

SECTION 4

Assessment of wetlands – Fleurieu Peninsula

A regional scale, defined by the study region boundaries, analysis of wetland values is presented in this report and provides an assessment of wetland distribution, character, threats, management issues, and condition at this scale.

The assessment of wetlands across the Fleurieu Peninsula was based upon all data stored within the South Australia Wetland Inventory Database (SAWID), including both wetland surveys completed as a part of this project, and data gathered from other sources. Mention of specific wetland bodies is confined to the listing of wetlands of particular ecological significance within the region. However data can be generated for each individual wetland identified within the Fleurieu Peninsula using SAWID. A brief user guide for viewing specific data is provided as Appendix 8.

4.1 Wetland distribution

Wetland bodies are unevenly distributed throughout the Fleurieu Peninsula region, and tend to be localised in eleven major groupings:

- Parawa / Deep Creek / Willow Creek;
- Victor Harbor;
- Inman Valley;
- Hindmarsh Valley;
- Mount Jagged;
- Glenshera (Mount Compass);
- Mount Compass;
- Nangkita;
- Currency Creek / Finniss River;
- Yundi; and
- Kyeema.

The major wetland groups are shown in Figure 4.1 where wetland density (based on wetland area) is compared across the study area

The majority of wetlands are found in the Southern Fleurieu region, with only a few isolated wetlands in the north of the study area.

A total of 858 wetland bodies were mapped throughout the Fleurieu Peninsula region for the wetland inventory project, incorporating a total area of 4,411 hectares (1.17% of the total study area). Wetlands on the Fleurieu tend to be small (averaging only 5.14 ha), and are often isolated ecological communities. Map 1 (back of this report) shows the location of individual wetlands mapped for the Fleurieu Peninsula wetland inventory.

Data suggests that pre-European distribution of swamps and wetlands on the Fleurieu Peninsula was once much more extensive. Derived information using soil and landscape data has been compiled and provides an indication of the susceptibility of soils to flooding and waterlogging (DWLBC 2002). This data has been used to infer the potential extent of wet areas pre-European settlement (indicative of wetland habitat). The derived data takes into consideration soil types, elevation, rainfall, and permeability of the soil, depth to water table and plant water use. However, soil landscapes are classified according to their most waterlogged areas, provided that those areas account for at least 30% of the total area of an individual landscape unit. It is possible therefore, that up to 70% of an area identified as waterlogged is less affected by waterlogging than the map suggests. Figure 4.1 shows the distribution of potentially waterlogged area, and provides a coarse estimation of past wetland distribution.

From the data available, an estimated 42% loss of total wetland area across the Fleurieu Peninsula since European settlement can be inferred. Loss was calculated from current wetland mapping, and waterlogging data from Soil and Landscape mapping (DWLBC 2002). Due to spatial limitations of the waterlog data for identifying wetland bodies, only 30% of the total area identified as waterlogged was considered in the calculation.

Littlely & Cutten (1994) indicate that intact Fleurieu Peninsula swamps have been reduced by 75% of their original extent – from an estimated 2000 ha (Lamprey & Mitchell 1979) to approximately 500 ha (Littlely & Cutten 1994; Duffield *et al.* 2000). Given the available data, including mapping for the wetland inventory and topography and soils data (DWLBC 2002), this is likely to be an underestimation of current wetland extent and does not consider wetland types other than those identified as Fleurieu Peninsula swamps (Duffield *et al.* 2000).

Distribution of wetlands in relation to landscape features

Landscape geomorphology and hydrology plays an important role in determining the position and distribution of wetlands across the Fleurieu Peninsula. Typically, wetlands on the Fleurieu Peninsula are positioned in depressions of the landscape, often between steeply dissected hills or within gullies (Plate 4.1) or as perched wetlands on plateau regions of the study area. Many wetlands are formed as a result of groundwater interactions (natural springs) at the top of catchments, or floodplains from stream flow and local runoff lower in the catchment and generally flow into major stream networks. (Figure 4.2). Wetlands often occur as linear features following the creeklines of the upper catchments where wet soils have developed. Geomorphological and hydrological processes have resulted in soils which are typically permanently waterlogged, infertile, acidic and peaty which support many wetland ecosystems (Duffield *et al.* 2000). Rainfall also appears to affect wetland distribution, as the majority (63%) of wetlands are located in the higher rainfall bands (800 – 1000mm average annual rainfall) (see Section 4.2).



Plate 4.1. Typical upper catchment wetland system on the Fleurieu Peninsula, positioned between steeply dissected hills (Upper Tookayerta catchment wetland).

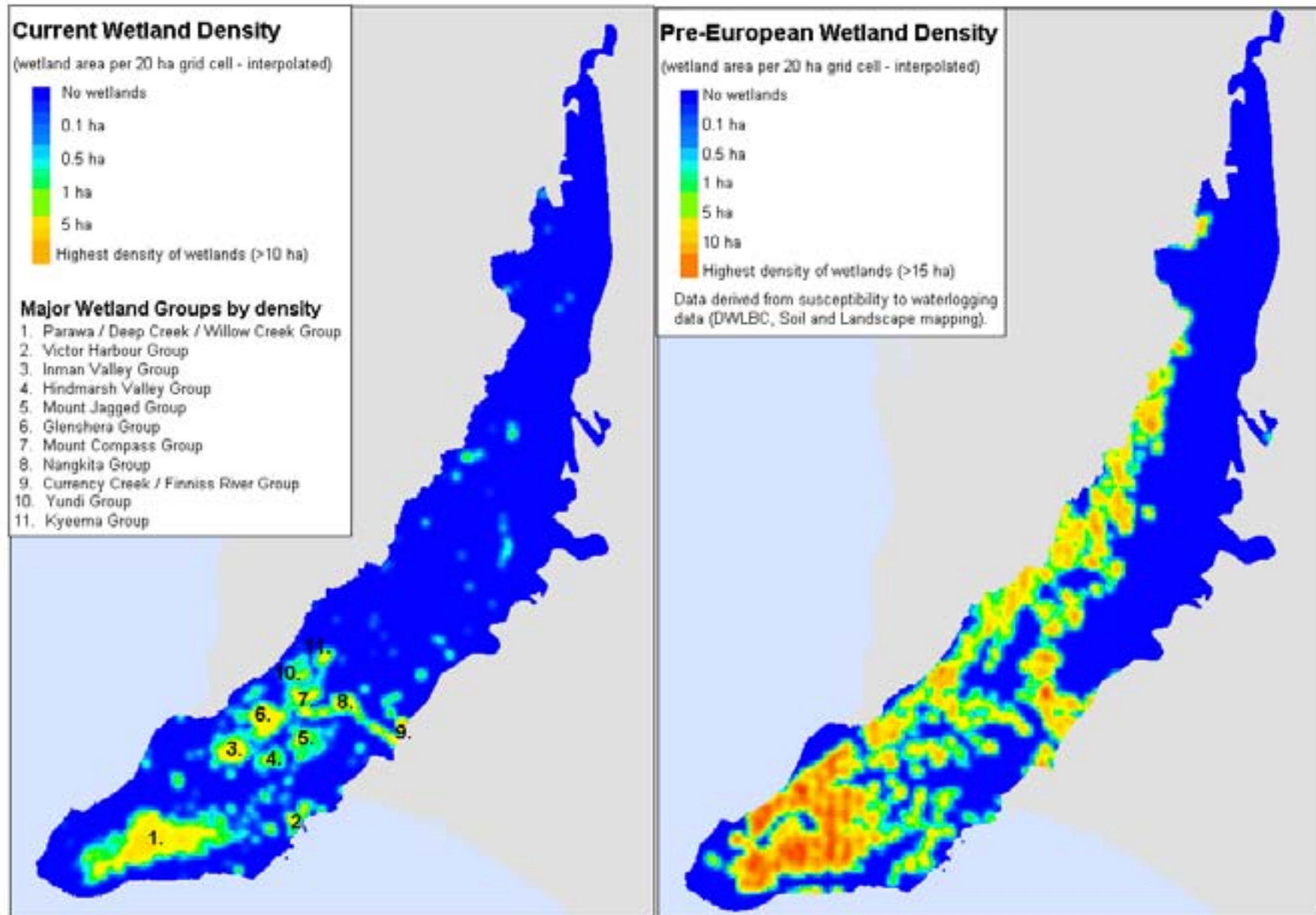


Figure 4.1. Density of wetlands across the Fleurieu Peninsula region shown as total area of wetland per 20 hectare grid square

Wetlands occur in 37 of the 70 sub-catchments mapped within the Fleurieu Peninsula region. Figures 4.3 and 4.4 show the distribution of wetlands across the sub-catchment boundaries.

The highest total numbers of wetlands (>50) occur in the sub-catchments of Inman River, Myponga River, Hindmarsh, Finniss River, Tookayerta, Currency Creek, Yankalilla River and Deep Creek (see Figure 4.2). However, many of these catchments are very large, and do not accurately depict the distribution of wetlands across the Fleurieu region. Figure 4.4 provides an indication of the percentage of each sub-catchment area that has been identified as wetland habitat. From this analysis, the highest densities of wetlands in the study region occur within the sub-catchments of Boat Harbour Creek, Tunkalilla Creek, Callawonga Creek, Deep Creek, Tapanappa Creek, Bollaparudda, Coolawang Creek and Tookayerta.

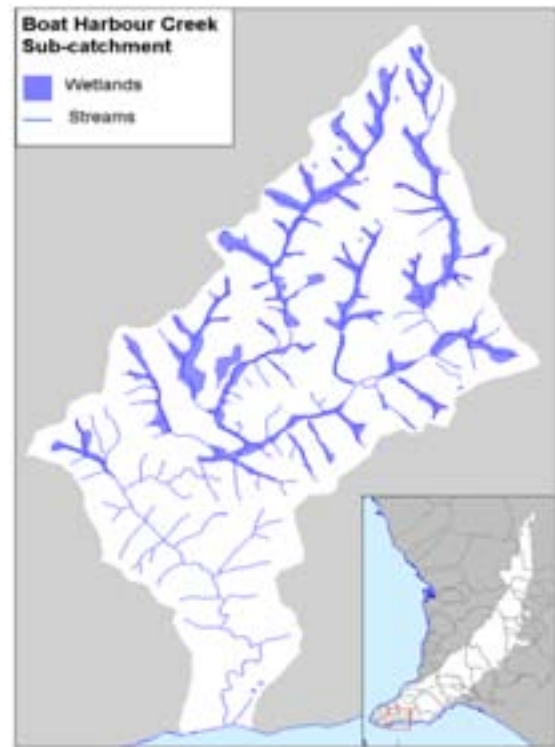


Figure 4.2. Position of wetlands within the stream network (example sub-catchment).



Figure 4.3. Number of wetlands per sub-catchment boundary.

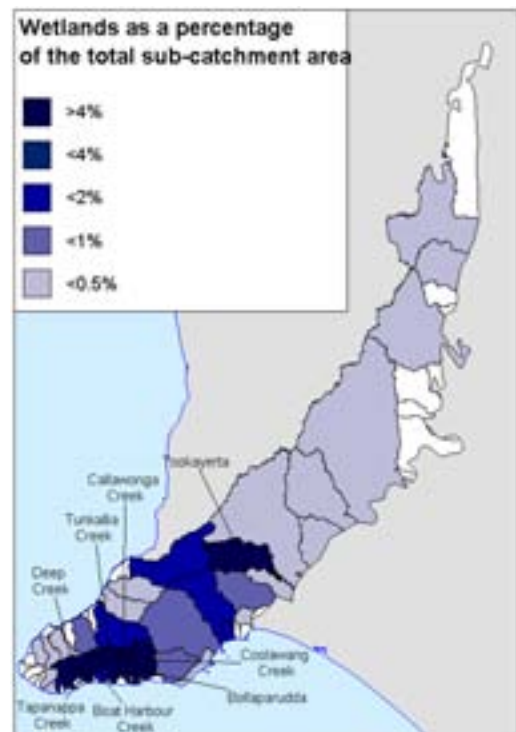


Figure 4.4. Percentage of sub-catchment area occupied by wetland bodies.

Land tenure and land use

The large majority (92%) of all wetlands on the Fleurieu Peninsula are situated within privately managed freehold land. Publicly owned lands containing wetlands include Conservation Parks and Reserves, Forestry SA land, Crown leaseholds, and land managed by Local Government. Figure 4.5 shows the distribution of wetlands by area within major land use categories identified throughout the Fleurieu Peninsula region. The majority (approximately 75%) of wetlands are located within agricultural production zones (namely livestock grazing, dairy cattle and improved pastures). A small percentage (14%) of wetlands occur within areas of remnant native vegetation on privately owned land. These are however not solely managed for conservation purposes, and it is suggested by the author that the majority are grazed by stock.

