

Stokes Inlet Literature Review – a working document

		Values / Condition	Threats / comments	Existing management	Suggestions for management / Information gaps
<p><i>Note: the information within this document has been separated into groups such as water quality, flora and fauna, history etc. All comments are referenced by number with the full reference listed at the end of the document. Information added after 22 January 2007 is in blue</i></p>					
General		<p>With the growth of the bar and its closure (over time) the inlet has changed from a marine to estuarine system (4000 yrs ago) with variable water level, salinity and a very restricted flora and fauna.²</p> <p>Stokes Inlet is listed as estuary 637 on the national database: Central basin 8.62 km², wave dominated estuary, with mean wave height 1.48m. 12.85km long and 2.46km wide, water area 11.57km², catchment area 6384km².²⁶</p> <p>The inlet lies in a relatively deep valley (old fault line). Depth to 10m.² and receives 540 mm/annum.⁴</p> <p>Stokes Inlet is one of the major assets focused on by the Young River Strategic Catchment group because of its high public value throughout the whole community.³⁹</p> <p>The water resources background paper for the South Coast regional strategy for NRM suggested that Stokes Inlet has high visual amenity and moderate commercial value.⁴⁷ Overall the estuary is classified as severely impacted with moderate waterway values, pressures, condition and management response.⁴⁷</p>	<p>To make sound strategic decisions about how to manage estuaries we need to understand the importance of how they have changed in response to both natural factors and human activities.⁵</p>		<p>Information gaps according to Hodgkin: flow into the estuary, input of sediment, behaviour of basins in relation to the retention of water and the resulting viability of the estuarine habitats for fish and other fauna.</p> <p>What should be done:</p> <ul style="list-style-type: none"> -Deep sediment coring in the basin -Constant flow recordings -Water nutrient sampling.¹
Use / tenure		<p>Stokes and Torradup Inlets have high conservation value as representative of the South Coast semi-permanently closed lagoonal and riverine estuaries. Stokes is the largest easterly lagoonal estuary and is deep and does not dry out and therefore supports more diverse aquatic flora and fauna. It has a high scenic value and has considerable value for recreational fishing.¹⁸</p> <p>Recreation: Stokes National Park (NP) is remote and as yet is not a popular tourist destination. Yet the coastal vegetation and scenery is of high quality and fishing in the inlet and on the coast is excellent. Increasing use of the park and the inlet for recreational purposes may be expected in the future.¹⁸</p> <p>Project researchers undertook a visitor survey at Stokes Inlet over the Easter 2005 holiday break.²⁵ There are two main seasons for Stokes NP. December – May is the high season and May – November is the low season. In the high season, there are two main user groups:</p> <ol style="list-style-type: none"> 1. Families on day visits, where the main activities are fishing at the estuary or beach (when accessible), and 	<p>Stokes Inlet has been identified as a potential source of heavy mineral sands. The resource has not yet been fully explored and confirmed as economically significant.⁸</p> <p><i>NOTE: this may influence the inclusion of the Inlet in Stokes NP.</i></p>	<p>Stokes Inlet is presently Unallocated Crown Land and is 1110ha in size.⁸</p> <p>Stokes National Park (NP) extends to the low water mark. There is a question as to whether the inlet is 'tidal' and therefore excluded from the national park by terms of the Land Act.¹⁸</p> <p><i>NOTE: a coastal reserve plan is being prepared by DEC and</i></p>	<p>The Wilson report suggested that the State coastal waters adjacent to the Stokes NP, encompassing Margaret Cove, Dunster Castle Bay and Fanny Cove, and including the tidal parts of Stokes Inlet and Torradup Inlet, be considered for reservation as a marine reserve for the purpose of conservation of flora and fauna and public recreation, and managed in conjunction with the national park.¹⁸ (Recreational and commercial fishing is permitted in marine parks but not marine nature reserves.¹⁸) <i>This recommendation is based on the values listed in the left hand column.</i></p> <p>5 submissions were received in response to the Wilson Reports recommendations: 1 supportive and 4 opposed. The supportive</p>

