed the main water body. They are important for bird foraging especially egrets and larger waterbirds (see Section 5.4). As water recedes in the spring these areas becomes important nesting sites for waterfowl such as pelicans and Caspian tern, particularly in the island areas (Oborne, 2003). *&DGRSKRUD* and other macroalgal species can be found in the areas subject to regular inundation and there are abundant 'tube worms' *)LFRSRP DWXV HQLJ P DWLFXV* in the Murray Mouth and Estuary and North Lagoon. Although there is evidence of abundant 'tube worms' *)LFRSRP DWXV HQLJ P DWLFXV* in the past (perhaps 40 years ago) in South Lagoon they are not considered to be current residents. These rocky shores are at risk from being smothered with sediments and decaying algae. Since 2003, a black, odoriferous mud overlain by calcifying algae has formed 5–15 cm thick on areas of once, clean rocky shorelines near Wood's Well (see Section 7.2).		
Limit of acceptable change—rationale	2% (areal extent)—there is relatively little area of this type, it is under threat from sedimentation and it plays important ecological roles.		

Type E: Sand shores and dunes

7UDIAF OLJKW DVVHVV P HQW

This wetland type is considered to be under threat from wind and water erosion, exotic plant domination and recreation impacts. They are also vulnerable systems because of their dynamic morphology.

Ramsar wetland types	**E**	**Sand, shingle or pebble shores**; includes sand bars, spits and sandy islets; includes dune systems and humid dune slacks	
Units where found	Murray Mouth and Estuary	North Lagoon	South Lagoon
Estimated areal extent in 2005 (ha)	56	246	717
Description(s)	The Murray Mouth is the only break in c. 140 km of oceanic sand dunes along the two peninsulas. Sandy shores DQG ED\V RFFXU EHWZHHQ *RRUZD &KDQQHO 6LU 5LFKDUG 3HQLQVXOD DQG %LUG ,VODQG ZLWK VSLWV DQG VDQG EDUV near the Murray Mouth. Bird Island has only formed since the construction of the barrages. Sections of narrow sandy shorelines occur in patches along the Coorong. For example, between the township of Salt Creek and 3DUQND 3RLQW RQ WKH ODQGZDUG VLGH RI 6RXWK /DJRRQ 7KHUH DUH DVR GLVWLQFWLYH EDQGV RI VDQG ADWV DURXQG 7\SH R wetlands, along the coastal dune-wetland interfaces and between the coastal dunes and the lagoons. Sand bars also form between the dunes and the lagoon. Recreation is focussed in the Murray Mouth Estuary and the northern end of North Lagoon around this wetland type.		
Key biological components supported and how	Marsh saltbush and native and exotic grasses are the dominant plant associations within the sand dunes of the 0XUUD\ (VWXDU\ %UDQGH 6LJQÀFDQW GXQDO VSHFLHV LQFXGH *Scaevola calendulacea* 'XQH IDQÁRZHU VHH Section 5.1.1). These areas provide habitat for water rats, and terrestrial mammals such as kangaroos and emus as well as feeding grounds for birds such as parrots (Brandle, 2002). The close proximity of aquatic and terrestrial habitats is considered very important component of ecological character. The spits and sand bars and Bird Island are important waterbird habitats.		
Limit of acceptable change—rationale	2% (areal extent)—there is relatively little area, this is a vulnerable type and plays important ecological roles.		

7\SH * .OWHUWLGD0 P XG VDQG RU VD0W ÁDWV

7UDIAF 0L JKW DVVHVV P HQW

This wetland type is vital for waders and is considered to be under extreme threat from increased sedimentation and changes to the RU J DQLF FDUERQ DQG VHGL P HQW SURÀOHV 7KHVH VLWHV are also extremely vulnerable because of the short LIH F\ F0HV DQG VSHFLHV VSHFLÀF VDLQLW\ WR0HUDQFHV of the decomposers and the macroinvertebrates that utilise these habitats and provide feed to waders (see Sections 5.4 and 6.3).