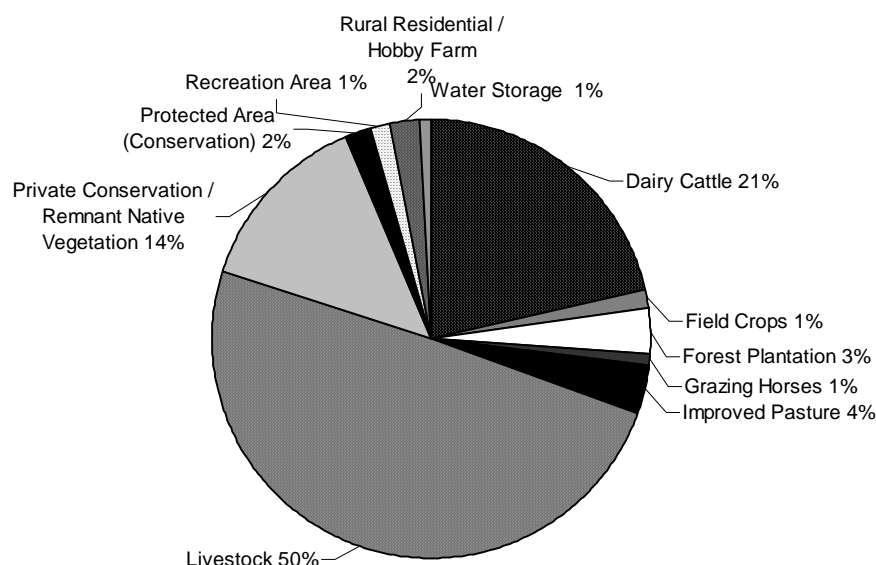


Figure 4.5. Major land uses of wetlands on the Fleurieu Peninsula (Source: DCDB).

Grazing by cattle was the most common land use, both within and surrounding wetlands on the Fleurieu Peninsula (Figure 4.6). Sheep grazing and dairy cattle were also common land uses of wetland areas. Many wetlands surveyed were managed for some degree of private conservation, with either grazing exclusion or periodic grazing regimes.

Land tenure and land use was recorded at each wetland site surveyed for the wetland inventory. Figure 4.6 illustrates the frequency of land use categories identified during field survey, both within the wetland and the surrounding landscape. Note that more than one land use category can be recorded for each wetland surveyed. The survey data aims to provide a representative sample, however due to the prioritisation process it is likely that categories such as Conservation Parks and Forestry appear more frequently than the actual values would suggest because surveys are slightly skewed towards wetlands located within publicly owned land.

Swamps and wetlands are poorly represented in the reserves system for South Australia (MLRSEW Recovery Team, in prep a). Five Conservation Parks on the Fleurieu Peninsula contain wetland areas:

- A total of 10 swamps/wetland areas are within, or partially within Deep Creek Conservation Park (totalling approximately 70 ha);
- Waitpinga Conservation Park encompasses a small portion of a large swamp complex known as Illawong Swamp;
- Newland Head Conservation Park encompasses a small (13.4 ha) estuarine salt marsh wetland on Waitpinga Creek inlet;
- Stipiturus Conservation Park (formerly known as Glenshera Swamp) was specifically purchased in 2001 to conserve one of the most significant and largest (30 ha) swamp complexes remaining in the region (DEH 2005); and
- Mount Billy Conservation Park contains a small (2 ha) swampy gully wetland.

In total, the current reserve system conserves 1.6% of the total number of wetlands, or 2.6% (114.6 ha) of the total wetland area identified on the Fleurieu Peninsula. A further 25 wetlands are entirely or partially protected under Heritage Agreements, incorporating approximately 68 ha of wetland area.

Additionally, a significant number of swamps and wetland areas are within Forestry SA reserves, all of which are located in the Second Valley Forests on the Southern Fleurieu Peninsula and are offered varying degrees of protection and management for conservation purposes. A total of 28 wetlands have been identified within Second Valley Forests, comprising approximately 135 ha, or 3.2% of the total wetland area identified on the Fleurieu Peninsula.

Various Local Government reserves, including recreation reserves contain small areas of wetlands. A total of 53 ha of wetland have been identified on Local Government land, mostly within residential areas and townships (e.g. estuarine inlets at Victor Harbor, Port Elliot and Normanville).

Therefore, a total of approximately 8.6 % of all wetland area on the Fleurieu Peninsula is currently within public land or under some form of conservation protection within the State Reserve Network, Heritage Agreements, and Local Government or within Forestry SA reserves. The conservation measures taken and management practices among tenures varies, where not all of the wetlands identified are specifically managed for conservation purposes, and not all can be considered to be in good condition.

Crown land under various long-term leasehold arrangements used primarily for agricultural purposes encompasses 423 ha of wetland area on the Fleurieu. Significantly, only 5.2 ha of wetlands identified on Crown Leasehold land is currently recognised under Heritage Agreements.

There is significant opportunity to target wetlands in good condition (see Section 4.4 and 4.5), particularly those on Crown Lands, for inclusion in the Reserve System or to be formally recognised for conservation under a Heritage Agreement.

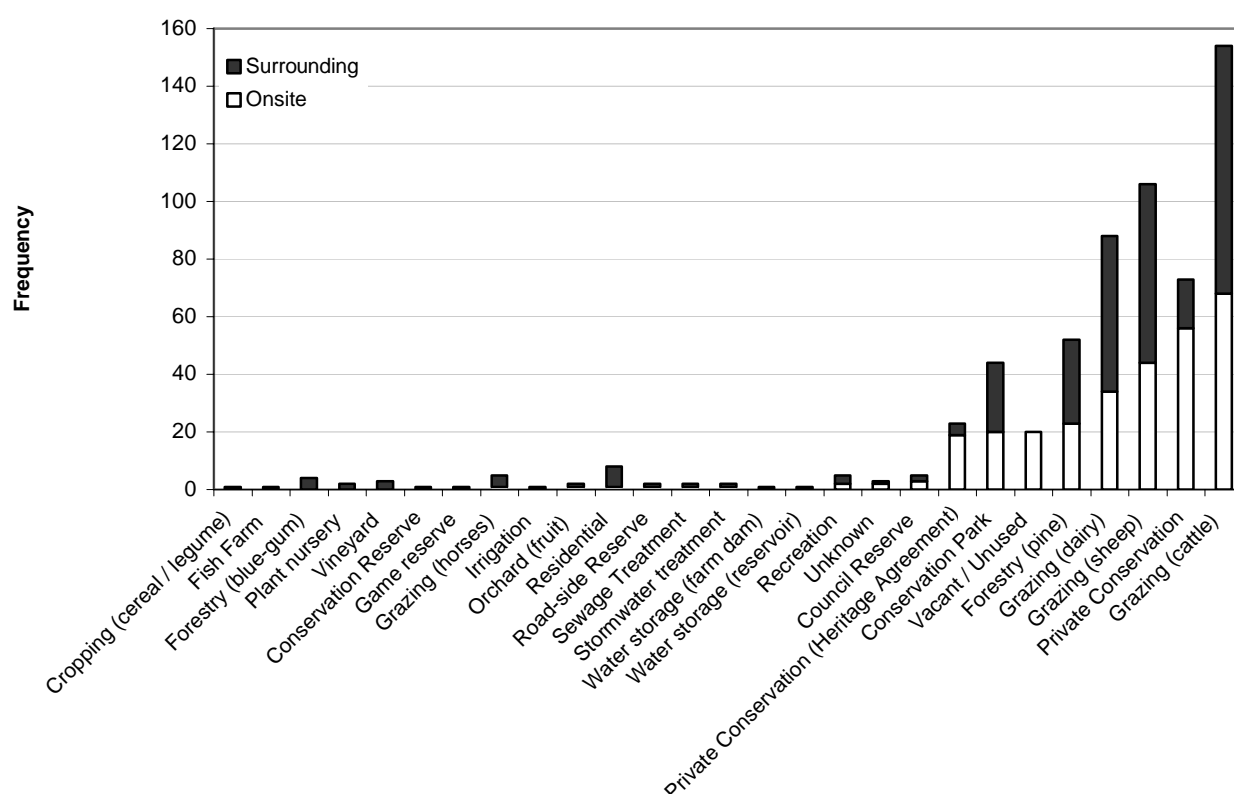


Figure 4.6. Wetland land use of sites surveyed for the Fleurieu Peninsula wetland inventory, onsite and surrounding.

Note: many land uses can be recorded for an individual wetland.

4.2 Character

Character of wetlands can be described in many ways and the method used to describe wetland habitats is largely dependent on the scale of the study. Broad character classes are given to wetlands using the Directory of Important Wetlands in Australia classification categories, which provides a classification system on a National scale. Figure 4.7 indicates the types of wetlands surveyed using the Directory of Important Wetlands (Environment Australia 2004) classifications. The large majority of wetlands surveyed were permanent peat-bog swamps (B15) or shrub-dominated freshwater swamps (B13). Only four wetlands of estuarine environments and six wetlands of human origin were surveyed for the Fleurieu Peninsula wetland inventory.

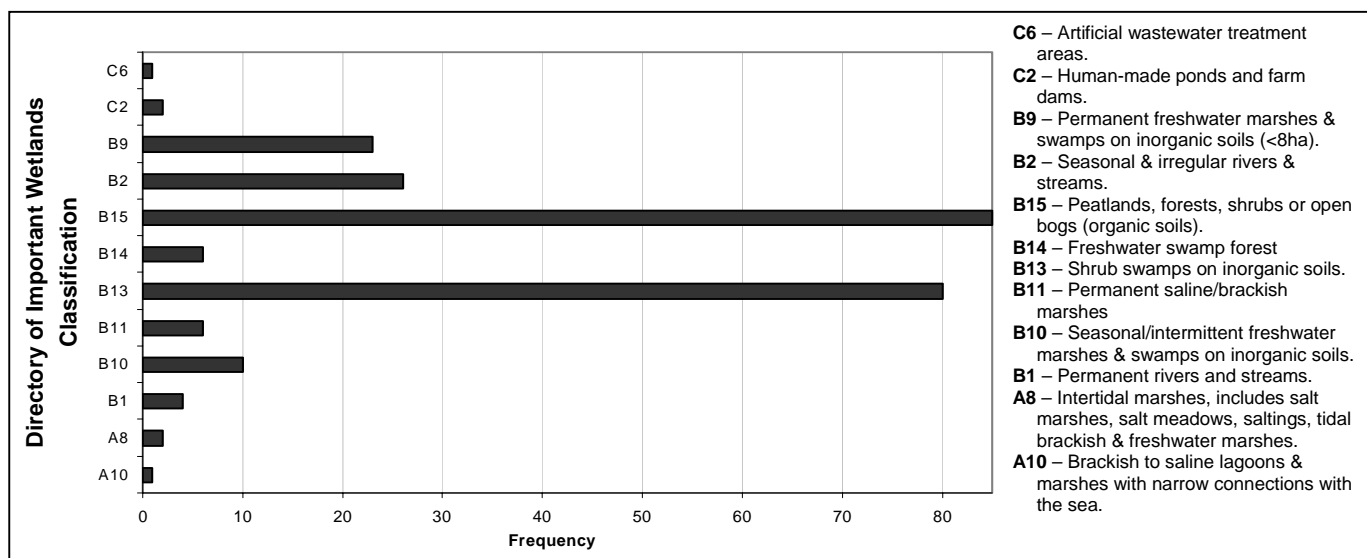


Figure 4.7. Wetland types in the Fleurieu Peninsula region (Directory of Important Wetlands in Australia classification).

The current project however, aims to provide a more descriptive classification than the Directory of Important Wetlands by using vegetation characteristics, water chemistry, geomorphology and hydrology. Several character classification systems have been developed using similar methods and groupings throughout Australia. Riggert (1966) and Goodrick (1970) have used classification schemes based on salinity, water regime and dominant vegetation types. Corrick and Norman (1980) expanded this system to include subcategories based on vegetation communities important to waterbirds in Victoria. No regional or Statewide scale classification system has been previously attempted for wetlands in South Australia.

Characterisation of the types of wetlands located on the Fleurieu Peninsula was investigated using data collected through field survey. Vegetation structural formation, salinity, substrate type and landform element information for each swamp surveyed were analysed and grouped into 23 distinct groups (Table 4.1). Vegetation structures, substrate and landform element categories follow those identified by Heard and Channon (1997) for the Biological Survey of South Australia. Appendix 4 provides descriptions of these fields.

The character groups identified for the Fleurieu Peninsula provide a more descriptive definition of the wetland environments present on the Fleurieu Peninsula at the study region scale. More detailed descriptions could be generated through analysis of vegetation communities and species compositions (eg. those identified by Duffield *et al.* 2000), however this type of analysis was beyond the scope of this project. Wetland character was determined for 68% of all mapped wetlands within the Fleurieu Peninsula region. Character was unable to be determined for the remaining 32% of wetlands due to data deficiencies.

Map 2 (back of this report) provides wetland character mapping for the study region. *Shrub-dominated freshwater peat swamps* and *shrub-dominated freshwater swamps* were the most commonly occurring wetland community. Figure 4.8 shows the percentage of wetlands identified within each of the broad classification groups. Less common wetland types on the Fleurieu Peninsula included *tree-dominated swamps*, and *fern-dominated swamps*, *brackish wetlands* and *estuarine wetlands*. Freshwater

wetlands dominated those wetlands surveyed, with only 17 brackish or saline sites visited during survey. Plate 4.2 provides examples of some of the wetland categories identified on the Fleurieu Peninsula.