		<p>2. Campers, where the main activities are boating, fishing and swimming. Stokes NP does not supply or provide potable water and there are no shower facilities, so most campers usually only stay for 2-3 days until they run out of water.</p> <p>In the low season, there are three main user groups:</p> <ol style="list-style-type: none"> 1. Local residents who visit the area on short notice if weather conditions permit., 2. 'Caravaners' –usually couples or families travelling across Australia who pull in off the road and usually stay overnight, and 3. Commercial estuary fishers who usually stay for 1-2 weeks at a time, going home on Saturday nights when fishing is banned. <p>According to the ranger, visitors to Stokes visit all of the main areas – the beach, the estuary and the river. A small but committed group of bird watchers also regularly visit the lake area.</p> <p>Of the 36,000 visitors per annum, 24,000 will visit the in the high season. Of the 12,000 vehicles to enter the Park each year, approximately 25% or 3,000 vehicles will be towing a trailer (boat or caravan).²⁵</p> <p>Results from 34 DEC visitor surveys February-May 2006:</p> <ul style="list-style-type: none"> -Main purposes of visit included holiday / travel / recreation / fishing / bird watching / walking / camping, -Activities undertaken in order of priority were camping, bushwalking, relaxing, fishing, picnicking/BBQ, bird watching, sightseeing, swimming. -73% of respondents camped in park, 35.3% were 60+ years old, 85.3% visited with friends/family, 52.9% were female, 85.3% it was their first visit, 23.5% were from overseas. 		<p><i>will include Stokes NP.</i></p>	<p>submission suggested that a management plan for Stokes NP should be developed first. Grounds for the opposing submissions were:</p> <ul style="list-style-type: none"> -reservation unnecessary as the area is remote and the weather conditions provide protection against excessive use and that reservation would lead to restrictions in access, -marine fauna is already adequately protected under fisheries legislation, and -entry fees would be introduced and would have detrimental effect of the local people and the tourism industry.¹⁹ <p>Another CALM report in 1997 also recommended that Stokes Inlet should be considered for inclusion in the marine conservation reserve system as suggested in the Wilson report.²⁰</p> <p>DEC inspection notes suggest that the Inlet should be added to the NP in order to conserve important nature conservation values and to accommodate a range of recreational activities for which there is limited opportunity within the NP.⁸</p>
Flora / Plants	Terrestrial - within park	<p>Within the NP in 1989 vegetation diversity was high, with twenty different vegetation communities identified¹⁵ and 456 species (spp)¹³. These include Eucalypt and Casuarina woodlands, heaths of different substrates, and several different dominant species, including <i>Eucalyptus</i>, <i>Melaleuca</i>, <i>Banksia</i> and <i>Dryandra</i> spp, coastal <i>Acacia</i> dominated shrubland and low shrubland, Paperbark swamp, Mallee over limestone, sedgeland, damplands, and coastal foredune.¹⁵</p> <p>Beard vegetation types present include:</p> <ul style="list-style-type: none"> 4048: Shrublands; scrub-heath in the Esperance Plains including Mt Ragged scrub-heath (majority of park) 42: Shrublands; mallee & acacia scrub on south coastal dunes (coastal strip) 125: Bare areas; salt lakes (lake connected to the Inlet) 47: Shrublands; tallerack mallee-heath (in small area in the north of park near farmlands, only veg type with low representation of 33% pre-clearing extent remaining) 129: Bare areas; drift sand (small areas near coast).³⁷ <p>A fire burnt 4000 ha of Stokes in 1993.⁴⁰</p>	In 1989, 9.3% of spp found in park were introduced. ¹³	No management plan exists for Stokes NP as yet. ¹	

