

Background Paper **Four**

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*The South Coast Regional
Strategy For Natural
Resource Management*

WATER RESOURCES IN THE SOUTH COAST REGION

A report commissioned by SCRIPT

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South Coast Regional Strategy for
Natural Resource Management

Background Paper 4
Water Resources in the South Coast Region

Prepared by

Chris Gunby

District Manager, Albany

Department of Environment

And

Naomi Arrowsmith

Regional Manager

Department of Environment

Assisted by

John Bryant

Rivercare Officer, Albany

Department of Environment

For the South Coast Regional Initiatives Planning Team (SCRIPT)

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1. Introduction

1.1 Scope of Paper

This paper provides an overview of water resources in the South Coast NRM Region. It briefly describes the water resources in the Region, the values of these water resources, the threats to these resources and the way that some of these threats are being managed. The paper also discusses some potential future management options.

The paper is provided to aid in the preparation of the South Coast Regional Strategy for Natural Resource Management (the Strategy) and has been written with information available to the Department of Environment. The information and discussion in the paper may help explain objectives and Management Actions prepared in the Strategy.

This paper should be read in conjunction with other papers prepared to assist with the Strategy.

Water Resources are broken down into the two categories of Waterscapes (wetlands, rivers and estuaries) and Water Supplies to provide consistency with the Preliminary Agency statement of NRM profiles (October 2003).

The boundary of the NRM region is taken to be the Deep River in the west, and Weanerjungup Creek in the east. These boundaries may be altered.

1.2 Overview of Water Resources in South Coast Region

Water resources in the South Coast NRM Region are tremendously varied, with over 100 rivers or major tributaries, 33 estuaries, more than 300 Conservation category wetlands, and Regionally significant coastal freshwater aquifers.

The Region is characterised by southerly flowing rivers discharging into estuaries. Further inland, the fairly flat landform provides a poorly drained landscape. Wetlands are abundant in both the poorly drained interior and the coastal strip. Coastal wetlands have formed from a range of processes, including infilling of estuaries, groundwater interception of the landscape and perched water tables.

Rainfall is a major influence on the abundance and quality of water resources in the Region. Rainfall declines to both the east and from the coast with the south west of the region experiencing 1400 mm of annual rainfall and the north east of the Region having an average of only 300 mm of annual rainfall. As a consequence, the only rivers having year round freshwater (below 500mg/1 TSS) are located in the west of the region. Coastal sedimentary aquifers also provide a small but highly significant source of freshwater and provide the source of drinking water for the majority of the Region's urban population.

Water resources in the Region provide many social and economic values. Agricultural production is the economic backbone of the Region, and its continuation, growth and diversification is dependent on water availability. Trade and shipping in the Region is also dependent on the safe anchorage offered by the Albany harbours, the initial reason for the establishment of Albany as Western Australia's earliest European settlement. The Region's estuaries provide an important commercial fishery as well as opportunities for tourism and recreation. Other industries are dependent on the water available from the coastal groundwater reserves and the expansion of industry is dependent on the future use of surface freshwater in the western part of the Region.

The Region's water resources provide outstanding environmental values. The beauty of the coastal estuaries is appreciated by both visitors and residents alike. The Region's rivers and estuaries provide important nurseries and habitats for many endangered flora and fauna, some being unique to a certain waterway. The region has three wetland systems (Lakes Gore, Warden and Muir-Byenup) that have international recognition, being listed on the RAMSAR Convention.

Although highly valued, the Region's water resources are under many threats. The clearing of native vegetation to establish agricultural areas and urban growth has led to a raising of groundwater levels and an increase in both the volume and rate of surface run-off, causing greater erosion and sediment transportation. The introduction of fertilisers, although essential for the development of agriculture, has also led to increased nutrient levels in rivers, wetlands and estuaries. Livestock have also reduced the cover of vegetation along rivers, destabilising banks and exacerbating the erosion and nutrient transportation downstream.

As a consequence of these pressures, many wetlands are suffering from higher water levels and inundation, along with increased salinity levels, which is destroying wetland dependent vegetation and severely affecting wetland ecology. River pools are being filled by sediment, while estuaries in the Region are suffering from prolific algal growth, and in some cases, toxic algal blooms. Increasing salinity levels are a threat to the Region's already limited fresh surface water sources.

Other pressures include the overuse of the limited freshwater supplies. Over abstraction of water from wetlands or groundwater may lead to more saline groundwater contaminating these resources, rendering them unusable in the future. Albany Groundwater Area is fully allocated, and overuse may result in saltwater intrusion. Development over the coastal aquifers is also a threat to their use for potable water. The coastal strip is the location of much of the Region's urban population, with Albany, Bremer Bay, Hopetoun and Esperance all being located adjacent to important coastal aquifers. The growth of these centres and nearby land uses poses the threat of contaminating the limited groundwater reserves.

Urban development and land use changes also pose a threat to the region's water resources through modifying floodplains and removing wetland and foreshore vegetation. Estuarine water levels have been modified in part of the Region to facilitate urban development and agriculture, altering the value of these systems. Other estuaries have increasing water regimes as a result of catchment clearing and dry land salinity increasing run-off. Tourism and recreational use poses a further threat to the estuarine systems, as increasing number of visitors place more and more pressure on the limited sites and fragile environment.

Today there is a much greater appreciation and awareness of the value of these water resources, and the threatening processes they are subject to. Natural resources management, including landcare and rivercare is a major theme in today's farming and there are many initiatives, at a local, catchment or regional scale, seeking to improve the condition of these water resources.

The Department of Environment has a number of major initiatives aimed at improving the management of water resources in the Region. Programs of work aimed at reducing nutrient levels have been prepared for the Albany harbours and Wilson Inlet and are in preparation for Torbay Inlet and Wellstead Estuary. Rivercare officers have undertaken surveys of rivers and, in partnership with catchment groups, are working on fencing and revegetation programs aimed at enhancing the condition of priority rivers. Under a Regional Wetland Project, management plans are prepared for priority wetlands, and monitoring of the condition of representative wetlands is undertaken. Workshops to raise community awareness have been held, and a program of onground works aimed at rehabilitating priority wetlands is being progressively undertaken.

The Kent and Denmark rivers are Potable Water Source Recovery catchments under the State's Salinity Action Plan, with the expectation that salinity levels can be reduced and potable (drinking water) standards restored. Working with catchment groups, landowners and other agencies (notably Department of Agriculture), extensive programs of revegetation and high water use farming are being implemented to reduce salinity in these catchments.

To manage (where required) the potential of over allocation of the limited freshwater, the Department licences extraction using powers available through the Rights in Water and Irrigation Act. The Department protects the quality of the coastal groundwater reserves through the preparation of protection plans, which are then incorporated into the local town planning schemes, so guiding development. However, Ecological Water Requirement studies have not been undertaken for any water resources on the South Coast with the exception of Angove Creek, and COAG commitments in this area have not been met.

Managing increasing public use and development of the Region's estuaries, rivers and wetlands has in part been achieved through the preparation of planning strategies, foreshore management plans and in the provision of advice on development proposals. This planning until 1996 was mainly centred on the Albany harbours and Wilson Inlet, as a consequence of specific duties under the Waterways Conservation Act, but has since that date extended to other estuaries as required.

Along with these initiatives are a large number of other actions being taken by other agencies and the community. Collectively, these initiatives are increasing the level of protection for water resources in the Region. However, much more needs to be done.

Baseline information on the condition and level of threat to water resources is very limited. There is insufficient information and history of gathering information to make conclusions on recent changes to the condition of water resources in the Region. There are notable success stories, such as the reducing salinity trend in the Denmark River, an improvement in the condition of the Albany harbours, and in the continued protection of the limited coastal freshwater sources, but there is insufficient data to say whether the condition of the Region's rivers, wetlands and estuaries is worsening or improving. There is

also a lack of information on the environmental, social and economic values of many of the Region's waterways.

2. Water Supplies

2.1 Description

Freshwater supplies are very limited in the South Coast NRM region, with limited coastal groundwater reserves already fully allocated or highly utilised and potential surface water supplies restricted to a few rivers in the western quarter of the Region, many of which are within the conservation estate.

The rivers presently used for reticulated supplies to settlements are the Walpole River (for the Walpole townsite), Quickup River, and occasionally the Denmark River (for Denmark) and Angove Creek and Limeburners Creek (for Albany and Mt Barker). To the east of Albany, rivers become increasingly brackish or saline and are not used for potable supplies.

The Denmark, Styx and Bow Rivers offer the Region's most strategic long term potential source of future freshwater supplies, with the Denmark River the highest priority, given its closer position to the urban growth areas. Marbellup Brook also offers an important source of future water supply in the shorter term, and given its location, is considered by the Water Corporation to be the most likely source area for Albany's future needs.

The most important source of present potable water supplies is contained in the Quaternary dunes and Werillup formations along the coast. These loosely consolidated sedimentary rock formations provide a reservoir of groundwater reserves confined by suitable underlying impervious material, as is the case near Albany and Esperance. This source provides the bulk of the Region's present day reticulated supplies, including all of the supply for Esperance, Hopetoun, Bremer Bay and 65% of the lower Great Southern Town Water Supply for Albany and Mt Barker.

Further inland, most groundwater in the west of the Region is brackish and becomes increasingly saline to the east.

Table 1 Where does the Region's Water Supply come from?

Town	Qty of Water (MI)	Source	River or Groundwater (GW)	Future Supply
Walpole		Walpole River	River	Potential to use another tributary of Walpole River.
Denmark	750	Quickup River/ Denmark River	River	Present use 400,000kl. Future supply can be met from this source.
Albany, Mt Barker, Kendenup	3,950 1,600 200 200	South Coast Water Reserve Angove Creek Bolganup Dam Limeburners Creek	GW River River River	South Coast Water Reserve considered fully allocated. Extension of borefield being considered and potential for this to satisfy demand for up to 10 years. Marbellup Brook and Denmark River expected to provide future supplies. Timing dependent on growth and needs.
Bremer Bay	90	Bremer Bay Water Reserve	GW	Reserve expected to meet future needs.
Ravensthorpe	65	2 road catchment and 1 groundwater bore	GW and roaded catchment	Desalination of groundwater to blend with surface water. Timing dependant on Ravensthorpe Nickel Project.
Hopetoun	140	Hopetoun Water Reserve	GW	Desalination plant to make use of brackish groundwater reserves.
Gibson	25	Gibson Water Reserve	GW	Considered present supply adequate for future growth.
Condingup	10	Condingup Water Reserve	GW	New bore to be drilled. Should address needs.
Esperance	2,200	Esperance Water Reserve	GW	Sufficient reserves for 20+ years at present rate of growth.

Notes:

- 1) 1 MI (megalitres) = 1 million litres
- 2) Quantity of water shown as presently licensed or able to be supplied. Actual use may be lower.
- 3) Small towns such as Rocky Gully, Wellstead, Cranbrook, Frankland obtain water from roaded catchments (artificial drainage capturing water to dam). Peaceful Bay, Manypeaks, Normalup and other settlements use rainwater tanks for self-supply.

2.2 Threats

Threats to existing water supplies come mainly from urbanisation, over abstraction, and the risk of pollution, with the majority of present water supplies coming from groundwater located in reserves adjacent to settlements. Historical land uses, such as the landfill site at Bremer Bay or the race course at Albany are not considered compatible with the need to protect ground water reserves but are accepted as historical land uses. Future expansion of these centres could increase the risk of pollution if inappropriate development takes place over the water reserves.

For future supplies, the impact of agricultural land use and activities is the prime concern. The Bow, Styx, Denmark and Marbellup rivers provide the Region's most strategic future surface water supplies, but all contain land in private ownership (the Marbellup being almost entirely in private ownership) and are used for agricultural production. Agricultural activities can cause pollution from chemicals or animal faeces, and clearing of native vegetation can increase salinity levels in these rivers. As an example, land clearing for agriculture increased salinity levels in the upper Denmark River, and led to its cessation as the town's primary water supply in 1989, with the Quickup (a tributary of the Denmark River) being used instead.

These strategically important rivers are also located within national parks and State forest, and the high conservation status of this part of the Region could provide an impediment to the future use of these water supplies, particularly in terms of dam and pipeline construction.