Table 4.1. Wetland character classes – Fleurieu Peninsula.

Landform element	Salinity	Substrate	Veg structure	Character description
Swamp	fresh	organic (peat)	fern-dominated	Fern-dominated freshwater peat swamp
			sedge-dominated	Sedge-dominated freshwater peat swamp
			shrub-dominated	Shrub-dominated freshwater peat swamp
		non-organic	reed-dominated	Reed-dominated freshwater swamp
			sedge-dominated	Sedge-dominated freshwater swamp
			shrub-dominated	Shrub-dominated freshwater swamp
			tree-dominated	Tree-dominated freshwater swamp
	fresh/brackish	organic (peat)	reed-dominated	Reed-dominated fresh/brackish peat swamp
		non-organic	reed-dominated	Reed-dominated fresh/brackish swamp
Perched Swamp	fresh	organic (peat)	sedge-dominated	Sedge-dominated freshwater perched peat swamp
			shrub-dominated	Shrub-dominated freshwater perched peat swamp
		non-organic	shrub-dominated	Shrub-dominated freshwater perched swamp
			tree-dominated	Tree-dominated freshwater perched swamp
Drainage depression	fresh	non-organic	fern-dominated	Fern-dominated freshwater drainage depression
			reed-dominated	Reed-dominated freshwater drainage depression
			sedge-dominated	Sedge-dominated freshwater drainage depression
			shrub-dominated	Shrub-dominated freshwater drainage depression
			tree-dominated	Tree-dominated freshwater drainage depression
	brackish	non-organic	reed-dominated	Reed-dominated brackish drainage depression
			sedge-dominated	Sedge-dominated brackish drainage depression
Estuary	saline/brackish	N/A	reedbed	Estuarine reedbed
			saltmarsh	Estuarine saltmarsh
Human-made	fresh	N/A	sedge-dominated	Waste treatment wetland – sedge-dominated

The ecological character of wetlands on the Fleurieu Peninsula is further discussed in relation to vegetation characteristics, fauna, water chemistry and hydrology in more detail in the following sections.

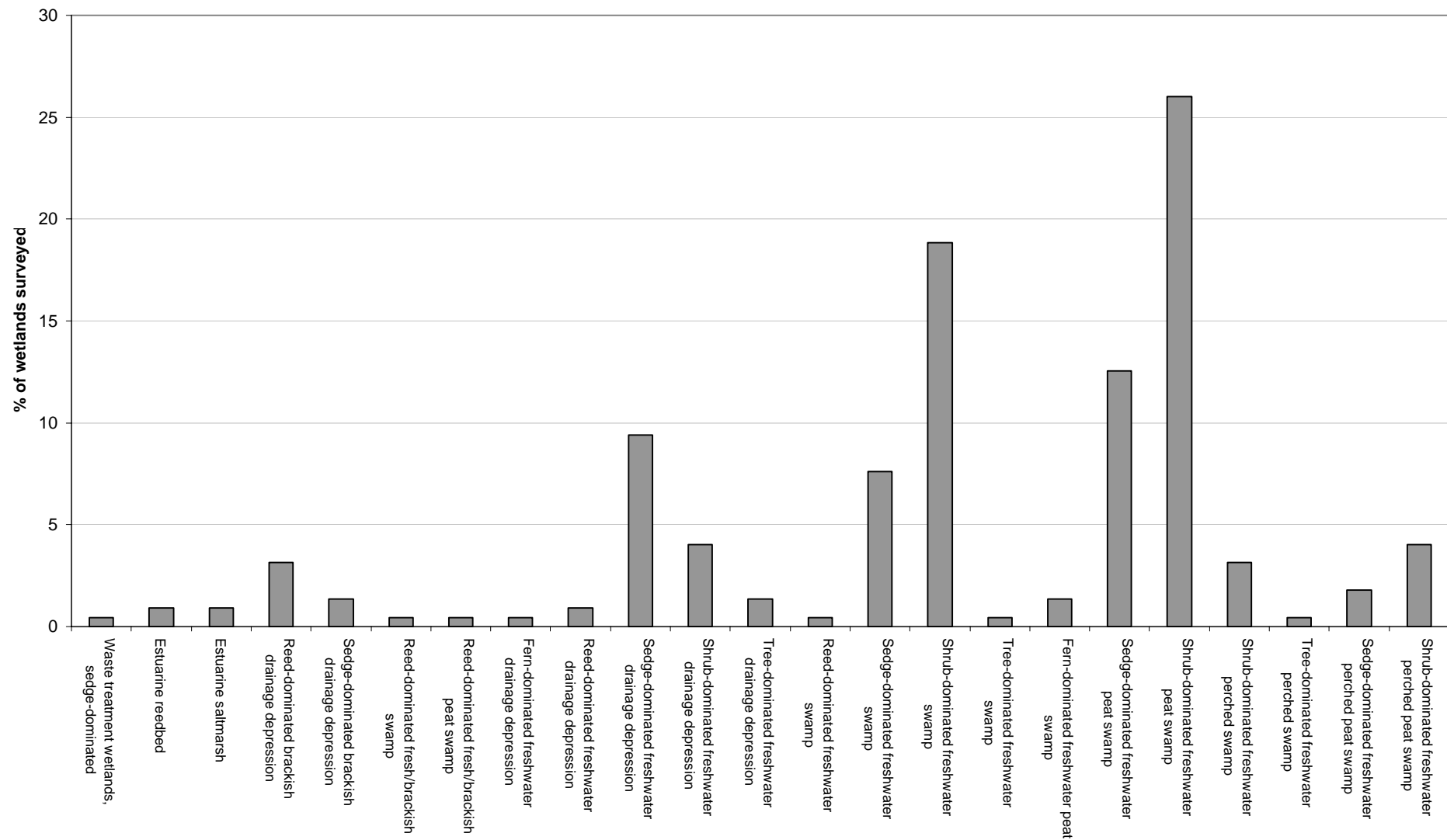


Figure 4.8. Percentage of wetlands within each wetland character group.



Plate 4.2. Examples of wetland character categories on the Fleurieu Peninsula.

Wetland vegetation

A total of 741 flora species have been recorded within and on the margins of Fleurieu Peninsula wetlands (identified from field survey and data review), of which 80% are indigenous. Appendix 11 lists the most commonly recorded species. *Lepidosperma longitudinale* (Pithy Sword-sedge), *Leptospermum continentale* (Prickly Tea-tree) and *Baumea rubiginosa* (Soft Twig-rush) were recorded in over 80% of all wetlands surveyed (refer to Appendix 11). Over 30% of all flora species recorded for Fleurieu Peninsula wetlands are of conservation significance, including 73 listed in State schedules

and six listed as Nationally threatened under the EPBC Act. Appendix 2 provides a list of all threatened flora identified for wetlands on the Fleurieu Peninsula and their conservation status.

Shrub-dominated freshwater (peat and non-organic) swamps consistently recorded the highest flora species diversity (Figure 4.9). Swamp ecosystems were generally more diverse than drainage depressions, estuarine environments and human-made wetlands. Fleurieu Peninsula swamps are known to be some of the most floristically and structurally diverse wetland ecosystems in the State (MLRSEW Recovery Team, in prep a). Their status as a distinctive and ecologically significant ecosystem is acknowledged in the listing of Fleurieu Peninsula swamps as a Critically Endangered ecological community under the EPBC Act.

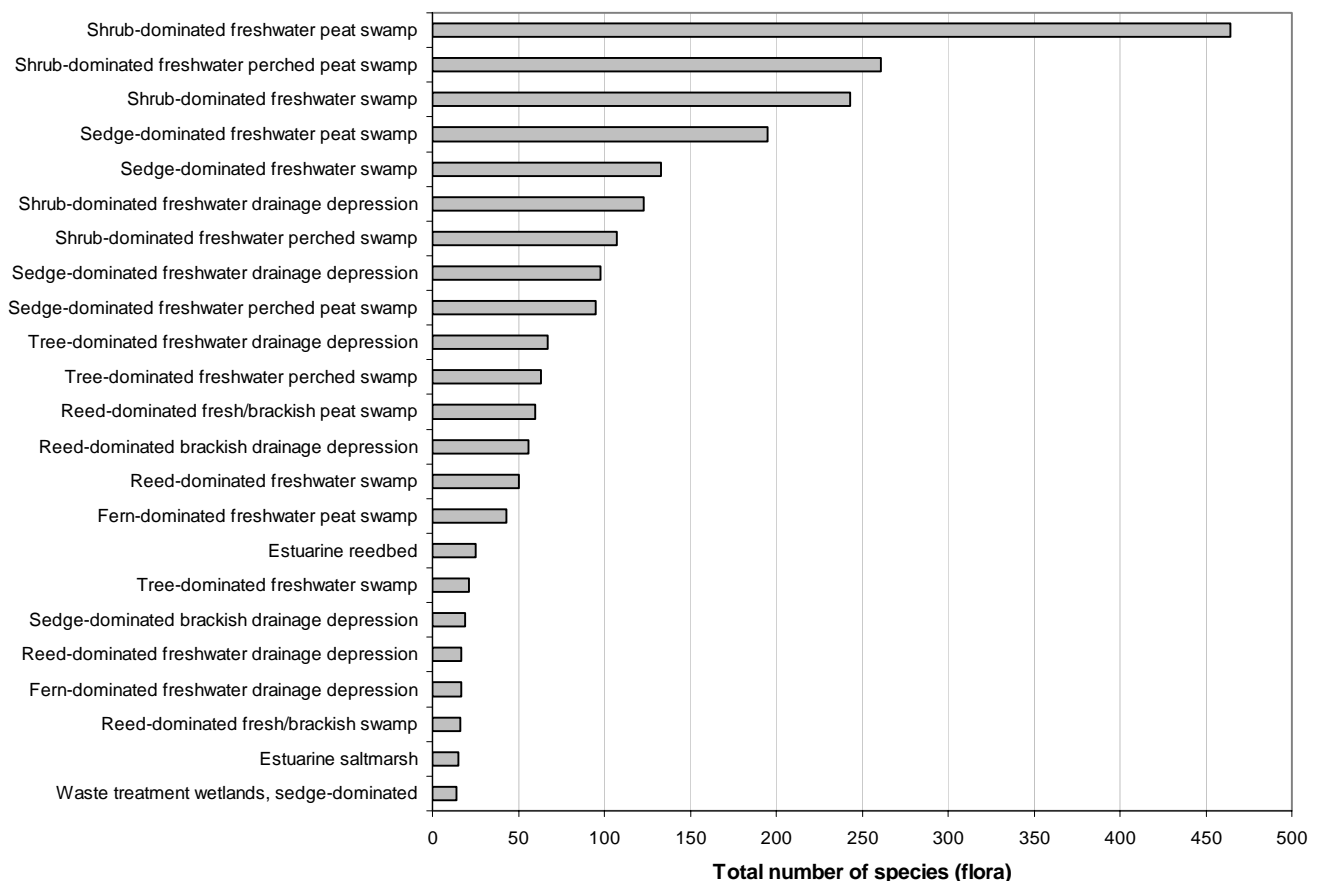


Figure 4.9. Flora species richness within each wetland character category identified on the Fleurieu Peninsula.

Distinct vegetative communities were apparent between wetland character categories identified. Table 4.2 lists the most commonly recorded, and most dominant flora species within each category. Tree life-forms are mostly absent from swamp communities, although where present include species such as *Eucalyptus ovata* (Swamp Gum) and *Eucalyptus cosmophylla* (Cup Gum). The tallest stratum is commonly a medium-tall shrub layer, the medium stratum is a tall sedge and/or fern layer and the ground layer stratum is a variety of herbaceous plants, grasses or low-lying sedges (MLRSEW Recovery Team, in prep a; Duffield *et al.* 2000).

Dominant and co-dominant overstorey species for swamp habitats commonly included the sclerophyllous shrubs *Leptospermum continentale* (Prickly Tea-tree), *Leptospermum lanigerum* (Silky Tea-tree), *Melaleuca squamea* (Swamp Honey-myrtle), *Melaleuca decussata* (Totem-poles), *Acacia retinodes* var. *retinodes* (Swamp Wattle) and *Viminaria juncea* (Native Broom). *Viminaria juncea* and *Acacia retinodes* var. *retinodes* can also be present as an emergent species rather than dominant overstorey. Dominant understorey species are typically sedge and rush genera such as *Baumea* spp., *Juncus* spp., *Eleocharis* spp., *Lepidosperma* spp., *Empodisma* spp., *Carex* spp. and *Gahnia* spp. Ferns commonly found in the medium stratum of many swamps included *Blechnum minus* (Soft Water-fern), *Gleichenia microphylla* (Coral Fern) and *Pteridium esculentum* (Bracken Fern).

Brackish wetland ecosystems were dominated by more salt-tolerant species such as *Phragmites australis* (Common Reed), *Sarcocornia quinqueflora* (Beaded Samphire), *Juncus kraussii* (Sea Rush) and *Samolus repens* (Creeping Brookweed).