<p>Terrestrial – within the catchment / clearing</p>	<p>The upper part of the Stokes catchment was only released for agricultural development in the 1970s and 1980s.⁸ ~60% catchment cleared by January 1987.¹ Most of the Young catchment clearing took place since the early 1960's. With 55% cleared by 1996.³⁴ Most of the Lort catchment clearing took place from the mid 1950's on. With 65% cleared by 1996.²⁴</p> <p>The catchment covers Esperance Sandplain and Esperance Mallee Bioregions and 503,273 ha, with 328,863 ha allocated agricultural land.³ Within the farmed areas only 24% is vegetated.³</p> <p>The Lort and Young Rivers are in good to excellent condition, have wide foreshore vegetation buffers. The rivers have considerable habitat values, including riffle zones, extensive pools that retain water all year round, and overhanging vegetation along their entire lengths (comments by Kaylene Parker).³</p> <p>The Young River has 2 vegetation systems recognised by Beard includes mallee shrublands and low forest associations of Moort.¹¹</p> <p>The Lort River has vegetation communities as described by Beard include shrublands of mallee in valleys, mallee-heath, mallee on domed clay soil, mallee on Gilgai country, Broombush thicket, mallee on calcareous soil. The vegetation is in a relatively undisturbed condition.¹¹ Much of the riparian vegetation is near pristine (A2).²⁸</p>	<p>In catchment there are 2 spp of Declared Rare Flora (DRF) and 10 spp of priority flora which will be threatened by rising watertables.³</p>		
<p>Fringing</p>	<p>Saltwater paperbarks (<i>Melaleuca cuticularis</i>) form a continuous fringe band around the estuary and sedges (<i>Juncus kraussii</i>¹) / samphire (<i>Sarcocornia</i> and <i>Halosarcia</i>) along the water or low sandy beach ridges.⁶ Where the groundwater is less saline the low lying areas are colonised by the sedges <i>Gahnia trifida</i> and <i>Baumea juncea</i>.¹ <i>Sarcocornia quinqueflora</i> (beaded grasswort) is common along the north and north-western shores of the Inlet, associated with other common salt tolerant spp. Behind these on slightly higher ground, there is either <i>Isolepis nodosa</i> and <i>Euphorbia</i> or <i>Juncus kraussii</i> and <i>Baumea juncea</i>.¹</p> <p>On the west side of Inlet there is; sedgeland, paperbark (<i>Melaleuca cuticularis</i>) and shrubland slopes of <i>Acacia Cyclops</i> to 3m over very dense shrubland dominated by <i>Spyridium globulosum</i> and high incidence of introduced spp.¹³</p> <p>Wood from a <i>Melaleuca</i> stump found 1m below present level of living paperbark trees was carbon dated to ~7300yrs old suggesting that perhaps trees were growing there while the sea level was still rising to its present level.²</p>	<p>Campers have already seriously damaged paperbark trees on the estuary shores.¹</p> <p>Natural assemblages of plants and animals found within the Inlet are adapted to the natural variability of the estuary's water chemistry and are probably unaffected by recent modifications brought on by land</p>		<p>Important to maintain the bush around the inlet.¹</p> <p><i>NOTE: No other known surveys of riparian vegetation have been undertaken since the late 1980's to assess the current condition in riparian vegetation.</i></p>

		Vegetation change from 1988-2004 (Land Monitor) indicates that the fringing vegetation on the western side of the estuary is declining and improving on the eastern side. ⁴¹	clearing, this should lead to long-term viability. ⁸		
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	Aquatic	<p>The aquatic plants are dominated by three salt-tolerant spp. A small green alga (<i>Polyphysa peniculus</i>) grows in shallow water throughout the Inlet, sometimes forming continuous cover both on sand and rock. Seagrass (<i>Ruppia megacarpa</i>) is sometimes abundant, even on the eastern shallows of Stokes Inlet when they are flooded, and it also grows in the riverine reaches of the estuary. At times it is heavily grazed by swans. A species of stonewort (<i>Lamprothamnium papulosum</i>) also grows in the shallows.²</p> <p>In 1977 the western sandflat had <i>Acetabularia</i>, eastern shallow basin (dry) had remains of <i>Ruppia</i> and <i>Chara</i>(?), sand at the mouth had patchy <i>Ruppia</i> and a Young River pool had <i>Spirogyra</i>, <i>Acetabularia</i> and remains of <i>Ruppia</i>. (M. Cambridge).⁴⁰</p> <p>In 1989 the inlet was very weedy before the break of the season.⁴⁰</p> <p>2006 Phytoplankton samples show salt tolerant (marine) Dinophyta algae dominated at all sampling sites. Cryptophyta and Diatoms (planktonic) were also present which are common in all water bodies at various times depending on many factors.¹⁴ In terms of algal densities the Department of Water, Phytoplankton Ecology Unit reported very high micro algal densities in the Inlet which was considered unsatisfactory. Taxonomic interpretation to species level also identified two potentially toxic species that included two dinoflagellate species, <i>Karlodinium micrum</i> and <i>Prorocentrum rathymum</i> whose cell densities were above the National guidelines (New Zealand Food Safety Authority (NZFSA) Phytoplankton action levels). <i>Heterosigma akashiwo</i> (recently removed from the NZFSA and Western Australian Shellfish Quality Assurance Program (WASQAP) harmful species) was also found at site 5.¹⁴</p>	<p>No weed species or introduced marine organism have been recorded from the estuary.⁸</p> <p>Signs of mild excess in macroalgae are a symptom of reduced estuary health.⁴</p> <p>Suspended particles may reduce light penetration and restrict macrophytes distribution.¹</p>		<p><i>NOTE: No up to date information on species, distribution and condition exists.</i></p> <p>Phytoplankton assemblages have not been thoroughly investigated in the Stokes Inlet to date. Further investigations are required in regards to seasonal trends in phytoplankton assemblages along with nutrient and salinity dynamics.¹⁴</p> <p>The response of submerged aquatic vegetation to the high organic loading is unknown.¹⁴</p>
Fauna / animals	terrestrial - within the park	Biological survey in 1989 recorded 147 spp, included 8 amphibians, 24 reptiles, 108 birds and 11 mammals. 4 of the 11 mammal spp were introduced. ¹³	Fox population at the time of survey was of concern. Kangaroos have been favoured by juxtaposition of farmland and reserve. ¹³		Populations of foxes, cats, rabbits and kangaroos should be kept low. ¹³
	birds	At least 29 waterbirds spp have been observed including large numbers of Australian shelduck, grey teal, little black cormorants, black swans and chestnut teal. Migratory species include the common sandpiper	<i>NOTE: Starlings are known to be in the area around the</i>	The Department of Agriculture plans to form a six-man team	