Ramsar wetland types	G	,QWHUWLGD0 P XG VDQG RU VD0W ÁDWV	
Units where found	Murray Mouth and Estuary	North Lagoon	South Lagoon
Estimated areal extent in 2005 (ha)	700	1480	962
Description(s)	Fine to medium sands with a relatively high organic content, and areas RI P LFUREL D0 P DWV FR P SULVHG RI F\DQREDFWHULD DQG À0D P HQWRXV D0J DH (Diittman et al., 2005). Inundation is variable both diurnally (with the tide) and seasonally (Diittman et al., 2005) and provides the drivers for Z DWHU 0HYH0 FKDQ J HV UH J L P H * URXQG Z DWHU LQÁR Z V IUR P WKH FRDVW D0 GXQH V\ VWH P DUH GULYHQ E\ P RRQ WLGHV LQ DXX P Q WKXV Z DWHU 0HYH0V LQ WKH &RRURQ J 0D J RRQV FDQ ULVH EHIRUH VXUIDFH Z DWHU LQÁR Z V FR P P HQFH Z KLFK may generate head differences. Preliminary information on invertebrates suggests that abundance and diversity is relatively higher in the Murray Mouth and Estuary compared to the North Lagoon which is higher than the South Lagoon. These communities are comprised of crustaceans, insects and mollusc species (Diittman et al., 2005).		Fine to medium sands occur at either end of the lagoon and coarse sands occur in the middle sections with a very low organic content, and an absence of microbial mats (Diittman et al., 2005). The South Lagoon of the Coorong is not strictly an LQWHUWLGD0 0D J RRQ DV WLGD0 LQÁXHQFH is minimal, but this is the best description of this habitat in terms of wetland types. Water levels vary seasonally, being higher in winter than summer, but diurnal variability due to tidal LQÁXHQFH LV P LQ P D0 ' LWW P DQ HW D0 * URXQG Z DWHU LQÁR Z V from the coastal dune system are GULYHQ E\ P RRQ WLGHV LQ DXX P Q thus water levels in the Coorong lagoons can rise before surface Z DWHU LQÁR Z V FR P P HQFH Invertebrate abundance and diversity is very low compared to North Lagoon and Murray (VWXDU\ * HGGHV ' LWW P DQ et al., 2005) and is comprised of salt-tolerant insects such as the chironomid *Tanytarsus barbitarsus* %RRQ * HGGHV
Key biological components supported and how	This wetland type represents an important foraging area for waders given the high concentration and diversity RI P DFURLQYHUWHEUDWHV 0 ' %& VHH 6HFWLRQ $0VR L P SRUWDQW IHHGLQJ J URXQG IRU ÁVK Z KHQ LQXQGDWHG (Brandle 2002) (see Section 5.6.2). The maximum natural rate of sedimentation rate of the Coorong was <1 mm/yr. This has increased to in excess of 15 mm/yr, representing a more than 70-fold increase in sedimentation rate near Salt Creek since European VHWWOH P HQW * H0 DQG +D\QHV 6XFK DQ LQFUHDVH LQ F0D\ EDVHG VHGL P HQW KDV P D0RU L P SOLFDWLRQV IRU LQWHUWLGD0 ecosystem processes and components (see Section 6.2).		
Limit of acceptable change—rationale	D0HD0 H[WHQW ³ Z K0H WKHUH LV VL J QLÀFDQW D0HD WKLV LV Y0WD0 IRU Z DGLQJ EL0GV		

Type H: Intertidal marshes

7UDIAF OLJKW DVVHVV P HQW

This wetland type once dominated the tidal LQÁXHQFHG XQWV DQG LV QRZ XQGHU UHSUHVHQWHG As such it represents an extremely threatened and vulnerable refuge area for ecosystem processes and components that will be relied upon to expand into other areas of the Ramsar site once estuarine conditions are restored.

Ramsar wetland types	**H**	**Intertidal marshes**; includes salt marshes, salt meadows, saltings, raised salt marshes; includes tidal brackish and freshwater marshes
Units where found	Murray Mouth and Estuary	North Lagoon
Estimated areal extent in 2005 (ha)	369	167
Description(s)	7KHVH ZHWDQGV DUH DUHDV WKDW DUH LQXQGDWHG GLXUQDO\ ZLWK WLGDO ARZ DURQJ WKH *RRUZD FKDQQHO DQG LQWR WKH North Lagoon. They also receive some freshwater inputs from local catchments and groundwater.	
Key biological components supported and how	The saline waters samphire (e.g. *Salicornia blackiana*) and saltmarsh species with macroalgal mats of cyanobacteria underneath occur in these wetlands (Boon, 2000). Some areas (e.g. Tauwitchere Point) contain areas of lignum and Typha (Brandle, 2002) and other salt-tolerant sedges (*Juncus kraussii* and *Bolboschoenus caldwellii*) (Brandle, 2002). These areas are considered important foraging areas for rails, crakes and waterhens, nesting habitats for a range RI ZDWHUEUGV DV ZHO DV UHIXJH DUHDV IRU V P DO QDWLYH ÀVK %UDQGH &DSH %DUHQ *HHVH KDYH DVR EHHQ recorded utilising this wetland type in the Murray Mouth and Estuary unit (Brandle, 2002) (see Sections 5.3, 5.4 and 5.5).	
Limit of acceptable change—rationale	2% (areal extent)—there is relatively little area and it plays important ecological roles.	