Over abstraction of water from fresh groundwater or surface supplies is also a threat and can lead to the intrusion of more saline water into the fresh water reserves. Over abstraction can also harm the environmental values of rivers, such as impacting on floodplain or riparian vegetation. Ecological water requirement studies need to be undertaken to determine ecological needs.

Over abstraction of water from the limited freshwater rivers is increasingly becoming an issue for the South Coast Region with more complaints being received on upstream water use and impacts on downstream users.

In Western Australia it is estimated that water use increased by 115% between 1983 and 1996. In the Albany sub-region it is expected that the present use of approximately 10 GL (1 GL = 1 000 000 000 litres) will increase to 32 GL by 2030. However, this assumes a significant expansion in the timber processing and horticultural sectors. This increase in part will be provided by self supply by industry and agriculture finding their own supplies of water, with consequent potential impacts including private dams. Nevertheless, this growth will increase pressure on existing reserves and water users and will hasten the need for further source development.

2.3 Management Responses

Under the Country Areas Water Supply Act the Department gives advice on the suitability of development within Public Drinking Water Source Areas and this advice is incorporated into the appropriate Town Planning Scheme. An example is the planning provisions for the South Coast Water Reserve contained within the City of Albany's Local Rural Strategy. There are 11 areas gazetted under the CAWS Act in the region, and these cover surface and groundwater supplies to most towns in the Region. Within these areas the Department gives advice on any proposed development to ensure it will not degrade water supplies.

Present supplies are either contained in public reserves or on private land. The greatest threat is considered to be to those water supplies on private land as this is at most risk of new development and contamination. For these areas the Department has commenced development of Protection Plans to identify risks and the Management Actions needed to address the threats.

The Department negotiates with other agencies to ensure the strategic nature of potential water resources is recognised. A case in point at present is the inclusion of the Denmark and Styx Rivers within the Walpole Wilderness Area. The Department is seeking to ensure inclusion of these rivers within the new wilderness area does not jeopardise the opportunity for dam sites to be created and water sourced in the future.

As a decision on future water supplies needs to consider many environmental, social and economic factors, the Department is involved in sub-regional planning to identify suitable options for development, and area water allocation plans to manage use at a resource level. Area allocation planning includes the identification of ecological water requirements and development of water provisions to ensure environmental impacts of a reduced flow are acceptable. The Department is involved in sub-regional water supply planning for the Albany and Denmark area.

To manage the water sources, the Department uses the Rights in Water and Irrigation Act to licence water extraction in certain areas (this presently applies to 8 areas proclaimed in the Region). The department is presently seeking to extend this level of management to the Marbellup Brook.

To combat the risk of increasing salinity in the Denmark and Kent Rivers, the Department is working with landowners and the Department of Agriculture on a program of revegetation and other onground works to reduce recharge and salinity levels. More than 90% of the upper Kent farmers are involved in the work which in 2002/3 led to the fencing of 16km of river vegetation, the planting of 23 hectares of foreshore vegetation, fencing to protect 54 hectares of native vegetation and the planting of 148 hectares of perennial pasture and lucerne, 331 hectares of saw log trees, 67 hectares of salt land vegetation, 24km of surface water drains, and the trialling of relief wells. In addition, the Department is a major landowner managing some 12,700 hectares of land acquired in the 1970's as a consequence of refusing permits to clear vegetation. These permits are enabled under the Country Areas Water Supply Act and are still required for clearing of native vegetation within these two catchments.

The Upper Kent and Denmark River catchments are Water Recovery catchments under the Salinity Action Plan and it is planned to achieve potable water standards (500 mg/l TSS) by 2030 and 2020 respectively. The Denmark River has only 28% of its catchment cleared, compared with 52% for the Kent, hence the different time frames. A situation statement is being prepared at present to guide future programs of work within these two catchments.

The expansion of plantations in the 1990s has led to a stabilisation of salinity levels in the Denmark River and since 1997 a decrease in salinity levels has been measured. Maintaining and expanding vegetation coverage is considered a main priority for the catchment, and other options to further reduce salinity are being investigated.

2.4 Future Management - Discussion

The implementation of the existing Protection Plans is a priority for the protection of existing water supplies. Preparation of other plans is currently proceeding and will require review on a regular basis. Incorporation of these plans into Town Planning Schemes is required, as and when such Schemes are reviewed.

For the Albany Hinterland area, completion of a subregional allocation plan, giving guidance on the availability and appropriateness of alternate sources, is a priority. In addition, the Marbellup Brook needs to be proclaimed under the Rights in Water and Irrigation Act to protect its value as a future source of water for Albany and to give greater certainty for present horticultural operators in the catchment. Ecological water requirements need to be determined for Marbellup and other potential future water sources. Working with the Torbay catchment Group, rehabilitation works are required in the Marbellup catchment to maintain the quality of this important resource and reduce pathogen and other risks from the cleared catchment.

For Denmark and the Kent Recovery Catchments, the program of on ground works is continuing and needs to be guided by a review of the works to date, with an increased focus on the Denmark River given its certainty as a strategic resource. The strategic value of the Denmark River, needs recognition in regional studies such as the Lower Great Southern Planning Strategy.

The Bow and Styx Rivers and known areas of fresh ground water, such as the Nanarup area just east of Albany, need to be given appropriate levels of protection while there is uncertainty over their potential use. The Region has limited freshwater resources and no reserves should be compromised.

Desalination offers the most realistic option of future supplies in the Jerramungup and Ravensthorpe districts and a major issue will be in assessing any such proposals for their environmental impacts. This is also true of industry proposals for desalination, e.g. by wineries, with disposal of highly saline waste water an issue.

3. Waterscapes-Rivers

3.1 Description of Region's Rivers

The South Coast NRM Region contains some 107 rivers or major tributaries, which flow south and discharge into the Southern Ocean, estuaries or wetlands. The amount of rainfall and the amount of catchment vegetation influence river flow and salinity levels, with flows decreasing to the east and inland. Freshwater surface flow appears only seasonally east of the Albany subregion.

The largest river flow occurs in the western quarter of the Region, with the Frankland River the Region's largest river and WA's eighth largest.

Table 2 The South Coast Region's Largest Rivers

River	Flow (Annual Average)	Receiving Water Body	Salinity Level	Catchment Size
Frankland	200,000 ML	Nornalup Estuary	Marginal/brackish	4650km ²
Deep	140,000 ML	Nornalup Estuary	Fresh	1000km ²
Kent	123,000 ML	Irwin Inlet	Marginal	1985km ²
Hay	78,000 ML	Wilson Inlet	Marginal/brackish	1280km ²
Kalgan	52,000 ML	Oyster Harbour	Brackish	2562km ²
Denmark	45,000 ML	Wilson Inlet	Fresh/marginal	800km ²
Bow	41,000 ML	Irwin Inlet	Fresh	254km ²
King	40,000ML	Oyster Harbour	Fresh	402km ²
Pallinup	36,000 ML	Beaufort Inlet	Saline	4970km ²

Notes: (1) 1 ML = 1 megalitre or 1 000 000 litres

(2) Fresh 0-500 mg/l TSS (Total Soluble Salts), Marginal 500-1000, brackish 1000-1500, saline 2000+

The Frankland River has a catchment size of 4650km² (exceeded by the Pallinup River which has only a 5th of the flow due to the lesser rainfall) and a length of 400km. The Deep, Pallinup, Kalgan, Gairdner, Young, Lort and Kent are the Region's only other rivers to have a length of at least 100km.

Information on the Region's rivers is limited, with gauging stations located on 30 rivers, and only two having more than one gauging station. Monitoring has been focussed on rivers within the Albany harbours, Wilson Inlet and Torbay Inlet catchments (for nutrient monitoring) and the Kent and Denmark River catchments (for salinity levels).

Outside of these catchments monitoring occurs on selected rivers spread across the Region, and these are used as a reference network. For the majority of rivers in the Region, flow is calculated based on extrapolating information from this network.

The condition of the majority of the Region's rivers is only poorly understood, with only a fifth of the Region's rivers having an assessment of foreshore condition. A comparative assessment of the ecological values of South Coast rivers has not been undertaken. Flood level surveys have only been undertaken for parts of the Lower Denmark River and Yakamia Creek, and social, cultural and economic values for the Region's rivers has only been developed to a basic level of understanding. Water quality data is not comprehensive, and therefore, there is a poor understanding of condition trends and level of threat.

3.2 River Values

Rivers provide many environmental, social and economic values, but a comprehensive evaluation of these values is made difficult for the region given the limited information.

A basic value often overlooked is the drainage of land. This river function is often overlooked and not appreciated until the function is impeded, such as through the construction of a dam.

Ecological values include the range of habitats rivers provide, deep pools (pools on the Kalgan River are in places more than 12 metres deep), shallow mudflats, fringing vegetation, floodplains and associated wetlands, and riverbanks. A range of perennial (continual) flows, intermittent (seasonal) flows and episodic (brief) flows all exist in the Region, offering different habitats. Rivers and their fringing vegetation provide linkages in the landscape connecting other areas of native vegetation and habitats. These green linkages provide corridors for the movement of flora and fauna and are the only intact north-south corridors in the Region.

River fringing vegetation and floodplains provide a filtering mechanism, filtering out sediment, nutrients and other pollutants. Endangered species of flora and fauna are also dependent on the river systems, an example being the existence of a native fish species that is found only in one small coastal catchment east of Albany.

Despite the superficial knowledge of ecological attributes, there is insufficient information to comparatively assess the ecological value of rivers in the Region. There is the need for considerable more work in this area.

An example is the better understanding the values of the Region's river pools, which in the east of the Region at least provide the more permanent habitat than rivers themselves. The Oldfield, Young, Pallinup and Gairdner rivers all contain large numbers of substantial pools which have both ecological and human values that are only partially understood.

In Australia as a whole, very few river systems can be said to be in a relatively pristine condition, with most having been modified by some changes in the catchment, in water quality or foreshore vegetation (see later). In WA only 7% of the rivers are considered largely unmodified and the protection of near pristine rivers to act as representative samples of unmodified river systems is considered a high priority.

The Region has 3 river systems named as "Wild River Systems" in recognition of their unmodified condition, and another 21 river systems have catchments that are relatively uncleared (with at least 80% of catchment vegetated). The retention of these 'near pristine' rivers is considered a priority and has been included in the Draft NRM Strategy.

Table 3 *Near Pristine Rivers in the South Coast Region*

Deep *	Boondadup	Jorndee Creek
Quickup	St Mary *	Poison Creek
Mitchell	Dempster *	Fern Creek
Limeburner Creek	Lake Nameless unnamed tributary	Weanerjungup
Angove River	Weld	Hamersley
Mullocullup Creek	Copper Mine Creek	Bluff
Hunter	Styx	Wongerup Creek
Kellys Creek	Jenamullup	Walpole

Notes: (1) Rivers with at least 80% of catchment vegetated (where vegetation information available)
 (2) * denotes Wild River status recognised by Australian Heritage Commission/Environment Australia/WRC 2002
 (3) Although included, Angove Creek, Limeburners Creek, Quickup River and the Walpole River are used for water supply and the impact of this abstraction is unknown. EWRs are met for Angove Creek.

The identification of near pristine rivers based on level of catchment clearing may hide substantially pristine sections of catchments. For example, the upper catchments of the Oldfield, Young and Lort rivers have substantially pristine and unique landscape characteristics.

Rivers in the Region have cultural and social values, with rivers being early areas of human habitation, trade and transport. They have aesthetic appeal and considerable recreational value with canoeing, camping, walking and fishing for black bream and trout in the fresher rivers being very popular.

Rivers in the region provide many economic and social benefits, and for the development of the Regional Strategy an attempt has been made to assess their comparative social and economic values. The economic assessment considered whether a river was used for present water supplies, (for public drinking water, irrigation, livestock or industry), had the potential to provide future water supplies, maintained important fisheries and aquaculture or catered for tourism (through having accommodation, charter boats). The social assessment used visual amenity, recreational facilities and level of use as indicators. The results of the assessment are shown below. In the Draft Strategy it is proposed that these highly valued rivers be protected and enhanced.