	<p>and red-capped plover. Australasian grebes, Australian pelicans, little pied cormorants, white-faced herons, great egrets and pied oystercatchers also visit the inlet.⁶</p> <p>Hooded Plovers were bathing, feeding and sheltering at the mouth of a creek entering the Inlet and an observation was made of birds feeding from seaweed at the Inlet.²¹</p> <p>Important waterbird and waterfowl habitat, particularly on the riverine delta, mudflats, and shallows. Records for the NP list more than 50 species which are likely to use the Inlet.⁸</p> <p>Birds list of Esperance Shire indicated that a rare Black Kite, masked Lapwing and Dunlin (in 1985) were sited at the Inlet. The uncommon Fairy Tern was also seen.³⁶</p> <p>A bird list for a ~20km radius from Stokes Inlet is available from the Atlas of Australian Birds (Birds Australia 1998-2004) and included 58 species in February 2007.</p>	NP.	of Indigenous people to search for the controlled pest. They will search for unknown starling populations in reserve land between Hopetoun and Stokes Inlet. ³⁵	
fish	<p>The WA Museum has 25 spp of fish from Stokes Inlet and the park's rivers.¹³ List of 25 spp from 1977, 72 and 71.⁴⁰</p> <p>Sea mullet enter when the bar is open and reports of large numbers of Australian salmon, whiting and silver bream entering when the bar opened in 1968.²</p> <p>The composition of the fish fauna depends largely on the time and duration of bar openings and the salinity of the water. At one stage the bar had been closed for more than 30 years and black bream was the only commercial fish caught (apart from a few very large, blind, sea mullet). Black bream is an estuarine species that also lives in river pools. A few non-commercial estuarine species such as the common minnow and species of hardyheads and gobies also survive under these conditions. When the bar breaks, fertilised eggs, larvae and juveniles of a variety of marine species such as sea mullet enter and survive for as long as conditions favour their growth and survival. Adults of marine species must return to the sea to spawn at the next bar opening and then continue their growth in coastal waters. Quite a variety of fish species were reported in the estuary before the bar again broke in November 1975, but after the opening only black bream were caught. Mass mortality has been reported in times of severe drought, when the waters dry up and become too saline, such as in 1983.¹</p> <p>When bar remained closed from 1927-1967 Charlie Moir reported that only bream were left.⁴⁰</p> <p>Surveyor records from 1848 indicate that there were over a foot long bream ½ mile up the Lort River in salt water pools about 20 feet deep.¹¹</p> <p>15.6.89 – Fisherman have caught Cobbler (300-350mm) for the first time, big flathead and salmon.⁴⁰</p>	<p>Important that water levels do not drop too low as this may result in hypersaline conditions leading to fish deaths.¹⁶</p> <p>When salinity rises it results in less species, with high mortalities in 1932, 1938, 1983.²</p> <p>This estuary is highly productive from a fisheries perspective. The presence of potentially ichthyotoxic species and very low oxygen indicates the probability of fish kill events in this estuary.¹⁴</p> <p>A Fish kill incident was reported to Waters and Rivers Commission (WRC) in</p>	<p>The Inlet is open to commercial and recreational fishers principally black bream and sea mullet. In 2003 net fishing was prohibited from 1 Dec – 30 April.²</p> <p>A half year closed season was introduced in 1982.⁴</p> <p>The fishery at the Inlet is regulated by the Department of Fisheries; the season commences in May and finishes in Nov.⁸</p> <p>Estuarine Fishery (Interim) Management Plan was up for revision in 2005 with amendment to the plan due to take effect on 1 July 2005.¹⁷ Now the South Coast</p>	<p>Increasing recreational fishing and tourism has increased pressure for the inlet to be closed to all forms of netting.²</p> <p>There is a strong held perception, by recreational fishers, that commercial fishing depletes fish stocks. Potential for conflict on this issue.⁸</p> <p>There have been requests to close the commercial fishery at Stokes Inlet. Low numbers of commercial fishers. A reduction in commercial access or total commercial closure may generate significant benefits to the recreational fishery and the Esperance community while having no major impact on the fishery as a whole.³⁸ The report gave 4 options to deal with this issue which range from complete closure of fishery to commercial fishers to altering net sizes.³⁸</p> <p>The stocks of Black Bream can only be sustained permanently in the basins of estuaries if the quality of environmental conditions in those systems is maintained at an appropriate level.²²</p>