Type I: Intertidal forested wetlands

7UDIAF OLJKW DVVHVV P HQW

Critical remnants considered threatened by altered water regime and increased salinities and vulnerable due to low rates of recruitment and relatively old age and poor condition of many trees. There is an urgent need to rehabilitate this wetland type and provide missing habitats for colonial birds and birds of prey.

Ramsar wetland types	**I**	**Intertidal forested wetlands**; includes mangrove swamps, nipah swamps and tidal freshwater swamp forests
Units where found	Murray Mouth and Estuary	
Estimated areal extent in 2005 (ha)	4	
Description(s)	6 P DO DUHD DS SUR[L P DWHO\ KD LQ WKH 0 XQGRR &KDQQHO QHDU WKH FRQXHQFH RI +XQWHU·V &UHHN DQG 0 XUD\ Mouth Estuary.	
Key biological components supported and how	Swamp Paperbark *0 HDOHXFD KDOP DWXURX P* forms the overstorey with low sedge and shrubs beneath (Brandle, 2002). *M. halmatuorum* KDV EHHQ SUDQWHG DURQJ WKH *RRUZD FKDQQHO EXW WKHUH DUH QR LQWDFW IRUHVW UH P QDQWV 7KH trees represent an important nesting site for a range of waterbirds (Jensen et al., 2000). In addition, the reedbeds provide nesting and foraging habitat for some waterbird species and, when inundated, habitat for aquatic invertebrates (see Xf following and Section 5.3). : KHQ LQXQGDWHG WKLV ZRXG EHFR P H KDEWDW IRU V P DO ÀVK DV ZH DV IRUDJLQJ KDEWDW IRU SLVFLYRUXV ZDWHUEUGV (see Section 5.4).	
Limit of acceptable change—rationale	0% (areal extent)—there is little area, this is a vulnerable type and it plays important ecological roles.	

Type J: Coastal saline lagoons

7UDIAF OL J KW DVVHVV P HQW

The miniature 'coves' described in the Murray Mouth and Estuary unit are unique, poorly described and considered highly important habitats that are vulnerable because of their morphology and dependence on localised recharge-discharge rates. The coastal saline waters that form the North and South Lagoons may cover a vast area but they are in such poor condition as to be likely to undergo an irreversible shift in ecological character within the next few \HDUV XQHVV WKHUH LV VL J QLÀFDQW P DQD J H P HQW intervention in the near future. Immediate reductions in salinity and turbidity levels and re-establishment of *Ruppia* spp. beds are required to prevent this occurring (see Sections 6 and 8).

Ramsar wetland types	**J**	**Coastal brackish/saline lagoons**; brackish to saline lagoons with at least one relatively narrow connection to the sea	
Units where found	Murray Mouth and Estuary	North Lagoon	South Lagoon
Estimated areal extent in 2005 (ha)	2	8910	1218
Description(s)	Tidal lagoons and creeks occur on the coastal dune system between Younghusband Peninsula and North Lagoon. Miniature coves have formed within the sand dunes and samphire lagoons with vegetation similar to wetland Type H occur on the fringes of these coves. Freshwater soaks, driven by recharge through the encircling sand dunes, provide VXIÀFLHQW IUHVKZDWHU WR VXSSRUW *Phragmites* (and in some cases *Typha*) at the break of slope and drain into the 'cove' features.	Permanent, shallow estuarine-saline water body that ranges from 5 ppt salinity at the northern end in periods of high freshwater LQÁRZV WR SSW QHDU WKH connection to South Lagoon GXULQJ SHULRGV RI QR RU ORZ ÁRZ	Permanent, shallow saline-hypersaline water body that ranges from 20 ppt salinity at the northern end in periods of high IUHVKZDWHU LQÁRZV WR SSW DW WKH southern end during periods of no RU ORZ ÁRZ

» continued »