Table 4

South Coast Rivers Considered to have high commercial, recreational or visual amenity values

River System	Main Attributes
Frankland	Visual amenity, recreation
Kent	Potential future strategic water supply
Styx	Potential future strategic water supply
Scotsdale	Horticulture, past and potential water supply
Denmark	Strategic water supply. Tourism in Lower Section.
Quickup	Existing and future water supply
Marbellup	Future water supply. Horticulture
Lower Kalgan	Tourism, estuarine fisheries, recreation
King	Recreation, visual amenity, estuarine fishing
Angove	Existing water supply

Note: (1) Initial assessment based on available information. Includes rivers that score high in at least one category.
 (2) Bow River may need inclusion should it be considered for water supply.

There is insignificant data available to comparatively assess the cultural value of rivers in the Region. More work is needed in this area.

3.3 Threats to River Values

The clearing of native vegetation to accommodate agricultural expansion has brought about the biggest changes to South Coast rivers. Reductions in vegetation coverage have increased groundwater levels and brought salts to the surface. This has increased salinity levels in rivers. As described in an earlier section, this is a major threat to the Region's very limited freshwater resources. Rising salinity levels were seen as a threat to the strategic water supply values of the Kent and Denmark Rivers and led to their inclusion in the State Salinity Plan as Water Resource Recovery Catchments. Reductions in catchment vegetation coverage also changes a river's hydrology with increased run-off and an increase in the rate of run-off, which itself can lead to greater erosion, sediment transportation and transportation of nutrients and other pollutants downstream. This altered hydrology is a major threat to the Region's rivers, resulting in the infilling of river pools, an increased rate of sedimentation of estuaries and altered turbidity and nutrient levels. Altered hydrology also significantly increases the flood risk for many rivers, and there needs to be a much better understanding about changed flood frequency and intensity.

Restoring the hydrological balance of rivers in order to reinstate water regimes and combat sedimentation is an emerging issue for the Region. The percentage of catchment vegetation cover is used to assess the level of risk to river systems. Those rivers with 80% of the catchment cleared are listed below, but priorities have not been set, given a lack of understanding of the intervention required to achieve any meaningful outcome.

Table 5

Rivers with greatest level of catchment clearing

Cuppup Creek	Coramup Creek
Torbay Main Drain	Bandy Creek
King River	Yakamia Creek
Pallinup River	Six Mile Creek
Coomalbidgup Creek	Jackitup Creek
Dalyup River	Coobidge Creek
Robinson Drain	Corackerup Creek
Warperup Creek	

Note: Rivers with 80% or more catchment cleared. Not all rivers have vegetation mapping.

Other threats to river values include unmanaged livestock access, leading to loss of riparian vegetation, trampled riverbanks and introduction of animal faeces into waterways. This is a pressure across the Region, as is the potential for contamination from agricultural chemicals.

Nutrient enrichment of Australian rivers is a major issue as Australian soils are mainly nutrient poor and rivers have low nutrient status. With the development of aquaculture, the use of fertilisers and an increase in organic matter and animal waste, more nutrients are entering waterways. Intensive agriculture and industry also provide increased sources of nutrients to our rivers. This increase in nutrients is increasing algal growth in rivers and downstream estuaries, increasing the risk of algal blooms.

Nutrient enrichment (or eutrophication) is an issue for all South Coast rivers, but to guide Management Action for the purpose of the Strategy priority rivers have been put forward based on rivers with very high nutrient levels, or high nutrient levels discharging into highly valued or eutrophic estuaries or wetlands. Also rivers with significant river pool values have been identified, where infilling and eutrophication of these drought refuges is having a significant impact on ecological values.

Table 6 Rivers with the highest nutrient levels

Frankland River ²⁴	Robinson Drain ¹	Devil Creek ^{2 3}
Gordon River ¹⁴	Munster Hill Drain ¹	Gairdner River ¹
Kent River ²	Yakamia Creek ¹	Needilup River ¹
Kordabup River ¹	King River ¹	Jerdacuttup River ²
Little River ¹	Wilyung Creek ^{2 3}	Munglinup River ¹
Scotsdale Brook ^{2 3}	Mill Brook ^{2 3}	Young River ¹
Hay River ^{2 3}	Kalgan River ^{2 3}	Lort River ²
Sunny Glen Creek ¹	Goodga River ¹	Coobidge Creek ²
Sleeman River ^{2 3}	Taylor Inlet Tribs ³	Dalyup River ²
Cuppup Creek ¹	Pallinup River ¹⁴	Dalyup River West ²
Lake Saide Drain ¹	Salt Creek ^{2 3}	Kateup Creek ²
Torbay Main Drain ¹	Six Mile Creek ^{2 3}	Melijinup Creek ¹
Marbelup Brook ³	Jackitup Creek ^{2 3}	Coramup Creek ¹
Seven Mile Creek ¹	Peenebup Creek ^{2 3}	Bandy Creek ²
Five Mile Creek ¹	Warperup Creek ¹	Neridup Creek ¹
Princess Royal Drain ¹	Bremer River ^{2 3}	

Note: (1) Combined N & P Risk = VH
 (2) Risk = H and the river drains into highly valued estuaries or wetlands
 (3) Risk = H and the river drains into eutrophic estuaries or wetlands

Other threats to the Region's rivers include the over extraction of water from the limited freshwater supplies, unmanaged recreational use (particularly on the lower reaches of major rivers), pollution from rural and urban land uses such as via urban stormwater, drainage practices, and physical alterations to river banks, channels and floodplains due to developing land use change and agricultural land practices. Physical developments include the damming of rivers, construction of deep drains, and alteration and development of floodplains. Weeds and feral animals also pose a threat to foreshore values.

Fire management of foreshores is a key issue for the community, especially as it has been enhanced through weed infestation, or through fencing which has prevented stock access.

3.4 Management Responses

The South Coast Region has a well established program of rivercare, facilitated by Rivercare officers working from the Department of Environment and Community Landcare Coordinators across the Region. This program of rivercare includes monitoring of river water quality, the undertaking of foreshore vegetation assessments and mapping of foreshore condition, and the implementation of fencing, revegetation and engineering works to improve the protection and condition of foreshore vegetation. This program of work is guided by catchment plans such as the Wilson Inlet Action Plan which identifies, at a whole of catchment level, priorities for river rehabilitation. Fish ladders to aid fish migration over critical artificial barriers have been established on both Angove Creek and Walpole River and are reported to be successful.

Section 2 detailed the management initiatives undertaken to protect water supplies, including rivers. Presently, on ground actions are focussed on the Kent River, but there is considerable research and catchment work also being organised in the Marbellup Brook catchment. Legislation is used to protect the quality and quantity of water in rivers located in Public Drinking Water Source Areas.

The nutrient enrichment of rivers is addressed in priority areas, these being the Wilson Inlet, Albany Harbours and Torbay Inlet catchments. Complementing river action plans and surveys in these areas are

programs of work to reduce nutrient loss from agricultural point sources, urban stormwater and broadacre farming.

The landuse planning process is used to ensure development does not lead to greater nutrient loss, cause unnecessary alteration of river floodplains or reduce the movement of aquatic flora or fauna. For example, aquaculture ponds are only supported by the Department where they are located out of rivers, so movement of fish and native fauna is not impeded or river water quality affected.

Controls provided by the Environmental Protection Act are also used to regulate large scale industry that may cause pollution. For other industry educational programs are more commonly used.

Management of recreational activities is achieved through the preparation of foreshore management plans. These are required as a condition of any major recreational development.

3.5 Future Management - Discussion

As stated above, more information is needed to determine the condition of the majority of the Region's rivers. Most rivers are not monitored and there is no effective means as yet of determining a comparative evaluation of their ecological values. Similarly, there is insufficient information to assess their cultural value.

More information on foreshore vegetation condition, hydrological regimes, ecological status, water quality and catchment vegetation coverage is required to determine priorities for management.

Priority actions for the near pristine rivers appear to be undertaking river surveys, fencing and revegetation on the river sections on private land. The Hamersley River is a prime example, with the majority protected in National Park while the upper reaches have no program of protective works.

To restore the hydrological regimes to rivers and the most severe cases of erosion and sedimentation, a decision needs to be made on whether funding should be directed to the more degraded river systems or provided to those systems in better condition. This decision will require much better information on the technical and social feasibility, and the level of investment required. Any priority actions include the need to promote greater on farm water use, through the use of perennials, agroforestry or other means, which provide both environmental and economic benefits. Bank stabilisation and restoration which recognises the changed water regime and likely future regimes at equilibrium is required, rather than reinstating existing vegetation.

For nutrient reduction, rivers in the Wilson Inlet, Torbay Inlet and Albany harbour catchments are likely to remain the immediate focus, while rivers in the Wellstead estuary catchment are the next priority, given community concerns with that estuary. Other priorities are those rivers that feed into RAMSAR wetlands (eg Dalyup Rivers into Lake Gore). Support for rivercare work is required for all identified eutrophic river systems, and opportunities made from external funding sources.

Within urban areas the clear delineation of floodplains is required, through surveys and demarcation of Special Control Areas in Town Planning Schemes. Developments will need to be individually assessed against their ability to protect or enhance the river floodplain.

The program of rivercare needs to be extended to include more rivers, but also to implement existing survey recommendations. For priority areas, the normal level of grant aid for fencing may need to be supplemented by assistance with implementation of the works, as has been occurring in the Sleeman and Cuppup drainage catchments since 2002. This work needs to be complemented by on farm works to better retain water, nutrients and sediment on farm, through cost effective means that provide the greatest benefit for farmers. Future fire management, foreshore tenure and weed management are also critical issues which need to be considered.

Recreational pressures need to be managed through advice on new facilities and areas, and in requiring foreshore management plans to be prepared as a consequence of any major new development nearby rivers.

A critical issue for river management is to recognise that the physical parameters of our rivers will be very different in the future to what they are now. Though information is lacking, it is anticipated that river condition does not yet fully reflect the level of catchment degradation and water quality will continue to decrease and for some rivers, flows will increase. Given the intractable nature of water regimes, it is essentially that future conditions are anticipated and incorporated into any restoration activities.

4. Waterscapes - Estuaries

4.1 Description of Region's Estuaries

Estuaries are semi-enclosed coastal water bodies where ocean water mixes with fresh water draining from the land. The term estuaries normally also includes marine embayments, such as Princess Royal Harbour.

Estuaries on the South Coast of WA are generally what are termed 'wave dominated.' This type of estuaries have sand bars separating them from the ocean, with the sand bar either permanently opened, or naturally opening on a seasonal or less frequent basis. These estuaries gradually evolve, through a process of sedimentation and coastal processes, to become wetlands.

There are 33 estuaries in the South Coast NRM region. Only Walpole/Nornalup Inlet, Princess Royal Harbour, Oyster Harbour and Waychinicup Inlet are permanently open to the Southern Ocean. All other estuaries are open as a consequence of heavy rainfall events, high season water levels or infrequent opening. As a consequence of catchment clearing and changed river hydrology, South Coast estuaries are now open to the Southern Ocean on a more frequent basis than before European settlement. For example, Culham Inlet has opened three times in the last 10 years, but reportedly only opened once in the previous century.

Heavy rainfall and flows from the Frankland and Deep Rivers keep the Nornalup Inlet open to the Southern Ocean, while Waychinicup and Princess Royal Harbour have narrow rocky headland entrances that are kept scoured by tidal movements. Only Princess Royal Harbour provides safe boating access to the Southern Ocean, and accounted for the settlement of Albany and the Port of Albany. Bandy Creek at Esperance also has boating facilities, although the mouth of this inlet is kept open through dredging.

As rainfall reduces to the east, rivers become more saline and flow intermittent, opening frequency of estuaries reduces, and estuary size is reduced. In these conditions water quality is affected, with higher salinity levels being recorded. As a result of evapoconcentration, salinity levels of over 100000 ppm are not uncommon in eastern estuaries.

Of the region's 33 estuaries, only 4 could be considered relatively pristine as they and their catchments fall entirely within National Parks. These are the Dempster and St Mary inlets within the Fitzgerald National Park, and Jorndee and Poison Creek estuaries within the Cape Arid National Park. These are small waterways, Dempster Inlet being by far the largest at 240 hectares.