	<p><u>Commercial fishery</u> Commercial catch in tonnes was 7.9 in 1991, 42.6 in 1992, 14.7 in 1993, 13.6 in 1994, 9.6 in 1995, and 15 in 1996.⁴</p> <p>15 tonne of Black bream was caught in 2004. Black bream stock levels increased in abundance from mid-1990s until 2003 then declined slightly in 2004. Estimated value of fisheries in 2004, for all south coast estuaries was \$556000.¹⁷</p> <p>Fisheries data suggests that 96-05 average yearly commercial catch was almost 12 tonne with Black bream making up 92% of the total catch. Other species caught in that period were sea and yellow-eye mullet, silver bream, flathead, salmon, blue manna crab, tailor, cobbler, prawn, blue groper, trevally, herring, flounder and mulloway.²⁷ A survey of recreational fishing at the estuary 2002/03 with 104 interviews, 72% were shore based groups, 93% of boat-based groups were fishing, 40% of shore-based fishers were from local postcode area and 32% from interstate/overseas.²⁷</p> <p>Commercial catch data from 1986-2006 was made available by the Department of Fisheries. The graph provided shows total commercial catch with the largest catch of ~43000kg caught in the 1992-93 period. Lowest catch of <2000kg were recorded in 1984-85 and 1998-99. For the majority of the time catch was between 5000 and 20000kg per year.</p> <p>1995-2004 Stokes has provided a high proportion of the South Coast Estuarine Fisheries (SCEF) black bream landings (42.5%). However, in 2005 it contributed less than 10%, suggesting lower stock abundance possibly as a result of lower rainfall in the catchment.⁵¹ Recreational fishing makes up ~27% of the SCEF catch.⁵¹ Trends in catch suggest that bream breeding stock levels are adequate to maintain recruitment in the estuary.⁵¹</p> <p>Variation in abundance of target species in south coast estuaries is largely driven by environmental factors, independent of fishing.⁵¹</p> <p><u>Murdoch University Fish Group findings</u> The number of fish species present is lower than found in more western estuaries.²²</p> <p>The atherinid <i>Atherinosoma elongata</i>, the gobiid <i>Pseudogobius olorum</i> and the sparid <i>Acanthopagrus butcheri</i>, each of which completes its life cycle within estuaries, ranked first, second and third, respectively, in terms of abundance, and collectively contributed 99.8% to the total number of individuals caught in nearshore, shallow waters.²²</p> <p>The four individuals of the freshwater species <i>Galaxias maculatus</i> were caught in the Young River during a period of freshwater discharge, whereas the single and very small individual of the marine estuarine-</p>	18/6/1999.	Estuarine Fishery Management Plan 2005 is in place. ³¹	All of the 25 licensed commercial fishermen could fish Stokes Inlet and tributaries (to the South Coast Hwy) between 1 May and 1 December. ³¹
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	<p>opportunist species <i>Aldrichetta forsteri</i> was caught in the basin.²² <i>A. butcheri</i> contributed over 97% to the total catch of fish. The eight species caught in offshore, deeper waters comprised four that complete their life cycles in estuaries and four marine estuarine-opportunists, with the contribution made by the number of individuals belonging to the former category far outweighing that of the latter category, <i>i.e.</i> 98.6 vs 1.4%.²²</p> <p>In nearshore, shallow waters the number of fish species was significantly influenced by year, season and region (basin and Young River) and that the density of fish was also significantly influenced by the first two of those variables. The mean number of species was significantly greater in 2002 than in both 2003 and 2004 was significantly greater in each of summer, autumn and spring than in winter and was greater in the main tributary than in the basin. The density of fish in nearshore, shallow waters was significantly greater in summer and autumn than in winter in both 2002 and 2003 and spring vs winter in 2003, but did not differ among seasons in 2004.²² Furthermore, while densities in summer, autumn and winter did not differ significantly between years, those in spring were significantly greater in both 2003 and 2004 than in 2002.²²</p> <p>The number of fish species in offshore, deeper waters was not significantly influenced by either year, season or region (basin and major tributary) and that, of those three variables, only region significantly influenced the catch rate of fish. Although the catch rate in the basin of Stokes Inlet remained relatively constant among seasons, those in the Young River in summer, autumn and spring were significantly greater than that in winter.²²</p> <p>Black Bream spawn in late winter and spring in normally-closed estuaries, and allows them to produce offspring before salinities become high during the typically dry summer months. Black Bream typically reach maturity in Stokes Inlet at the end of their second year of life, when they are about 150 mm in length.²²</p> <p>Plant material, polychaete worms, molluscs, crustaceans, insects and fish were ingested by Black Bream in Stokes Inlet. Dietary data emphasise that Black Bream is a highly opportunistic omnivore and thus able to withstand major changes in potential food types.²²</p> <p>The diversity of the diet was far greater in Stokes Inlet than in Culham and Hamersley Inlets (far more variably saline estuaries), presumably reflecting a greater diversity of prey in Stokes.²²</p> <p>An examination of annual growth rings in otoliths (ear bones) demonstrated that the population of Black Bream in Stokes Inlet bred successfully in all but one of the years between 1992 and 2003. The recruitment of juveniles was greatest in years of moderate flow in the months preceding and during the spawning period.²²</p>			
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		Growth of Black Bream varies among estuaries, which reflect s differences in density rather than diet. Upstream pools can act as refugia for Black Bream when extreme conditions exist downstream. ²²			
	other aquatic fauna	<p>Although few studies have focused on invertebrates of Stokes Inlet, Hodgkins and Clark 1989, observed the presence of the copepod species, <i>Gladioferens imparipes</i> and <i>Acartia clausi</i> (?tranteri). Bottom fauna are predominately estuarine species tolerant of a wide range of salinities.¹ Marine species maybe introduced into the Inlet when the sandbar breaks and in the past has included juvenile prawns (<i>Penaeus latisulcatus</i>), mussels (<i>Mytilus edulis</i>) and blue manner crab (<i>Portunus pelagicus</i>)¹ and small jellyfish.² These spp often grow rapidly until they die in the retreating shallow water that evaporation has made too saline.¹ Sometimes millions of small salt lake snails (<i>Coxiella</i>) that feed on microscopic plants on the salt flats while these are still moist.¹</p> <p>Aquatic invertebrates found in Lort and Young Rivers and Yerritup Creek in 1995 and 1997 included the classes Malacostraca, insecta, ligochaete and gastropoda.²³</p> <p>In 1988 there were thousands of mytilus (common mussel) in the Inlet, up to 75mm also small jellyfish ~50mm, Bream were eating the mussels.⁴⁰ In 1989 mussels and cockles were also seen.⁴⁰</p>			Further investigations into invertebrates are required to evaluate the current species composition and condition in the Inlet. ¹
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Historical	European	<p>Stokes Inlet and the Lort River were named by Surveyor-General John Septimus Roe in 1848, after his friend John Lort Stokes.⁶ This surveyor also named the Lort and the Young Rivers (after H.E. the Governor of SA).</p> <p>In 1863, Charles and William Dempster took up a 41,000 acre pastoral lease included land on either side of Stokes Inlet. Then, in 1873, Alexander and John Moir were granted a lease of 14,000 acres around Stokes Inlet, extended by 57,000 acres in 1888. The Moirs established a homestead (in1870's⁴⁰) near the eastern shore of the Inlet and grazed sheep through the coastal vegetation, which they burned in patterns to provide fresh feed. Despite these activities, the area around Stokes Inlet was largely spared from agricultural development until recent times. There was little further development around or inland from Stokes Inlet until pastoralist Noel White established the Young River Station at the head of the inlet in 1950.⁸</p>		<p>The limestone walls of the Moir homestead survived until they were razed by fire in 1993; the remains lie in a small reserve for the Preservation of Historical Buildings within the NP.² Managed by the National Trust of Australia.⁸ <i>NOTE: The area surrounding the homestead is vested in DEC.</i> The Shire of Esperance has discussed a partnering agreement</p>	