Table 4.2. Most commonly recorded species within each wetland character category identified on the Fleurieu Peninsula.

Wetland Character Type	Most commonly recorded species	Common Name
Waste treatment wetlands, sedge-dominated	<i>*Rorippa nasturtium-aquaticum</i> <i>Bolboschoenus caldwellii</i> <i>Isolepis nodosa</i> <i>Cyperus vaginatus</i> <i>Carex appressa</i>	Watercress Salt Club-sedge Knobby Club-sedge Stiff Flat-sedge Tall Sedge
Estuarine reedbed	<i>Phragmites australis</i> <i>Distichlis distichophylla</i> <i>Sarcocornia quinqueflora</i> <i>Juncus kraussii</i> <i>Gahnia filum</i>	Common Reed Emu-grass Beaded Samphire Sea Rush Thatching Grass
Estuarine saltmarsh	<i>Sarcocornia quinqueflora</i> <i>Mimulus repens</i> <i>Juncus kraussii</i> <i>Potamogeton pectinatus</i> <i>Samolus repens</i>	Beaded Samphire Creeping Monkey-flower Sea Rush Fennel Pondweed Creeping Brookweed
Reed-dominated brackish drainage depression	<i>Phragmites australis</i> <i>Typha domingensis</i> <i>Juncus kraussii</i> <i>Muehlenbeckia florulenta</i> <i>Juncus pallidus</i>	Common Reed Narrow-leaf Bulrush Sea Rush Lignum Pale Rush
Sedge-dominated brackish drainage depression	<i>Juncus kraussii</i> <i>Samolus repens</i> <i>Cyperus vaginatus</i> <i>Distichlis distichophylla</i> <i>Isolepis nodosa</i>	Sea Rush Creeping Brookweed Stiff Flat-sedge Emu-grass Knobby Club-rush
Reed-dominated fresh/brackish swamp	<i>Phragmites australis</i> <i>Muehlenbeckia florulenta</i> <i>Juncus kraussii</i> <i>Leptospermum lanigerum</i>	Common Reed Lignum Sea Rush Silky Tea-tree
Reed-dominated fresh/brackish peat swamp	<i>Phragmites australis</i> <i>Leptospermum lanigerum</i> <i>Leptospermum continentale</i> <i>Viminaria juncea</i> <i>Baumea juncea</i>	Common Reed Silky Tea-tree Prickly Tea-tree Native Broom Bare Twig-rush
Fern-dominated freshwater drainage depression	<i>Blechnum minus</i> <i>Pteridium esculentum</i> <i>Carex appressa</i> <i>*Rubus discolor</i> <i>Blechnum wattsii</i>	Soft Water-fern Bracken Fern Tall Sedge Blackberry Hard Water-fern
Reed-dominated freshwater drainage depression	<i>Phragmites australis</i> <i>Leptospermum lanigerum</i> <i>Acacia retinodes</i> var. <i>retinodes</i> (swamp form)	Common Reed Silky Tea-tree Swamp Wattle
Sedge-dominated freshwater drainage depression	<i>Juncus pallidus</i> <i>Juncus sarophorus</i> <i>*Holcus lanatus</i> <i>Lepidosperma longitudinale</i> <i>Carex appressa</i>	Pale Rush Yorkshire Fog Pithy Sword-sedge Tall Sedge
Shrub-dominated freshwater drainage depression	<i>Acacia retinodes</i> var. <i>retinodes</i> (swamp form) <i>Leptospermum continentale</i> <i>Lepidosperma longitudinale</i> <i>Pteridium esculentum</i> <i>Leptospermum lanigerum</i>	Swamp Wattle Prickly Tea-tree Pithy Sword-sedge Bracken Fern Silky Tea-tree

Table 4.2. *continued*

Wetland Character Type	Most commonly recorded species	Common Name
Tree-dominated freshwater drainage depression	<i>Eucalyptus ovata</i>	Swamp Gum
	<i>Carex appressa</i>	Tall Sedge
	<i>Pteridium esculentum</i>	Bracken Fern
	<i>Juncus pallidus</i> <i>Goodenia ovata</i>	Pale Rush Hop Goodenia
Reed-dominated freshwater swamp	<i>Phragmites australis</i>	Common Reed
	<i>Leptospermum continentale</i>	Prickly Tea-tree
	<i>Pteridium esculentum</i>	Bracken Fern
	<i>Melaleuca decussata</i>	Totem-poles
Sedge-dominated freshwater swamp	<i>Lepidosperma longitudinale</i>	Pithy Sword-sedge
	<i>Carex appressa</i>	Tall Sedge
	<i>Gahnia sieberiana</i>	Pithy Sword-sedge
	<i>Epilobium pallidiflorum</i>	Showy Willow-herb
	<i>Baumea rubiginosa</i>	Soft Twig-rush
Shrub-dominated freshwater swamp	<i>Leptospermum lanigerum</i>	Silky Tea-tree
	<i>Lepidosperma longitudinale</i>	Pithy Sword-sedge
	<i>Leptospermum continentale</i>	Prickly Tea-tree
	<i>Acacia retinodes</i> var. <i>retinodes</i> (swamp form)	Swamp Wattle
	<i>Gahnia trifida</i>	Cutting Grass
Tree-dominated freshwater swamp	<i>Eucalyptus ovata</i>	Swamp Gum
	<i>Gahnia trifida</i>	Cutting Grass
	<i>Leptospermum continentale</i>	Prickly Tea-tree
	<i>Leptospermum lanigerum</i>	Silky Tea-tree
	<i>Melaleuca decussata</i>	Totem-poles
Fern-dominated freshwater peat swamp	<i>Gleichenia microphylla</i>	Coral Fern
	<i>Leptospermum continentale</i>	Prickly Tea-tree
	<i>Lepidosperma longitudinale</i>	Pithy Sword-sedge
	<i>Blechnum minus</i>	Soft Water-fern
	<i>Pteridium esculentum</i>	Bracken Fern
Sedge-dominated freshwater peat swamp	<i>Baumea rubiginosa</i>	Soft Twig-rush
	<i>Baumea tetragona</i>	Square Twig-rush
	<i>Gahnia sieberiana</i>	Pithy Sword-sedge
	<i>Blechnum minus</i>	Soft Water-fern
	<i>Empodisma minus</i>	Tangled Rope-rush
Shrub-dominated freshwater peat swamp	<i>Leptospermum continentale</i>	Prickly Tea-tree
	<i>Leptospermum lanigerum</i>	Silky Tea-tree
	<i>Baumea rubiginosa</i>	Soft Twig-rush
	<i>Baumea tetragona</i>	Square Twig-rush
	<i>Viminaria juncea</i>	Native Broom
Shrub-dominated freshwater perched swamp	<i>Leptospermum continentale</i>	Prickly Tea-tree
	<i>Baumea rubiginosa</i>	Soft Twig-rush
	<i>Lepidosperma longitudinale</i>	Pithy Sword-sedge
	<i>Gahnia sieberiana</i> <i>Blechnum minus</i>	Red-fruit Cutting-grass Soft Water-fern
Tree-dominated freshwater perched swamp	<i>Eucalyptus ovata</i>	Swamp Gum
	<i>Leptospermum lanigerum</i>	Silky Tea-tree
	* <i>Rubus</i> sp.	Blackberry
	<i>Isolepis nodosa</i>	Knobby Club-rush
	<i>Baumea rubiginosa</i>	Soft Twig-rush
Sedge-dominated freshwater perched peat swamp	<i>Baumea rubiginosa</i>	Soft Twig-rush
	<i>Blechnum minus</i>	Soft Water-fern
	<i>Gahnia sieberiana</i>	Red-fruit Cutting-grass
	<i>Lepidosperma longitudinale</i>	Pithy Sword-sedge
	<i>Empodisma minus</i>	Tangled Rope-rush
Shrub-dominated freshwater perched peat swamp	<i>Leptospermum continentale</i>	Prickly Tea-tree
	<i>Gahnia sieberiana</i>	Red-fruit Cutting-grass
	<i>Empodisma minus</i>	Tangled Rope-rush
	<i>Baumea rubiginosa</i>	Soft Twig-rush
	<i>Melaleuca squamea</i>	Swamp Honey-myrtle
	<i>Sprengelia incarta</i>	Pink Swamp-heath



Plate 4.3. Examples of common flora species within Fleurieu Peninsula wetlands.

Intact Fleurieu Peninsula swamps are characteristically a mosaic of varied structural formations that merge into one another, depending on soil, hydrology and terrain. Duffield *et al.* (2000) have identified eleven different vegetation communities that are recognised within the description of Fleurieu Peninsula Swamp as defined by the EPBC Act (refer to Appendix 1).

Vertebrate fauna

Many species of vertebrate fauna make extensive use of wetlands on the Fleurieu Peninsula. A total of 183 species have been recorded within wetlands (Appendix 12). Data was sourced from fauna surveys relating to wetland environments incorporating many different surveys of differing intensities and methods. Frequency of presence of certain species may be distorted by unequal survey intensities or species-specific surveys and therefore does not provide an accurate account of all species present or likely to be present within wetlands or their abundances. Figure 4.10 provides an indication of the types of fauna survey methods used in wetlands on the Fleurieu Peninsula from all known surveys. The majority of fauna recorded were by opportune sightings, usually of birds. Audio recording analysis is used for the South Australian Frogwatch census (Walker 2003), and provides a good indication of the types of amphibians found in Fleurieu Peninsula wetlands. Fish surveys (Wedderburn & Hammer 2003; Hammer, in prep) used bait, dip, fyke and seine nets. The limited use of these methods contributes to the lack of fish data for wetland ecosystems on the Fleurieu Peninsula.

The most commonly identified vertebrate species included Superb Fairy-wren (*Malurus cyaneus*), Common Froglet (*Crinia signifera*), Western Grey Kangaroo (*Macropus fuliginosus*), Grey Fantail (*Rhipidura albiscapa*), Crimson Rosella (*Platycercus elegans*) and New Holland Honeyeater (*Phylidonyris novaehollandiae*). These species are generally not specifically wetland dependant fauna, and are some of the more common and readily identifiable species on the Fleurieu Peninsula.

None of the fauna species identified are considered entirely dependent on Fleurieu Peninsula wetland ecosystems. However, several species including the Nationally endangered Mount Lofty Ranges Southern Emu-wren (*Stipiturus malachurus intermedius*), Yarra Pygmy Perch (*Nannoperca obscura*), and several frogs and other native fish species rely on wetland environments at various stages of their life cycle.

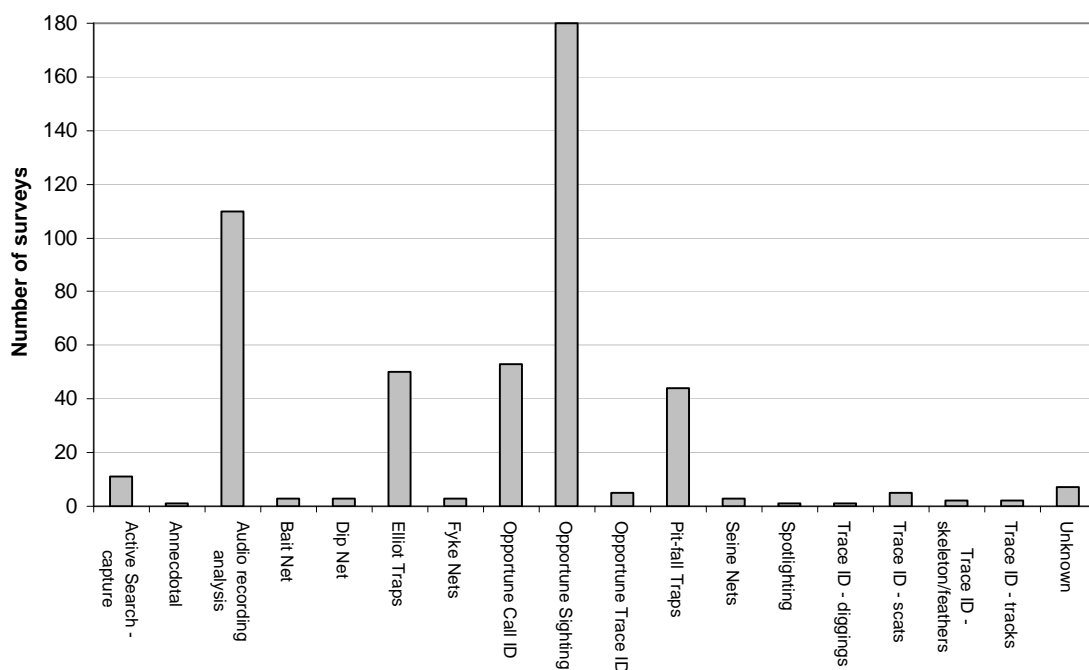


Figure 4.10. Fauna survey methods - frequency of use.