Key biological components supported and how	These are unique features that represent a more natural Coorong environment on a micro-scale and thus provide habitats for a range of remnant and threatened VSHFLHV DQG DQ RS SRUXQW\ WR À knowledge gaps on ecosystem components and processes. Little is known about these PLQDWXUH FRYHV EXW LW LV OLNH\ from the habitat types, condition, high levels of connectivity and location near the Murray Mouth that they would be important AVK QXUVHU\ DQG VSDZQLQJ VLWHV These sites do not represent a VLJQLÀFDQW SHUFHQWDJH DUHD cover of this component but they are unique and are likely to be of disproportionally high value ecologically.	The waters of North Lagoon once supported extensive beds of *Ruppia megacarpa*, locally known DV EDQNHW ZHHG ,Q UHFHQW years these beds have been lost (Nicol, 2005). *Ruppia tuberosa*, the dominant species in the South Lagoon, has started to colonise the North Lagoon, presumably because of increasing salinities (due to decreased freshwater inputs) and lack of competition with *Ruppia megacarpa* (Nicol, 2005). Seagrasses (*Zostera* and *Heterozostera*) have been recorded (Boon, 2000) but are considered locally extinct. Submerged aquatic plant beds such as *Ruppia* are the keystone to the Coorong ecosystem and provide foraging for waterfowl such as swans and ducks as well as habitat for estuarine and PDULQH ÀVK 2 ERUQH (see Section 6). The invertebrate fauna in the North Lagoon was considered to be a restricted euryhaline estuarine-lagoon assemblage composed of polychaete worms, crustaceans and molluscs (bivalves and gastropods) that tolerate salinities from near freshwater to approximately SSW *HGGHV FLWHG LQ *HGGHV +RZHYHU WKHVH species are now missing from most of the North Lagoon sampling URFDWLRQV *HGGHV DQG see Section 5.4). A reduction in abundance of species and restriction of distribution patterns, most likely related to high summer salinities, has been recorded since V *HGGHV	The waters of South Lagoon once supported vast beds of submerged aquatic plant species dominated by *Ruppia tuberosa* (Nichols, 2005). These beds have effectively been lost from the South Lagoon due to increased salinity and turbidity (Paton (2005) and see Section 5.4). Other submerged species previously recorded in South Lagoon included *Lamprothamnium* and *Lepilaena* (Boon, 2000) but these species were not found in recent surveys *HGGHV DQG DUH SUHVX PHG locally extinct. The water column provides habitat for phytoplankton and salinity tolerant macroinvertebrates such as shrimps and copepods (Boon, ,Q IRU WKH ÀUVW WLPH WKH macroinvertebrate community was dominated by brine shrimp (indicating a fundamental shift in ecological character see Section 5.4). Fish such as Southern Bream and Yellow-eye Mullet were recorded in the South Lagoon in 1985 (Boon, 2000). Small-Mouthed Hardyheads were the only species able to tolerate hypersaline conditions in 2000 (Boon, 2000). However, it appears that even the Hardyheads are no longer thriving in the hypersaline conditions of the South Lagoon DV *HGGHV IRXQG WKH numbers of Hardyhead in South Lagoon were very low compared to abundances recorded in the 1980s, Paton (2005) concludes.
	The water column provides habitat for phytoplankton and macroinvertebrates such as amphipods and copepods (Brandle, 2002). Sampling in June–July 2003 recorded no seagrasses or estuarine PDFURSK\WHV LQ WKH 0XUUD\ 0RXWK DQG 1RUWK /DJRRQ *HGGHV Brown algae *Gracilaria* and *AUDPHQWRXV* algae (*Enteromorpha* and *Rhizoconium*) were recorded in North Lagoon and the Murray Mouth.	
Limit of acceptable change—rationale	DUHD H[WHQW ³ ZKUH WKHUH LV VLJQLÀFDQW DUHD LW SUD\V LP SRUWDQW HFRRJLFDO URHV 0XUUD\ 0RXWK DQG (VWXDU\ ³ WKH XQLTXH FRYH IHDWXUHV DUH FRQVLGHUHG FULWLFDO UH PQDQW KDEWDWV		

Type K: Coastal freshwater lagoons

7UDIAF OL J KW DVVHVV P HQW

These wetlands are the only source of fresh water for many terrestrial species as well as being important habitats, per se. The remaining springs are considered extremely vulnerable because of their dependence on undisturbed recharge-discharge processes and their declining quantity and water quality. They are also considered under extreme threat from land and water resource development and altered surface-groundwater interactions.