Our knowledge of the Region's estuaries is limited. Wilson Inlet was the subject of considerable research between 1997 and 2000 as it formed part of the National Eutrophication Management Program into investigations into algal management. The inlet is still monitored to assess changes in its condition. The Albany harbours have been extensively studied in terms of seagrass decline, algal growth and nutrient sources, particularly between 1988-1990. Torbay Inlet has been intensively sampled in recent years. Outside of these areas, detailed research has been limited to specific and infrequent investigation.

Since 1998 the Department has been undertaking quarterly monitoring of 8 additional estuaries to gain an understanding of baseline condition, providing only a very basic understanding of seasonal variation. There is insufficient monitoring to detect trends in estuary condition. The estuaries monitored are the Oldfield, Hamersley, Gordon, Wellstead, Beaufort, Parry, Walpole and Nornalup.

Management of the South Coast Region's estuaries falls into the responsibility of many different agencies, including local government, Department of Environment, CALM, Fisheries WA, Department of Planning and Infrastructure and DOLA, to name a few. The majority of estuaries have no management plan or management structure, and there is uncertainty over responsibilities for issues such as sandbar management. Community values for the majority of the South Coast estuaries have not been established.

4.2 South Coast Estuarine Values

The estuaries, perhaps more than any other water resources, form part of the South Coast environment and experience. Along with the rugged coastline and beaches, they form a spectacular coastline that is admired and used by residents and visitors alike. The majority of the south coast population lives within a few kilometres of an estuary, and spends a considerable amount of time either at work or play in the setting of an estuary.

Determining visual amenity is not an easy exercise, but there is plenty of evidence to show south coast estuaries provide an attractive setting for visitors and residents. Viewpoints and vantage points for estuaries are common and popularly used, and people are prepared to pay premium house prices for

views of estuaries adjacent to urban settlements. Planning controls that limit the height, nature or colour of building materials are further evidence of the community valuing the green backdrop to estuaries.

All the Region’s estuaries have important visual values. Outstanding scenery includes the Karri-lined Nornalup and Walpole Inlets, the gorge at Waychinicup Estuary, and the landscape views overlooking Hamersley and Culham Inlets. Oyster Harbour, Princess Royal Harbour and Wilson Inlet all have high vantage points and national park backdrops and provide spectacular scenery that is adjacent to urban centres.

The commercial value of the Region’s estuaries is not easy to estimate but is considerable. The South Coast estuarine fishery provides approximately \$1million at net prices, with Wilson Inlet being the major fishery and source of King George whiting. Cobbler, mullet, black bream and herring are other common species caught, with Oyster Harbour, Princess Royal Harbour and Irwin Inlet being the other main fisheries. Aquaculture also exists, with oyster and mussel production occurring in King George Sound.

Shipping and trade is centred on Princess Royal Harbour, its safe deep anchorage providing a natural harbour that is important not only for Albany but for the western portion of the Region (with the eastern section being served by Esperance Port, which is in part protected by the Recherche Archipelago and by breakwaters). Oyster Harbour and Bandy Creek provide marina facilities for commercial fishing vessels and charter boat operators provide tourism ventures in Walpole-Nornalup inlets, Oyster Harbour and Wilson Inlet. Houseboats also operate in Walpole-Nornalup inlets, as well as Oyster Harbour and have been proposed for Wilson Inlet.

Table 7 South Coast Estuaries with high recreational, commercial or amenity values

Estuary	Main Attributes
Walpole-Nornalup Inlets	Visual amenity (H). Commercial (M). Recreational (M).
Wilson Inlet	Commercial (H). Visual amenity (H). Recreational (M).
Princess Royal Harbour	Commercial (H). Recreational (H). Visual amenity (H).
Oyster Harbour	Commercial (H). Recreational (H). Visual Amenity (H).
Waychinicup Inlet	Visual amenity (H). Recreational (M).
Irwin Inlet	Visual amenity (H). Commercial (M).
Hamersley Inlet	Visual amenity (H). Commercial (M).
Stokes Inlet	Visual amenity (H). Commercial (M).
Culham Inlet	Visual amenity (H). Commercial (M).
Bandy Creek	Commercial (H). Recreational (M).

Notes: Initial assessment by DoE. Commercial value based on level of commercial fishing, tourism and boating/shipping. Recreational value based on level of recreational infrastructure and public use. Visual amenity based on level of use, ease of access and vantage points. Value scored 5 (highest) to 1 (lowest) and then categorised into High, Medium and Low. Only estuaries with High value for at least one attribute are shown in table.

Recreational fishing is very popular in all of the Region’s estuaries, with Black Bream being a popular target. Boating is most commonly used in the Albany Harbours, Walpole and Nornalup Inlets, and Wilson Inlet with favoured species being King George Whiting, Flathead, Skippy and Herring. The economic value of recreational fishing has not been determined but is likely to be a major industry for these estuaries as anybody who owns and maintains a boat knows!

Tourism is assisted with considerable numbers of caravan parks, camping sites and picnic facilities adjacent to the Region’s estuaries. Birdwatching, canoeing, swimming, and walking are all popular recreational activities. Nearly all of the Region’s estuaries have some facilities with these facilities increasing the closer they are to the urban centres.

Ecological values of the Region’s estuaries are only understood in part. Walpole-Nornalup and Oyster Harbour provide important fish habitat values, however, each estuary has important ecological values. For example, it has been determined that each estuary has its own Black Bream population, which is isolated from other populations, making them genetically unique.

South Coast estuaries contain high populations of wading birds, which make use of the mudflats, intertidal areas or shallow margins. The ecological values of South Coast estuaries is noted with the inclusion of Beaufort Inlet, Albany Harbours and Wilson Inlet on the National Estate and Oyster Harbour, Culham Inlet, and Fitzgerald Inlet being on the Directory of Important Wetlands. A number of other estuaries are entirely contained within national parks.

The South Coast Region is fortunate in having four estuaries and their catchments entirely contained within national parks, there being St Mary and Dempster Inlets in the Fitzgerald National Park, and Jorndee Creek and Poison Creek estuaries in Cape Arid National Park. For the benefit of the Regional NRM Strategy other 'near pristine' estuaries are listed, with the definition being based on at least 80% of the estuary's catchment being covered in native vegetation and only minor alteration (if any) of the estuary's foreshore vegetation. (A decision to use 80% of catchment in native vegetation as opposed to the 90% used in the National Audit was made as nationally, 50% of estuaries are in a 'near pristine' condition, whereas only 4 fitted the criteria in the South Coast Region and as these are located in a National Park, their management is not considered a higher priority than estuaries with a small percentage of land in private ownership).

Table 8 South Coast Near Pristine Estuaries

Saint Mary Inlet	Poison Creek Inlet
Dempster Inlet	Hamersley Inlet
Jorndee Creek Inlet	Fern Creek Inlet

Notes: Based on at least 80% of catchment in native vegetation.

The small number of 'near pristine' estuaries makes their protection and, where possible, enhancement a major priority and this has been suggested in the Draft NRM Strategy. While many of the near pristine estuaries lie in protected areas, some of the catchment of many of them is in private ownership.

4.3 Threats to Estuarine Values

Estuaries are in the main a barometer of catchment health and are very much affected by the condition of rivers and their catchments. In addition, estuaries are subject to considerable development and recreational pressure, being located in areas most attractive to shipping, many industries, residential development and recreation.

Estuarine water quality is greatly affected by changes in river water quality, and sedimentation and nutrient enrichment are major issues on the South Coast. Changed catchment hydrology is a major threat to South Coast estuaries, with increased river inputs and rates of inputs causing changes in estuarine water quality. The catchment clearing also greatly modifies an estuary's natural levels, causing it to more regularly open to the Southern Ocean.

Table 9 Estuaries with the Highest Level of Catchment Clearing

Parry Inlet	Beaufort Inlet
Wellstead Estuary	Barker Inlet
Bandy Creek Estuary	Dailey Estuary

Notes: Based on catchments with at least 80% of native vegetation removed.

Sedimentation of estuaries is also noticeable where part of its catchment has been mainly cleared. The Torbay Main Drain contributes significant sediment into Torbay Inlet as does the Cuppup and Sleeman Rivers to Wilson Inlet. The sedimentation is obvious through the build up of large deltas in recent times and these estuaries are therefore also considered priorities for management.

Nutrient enrichment or eutrophication is a major problem in South Coast estuaries. Algal growth in the Albany Harbours, prolific growth of *Ruppia* seagrass in Wilson Inlet and potentially toxic blue-green algal blooms in Taylor Inlet and Torbay Inlet are all symptoms of excess nutrient levels. This proliferation of algae is being caused by nutrients from agricultural and urban sources and is impeding recreational and commercial uses of these waterways.

For the purpose of the Draft NRM Strategy, priority eutrophic estuaries were determined based on the existence of nuisance macroalgae, potentially toxic algal blooms, high chlorophyll levels and measured high levels of phosphorus and nitrogen in the estuary.

Table 10 Estuaries subject to highest levels of nutrient enrichment

Estuary	Factor
Torbay Inlet	Toxic algae blooms. VH nutrient levels. High chlorophyll levels
Parry Inlet	VH Phosphorus levels. High chlorophyll levels
Wilson Inlet	Potential toxic blooms. Nuisance algae. Medium nutrient levels
Taylor Inlet	Toxic algae blooms. VH nutrient levels. High chlorophyll levels
Beaufort Inlet	VH nutrient levels. High chlorophyll levels
Gordon Inlet	VH nutrient levels. High chlorophyll levels
Princess Royal Harbour	Nuisance macroalgae
Oyster Harbour	Nuisance macroalgae
Wellstead Estuary	VH phosphorus levels. Medium chlorophyll levels
Cheyne Inlet	VH phosphorus levels. Medium chlorophyll levels

Other threats to the value of South Coast Estuaries includes the discharge of polluted stormwater (which contributes the majority of nutrients into Princess Royal Harbour), industry discharges and pollution from shipping, and physical development on estuaries foreshore and floodplain areas. This development, through residential development, roads, recreational facilities or agricultural activities, reduces the capacity of the estuary to assimilate nutrients and other pollutants as well as changing important habitats. Developments of this nature then require the level of the estuary to be artificially controlled, through management of the estuary's sandbar.

Intervention and management of estuarine water levels, through artificial sandbar openings, occurs already at 11 estuaries in the Region and has caused changes to estuarine values and increased management costs.

4.4 Management Responses

The Department's management of estuaries has up to recently been focussed on Wilson Inlet and Albany Harbours, with considerable work being undertaken to manage nutrient inputs to the waterbodies. This focus has been a consequence of both estuaries being proclaimed Management Areas under the Waterways Conservation Act, giving the Department duties and powers with respect to these areas. The Department has no specific powers in relation to other South Coast estuaries, although in general terms it is the lead agency in terms of managing water resources (including estuaries) in WA. CALM, local government and other bodies play an important role in managing estuaries and their foreshores on the South Coast.

Both the Albany Harbours and Wilson Inlet have endorsed programs of work aimed at tackling nutrient inputs due to excessive algal growth and community concerns. The Environmental Protection Authority's Bulletin 442, Recommendations for the management of the Albany Harbours (1990), still provides a context for their management. A Nutrient Reduction Action Plan was released in 2003 for Wilson Inlet and its implementation is a major priority for the Department.

The Watershed Torbay Project is a National Rivers Consortium funded research project aimed at restoring a whole of catchment is developing priority actions that will help protect and enhance Torbay Inlet and its associated wetlands. This project is preparing a restoration plan, the implementation of which will be a priority in 2004/2005 onwards.

Management of recreational activities is well advanced in the Albany Harbours and Wilson Inlet with foreshore management plans in existence for all foreshore areas and programs of work to implement these plans. The Shire of Denmark and City of Albany are heavily involved with the work.

Within the Albany Harbours and Wilson Inlet the Department has approval powers for dredging and reclamation and licences certain activities. For other developments the department gives advice to ensure development is located a suitable distance from the foreshore. The Department gives advice on stormwater and industrial discharges and uses powers provided by the Environmental Protection Act to manage industrial discharges. These controls have led to the reduction of industrial discharge into the Albany Harbours from 5 in 1990 to only 2 today. Direct discharge of urban stormwater into estuaries is also not supported without prior infiltration provided.