				with the National Trust of Australia (WA) for the management of the Moir Homestead ruin premises. ³²	
	Indigenous	<p>There are several Registered Aboriginal Sites around the Stokes Inlet area and include ochre quarries, artefact sites, mythological sites and sites of recent historical value.⁸</p> <p>Walidj Benwenerup is the traditional name of Stokes Inlet. The hill on the eastern side of the Inlet was known as <i>Walidj Benwenerup</i>. It means place where the eagle came to scratch (the cliff) and die. It is a heritage listed place.¹⁰</p> <p>6 official sites along the Young River and early surveyor reports from 1848 mention many tracks and fires.¹¹ 'Track and fires of natives were numerous in the vicinity'. (taken from the exploration Diaries Vol 4, 1848-1949).⁴⁰ Lort River has 7 official Aboriginal sites recorded along its length.¹¹</p>			<p><i>NOTE: While there is some documentation relating to the significance of Stokes Inlet to the traditional owners, further detailed information has been gathered from the local Noongar community. A workshop was held December 2006 with the traditional owners (TOs). A report is being prepared which will contain recommendations in relation to indigenous values for the area.</i></p>
Water	Groundwater	<p>Stokes Inlet lies within the Albany-Fraser Fractured Rock Province. The crystalline bedrock consists of gneiss and migmatite, outcropping as partially buried hills, and is covered discontinuously by Eocene sediments of the Bremer Basin, and by Quaternary dunes and alluvium near the coast.¹²</p> <p>In the Lort and Young River catchments, a regional groundwater system occurs in the weathered crystalline bedrock and overlying Plantagenet Group sediments, but may be discontinuous in elevated areas or in areas of unweathered fractured rock. Groundwater is hypersaline in the upper catchment of the Lort River where there are salt lakes. Within the Young and Lort River catchments groundwater salinity ranges from 50 – 6500 mS/m (seawater is 5300 mS/m) with only small areas having groundwater suitable for stock. The depth to groundwater is generally less than 5 m below ground surface in valleys and can be as deep as 30 m along topographical divides. Groundwater levels are rising in the catchment at rates between 0.05 and 0.30 m per year. Therefore, saline groundwater discharge to the Young and Lort Rivers is likely to be increasing both in quantity and salinity.³ 1.4% of agricultural land is salt affected and 21% of the catchment has low-lying areas with the potential for shallow watertables (Land Monitor data from 1989 and in 1997).³</p> <p>Waterlogging has also been highlighted as a land degradation issue in the perched aquifer systems in shallow sands near Cascade approximately 45 km north of the Inlet.³</p> <p>Brackish groundwater derived from local rainfall recharge on the dunes,</p>			<p>Groundwater-estuary interactions have not been considered by past research and as such little is known regarding its possible contribution to the estuary.¹</p>