Ramsar wetland types	**K**	**Coastal freshwater lagoons**; includes freshwater delta lagoons	
Units where found	Murray Mouth and Estuary		North Lagoon
Estimated areal extent in 2005 (ha)	1		40
Description(s)	Isolated patches of discharging fresh groundwater appear along the dunes, particularly the southern shore of North Lagoon. Freshwater soaks are formed when fresh water that is recharged through the dunes collects as a lens-shaped freshwater aquifer above the saline water that lies around it (Mooney, 1982 as cited in Winter and Squire, 2003). In some areas, water collects in depressions or swales and forms soaks. Standing water may be present in winter drying to damp conditions in summer (Winter and Squire, 2003). There is a strong association with un-vegetated dune systems due to increased rates and volumes of recharge, and thus discharge, from unvegetated areas. Bands of *Phragmites* reeds hug the dunes in areas where recharge provides their freshwater needs.		
Key biological components supported and how	Dense stands of freshwater reeds form around freshwater soaks, at the base of un-vegetated dunes and at the Mouths of the miniature coves described in Type J above. Often associated with samphire communities, these patches of reeds provide a range of birds with nesting and foraging habitat. These soaks also support a range RI RWKHU VKUXEUDQG DQG H P HU J HQW Z HWDQG ÁRUD LQFUXGLQ J *Juncus* spp. Rushes, *Schoenoplectus pungens* Spiky Club-rush, *Samolus repens* Creeping Brookweed, *Apium prostratum* ssp *prostratum* Native Celery, *Triglochin striatium* Streaked Arrow-grass and *Sporobolus virginicus* Salt Couch (Winter and Squire, 2003). Freshwater soaks along the Younghusband Peninsula may provide the only freshwater source and wetland KDEWDW IRU P DQ\ ÁRUD DQG IDXQD LQFUXGLQ J NDQ J DURRV DQG H P XV WKURX J KRXW P XFK RI WKH \HDU : LQWHU DQG Squire, 2003). Anecdotal evidence suggests that the pressure, quality and number of soaks has decreased steadily since the 1940s to the point that terrestrial fauna, such as emus, are required to dig for water (see Section 7). See Type Y following also.		
Limit of acceptable change—rationale	0% (areal extent)—there is relatively little area, this is a vulnerable type and plays important ecological roles.		

Type I: Permanent rivers/streams

7UDIAF OLJKW DVVHVV P HQW

Salt Creek is undergoing another period of change in water regime due to regulation of ÁRZV IUR P 0 RUHUD %DVLQ DQG LW FRQWDLQV VLJ QLÀFDQW stands of *Gahnia* sp. (see Section 5.2.1). Based on this it is considered extremely vulnerable and under extreme threat.

Ramsar wetland types	**M**	**Permanent rivers/streams/creeks**; includes waterfalls
Units where found	South Lagoon	
Estimated areal extent in 2005 (ha)	5	
Description(s)	Salt Creek is a natural discharge point for the extensive wetlands and watercourses of the South East of South $XVWUDOLD DQG SDUWV RI ZHVWHUQ 9LFWRULD WR GUDLQ LQWR WKH 6RXWK /DJRRQ 7KHVH IUHVKZDWHU LQÁRZV ZRXG KDYH EHHQ FRQVGHUDEOH DQG UHJXODU SULRU WR (XURSHDQ VHWWOH P HQW 0 RGLÀFDWLRQV WR WKHVH ÁRZV EHJDQ LQ DQG FRQWLQXH WR WKLV GD\ (QJUDQG /RQJ WHU P UHVGHQWV UHSRUW WKDW WKH ÁRZ WKURXJK 6DW &UHHN ZDV VR JUHDW LQ VR P H \HDUV as to be heard approaching like a roaring train (see long-term stakeholder comments below). In recent years, a series of deep drains have been constructed that redirect groundwater into Morella Basin which holds water for controlled releases into the South Lagoon via Salt Creek (capped at 40,000 ML per annum on a 10 year rolling average).	
Key biological components supported and how	*Gahnia* VHG J HUDQGV VHH 6HFWLRQ DQG H[WHQVLYH P XGÁDWV VXSSRUW D ZLGH UDQJH RI EIRWD	
Limit of acceptable change—rationale	0% (areal extent)—there is relatively little area, this is a vulnerable type and plays important ecological roles.	

Comments on Salt Creek from one of the long-term stakeholders—as recorded fully in Section 7:

Frank Gibbs - Coorong fisher and hunter from the 1930s to the present

Water would rush in down at Salt Creek from the South East. We once had to move a Model T-Ford out of a swamp at Martins Washpool because we heard the water coming and we had to get to high ground. It came like a torrent. It sounded like a train, roaring down.

There were masses of birds, thousands of them, ducks and swans mostly all the way to Salt Creek, a place that also used to be the best place to catch Mulloway and bream—they would teem around Salt Creek Island.

Type R: Seasonal/intermittent saline lakes

7UDIAF OLJKW DVVHVV P HQW

Although covering a large area, this wetland type is still considered vulnerable because of dependence on close connections with other habitats, and the need for high lagoon levels and/or winter rainfalls for inundation.