The creation of foreshore reserves around estuaries is a well established government principle and the Department gives advice on the suitable width of such reserves.

Management of sandbar openings has been an important, and at times, contentious area of work for the Department. Strong but divided community views in Denmark have been expressed on the timing and location of the anticipated sandbar opening. The experience of Wilson Inlet has been used to provide the need for planning controls across the Region to avoid development of estuarine flood prone land to enable natural bar openings to occur. In Denmark, special control areas are being used to guide future development of Wilson Inlet's floodplain.

Commercial and recreational use of the Albany Harbours has been guided by the preparation of the Albany Harbours Planning Strategy and Guidelines, and aquaculture development of Wilson Inlet has been guided by the preparation of an Aquaculture Development Plan.

Management responses for other South Coast estuaries have focussed on the major threats, which are pressures arising from river and catchment condition. Programs of river care, catchment support, advice on drainage and development proposals, promotion of high water use farming practices, river restoration works and protection of remnant vegetation have all been used and are better explained in Section 3.

4.5 Future Management - Discussion

A major priority for future management of South Coast estuaries is to gain a better understanding of their ecological values, as, to date, this has only been achieved for two or three systems. The community and cultural values of the Region's estuaries also need to be better understood.

A management framework for estuaries, articulating management responsibilities, needs to be developed, to enable clear priority Management Actions to be implemented. The management of sandbars is a case in point.

Representative estuarine systems need to be identified and a level of protection provided so that each representative system is protected.

The lessons and experiences gained from the research and management of Wilson Inlet, Torbay Inlet and the Albany Harbours needs to be passed on to other South Coast estuaries. There is an urgent need to avoid the problems of the past. As an example, the flood plains of all estuaries subject to development needs to be mapped and incorporated into Town Planning Schemes to ensure development of an estuaries flood plain does not occur, or at least only occurs if compatible with the protection of the inlet. Industrial or sewerage discharge should not occur into estuaries and stormwater needs to receive treatment via filtration prior to discharge to any estuary. Planning strategies need to be reviewed accordingly.

Similarly, foreshore management plans need to be prepared where recreational growth or facilities is planned. Priorities include the Walpole-Nornalup Inlet and Wellstead estuaries.

A priority action to protect 'near pristine' estuaries is to undertake foreshore surveys and programs of work to protect existing foreshore vegetation and increase vegetation coverage and on farm water use. A priority is the upper reaches of the Hamersley River and other parts of near pristine estuarine catchments in private ownership.

Rivercare will continue to be a major priority for the management of South Coast estuaries and will need to address these estuaries subject to the greatest risk of sedimentation, nutrient enrichment or hydrological change. However, this needs to be in a planned context based on catchment risk assessment, rather than the generic whole catchment approaches that currently apply.

5. Waterscapes - Wetlands

5.1 Description of Region's Wetlands

Wetlands in the Region are complex systems, are not easily mapped or categorised and there is practically no information on their economic or social values in the Region. Only in 10% of WA has the mapping and assessment of wetlands been undertaken, with the main focus of work to date being in the South West, and on the swan coastal plain in particular. As assessments are being extended, the assessment process is likely to be revised.

The Department has undertaken a broad scale classification and a preliminary evaluation and risk assessment of wetlands at a suite level in the Region, through four studies undertaken by V & C Semeniuk and Ecologia between 1998 and 2000. To assist in the classification process, V & C Semeniuk devised a basic classification system based on landform shape and water regime, the main attributes of a wetland. The classification is shown below.

Table 11 Landform

Water Longevity	Basin	Channel	Flat	Slope	Highland
Permanent inundation	Lake	River	-	-	-
Seasonal inundation	Sumpland	Creek	Floodplain	-	-
Seasonal waterlogging	Dampland	Trough	Palusplain	Paluslope	Palusmont

The South Coast Region has examples of each type of wetland. Palusmonts occur typically near the high rainfall areas of Walpole, particularly where there are granite outcrops. Paluslopes are also common near Walpole, in the Deep and Frankland river valleys and shales of the Stirling Ranges. Palusplains occur along rivers such as the King and Upper Kent. Lakes, Sumplands and Damplands are formed by many processes and often evolve through each of these stages. Freshwater lakes occur generally close to the coast and may be relics of former estuaries (such as Lake Seppings and Gardiner Lake). Further inland lakes are normally saline and commonly occur in former river channels. There is evidence to suggest some have formed as a consequence of catchment clearing. Sumpland and Damplands can be the relics of lakes, again commonly found in former river valleys and often at the interface between coastal dunes and the interior plains.

The reports by V & C Semeniuk and Ecologia detailed nearly 300 individual wetlands or suites of wetlands that are considered to have a conservation category status. Under the Environmental Protection (South Coast Agricultural Zone) Policy 1997 there are 3 levels of management category assigned to wetlands in WA, with the conservation class category having the highest level of protection. These wetlands are relatively undisturbed and have high ecological value.

The reports by V & C Semeniuk and Ecologia provide useful base information on wetland distribution and conservation value but much needs to be done to better detail the extent of these wetlands, threats to these wetlands and their broader values.

Other guidance on the importance of Regional wetlands is provided through International and National registers. The South Coast NRM Region contains 3 RAMSAR wetlands, these being Lake Gore, the Lake Warden system and the Muir-Byenup system.

The Directory of Important Wetlands lists a number of SC wetlands as being of national significance.

Table 12 International and National significant South Coast Region Wetlands

RAMSAR	Register of National Estate
Lake Gore	Cape Le Grand Suite
Lake Warden system	Gardner Lake Dune Suite
Lake Muir system	Gardner Lake Suite
Directory of Important Wetlands	Geriberiwellup swamp, Stirling Range NP-Pabelup suite
Balicup	

Mortijinup lake system	Kojaneerup suite
Pink Lake	Lake Warden system
Yellilup Yate Swamp system	Lake William suite
Lake Pleasant View system	Mill Brook Reserve-King River suite
Moates Lake system	Moates Lake suite
Mt Soho Swamps	Pillenorup swamp, Stirling Range NP-Pabelup suite
Owingup Swamp system	Porongorup wetlands
Culham Inlet system	Reef dune suite
Fitzgerald Inlet system	Stokes Inlet suite
Oyster Harbour system	Stokes suite
Lake Gore system	Unnamed wetlands, Fitzgerald NP Pabelup suite
Lake Warden system	

Note: (1) Suites may contain many individual wetlands.
(2) Regionally important conservation class wetlands not listed due to large number.
(3) Register of National Estate sites shown are wetlands- sites on register may have different name. Only registered sites (not interim or indicative) shown.

The above evaluation of wetlands needs to be considered as evolving, with the likelihood of further additions being made as on ground investigation is carried out.

Social functions increase the value of many wetlands. For example, freshwater swamps near Wellstead provide a valuable source of freshwater in times of drought for local farmers. Lake Seppings and Lake Warden both provide important environmental educational opportunities given their location close to the population of Albany and Esperance respectively. These social values need to be recognised, but are presently little understood in the Region.

5.2 Values of the Region's Wetlands

Wetlands have many values, although, to date, there has been no Regional overall assessment of values, more a brief description of the different wetlands and a preliminary assessment of values and threats at a suite level. The very quantity of wetlands and the intensive nature of determining values, which requires site investigations, technical investigation and community consultation, means a comparative assessment of values is a major challenge.

Wetlands can provide many potential benefits, which can include functions, uses or attributes. The overall value of a wetland is dependent on how the community judges the importance of these benefits.

Wetland functions include:

- Water purification by removal of sediment, nutrients and other pollutants.
- Erosion control through stabilisation and flow control.
- Ground water recharge.
- Ecological functions such as providing habitat and breeding areas for flora and fauna.

Wetland use can include:

- Water abstraction and storage.
- Extraction of minerals, animals or plants.
- Recreation and education.
- Waste disposal and treatment.
- Agricultural production.

Wetland attributes that can be valued by the community include:

- Aesthetic qualities and recreational opportunities.
- Diversity and richness of associated flora and fauna, particularly rare or endangered species.
- Historical or cultural significance.
- Educational opportunities.
- Presence of a natural system that may be threatened or is rare.

The above list highlights the complexity of assigning values to wetlands and the amount of information that would be required to determine these values.

5.3 Threats to the Region's Wetlands

A lack of understanding and appreciation is a major threat to the Region's wetlands. Many wetlands are being filled in or cleared because the value of wetlands is not appreciated. In many cases the very existence of a wetland is not known.

The changing hydrological status of catchments due to clearing of native vegetation, with greater recharge, groundwater levels and run off, is the main threat to the Region's wetlands, particularly in inland areas. Increased groundwater levels can inundate wetlands and rapid changes can alter and destroy fringing vegetation. Where wetlands have only a limited area, such as provided in narrow reserves, these changes can destroy the entire wetland.

Increased salinity levels resulting from land clearing can also alter wetland water quality and increased salinity levels are altering or destroying the vegetation of many inland wetlands.

The physical clearing of vegetation, through agricultural land use or urban expansion, is an important issue in the Region. Numerous wetlands surround coastal settlements and are subject to pressures of urbanisation. Coastal wetlands have been artificially drained to allow potato production and other horticulture.

Nutrient enrichment is a pressure to wetlands as well as rivers, with wetlands having increased algal growth. Sedimentation, due to stream erosion and transportation of sediments, invasion of weeds, loss of fringing or wetland vegetation by livestock, over extraction of water for supply purposes (particularly of coastal wetlands in drought years) and infilling are all threats evident in the South Coast Region.

5.4 Management Responses

In 1999, V & C Semeniuk and Ecologia were contracted by the Water and Rivers Commission to survey, evaluate and classify the wetlands of the South Coast Region. These reports provided the first Regional assessment of wetlands and have formed the basis of an ongoing Regional wetland program.

The program was initiated in 1999 with the employment of a Project Officer, jointly managed by Green Skills and the Department. Using the above reports as a guide, management plans have been prepared for priority wetlands at a rate of approximately 2 a year (in 2003 these were Two Peoples Bay and Robert's swamp. Wellstead and Boyatup Swamp are priorities for 2004).

The Regional wetland program includes the monitoring of 30 wetlands across the Region, twice a year, to gain important information on wetland baseline condition and seasonal variation. Implementation of these management plans is also a priority, with some 68km of fencing and 80,000 seedlings used to help enhance wetland condition, using Green Corps teams of volunteers.

Workshops and leaflets are used to promote wetland conservation across the Region, as part of the program.

The Department's work is complemented by CALM's investigation of wetland flora and fauna values. Investigations by CALM are highlighting the unique ecological attributes of many wetlands, these values not being as yet reflected in any designation or register.

5.5 Future Management - Discussion

The overriding priority for the Region's wetlands is to obtain more information on the extent, values and threats to these wetlands, and to identify wetland through more detailed mapping in priority areas. Without this base information, management will not be guided and wetlands will continue to be lost.

The detailing of values needs to include all functions, uses and attributes. Social factors need greater recognition, as well as environmental and ecological values.

The environmental education values of Lake Seppings and Lake Warden need to be maximised, given their proximity to the Region's main urban centres.

The Regional wetland program of preparing management plans, implementation of works, maintaining of wetland condition and education awareness needs to be continued and expanded. Its reliance on numerous small grant and sources provides considerable uncertainty, and funding sources need to be made longer term.

Wetland boundaries need to be mapped for areas subject to greatest land use change or agricultural pressure to ensure wetlands can be protected and adequate buffer areas provided. Mapping of wetlands needs to be included into Regional planning strategies and Town Planning Schemes along with provision for their protection.