Several fauna species of conservation significance have been recorded within Fleurieu Peninsula wetlands. Appendix 2 provides a list of threatened taxa, and their conservation status. The Nationally endangered (EPBC Act 1999) Mount Lofty Ranges Southern Emu-wren (*Stipiturus malachurus intermedius*) has been recorded in 38 swamps on the Fleurieu Peninsula within the past 50 years (Mount Lofty Ranges Southern Emu-wren Survey: MLRSEW Recovery Team 1993 - 2004). These swamps are regularly surveyed by the MLRSEW Recovery Team for species presence and absence

(M. Pickett pers. com.). Approximately 17 swamps have positive records of Mount Lofty Ranges Southern Emu-wren for the 2004 census (M. Pickett, unpublished data).

Invertebrate aquatic fauna was not assessed for the purposes of the wetland inventory. However aquatic invertebrate data from EPA exists for 18 wetland sites on the Fleurieu Peninsula. Due to the complexity of this data and time-frames of this project, this data is not analysed or presented within this report. However, known endemic invertebrates to Fleurieu Peninsula swamps (specifically in the Tookayerta Catchment) include *Nousia fuscula* (Ephemeroptera) and *Leptoperla tasmanica* (Plecoptera) (Duffield *et al.* 2000). The Black Ground Beetle, *Acanthoferonia ferox* (previously thought to be extinct) was rediscovered in 1997 (Littlely 1998), suggesting that this species is also limited to the swamps of this region. Considering the limited number of invertebrate surveys within wetlands on the Fleurieu Peninsula, it is likely that other endemic species may exist.

Water chemistry

Conductivity, pH, temperature, turbidity and dissolved oxygen were recorded at each wetland surveyed as part of the wetland inventory. Methods for recording water chemistry are explained within the field survey instructions (Appendix 4). Existing water chemistry data for Fleurieu Peninsula wetlands has been recorded by the EPA (AusRivas data), and includes data for only 18 sites that occur within or close to areas identified as wetlands. The EPA data has been included in the analysis although only those parameters consistent with that collected for wetland inventory are considered.

Surface water nutrient indicators were not collected as part of the current project due to time and feasibility constraints. However, many of the wetlands on the Fleurieu Peninsula are expected to be affected by excessive nutrients from agricultural production. Point sources such as sewage treatment plants can be significant contributors to surface water nutrient loads (e.g. Victor Harbor Waste Water Treatment Plant) (Liddicoat *et al.* 2004). However most other studies have generally found a more significant contribution is made from sources such as soil erosion, domestic animal wastes (NLWRA 2003), and fertiliser applications (Liddicoat *et al.* 2004) which accumulate over large areas of each catchment. In the Fleurieu Peninsula region, intensive animal based industries (eg. dairies) have also been identified as potentially significant sources of nutrient pollution (Liddicoat *et al.* 2004). Threats to wetlands regarding nutrient enrichment and pollutants were identified during the wetland inventory process and included agricultural (animal based and fertilisers), dairy effluent, stormwater discharge and urban runoff (see Section 4.3).

Conductivity

Salinity issues on the Fleurieu Peninsula are considered minimal in comparison to other regions in South Australia. This is mostly due to the high rainfall and hilly landscape typical of much of the Fleurieu Peninsula region. However salinity has significant impacts on stream water quality in several catchments and on a few areas of agricultural land in flats and sluggish drainage lines (Liddicoat & Herrmann 2002; Liddicoat *et al.* 2004). Salinisation of watercourses is of great concern in the Fleurieu Peninsula region due to the importance of stream water quality for stock water supply, irrigation, and for the health of in-stream wetlands and riparian ecosystems (Liddicoat *et al.* 2004).

Wetland conductivity ranged between very fresh (24.2 $\mu\text{S}/\text{cm}$) to brackish (6500 $\mu\text{S}/\text{cm}$) as determined from data collected for the 2004 Spring survey for the wetland inventory. The majority (88%) of all wetlands surveyed recorded conductivities of less than 500 $\mu\text{S}/\text{cm}$ (Figure 4.11). Very few brackish wetlands were surveyed as part of the Fleurieu Peninsula wetland inventory and are representative of the scarcity of brackish wetland ecosystems on the Fleurieu Peninsula at the time of survey.

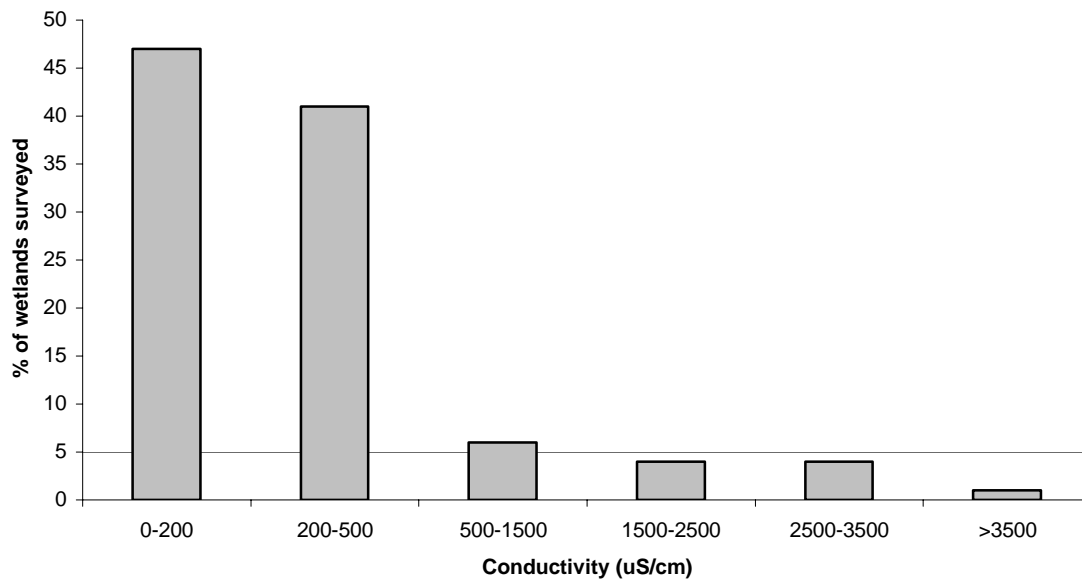


Figure 4.11. Conductivity of wetlands surveyed for the Fleurieu Peninsula wetland inventory.

Soil and Landscape mapping (DWLBC 2002) provides an indication of the varying degrees which land is affected by salinity across the Fleurieu Peninsula region, and shows the location of wetlands identified (Figure 4.12). The majority of mapped wetlands occur in areas of negligible salinity, however some swamps occur in drainage lines impacted by slight to moderate salinity.

Figure 4.13 illustrates conductivity of wetlands throughout the study region, and clearly identifies localities where brackish wetland ecosystems were identified. Slightly brackish – brackish conditions were commonly recorded in the north of the study area, including reedbeds of the Bremer River. Many of the sub-catchments flowing into estuarine wetlands, or Lake Alexandrina recorded brackish conditions in the lower extremities of the sub-catchment, including Currency Creek, Hindmarsh River, Finniss, Tookayerta and Inman River.

Brackish wetlands were predominantly recorded in the following sub-catchments:

- Waitpinga;
- Yattagolinga;
- Stockyard Creek;
- Aaron Creek;
- Bungala River;
- Brown Hill;
- Saundergrove;
- Lower Hindmarsh River sub-catchment;
- Lower Currency Creek sub-catchment;
- Carickalinga Creek;
- Lower Inman River sub-catchment;
- Middleton and Goolwa;
- Lower Finniss and Tookayerta catchments; and
- Bremer-Barker and Angas River.

Very fresh wetland ecosystems (<200 $\mu\text{S}/\text{cm}$) were common in the Parawa/Willow Creek and Hindmarsh Valley/Mount Compass areas including the following sub-catchments:

- Deep Creek;
- Boat Harbor Creek;
- Tapanappa Creek;
- Tunkalilla Creek;
- Callawonga Creek;
- Bollaparudda;
- Coolawang Creek;
- Yankalilla River;
- Myponga River;
- Upper Inman River catchment;
- Upper Hindmarsh River catchment;
- Upper Currency Creek catchment;
- Upper Tookayerta catchment; and
- Upper Finniss River catchment.

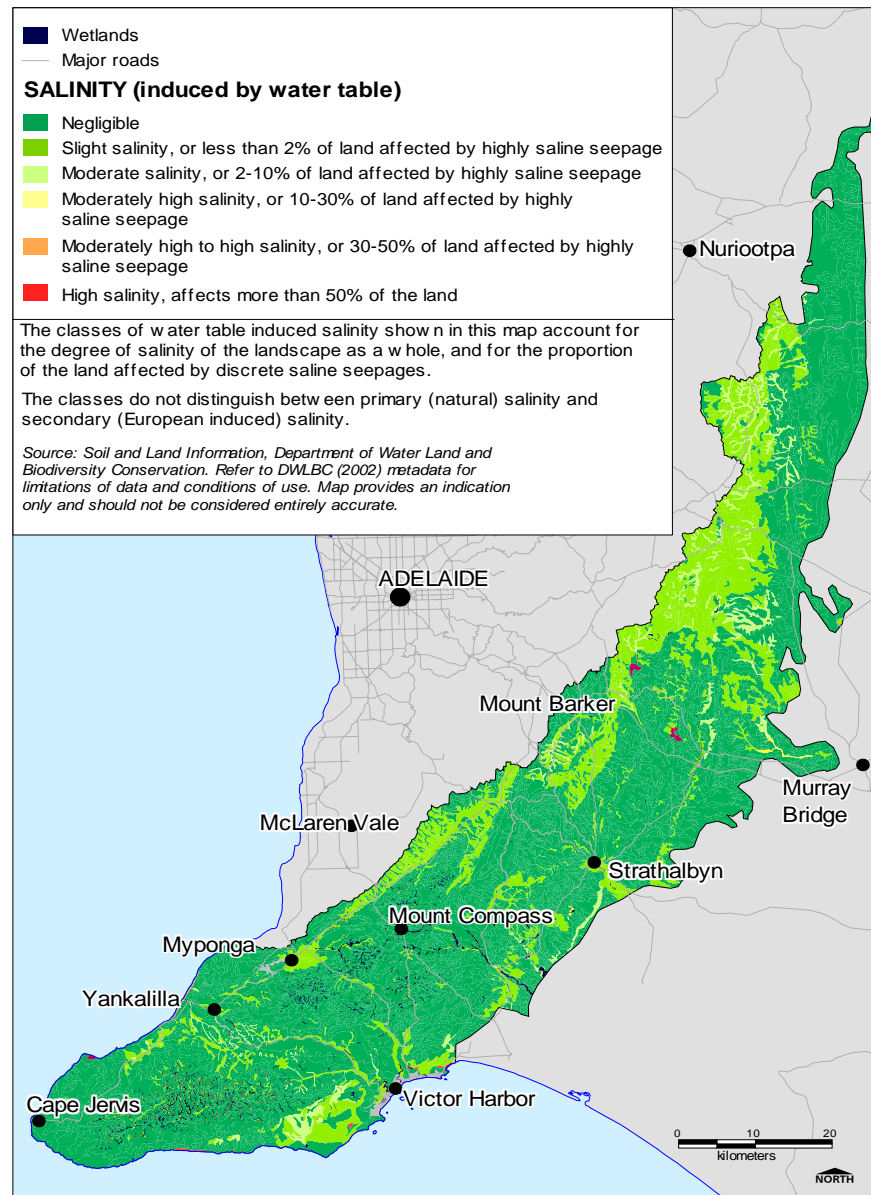


Figure 4.12. Salinity induced by the water table.

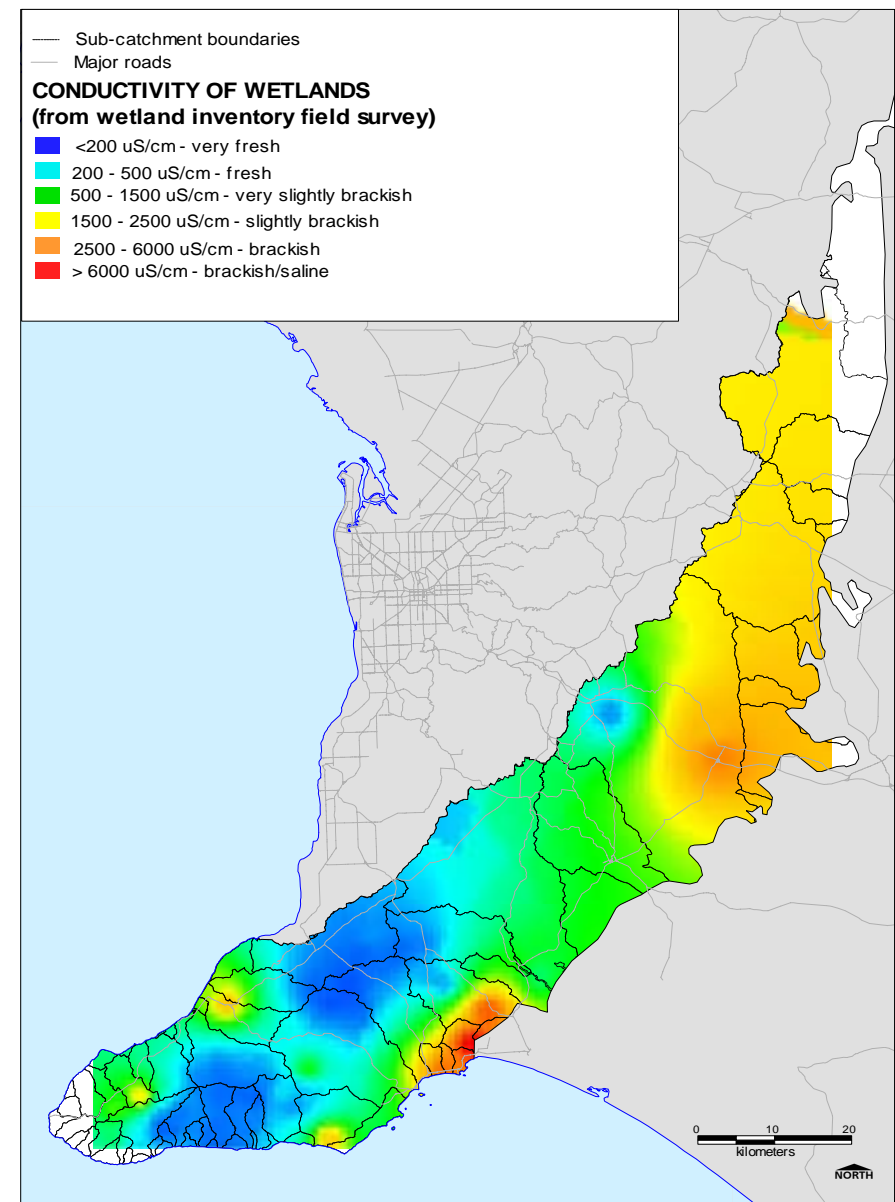


Figure 4.13. Conductivity distribution of wetlands.