Ramsar wetland types	**R**	6HDVRQDO LQWHU P LWWHQW VDOLQH EUDFNLVK DONDOLQH ODNHV DQG ÁDWV
Units where found	South Lagoon	
Estimated areal extent in 2005 (ha)	1689	
Description(s)	,QWHU P LWWHQW ODNHV ÀOO DW KLJK HOHYDWLRQV DURXQG WKH 6RXWK /DJRRQ ZKHQ OD JRRQ ZDWHU OHYHOV ULVH DQG FDWFK P HQW ZDWHU LQÁRZV RFFXU LQ ZLQWHU ([WHQVLYH VDW ÁDWV DQG VDOQDV RFFXU DFURVV WKLV DUHD WKDW FRQQHFW DQG GLVFRQQHFW over time and space. Supporting samphire shrublands (Ss, W), interspersed with *Melaleuca halmaturorum* Swamp paperbark ZRRGODQGV ;I DQG P XGÁDWV *	
Key biological components supported and how	These wetlands have extensive samphire coverage and are interspersed with other samphire shrublands (Ss, W), interspersed with *Melaleuca halmaturorum* 6ZDPS SDSHUEDUN ZRRGODQGV ;I DQG P XGADWV * 7KLV KDEWDW LV considered to be very important for Black-winged and Banded Stilts and smaller waders such as Red-capped Plovers (see Section 5.4) as well as a range of other terrestrial and aquatic biota. Whilst not well understood, nutrient and carbon cycling between the lagoon and adjacent fresh, saline and hypersaline samphire and *Melaleuca* P XGADWV LV EHOLHYHG WR EH DQ L P SRUWDQW IHDWXUH RI WKH HFROR J \ RI the lagoon.	
Limit of acceptable change—rationale	5% (areal extent)—this type plays important ecological roles. KDEWDW FRQQHFWLYLW\ ³ FRQQHFWV WR W\SHV * : 6V DQG ;I DW KLJK HOHYDWLRQV DURXQG WKH OD J RRQ	

Type Ss: Seasonal/intermittent saline marshes

7UDIAF OLJKW DVVHVV P HQW

This type of wetland is well represented in area but is still considered to be vulnerable. This is based primarily on threats to the maintenance of habitat connectivity between these wetlands and Types * : 5 DQG ;I DW KLJK HOHYDWLRQV DURXQG WKH 6RXWK Lagoon. This rating takes into account that this type is partly found within Coorong National Park, and these areas receive management attention.

Ramsar wetland types	Ss	Seasonal/intermittent saline/brackish/alkaline marshes/pools
Units where found	South Lagoon	
Estimated areal extent in 2005 (ha)	985	
Description(s)	A chain of intermittent saline marshes (salinas), that interconnect with larger salt lakes (Type R) and wetland types * : DQG ;I RFFXU EHWZHHQ 0LH &URVVLQJ DQG WKH VRXWKHUQ HGJH RI WKH &RRURQJ 1DWLRQDO 3DUN	
Key biological components supported and how	These small saline marshes support complex samphire communities (e.g. *Salicornia blackiana*) and exist in a PRVDLF RI KDEWDWV ZLWK ZHWDQGV RI 7\SHV 5 ;I DQG : WR IRUP D FRP SOH[EOHQGLQJ RI ZHWDQG ÅRUDO DVVH P EOD J HV All aspects of habitat availability are important across this mosaic. Very important habitat for Black-winged and Banded Stilts and smaller waders such as Red-capped Plovers (see Section 5.4). Nutrient and carbon cycling between these interconnected habitats is considered important for ecosystem components and processes, but is poorly understood.	
Limit of acceptable change—rationale	5% (areal extent)—this type plays important ecological roles. KDEWDW FRQQHFWLYW\ ³ FRQQHFWV WR \SHV * : 5 DQG ;I DW KLJK HOHYDWLRQV DURXQG WKH OD J RRQ	

Type W: Shrub dominated wetland

7UDIAF OLJKW DVVHVV P HQW

The mosaic of *Gahnia* sp. (see Section 5.2.1) and *M. halmaturorum* represents vital habitat that is considered to be under threat due to this wetland W\SH·V UHOLDQFH RQ IUHVKZDWHU LQÁRZV DQG WKH OLNHO\ FRQYHUVLRQ IUR P : WR 6V LI LQÁRZV UHGXFH 7KHVH wetlands are also considered vulnerable because the species assemblages are under-represented DW D 6WDWH OHYHO KDYH YHU\ ÀQH WRØHUDQFHV IRU ZDWHU UHJLP H DQG DUH GLÀFXOW WR UH HVWDEOLVK LI ORVW