Water Resources South Coast - Appendix 1

Water Resource Summary

Asset	Values	Threats	Focus Areas	Management Responses	Future Management -Discussion
Water Supplies	Beneficial uses include agriculture, industry and domestic uses	<p>Contamination of existing reticulated domestic supplies due to urban expansion.</p> <p>Incompatible land uses over ground water reserves.</p> <p>Increased salinity levels of future supplies due to land clearing.</p> <p>Pollution of future supplies from agricultural land uses.</p> <p>Over extraction of existing supplies.</p>	<p>Kent and Denmark river catchment for Salinity management.</p> <p>Public Drinking Water Source Areas (PDWSA's) as proclaimed under Country Areas Water Supply Act. (These show existing and some proposed water supplies).</p> <p>Marbellup Brook Catchment for catchment rehabilitation.</p> <p>Desalination trials and evaluation for Jerramungup and Ravensthorpe.</p>	<p>Protection Plans prepared for PDWSA's</p> <p>Controls on development within PDWSA's. Incorporation of Protection plans into Town Planning Schemes.</p> <p>Catchment rehabilitation work and promotion of on farm water use through Salinity Action Plan for Kent/Denmark catchments.</p> <p>Licensing of water extraction through Rights in Water and Irrigation Act.</p> <p>Promotion of water conservation, recycling and reuse</p>	<p>Allocation plan to guide Albany sub-regional Future water supplies</p> <p>Assessment of desalination options for areas without adequate freshwater supplies, including assessment of saline water disposal.</p> <p>Proclamation of Marbellup Brook under Rights in Water and Irrigation Act. Implementation of catchment rehabilitation work.</p> <p>Continuation of salinity management for Denmark River and Kent River catchments.</p> <p>Continued implementation and review of protection plans for PDWSA's.</p> <p>Recognition of Bow, Kent, Denmark River and Marbellup Brook as Strategic Water Supplies in Planning Strategies.</p>

Asset	Values	Threats	Focus Areas	Existing Management Responses	Future Management- Discussion
Water Scapes – Rivers	<p>Water supplies (existing and potential) for agricultural, industry and domestic drinking water.</p> <p>Drainage functions.</p> <p>Habitat and wildlife corridors.</p> <p>Nutrient and sediment filters</p> <p>Recreational, aesthetic and cultural values.</p> <p>Commercial activities e.g. fishing.</p>	<p>Changed hydrology (volume and rate of run-off) due to land clearing.</p> <p>Increased salinity.</p> <p>loss of foreshore vegetation due to livestock and development.</p> <p>Contamination of water quality due to agricultural activities or urban stormwater discharge.</p> <p>Nutrient enrichment</p> <p>Over extraction of water.</p> <p>Development of river floodplains and damming of rivers.</p>	<p>‘Near Pristine’ rivers. Based on at least 80% of catchment uncleared (22 rivers).</p> <p>‘High commercial, recreational or visual amenity’ value rivers. Based on examination of use for water supplies, level of recreational facilities and vantage points (10 rivers).</p> <p>Rivers with highest level of changed hydrology (defined as at least 80% of catchment cleared). (8 rivers)</p> <p>Rivers with high nutrient levels, based on monitored water quality or presence of algal blooms (44 rivers).</p> <p>Kent and Denmark for salinity management.</p> <p>Priority rivers based on ecological factors to be prepared. As yet insufficient information.</p>	<p>Regional rivercare work, including fencing and foreshore vegetation, replanting, in stream rehabilitation, catchment support and river foreshore surveys.</p> <p>Nutrient Action Plans, nutrient modelling and monitoring and setting of priorities to reduce river nutrient levels.</p> <p>Catchment rehabilitation work to reduce salinity levels in Kent and Denmark River catchments.</p> <p>Floodplains mapping and inclusion in town planning schemes.</p> <p>Monitoring and educational awareness.</p> <p>Foreshore management plans required as condition of recreational activities.</p>	<p>Ecological and cultural values of river to be identified.</p> <p>Continued monitoring of river condition and evaluation of works.</p> <p>Continuation and expansion of rivercare works, guided by the strategy.</p> <p>Inclusion of provisions in Town Planning Schemes to cater for River protection, including mapping of floodplains.</p> <p>Representative rivers to be identified, to assist in protection.</p> <p>Revegetation/promotion of greater on farm water use of river catchments most subject to hydrological change.</p> <p>Foreshore management plan be prepared to manage recreational use.</p> <p>Catchment works to continue salinity management in Kent and Denmark river catchments.</p> <p>Assess Development and drainage proposals affecting rivers.</p>

Asset	Values	Threats	Focus Areas	Management Responses	Future Management-Discussion
-Estuaries	<p>Port and boating facilities</p> <p>Commercial fishing</p> <p>Recreational use</p> <p>Visual amenity</p> <p>Cultural and historic importance</p> <p>Habitats and important nursery grounds for many flora and fauna</p>	<p>Changed catchment hydrology</p> <p>Physical modifications to floodplain and artificial openings of sandbar</p> <p>Nutrient enrichment, causing algal growth or toxic blooms</p> <p>Sedimentation due to increased river erosion</p> <p>Polluted urban stormwater</p> <p>Industrial discharge</p> <p>Dredging</p> <p>Introduction of exotic organisms</p> <p>Unmanaged recreational use</p>	<p>Estuaries with high recreational, commercial or visual amenity values (determined by commercial fishing, boating facilities, tourism infrastructure and public view points) (10 estuaries)</p> <p>'Near pristine' estuaries, based on at least 80% of catchment uncleared and foreshore in good condition (6 estuaries)</p> <p>Highly eutrophic estuaries, based on nutrient levels, algal abundance or occurrence of blooms (10 estuaries)</p> <p>Estuaries with greatest level of changed catchment hydrology (based on 80% of catchment cleared) 6 estuaries</p>	<p>Waterways Conservation Act and controls on development in Albany Harbours and Wilson Inlet</p> <p>Nutrient Reduction Plans for Wilson Inlet and Albany Harbours in preparation for Torbay Inlet</p> <p>Rivercare work</p> <p>Management of industrial discharges through Environmental Protection Act</p> <p>Advice and controls on urban stormwater</p> <p>Planning strategies and foreshore management plans to manage recreational use</p> <p>Monitoring of representative estuaries</p>	<p>Establish community values for priority estuaries</p> <p>Ecological and cultural values of estuaries to be better identified</p> <p>Estuarine floodplains to be mapped and incorporated into land use planning strategies</p> <p>Existing Nutrient reduction plans to be implemented, and Watershed Torbay project completed. New plans to be prepared for eutrophic estuaries such as Wellstead and Beaufort Inlets</p> <p>Representative estuaries to be determined</p> <p>Foreshore management plans to be prepared where recreational use expanded</p> <p>Increased vegetation coverage or higher water use farming to be encouraged in estuary catchments with most altered hydrology</p>

Asset	Values	Threats	Focus Areas	Management Responses	Future Management -Discussion
-Wetlands	<p>Habitat for flora/fauna</p> <p>Sediment/nutrient filter</p> <p>Provides catchment hydrological control</p> <p>Water abstraction and storage for agriculture</p> <p>Recreation</p> <p>Education</p> <p>Agricultural production</p> <p>Aesthetic qualities</p> <p>Appreciation of flora/fauna</p>	<p>Changes to catchment hydrology, leading to inundation.</p> <p>Sedimentation</p> <p>Increased salinity</p> <p>Livestock</p> <p>Infilling for agriculture or urban development</p> <p>Lack of appreciation and knowledge of wetland existence or values.</p>	<p>Wetlands named on International or National Registers or identified in regional surveys or being of 'conservation' class. Management to be focused on those wetlands subject to threatening processes.</p>	<p>Regional wetland programs with project officer, management plan preparation, monitoring, works program and educational awareness</p> <p>Advice and controls on development, drainage proposals, clearing and land use change.</p>	<p>Improve understanding of wetland values and threats</p> <p>Maintain regional wetland program to continue and expand management planning, monitoring, implementation of rehabilitation works and educational awareness</p> <p>Mapping of wetlands in areas subject to greatest change</p> <p>Review national register and regional surveys to ensure appropriate level of protection provided</p>

APPENDIX 2

WATER RESOURCE FOCUS AREAS - South Coast Regional NRM Strategy - DOE

text in green is adapted from criteria in the SCRIPT consultation document

assets in red are within DOE south coast region but west of SCRIPT region

updated 7 Jan 04 to supplement Chris Gunby's paper "Water Resources in the South Coast Region" -JB

Near Pristine Rivers C2.2

< 20% catchment cleared

- Meerup River
- Doggerup Creek
- Blackwater Creek
- Chesapeake Brook
- Shannon River
- Forth River
- Inlet River
- Deep River
- Quickup River
- Mitchell River
- Limeburner Creek
- Angove River
- Bluff River
- Wongerup Creek
- Mullocullup River
- Hunter River
- Kellys Creek
- Boondadup River
- Saint Mary River
- Unnamed tributary (of L. Nameless)
- Copper Mine Creek
- Dempster River
- Hammersley River
- Jenamullup
- Jorndee Creek
- Poison Creek
- Fern Creek
- Weanerjungup

Near Pristine Estuaries C3.5

<20% catchment cleared and only minor physical modification of estuary or foreshore

- Broke Inlet
- Walpole Inlet
- Saint Mary Inlet
- Dempster Inlet
- Hammersley Inlet
- Jorndee Creek Estuary
- Poison/Fern Creek Estuary

Eutrophic Rivers C2.4

1: Combined N & P Risk = VH, or
 2: Risk = H and the river drains into highly valued estuaries or wetlands, or
 3: Risk = H and the river drains into eutrophic estuaries or wetlands

- Frankland River ²
- Gordon River ¹
- Kent River ²
- Kordabup River ¹
- Little River ¹
- Scotsdale Brook ^{2 3}
- Hay River ^{2 3}
- Sunny Glen Creek ¹
- Sleeman River ^{2 3}
- Cuppup Creek ¹
- Lake Saide Drain ¹
- Torbay Main Drain ¹
- Marbelup Brook ³
- Seven Mile Creek ¹
- Five Mile Creek ¹
- Princess Royal Drain ¹
- Robinson Drain ¹
- Munster Hill Drain ¹
- Yakamia Creek ¹
- King River ¹
- Wilyung Creek ^{2 3}
- Mill Brook ^{2 3}
- Kalgan River ^{2 3}
- Goodga River ¹
- Taylor Inlet Tribs ³
- Pallinup River ¹
- Salt Creek ^{2 3}
- Six Mile Creek ^{2 3}
- Jackitup Creek ^{2 3}
- Peenebup Creek ^{2 3}
- Warperup Creek ¹
- Bremer River ^{2 3}
- Devil Creek ^{2 3}
- Gairdner River ¹
- Needilup River ¹
- Jerdacuttup River ²
- Munglinup River ¹
- Young River ¹
- Lort River ²
- Coobidge Creek ²
- Dalyup River ²
- Dalyup River West ²
- Kateup Creek ²
- Melijinup Creek ¹
- Coramup Creek ¹
- Bandy Creek ²
- Neridup Creek ¹

Eutrophic Estuaries C3.6

Based on combination of nutrient significance, high chlorophyll, toxic blooms, and nuisance algal growth

- Parry Inlet
- Wilson Inlet
- Torbay Inlet
- Princess Royal Harbour
- Oyster Harbour
- Taylor Inlet
- Beaufort Inlet
- Wellstead Estuary
- Gordon Inlet

Public Drinking Water Supply Areas

Existing SU3.6.6.1

	surface/GW
existing potable water resources	
Scotsdale Brook Water Reserve	surface
Quickup River Dam Catchment Area	surface
South Coast Water Reserve	gw
Angove Creek Catchment Area	surface
Bolganup Creek Catchment Area	surface
Bremer Bay Water Reserve	gw
Hopetoun Water Reserve	gw
Esperance Water Reserve	gw
Gibson Water Reserve	gw
Condingup Water Reserve	gw
Salmon Gums Catchment Area	surface
Limeburners Creek Catchment	surface
Walpole Weir	surface

Potential SU3.6.6.2

potential future surface & gw supplies	
Marbelup Water Reserve	surface
Kent River Water Reserve	surface
Denmark River Catchment Area	surface
Styx River	surface
Bow River	surface
Butler's Creek	surface

Roaded catchments:

Gnowangerup Water Supply Catchment Area	surface
Frankland	
Cranbrook	
Rocky Gully	
Wellstead	
Munglinup	
Ravensthorpe	
Ongerup	
Jerramungup	

High Economic/Social Value SU6.3

Estuaries:

Estuaries with high commercial, recreational, or visual amenity values

- Broke Inlet
- Normalup Inlet
- Walpole Inlet
- Wilson Inlet
- Princess Royal Harbour
- Oyster Harbour
- Waychincup Inlet
- Hammersley Inlet
- Culham Inlet
- Stokes Inlet
- Bandy Creek Estuary

Rivers:

Rivers with high commercial, recreational, or visual amenity values

- Frankland River
- Kent River
- Styx River
- Scotsdale Brook
- Denmark River
- Quickup River
- Marbelup Brook
- King River
- Lower Kalgan River
- Angove River

Intl/Nationally Significant Wetlands C2.5

RAMSAR wetlands

- Lake Muir - Byenup Lagoon
- Lake Gore
- Lake Warden

ANCA wetlands

- Doggerup Creek System (Doggerup Creek and extensive flats in N & E of catchment)
- Maringup Lake (Maringup Lake & associated swamp)
- Broke Inlet System (Broke Inlet and all wetlands within its catchment)
- Lake Muir
- Byenup Lagoon System (numerous lakes, swamps, and flats east and north of Lake Muir)
- Mt Soho Swamps (Boronia Rd suite) (3 swamps: Middle Rd, Boronia Rd, Mountain Rd)
- Owingup Swamp System (Kent R below 10m ctr, Owingup swamp & inundated area, Boat Harbour Lakes A-C & several nearby swamps)
- Balicup Lake System (Balicup Suite) (group of lakes immediately north of Stirling Range)
- Oyster Harbour (Estuary & associated tidal wetlands)
- Moates Lake System (Moates Lake, Lake Gardner & Angove Lake)
- Lake Pleasant View System (Corimup Suite - North Sister E Lake, North Sister W Lake, & Lake Pleasant View)
- Yellilup Yate Swamp System (reps from Pabelup/Mpks suites) (12 lakes/swamps north of Bremer Bay Rd)
- Fitzgerald Inlet System (Fitz & Dempster Inlets, Charles Bay Lake, Lake Nameless, Fitz R & Susetta R within park)
- Culham Inlet System (Culham Inlet & 6.5 km of the Phillips R & 3 km of the Steere R)
- Lake Gore System (Lakes Gore, Carbul, Kubitch, Gidong, Quallilup, about 10 unnamed, and a swamp connecting Gore & Quallilup)
- Mortijinup Lake System (from ESE to WNW: unnamed marsh, Mortijinup, Nambarup, wooded swamp (Nambarup W))
- Lake Warden System (Warden, Racecourse, Windabout, Woody, Wheatfield, Station, Mullet, Ewans Lakes)
- Pink Lake

Register of National Estate (actual listing title)


- Meerup River wetlands
- Doggerup creek wetlands system (Sth Coast NP)
- Doggerup lake (Doggerup lake)
- Gardner River lower wetlands (South Coast NP)
- Broke Inlet wetlands-NE+West (South Coast NP)
- Bell Brook floodplains (South Coast NP)
- Shannon River lower wetlands (Sth Coast NP)
- Chesapeake Brook floodplain wetlands (Sth Cst NP)
- Normalup/Lower Deep wetlands (South Coast NP)
- Lake William (West Cape Howe)
- Mill Brook wetlands (Mill Brook Reserve)
- Coyanarup suite (SRNP)
- Kojaneerup suite (Stirling Range NP)
- Pillenorup swamp-Pabelup suite (SRNP)
- Geriberiwellup swamp-Pabelup suite (SRNP)
- Unnamed wetlands -Pabelup suite-(Fitzgerald NP)
- Porongorup wetlands (Porongorup Nat. Pk)
- Moates Lake suite (Two Peoples Bay)
- Gardner lake suite (Two Peoples Bay)
- Gardner lake dune suite (Two Peoples Bay)
- Stokes/Stokes Inlet suite (Stokes National Park)
- Lake Warden System (Esperance lakes)
- Cape Le Grand suite (Cape Le Grand Nat Pk)

high priority for management C2.6

- Gore System
- Balicup Suite
- Mitchell Creek Suite
- Lake Barnes Suite
- Cobomup Suite
- Madjenapurdap Suite
- Manypeaks Suite
- Boyatup Swamp Suite
- Swan Lagoon Suite
- Cascade west suite
- Reserve swamp
- Benje Benjenup Suite
- Munglinup River Suite
- Lake Chidnup

Near Pristine Rivers and Estuaries

SCRIPT Regional Strategy Objectives C2.2, C3.5



SCRIPT Subregions

- Kent Frankland
- Albany Hinterland
- Pallinup North Stirling
- Fitzgerald Biosphere
- Mallee
- Esperance Sandplain
- National Park
- Near Pristine River/Estuary

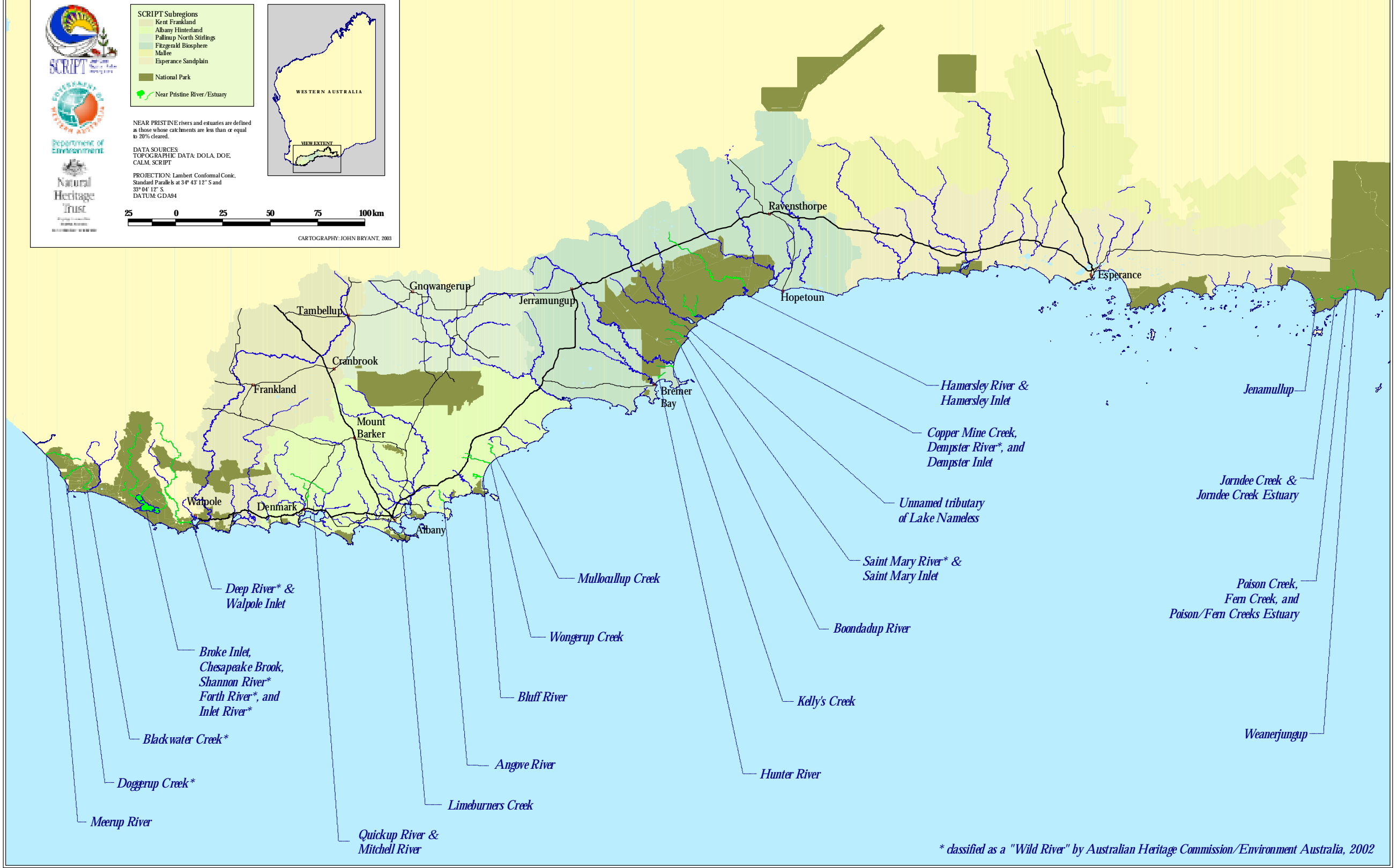
NEAR PRISTINE rivers and estuaries are defined as those whose catchments are less than or equal to 20% cleared.

DATA SOURCES
TOPOGRAPHIC DATA: DOLA, DOE, CALM, SCRIPT

PROJECTION: Lambert Conformal Conic, Standard Parallels at 34° 43' 12" S and 33° 04' 12" S, DATUM: GDA94

25 0 25 50 75 100 km


CARTOGRAPHY: JOHN BRYANT, 2003



* classified as a "Wild River" by Australian Heritage Commission/Environment Australia, 2002

Eutrophic Rivers and Estuaries

SCRIPT Regional Strategy Objectives C2.4, C3.6



SCRIPT Subregions

- Kent Frankland
- Albany Hinterland
- Pallinup North Stirling
- Fitzgerald Biosphere
- Mallee
- Esperance Sandplain

Eutrophic Estuary/River

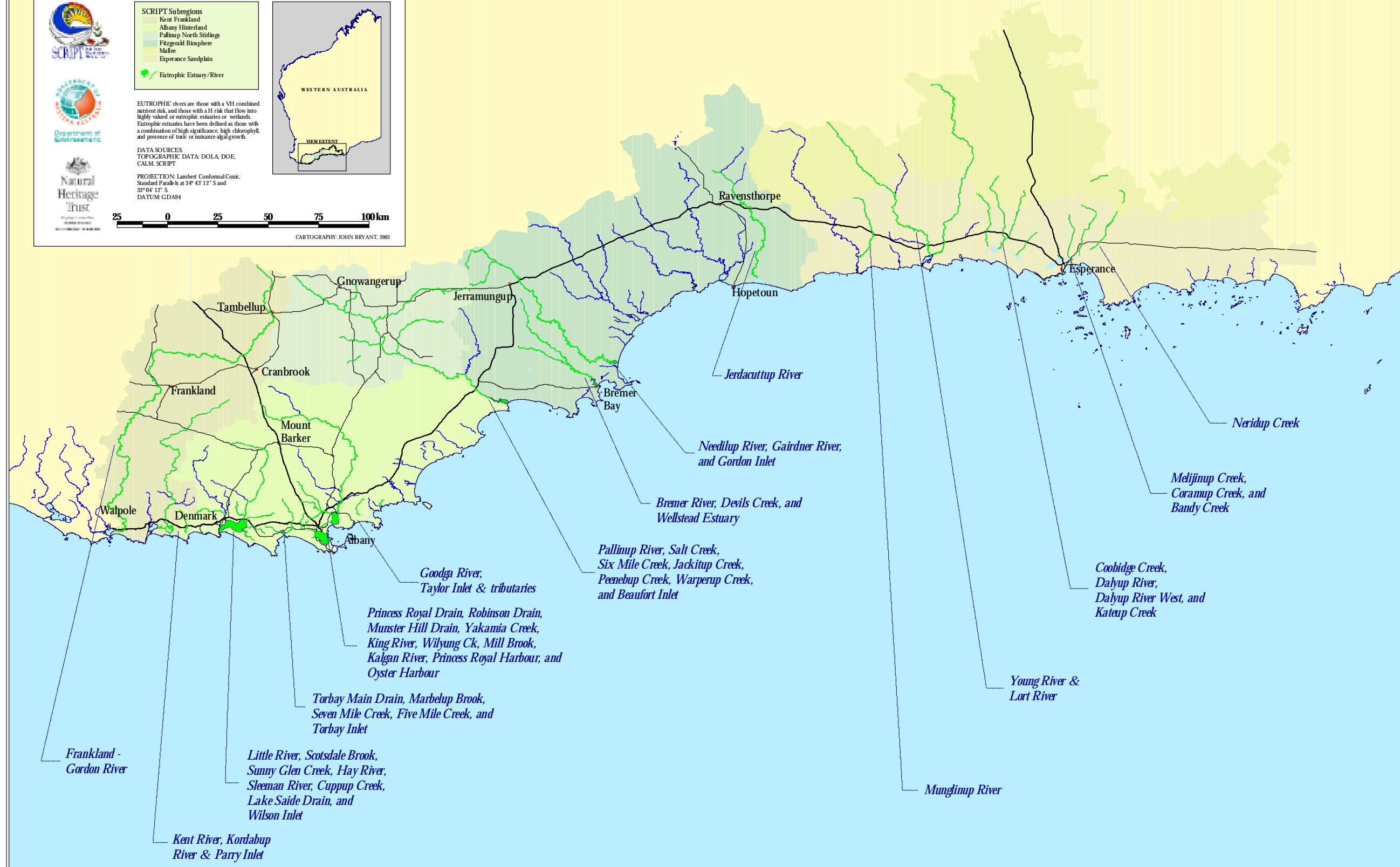
EUTROPHIC rivers are those with a VH combined nutrient risk, and those with a H risk that flow into highly valued or eutrophic estuaries or wetlands. Eutrophic estuaries have been defined as those with a combination of high significance, high chlorophyll, and presence of toxic or nuisance algal growth.