Analysis of wetland character suggests that salinity plays an important role in the presence and absence of aquatic flora species, where less tolerant species are replaced. Therefore, increases in salinity within freshwater swamps on the Fleurieu Peninsula have the potential to significantly alter vegetation compositions, and therefore the condition of susceptible swamps. Figure 4.14 indicates the conductivity ranges for each of the character groups identified. All freshwater swamps have average conductivity readings of less than 500 $\mu\text{S}/\text{cm}$.

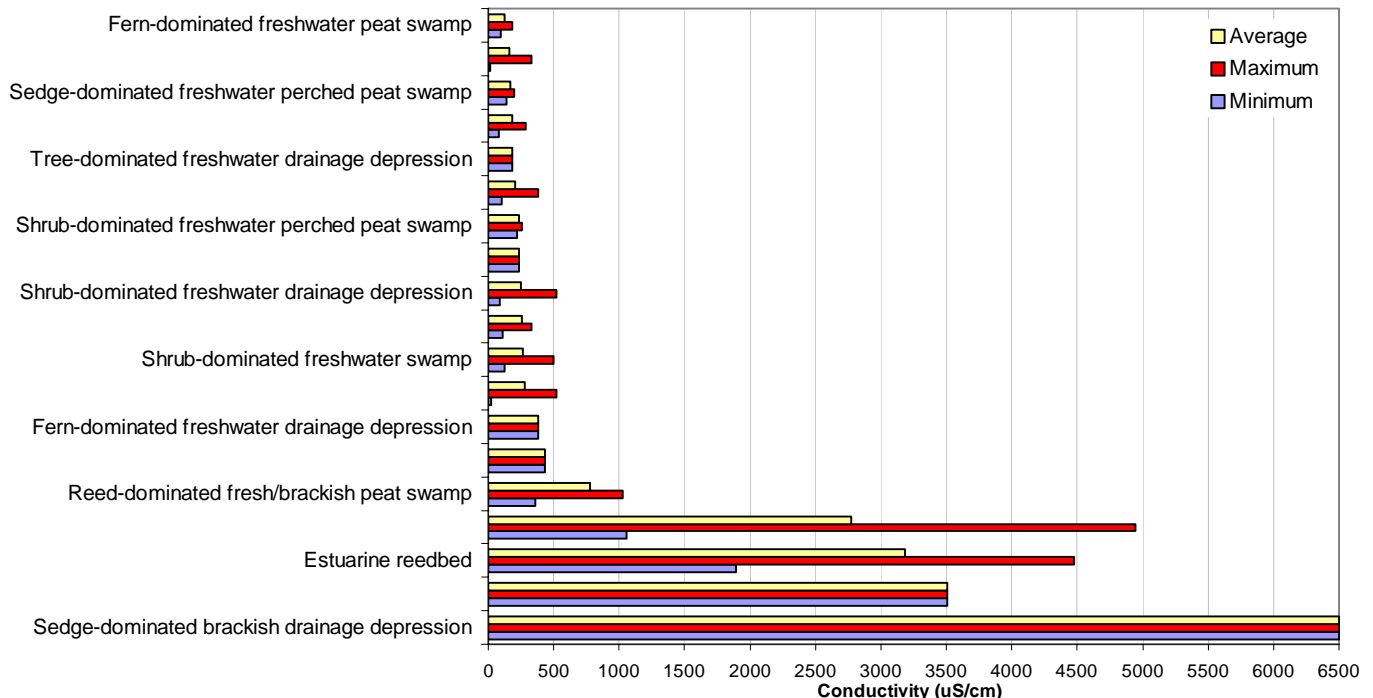


Figure 4.14. Conductivity of wetland character categories on the Fleurieu Peninsula.

An assessment of the presence of some of the more commonly recorded wetland flora species in relation to conductivity readings taken during field survey (Figure 4.15). This demonstrates the tolerability of common wetland species to salinity, and clearly shows intolerance of many of the typical swamp species to saline conditions. Species such as *Sprengelia incarta* (Pink Swamp-heath), *Gleichenia microphylla* (Coral Fern) and *Melaleuca squamea* (Swamp Honey-myrtle) show particular affinities to wetlands of very fresh (<200 $\mu\text{S}/\text{cm}$) conductivities. The majority of species shown were most commonly recorded in fresh water (average conductivity of <500 $\mu\text{S}/\text{cm}$). Some species characteristic of freshwater swamp ecosystems displayed limited tolerance to slightly brackish conditions (e.g. *Lepidosperma longitudinale*, *Acacia retinodes* var. *retinodes* (swamp form), and *Baumea rubiginosa*), however the presence of these species was usually associated with freshwater ecosystems.

More saline tolerant species included *Phragmites australis* (Common Reed) (present in all salinity levels recorded for the Fleurieu Peninsula, however more dominant in brackish conditions), *Sarcocornia quinqueflora* (Beaded Samphire), and *Samolus repens* (Creeping Brookweed). Notably, problem weed species identified for Fleurieu Peninsula wetlands including **Holcus lanatus* (Yorkshire Fog), **Juncus articulatus* (Jointed Rush) and **Rubus* sp. (Blackberry) exhibit a broader tolerance to brackish conditions than many of the freshwater specialist swamp species. Increases in salinity in wetland ecosystems could therefore have a dramatic impact on species composition of freshwater swamps, providing optimal conditions for weed invasions.

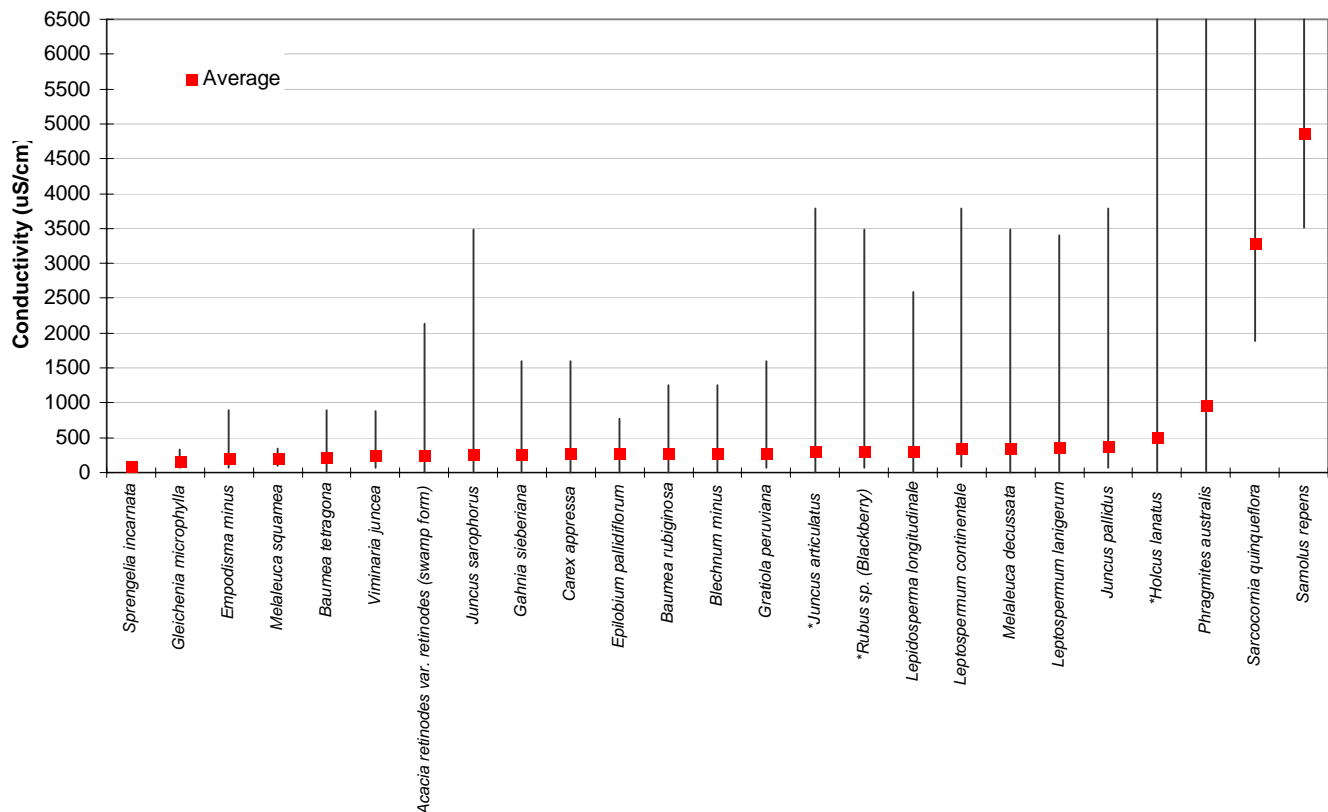


Figure 4.15. Salinity tolerance of commonly recorded wetland flora species on the Fleurieu Peninsula showing minimum / maximum and mean conductivity readings.

pH

The pH value of water indicates the acidity of water based on a \log_{10} -based scale. A low pH of around 2.0 – 4.0 indicates acidity with 2.0 being a strong acid such as sulphuric acid and 4.0 being a weak acid such as lactic acid. Alkalines have a high pH of around 12.0 for sodium hydroxide. A value of 6.0 – 8.0 indicates a neutral pH value. The natural range of water in South Australia is between 6.0 and 8.5, with most having a pH value of 7.0 – 8.0 (Seaman 2002a). The pH of water influences many biological and chemical processes. Lower pH in particular can increase the toxicity of some pollutants and cause greater solubilisation of heavy metals. At extremely high or low pH values the water becomes unsuitable for most organisms (Cugley *et al.* 2002).

The pH values of wetlands surveyed in the Fleurieu Peninsula ranged between 5.09 (recorded in the Tunkalilla Creek catchment) to 8.56 (recorded in the Waitpinga catchment). The majority of wetlands had pH values within the neutral range of 6.0 – 8.0 (Figure 4.16).

Whilst a value in the vicinity of 5.0 is considered slightly acidic this did not appear to have a noticeable effect on the health of the wetland or diversity of species present. However, acidity has been identified as a significant issue for surface soils on the Fleurieu Peninsula. Acid soils have the potential to cause wetland degradation through acidic runoff (and associated pollutants) from surrounding agricultural land, however there is limited evidence of this occurring in the study area (Liddicoat *et al.* 2004).