Ramsar wetland types	**W**	**Shrub-dominated wetlands**; shrub swamps, shrub-dominated freshwater marshes, shrub carr, alder thicket on inorganic soils
Units where found	South Lagoon	
Estimated areal extent in 2005 (ha)	2160	
Description(s)	The Type W samphire communities are supported by a fresher water regime than the Ss communities and are not dominated by evaporating salinas. They are however connected to Type Ss, Xf and R wetlands and form part of a mosaic from fresh to hypersaline wetland habitats. Approximately 90% of this habitat occurs as extensive bands of interconnected wetland assemblages between the Princes Highway and South Lagoon south of Salt Creek and extends as patches north of Salt Creek. The main stands occur in the area between the Loop Road and the highway.	
Key biological components supported and how	** DKQLD ÀXX P* 6DZ UXVK VHH 6HFWLRQ RFFXUV LQ GHQVH VWDQGV DFURVV WKH OD J RRQ ÁDWV DQG J UDGHV LQWR VD P SKLUH ADWV GHSUHVVLRQV *Melaleuca halmaturorum* Swamp paperbark and/or coastal dune vegetation depending on water regime, soil types and elevation. *Gahnia* sedgelands occur on both the coastal and landward side of South Lagoon and are considered vulnerable in the SA agricultural district (see Section 5.2.1).	
Limit of acceptable change—rationale	5% (areal extent)—this type plays important ecological roles. KDEWDW FRQQHFWLYW\ ³ FRQQHFWV WR W\SHV * 5 6V DQG ;I DW KLJK HØHYDWLRQV DURXQG WKH OD J RRQ	

Type Xf: freshwater, tree-dominated wetlands

7UDIAF OLJKW DVVHVV P HQW

Large areas of this wetland type remain around South Lagoon but they are considered to be under threat from land and water resource development and vulnerable because they represent the only wetland tree in the bulk of the Ramsar site and as such perform myriad ecosystem processes.

Ramsar wetland types	**Xf**	**Freshwater, tree-dominated wetlands** LQFOXGHV IUHVKZ DWHU VZ D P S IRUHVWV VHDVRQDO\ ÁRRGHG IRUHVWV wooded swamps on inorganic soils
Units where found	South Lagoon	
Estimated areal extent in 2005 (ha)	1345	
Description(s)	These wetlands are dominated by *Melaleuca halmaturorum* Swamp paperbark woodlands. They occur at a similar elevation to Type W wetlands *(Gahnia* sedgelands but tend to occur on calcrete outcrops rather than in swales as Type W do.	
Key biological components supported and how	Bands of *Melaleuca* occur in close association with coastal dune vegetation and Type W, R and Ss wetlands. They are concentrated between the edge of the South Lagoon seasonal lakes and the highway and are not common on the coastal side of the lagoon. Approximately 90% of this wetland type occurs in an assemblage of * 5 6V : DQG ;I ZHWDQGV WKDW H[WHQGV VRXWK RI 6DW &UHHN WR WKH &RRURQJ 1DWLRQDO 3DUN ERXQGDU\ 1RUWK RI 6DW &UHHN GHQVH ZRRGLDQGV VXUURXQG 7\SH 5 VHDVRQDO VDW ODNHV ZLWK ODUJH IRUHVWV RFFXUULQJ RSSRVLWH *HPLQL 'RZQV Swamp Paperbark woodland *0 HUDOHXFD KDOP DWXRUX P* provides important nesting and foraging grounds for a wide range of waterbirds (Jensen et al., 2000) and have been directly and indirectly linked with a range of HFRORJLFDO DQG K\GURORJLFDO IXQFWLRQV E\ *UHHQZD\ VXFK DV • LP SURYHG ZDWHU TXDOLW\ DQG FRQWUROOHG VHGLP HQWDWLRQ E\ ÀOWHULQJ VHGLP HQWV • essential cycling of carbon, nutrients and contaminants (food source for heterotrophic micro-organisms and detritivores) • SURYLGH ORQJ OLYHG WH P SRUDU\ DQG SHU P DQHQW KDEWDW IRU D YDULHW\ RI ÁRUD DQG IDXQD LQFOXGLQJ URRVWLQJ DQG breeding areas for wildlife particularly colonial nesting birds • SURYLGLQJ D SURWHFWLYH SK\VLFDO EXIIHU DQG ÁRRG PLWLJDWLRQ EHWZHHQ VKRUHOLQHV DQG ZDWHU ERGLHV • acting as long-term biomass sinks and drought refugia • provide groundwater recharge areas and thus freshwater source for people and wildlife • provide valuable food sources for migratory birds that rely on nectar during autumn and winter months.	
Limit of acceptable change—rationale	2% (areal extent)—there is relatively little area, this is a vulnerable type and plays important ecological roles. KDEWDW FRQQHFWV WR 7\SHV * 5 6V DQG : DW KLJK HOHYDWLRQV DURXQG WKH OD J RRQ	