	<p>and from runoff on areas of exposed crystalline bedrock, forms a thin low-salinity lens close to sea level in the dunes, and most likely discharges around the margins of the inlet. ³ Freshwater seeps on the western shore near the lakes (Charlie Moir 1988).⁴⁰</p> <p>Catchment of Stokes Inlet includes the following zones: Esperance Sandplain zone: Moderate risk of shallow watertables, within 20-50 years 15-20% will have a high risk of shallow watertables. Median groundwater salinity is 1,900mS/m. It may be 30-75years until salinity fully develops in this zone.⁴⁹ Salmon Gums Mallee zone: Moderate risk of shallow watertables, within 20-50 years risk should remain moderate. Median groundwater salinity is 5,600mS/m (~seawater). It may be >75years until salinity fully develops in this zone. When the potential salinity develops up to 25% of the zone may be affected (long term high salinity risk).⁴⁹ Information on salinity management technical feasibility and further information on groundwater can be found in this reference 49.</p>			
estuarine water quality	<p>Temperature followed seasonal trends with max 22-26°C in summer & 11-16°C in winter ^{16, 1} (During one study the greatest mean seasonal temperature of ca 28°C was recorded in the Young River in summer 2003, while the lowest minimum seasonal temperature of 16.9°C was recorded in the basin in winter 2003.²²)</p> <p>The Inlet has a slight tannin discolouration.⁴</p> <p>Salinity in the Inlet ranges from 28 to 86‰ and is seldom less than seawater (32-35‰) but can be twice that by end of summer when it can become hypersaline.^{2, 7}</p> <p>Salinities at 0.5km from bar blowout 27/10/1979 were 29.6‰ surface, halocline at 3m deep, 33‰ at 4m, 35‰ at 5m, 36.1‰ at 8m (temperature 17 °C).⁴⁰</p> <p>In 1982 salinity reached 65‰ and in 1984 surface salinities were at 60-61‰ with bottom water at 61-78‰. In April 1987 it was at 45‰ 1km up from the bar.⁴⁰</p> <p>Mean seasonal salinities in nearshore, shallow waters were ca 29 in summer 2002, subsequently rose progressively to ca 59 in autumn 2003, but then declined to ca 46 in spring, before rising again to reach their maxima of ca 64 in autumn 2004.²²</p> <p>When floodwater, which is less salty, enters the Inlet it results in brief stratification.²</p> <p>Marked haloclines and dissolved oxygen stratifications were formed during the winter and spring of 2003. Thus, for example, the mean salinities at the surface and bottom of the water column in winter 2003 were 19.8 and 49.8, respectively, and the mean dissolved oxygen</p>	<p>Based on nutrient and Chlorophyll a data collected to date, the Inlet can be considered eutrophic to hypereutrophic. Very low bottom water and in some cases surface water dissolved oxygen is an indication of high organic loading from high productivity within the estuary. In this scenario the bottom sediments will have become a substantial sink for nutrients and will, during low oxygen events when nutrients especially phosphorus are released from the sediments, be a</p>		<p>Nutrient sources have not been identified so catchment contributions to the estuary and relative importance are unknown. Routine sampling of the Lort and Young will establish this contribution along with routine estuarine water quality sampling. Sampling frequency should include additional sampling during bar open events to established degree of marine exchange and removal. Sediments will be acting as both a sink and a source so characterisation of sediment nutrient content and fluxes is critical to understanding nutrient cycles. Sediment coring and benthic chamber studies similar to those recently completed in the Wellstead, Gordon and Beaufort will answer these questions. This need has been identified in the Inland Aquatic Integrity component of the Strategic Reserve RCM component.¹⁴</p>