DATA SOURCES
 TOPOGRAPHIC DATA: DOLA, DOE, CALM, SCRIPT

PROJECTION: Lambert Conformal Conic, Standard Parallels at 34° 43' 12" S and 33° 04' 12" S, DATUM: GDA94


Scale: 0, 25, 50, 75, 100 km

CARTOGRAPHY: JOHN BRYANT, 2003



Public Water Supply

SCRIPT Regional Strategy Objectives SU3.6, SU6.1, SU6.2



SCRIPT Subregions

- Kent Frankland
- Albany Hinterland
- Pallinup North Stirling
- Fitzgerald Biosphere
- Mallee
- Esperance Sandplain

Legend

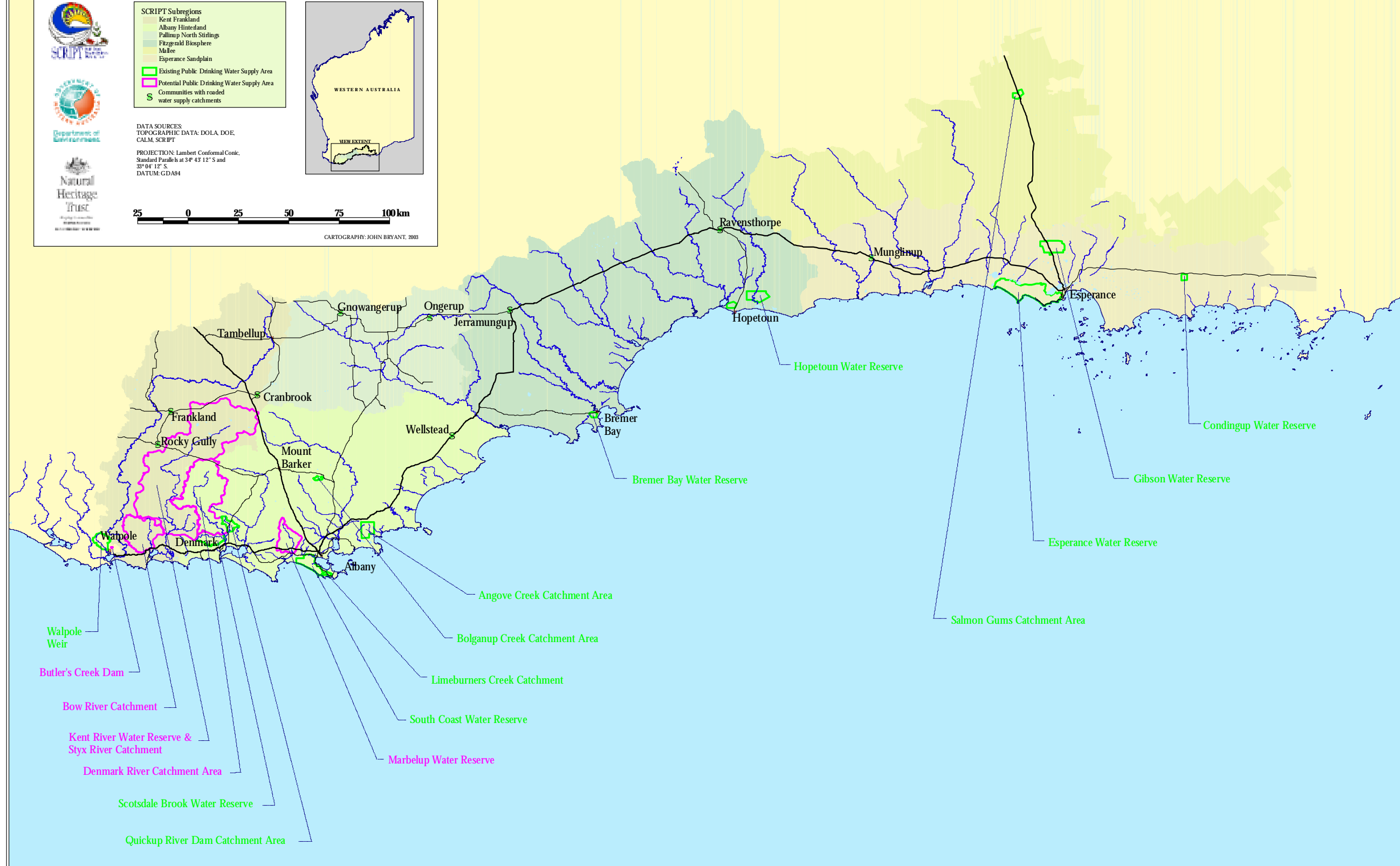
- Existing Public Drinking Water Supply Area
- Potential Public Drinking Water Supply Area
- Communities with roaded water supply catchments

DATA SOURCES:
 TOPOGRAPHIC DATA: DOLA, DOE, CALM, SCRIPT

PROJECTION: Lambert Conformal Conic, Standard Parallels at 34° 43' 12" S and 39° 04' 12" S, DATUM: GDA84

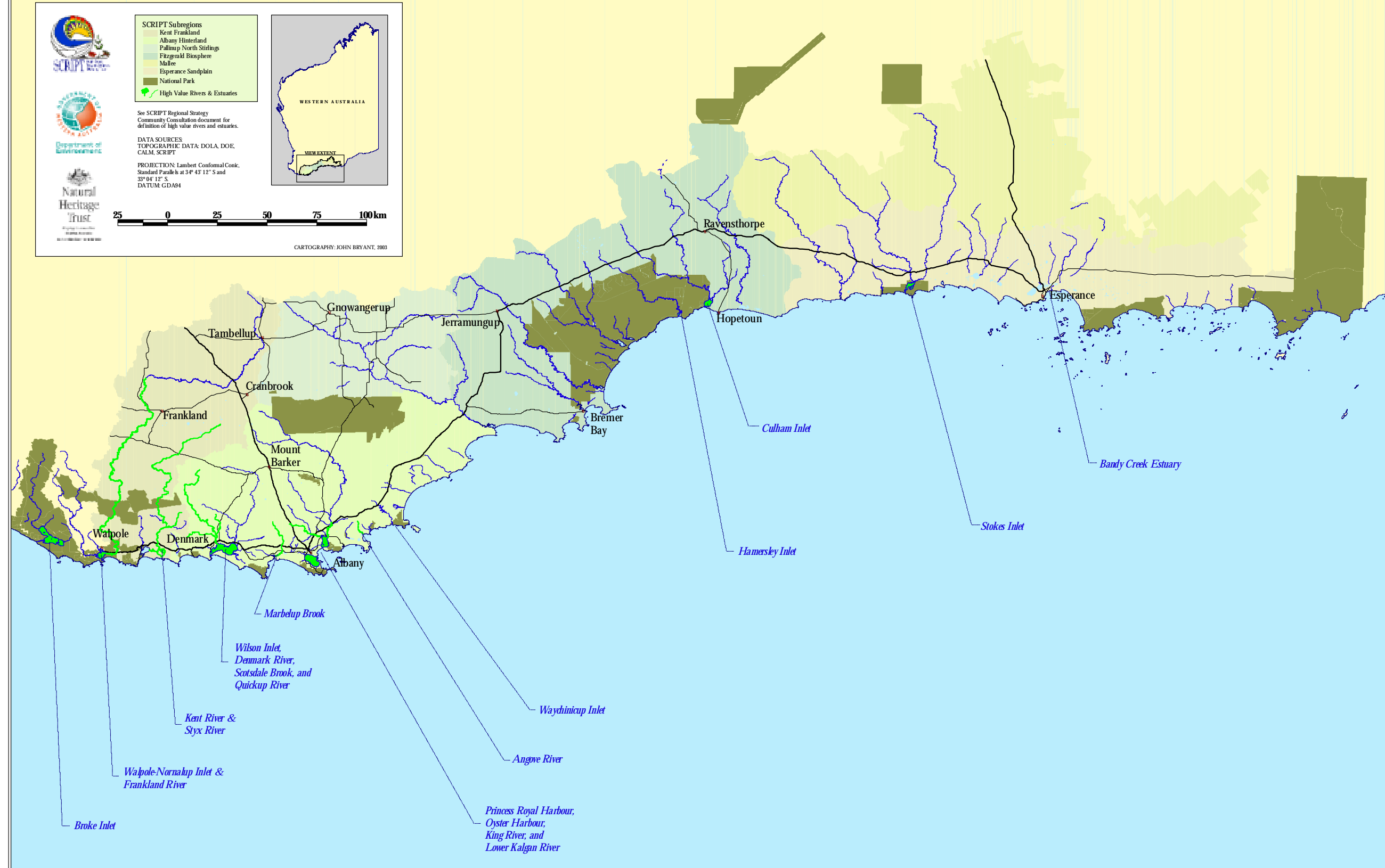
Scale: 0 to 100 km

CARTOGRAPHY: JOHN BRYANT, 2003




High Social/Economic Value Rivers and Estuaries

SCRIPT Regional Strategy Objective SU6.3



Wetlands of International/National Significance

SCRIPT Regional Strategy Objective C2.5



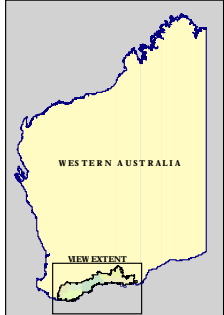
SCRIPT Subregions

- Kent Frankland
- Albany Hinterland
- Pallinup North Stidings
- Fitzgerald Biosphere
- Mallee
- Esperance Sandplain
- Wetlands of International/National Significance

Wetlands of International/National Significance are those that are listed by RAMSAR, ANCA, or are on the Register of the National Estate.

DATA SOURCES
 TOPOGRAPHIC DATA: DOLA, DOE, CALM, SCRIPT
 WETLAND INFORMATION: ENVIRONMENT AUSTRALIA, AUSTRALIAN HERITAGE COMMISSION

PROJECTION: Lambert Conformal Conic, Standard Parallels at 34° 43' 12" S and 33° 04' 12" S, DATUM: GDA84




25 0 25 50 75 100km

CARTOGRAPHY: JOHN BRYANT, 2003



Wetlands - Management Priorities

SCRIPT Regional Strategy Objective C2.6



SCRIPT Subregions

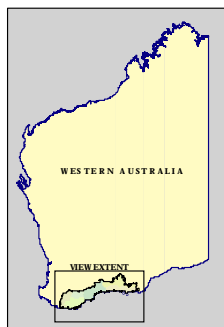
- Kent Frankland
- Albany Hinterland
- Pallinup North Stirling
- Fitzgerald Biosphere
- Mallee
- Esperance Sandplain

Wetlands identified as high management priority

These wetlands have been identified as a high priority for management action as per section C2.6 in the SCRIPT Draft Community Consultation paper.

DATA SOURCES
 TOPOGRAPHIC DATA: DOLA, DOE, CALM, SCRIPT

PROJECTION: Lambert Conformal Conic, Standard Parallels at 34° 45' 12" S and 33° 04' 12" S, DATUM: GDA84



25 0 25 50 75 100km

CARTOGRAPHY: JOHN BRYANT, 2003