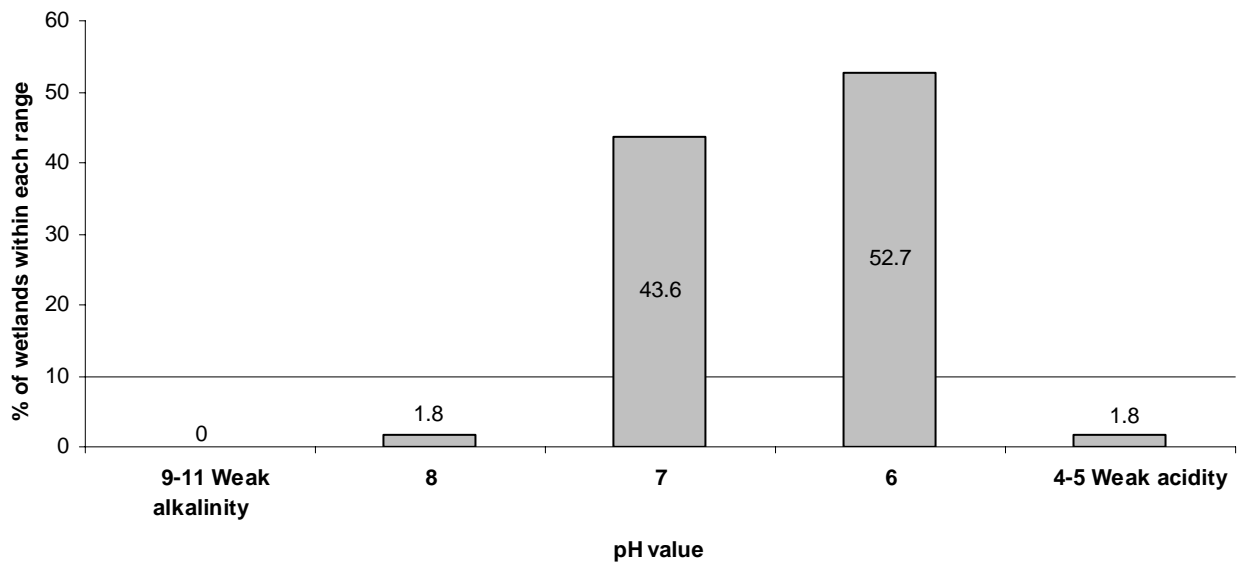


Figure 4.16. pH values of wetlands surveyed for the Fleurieu Peninsula wetland inventory.

Turbidity

Turbidity is a measure of water clarity and can be affected by the amount of suspended particles of clay, silt, plankton, industrial wastes and sewage in the water. Turbidity is caused by particles which are too small to settle out, but big enough to scatter light. These particles reduce light penetration and trap heat from the sun, which increases the temperature of the water. A reduction in light penetration results in diminished photosynthesis, which then leads to a decrease in dissolved oxygen (DO) in the water. At higher levels of turbidity, water loses its ability to support a high diversity of aquatic organisms (Munson *et al.* 2004). Turbidity is measured in Nephelometric Turbidity Units (NTU), which is calculated by measuring the dispersion of a light beam through a sample of water.

Ratings for turbidity are assessed as per the South Australian EPA (Cugley *et al.* 2002) and are defined in Table 4.3. With regards to water clarity, turbidity measurements equate to visibility per meter as defined in Table 4.4 (Cugley *et al.* 2002).

Table 4.3. Turbidity ratings.

Measurement SA (NTU)	Quality rating
<20	Good
20 – 50	Fair
>50	Poor

Table 4.4. Visibility ratings.

Measurement (NTU)	Visibility depth (meters)
2	10.0
5	4.0
10	2.0
25	0.9
100	0.2

Turbidity results ranged from 2.5 NTU (very clear) to 531 NTU (very turbid) for wetlands surveyed on the Fleurieu Peninsula. The majority (52.2%) of turbidity results fell within the 'good' (<20 NTU) and 27.2% within the 'fair' range as identified by the South Australian EPA (Figure 4.17). A total of 20% of wetlands surveyed were considered 'poor' in terms of turbidity quality by the South Australian EPA standards.

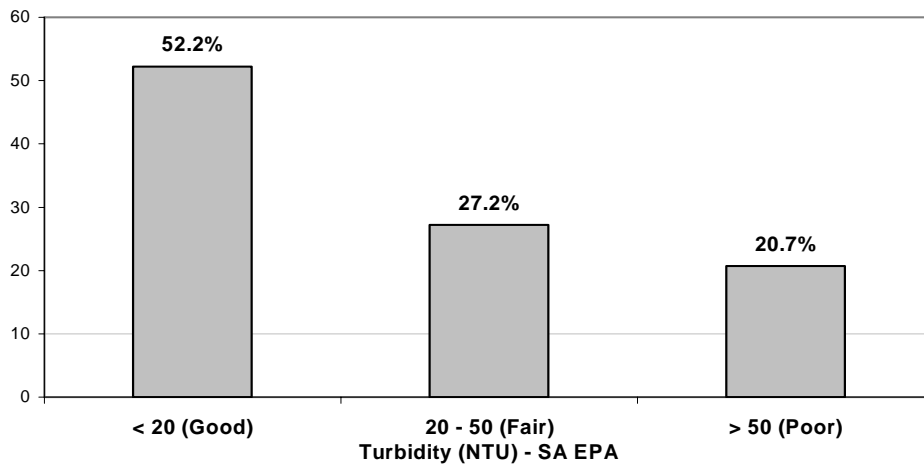


Figure 4.17. Turbidity results within EPA guideline ranges as percentage of individual samples.

Generally, turbidity of freshwater swamps was considered good, however disturbances such as pugging by stock contributed to greater turbidity readings. Plate 4.4 shows examples of wetlands with turbidity readings at the extremes of those recorded on the Fleurieu Peninsula. As expected, most wetlands that recorded very high turbidities were also highly degraded while less disturbed wetland ecosystems tended to record lower turbidity readings.

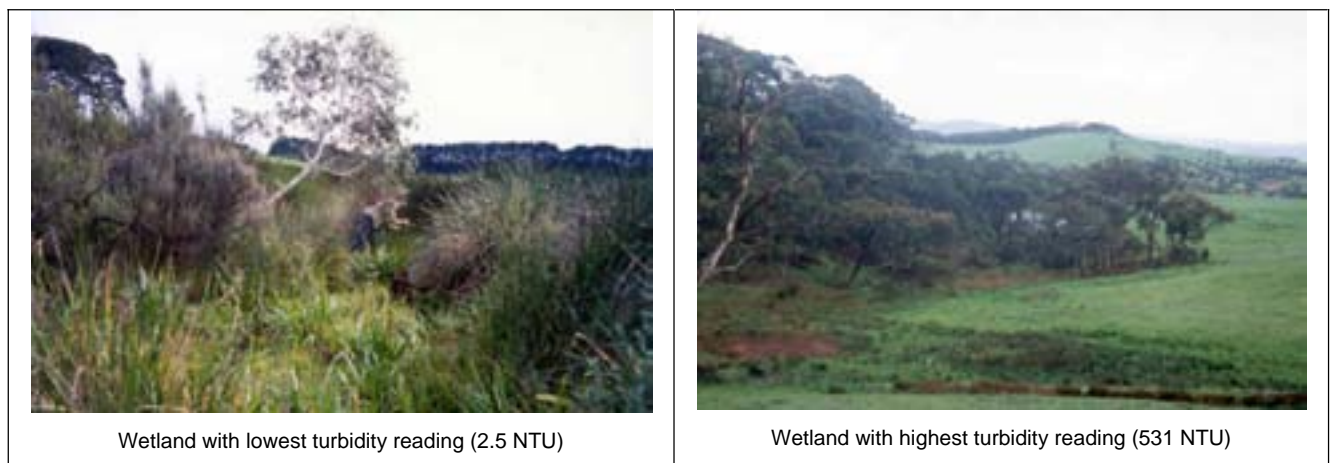


Plate 4.4. Examples of wetlands with minimum and maximum turbidity readings on the Fleurieu Peninsula.

Temperature

For a wetland to function, physically, biologically and chemically, there is a reliance on maintaining optimal water temperature. Temperature affects the solubility of oxygen in water, with warmer water recording higher dissolved oxygen (DO) levels than cooler water. As water becomes warmer the rate of photosynthesis by algae and other water plants increases, which can lead to eutrophication, thereby increasing the occurrence of algal blooms. Higher water temperatures can also lead to organisms becoming stressed and less resilient to other stresses such as toxic waste, parasites and diseases. Because many aquatic organisms such as freshwater fish are cold-blooded and unable to internally regulate their core body temperature, the majority of aquatic organisms function most

effectively within a narrow temperature range. An increase in water temperature also leads to increased biological activity. However should temperatures increase beyond the optimal range, individual numbers within species may decrease (Munson *et al.* 2004).

Seasonal changes in ambient temperature can account for some variation in water temperature, as can daily fluctuations between daylight and darkness, particularly in the surface layers of larger water bodies such as lakes (Munson *et al.* 2004), and shallow waters such as those present on the Fleurieu Peninsula.

Water temperatures recorded for the wetlands surveyed on the Fleurieu Peninsula ranged from 2.3°C (Upper Callawonga Creek wetlands) to 27.9°C (Black Swamp), with the majority of sites between 12°C and 15°C. The average water temperature was 13.1°C. Water temperatures within Fleurieu Peninsula wetlands fluctuated greatly dependant on the time of day, ambient temperature, and depth of water.

General hydrology

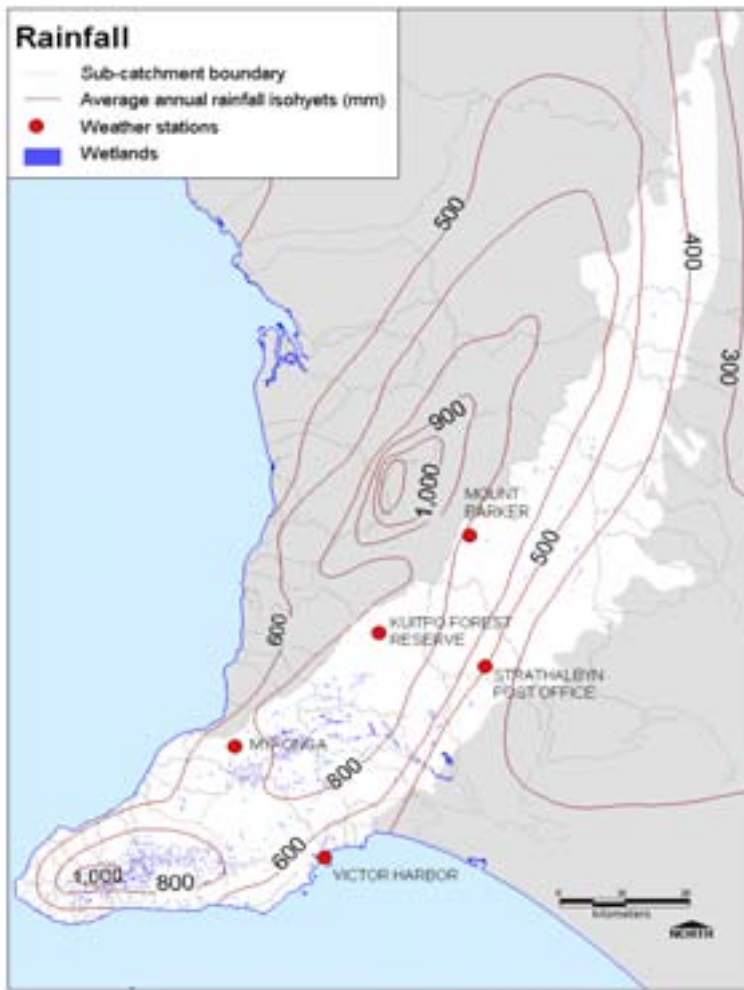
Palustrine wetland environments are dominant of the Fleurieu Peninsula, with 94% of all wetlands surveyed described as non-tidal wetlands substantially covered with vegetation. Small numbers of Estuarine (1%) and Riverine (4%) wetlands were also surveyed.

Fleurieu Peninsula wetlands are topogenous, dependent on surface runoff and groundwater for their development (Bickford 2000). The continued and gradual flow of springs, sedimentary aquifers and catchment processes support the majority of wetland ecosystems identified on the Fleurieu Peninsula (Duffield *et al.* 2000). Significant pressures on hydrological processes and groundwater and surface water resources in a developed landscape such as the Fleurieu Peninsula also contribute to deteriorating wetland condition and continuance. Threats to hydrological processes are further discussed in Section 4.3.

The wetland inventory field survey protocol documented the main sources of water supply to each wetland surveyed including dominant water regimes, and average / maximum water depths. Hydrological processes were determined by observation at the time of survey using guidelines documented in the field survey protocol (Appendix 4) and groundwater dependency assessment techniques outlined by Sinclair Knight Merz Pty Ltd (2001) including:

- *Observation of the importance of groundwater to the ecosystem:* where the groundwater dependency of some particular wetland types is self-evident due to their position in the landscape and presence of water during dry-periods (e.g. permanent perched swamps).
- *Indicators from plant water relations:* presence of certain vegetation communities reliant on stable/permanent water regimes and water qualities (e.g. densely-vegetated freshwater peat swamps) and/or comparisons with nearby wetland vegetation that is known to be ground water dependent.
- *Desk-top appraisal:* checks were made with existing ecological data and modelled groundwater depth mapping (DWLBC 2002) to identify potentially groundwater dependent ecosystems based on correlation with the ecology, location and/or function of known groundwater dependent ecosystems.

As the wetland inventory surveys represented the only basic hydrological data for most wetlands, it was difficult in some circumstances to accurately determine natural variations in water depth and water regimes. Identification of water sources from direct observation was largely incapable of determining the extent of dependence of wetlands to a particular water source where multiple water sources existed. Wetlands that were hydrologically connected to one another were also identified (wetland aggregations – see Appendix 4).



Regional rainfall is a significant contributor to water available to wetland ecosystems, both through direct runoff and recharge into groundwater aquifers. The average annual rainfall within the study area ranges from 1000mm in the south to 300mm in the north (Figure 4.18). Approximately 50% of the annual rainfall falls within three months (June - August) over the winter period. (Figure 4.19).