Type Y: Freshwater springs

7UDIAF OL J KW DVVHVV P HQW

There has been a marked decline in the number of active soaks—see comments from Ngarrindjeri and long-term stakeholders below—and the quality and quantity of water in those that remain. These soaks are considered to be under immediate and extreme threat of loss as a habitat type and vulnerable to changes in groundwater dynamics, reduced recharge in recent years and surface disconnection by animals digging for water. Their loss would be catastrophic to the terrestrial and aquatic fauna biota of the Younghusband Peninsula in particular.

Ramsar wetland types	**Y**	**Freshwater springs; oases**
Units where found	South Lagoon	
Estimated areal extent in 2005 (ha)	<10	
Description(s)	In 2001, eight freshwater soaks were located along the margins of South Lagoon and an additional four in the ephemeral lagoon section south of South Lagoon (Winter and Squire, 2003). Prior to 1970s there were more than 30 active soaks along the banks of the South Lagoon and on the Coorong islands (see Section below and Section 7). Freshwater soaks are formed when fresh water that is recharged through the dunes collects as a lens-shaped freshwater aquifer above the saline water that lies around it (Mooney, 1982 as cited in Winter and Squire, 2003). In some areas, water collects in depressions or swales and forms soaks. Standing water may be present in winter, drying to damp conditions in summer (Winter and Squire, 2003).	
Key biological components supported and how	Freshwater soaks along the Younghusband Peninsula may provide the only freshwater source and wetland KDEWDW IRU P DQ\ ÁRUD DQG IDXQD WKURX J KRXW P XFK RI WKH \HDU : LQWHU DQG 6TXUH 7KHVH VRDNV VXS SRUW D UDQ J H RI VKUXE DQG DQG H P HU J HQW Z HWDQG ARUD LQFXGLQ J VD P SKUHV *Juncus* spp. Rushes, *Schoenoplectus pungens* Spiky Club-rush, *Samolus repens* Creeping Brookweed, *Apium prostratum* ssp *prostratum* Native Celery, *Triglochin striatium* Streaked Arrow-grass and *Sporobolus virginicus* Salt Couch (Winter and Squire, 2003).	
Limit of acceptable change—rationale	0% of areal extent—there is little area remaining, these are a vulnerable type and play and important ecological role.	

Comments on the freshwater soaks from members of the Ngarrindjeri Indigenous community and long-term stakeholders—as recorded fully in Section 7:

Ngarrindjeri community
Freshwater soaks and fresh groundwater upwellings are important sources of fresh water to the Coorong lagoons. They are the only source of fresh water for fauna on the Coorong peninsula and an important source on the mainland side of the lagoons.

The soaks on the mainland side have become too salty to drink and many have dried up. On the peninsula, the soaks are still drinkable but the salinity is rising and they are not as plentiful as they were.

Wildlife on the peninsula are now struggling to get water. Emus and kangaroos on the peninsula now need to dig down 20 cm or more into the soaks for water. This suggests a major decline in the pressures of the soaks as they used to bubble up in summer as the water levels in the lagoons dropped. When the freshwater soaks and upwellings were more active, the water would look like it was 'full of diamonds' as the fresh, cool water would rise in 'bubbles' from the sandy floor. The soaks used to support all the water needs of both the aquatic and terrestrial animals of the Coorong as well as providing the Ngarrindjeri people themselves with drinking water.

A small, orange-coloured fish would lie dormant (as eggs) in the mud of the freshwater soak areas for years at a time waiting for good conditions when they would hatch in great numbers. It is unknown which fish species this was, but it is believed that it is now extinct as they were last seen in the late 1970s. The soaks were also full of long, pink worms and were a good place to find red-bellied snakes which are now all but gone due to lack of nursery habitat.

Bob Hera-Singh—Coorong fisher and hunter from the 1940s to the present
Freshwater soaks would teem with ducks and swans. It was clean clear water in the Coorong. Kurrawong, a property south of Salt Creek, had 10-foot deep holes with water flowing in from the South East, underground. It's now dry and grazed.

Frank Gibbs—Coorong fisher and hunter from the 1930s to the present
The freshwater springs would run a lot of water in, easily as much as Salt Creek. It was really fresh.