The majority (63%) of wetlands are located in the higher rainfall bands (800 – 1000mm average annual rainfall).

Figure 4.18. Average annual rainfall isohyets – Fleurieu Peninsula.

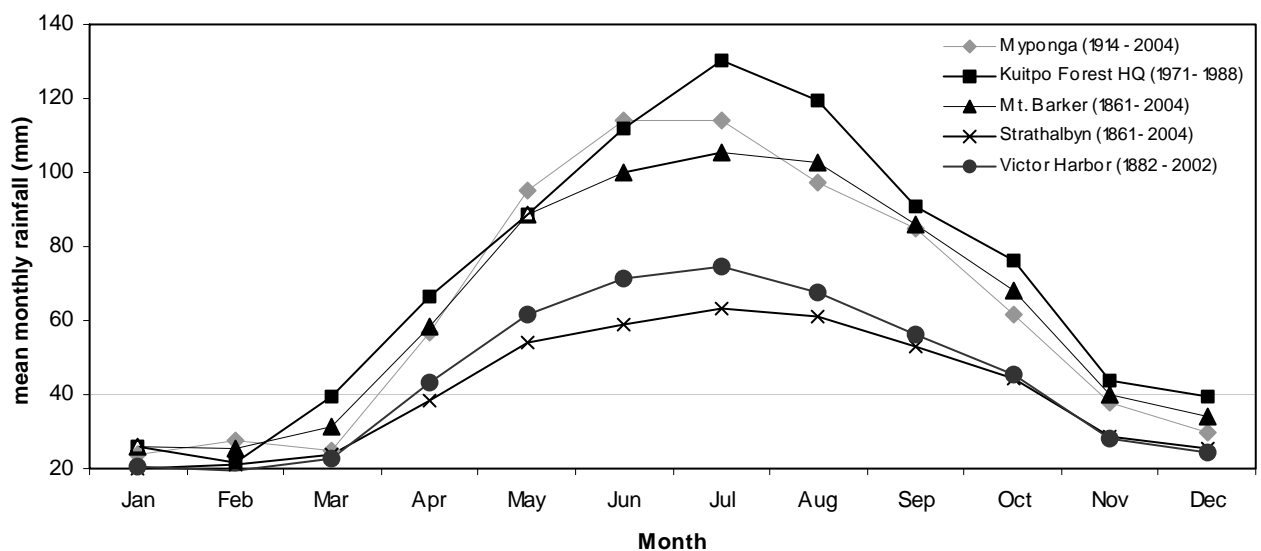


Figure 4.19. Mean monthly rainfall for weather stations on the Fleurieu Peninsula (Source: Bureau of Meteorology 2004).

Water source

Determining relative input from sources such as upstream water supply, local runoff and groundwater was largely unable to be identified. Bore hydrographs are required in order to monitor groundwater influence on various wetland ecosystems and could help improve the understanding of hydrological processes and relative dependence of wetlands on surface and groundwater resources.

The majority of Fleurieu Peninsula wetlands surveyed were identified as groundwater-fed (directly from an underground aquifer) or spring-fed (from groundwater originating as a spring beyond the wetland boundary) (Figure 4.20). The perpetual nature of this type of wetland recharge system usually results in low turbidity and high overall water quality with regards to heavy metals, nutrients and other chemicals. Local runoff from catchment processes was also a large contributor to water availability to wetlands (Figure 4.20), particularly in high rainfall areas (Figure 4.19).

The occurrence of many groundwater dependent wetlands on the Fleurieu Peninsula suggests that depth to groundwater is a significant contributor to wetland presence. Groundwater depth modelling has been performed by DWLBC (2002, data not shown). The modelling provides a general indication of the occurrence of landscapes where water tables are sufficiently shallow to affect plant growth. The information is however derived from soil landscape mapping and not a specific water table survey, and therefore there is a significant amount of estimation based on the local knowledge of land resource assessment specialists (DWLBC 2002).

Analysis of data revealed that water table depths of 100 – 200 cm or less corresponded with mapped wetlands 64% of the time. However the scale of water table data does not provide for accurate groundwater depth modelling throughout the Fleurieu Peninsula, where many known spring and groundwater dependent ecosystems are not represented by the water table data.

Wetlands that were entirely dependent on local runoff or stream-flow were scarce (Figure 4.20), and included creek-line floodplains and some brackish drainage depressions. Wetlands fed partially by marine waters included estuarine wetlands such as Waitpinga Beach Saltmarsh, Watson Gap (Middleton) and Normanville.

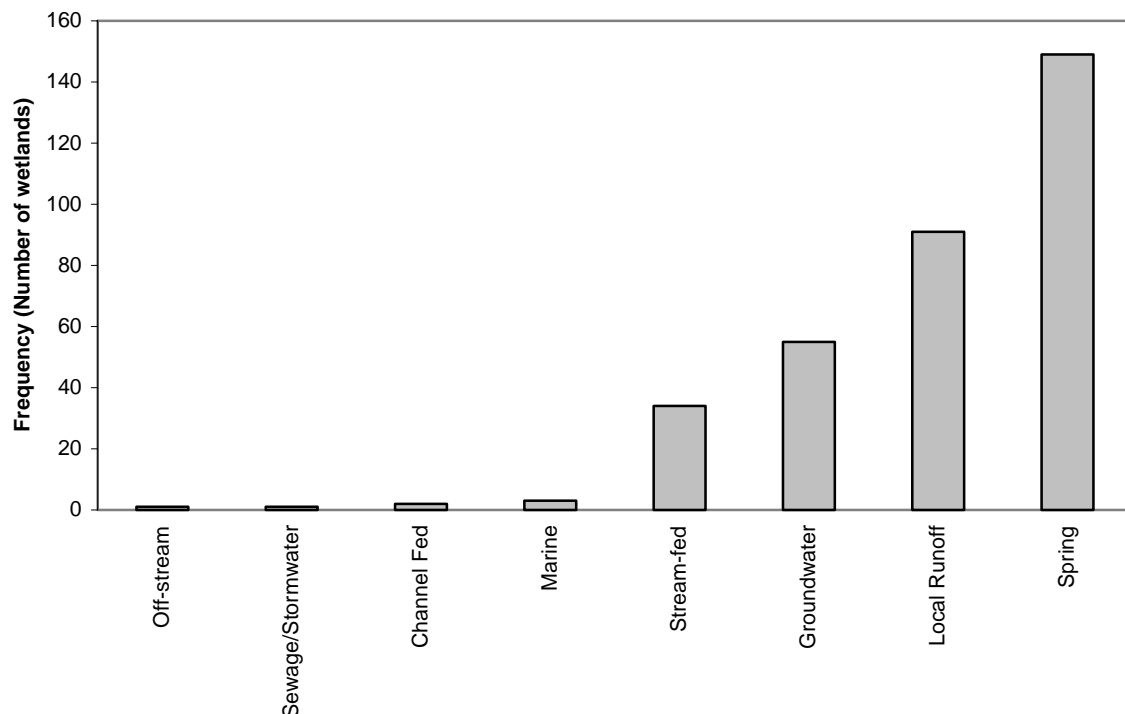


Figure 4.20. Water sources of wetlands on the Fleurieu Peninsula.

Stream order

Stream order classification systems assign a numerical 'order' to each stream segment. Under the system, a 'first order' stream has no tributaries. When two streams of equal order join, the section downstream of the junction increases in order (Figure 4.21) (Prosser *et al.* 1999). First order streams tend to be small and originate from local catchment runoff and from groundwater discharging as base flow into the stream. Streams become larger and deeper as their order rises and as an increasing number of segments contribute to the flow. First order streams may occur anywhere in the catchment, but large streams and rivers (fourth and fifth order and above) are only found lower down in catchments (Figure 4.21).



Over 80% of all wetlands mapped for the Fleurieu Peninsula were situated on first and second order streams. This reflects the number of wetlands originating from springs and direct groundwater associations in the upper sections of many catchments on the Fleurieu Peninsula. Fourth and fifth order streams are generally too deep and confined to support wetland communities. Plate 4.5 provides examples of upper catchment wetland systems.

The position of wetlands in the top of the catchments provides important filtering processes for downstream water supply. Loss of wetlands due to changes in groundwater depth (caused by human interference) can have severe impacts on water availability and quality in the downstream reaches of a stream system.

Figure 4.21. Relationship between stream order and wetland location.

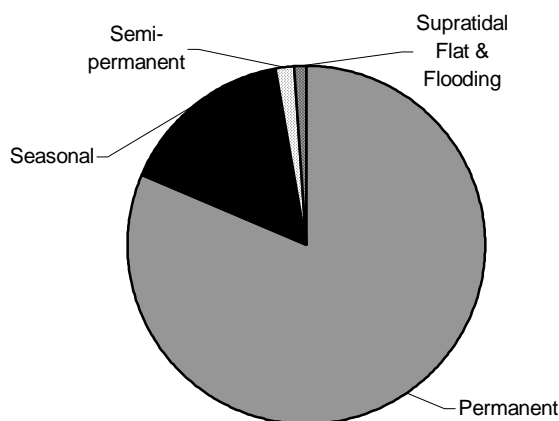


Plate 4.5. Examples of typical wetlands of upper catchment streams (stream orders 1 & 2).

Water regime

Water regime was determined by direct observation during field survey. Vegetation communities were used in many cases to determine likely water regimes where no previous data was available. Seasonal wetlands included those that dry-up over the late summer and autumn period and fill after winter rainfall. Fluctuations in water level in Fleurieu Peninsula swamps, particularly those influenced by groundwater, was difficult to assess. Many contributing factors including groundwater recharge rates (from catchment rainfall or irrigation output), local runoff from rainfall, and barometric pressure could influence water levels and wetting and drying regimes in these systems.

The majority of wetlands surveyed (80%) were considered permanent (containing water throughout the year, although water level may vary) (Figure 4.22). Permanent wetlands included many shrub-dominated and reed-dominated freshwater swamps (both peat and non-organic), perched swamps and some brackish drainage depressions. Groundwater wetlands and spring-fed wetlands tend to be more permanent; where over 90% of wetlands identified as permanent are supported by groundwater to some degree.



Seasonal wetlands incorporated 15% of all wetlands surveyed and included mainly sedge-dominated freshwater drainage depressions, and swamps, and brackish drainage depressions. The majority of seasonal wetlands (75%) gain water from local runoff and stream-flow. Seasonal wetlands also included some groundwater and spring-fed wetlands, where water tables appear to rise and fall with seasonal changes. Artificial lowering of water tables due to hydrological disturbances (e.g. uptake by adjacent forestry / bores) has potentially changed some wetland systems from a relatively permanent water regime to a more seasonal system, although evidence is anecdotal. Further assessment of these systems is required to develop a full understanding of such impacts.

Figure 4.22. Water regimes of wetlands surveyed for the Fleurieu Peninsula wetland inventory.

Fleurieu Peninsula wetlands tended to be very shallow in nature with the majority having a maximum depth of only 0.25 – 0.50 meters, and averaging approximately 0.10m (Figure 4.23). Many wetlands averaged water depths of less than 0.05m (very shallow to damp). Permanent peat-bog swamps consist of deep wet peat material, with often very little surface water accumulating.

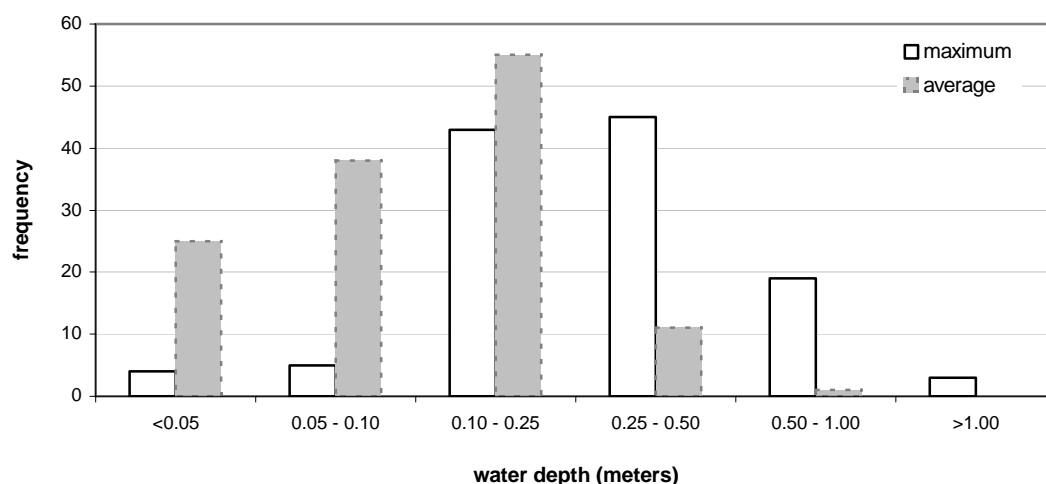


Figure 4.23. Average and maximum water depth of wetlands surveyed for the Fleurieu Peninsula wetland inventory.