concentrations in spring 2003 were 6.1 and 4.2 mg L-1, respectively.²²

Mean seasonal values for **dissolved oxygen** concentrations always exceeded 5 mg L-1 and, during the winter of 2002, rose to as high as 10.2 mg L-1 in the basin and ca 11.7 mg L-1 in the river.²²

In each season, the mean salinity, temperature and dissolved oxygen concentration at the surface and bottom of the water column in offshore, deeper waters of the basin of Stokes Inlet were very similar and comparable with those in nearshore waters of this region.²² *(indicating a well mixed system)*

Observations made by Hodgkin and Clark, 1989 indicates that there was a minor degree of **nutrient** enrichment in the Estuary in the mid 1970's, however little is known of the nutrient input during winter months when the rivers flow into the estuary.¹ A minor degree of nutrient enrichment and presence of blue-green algae in water on occasion.² A blue-green algal mat was found in front of the samphire in a bay near the Young River mouth in 1987.¹

Department of Water (DoW) sampled the Inlet once in 1999 and in February, May and August 2006 results suggest:

-Deep waters may remain hypersaline

-Anoxia occurs at depth (5.5-6.5m) and stratification.⁴

In comparison to the ANZECC/ARMCANZ (2000) national water quality guidelines (designed to assess risk of adverse effects on aquatic ecosystems including slightly disturbed systems), in some instances, nutrient concentrations sampled in February 2006 exceeded the recommended trigger levels. Total nitrogen exceeded the guidelines at all sites with measurements between 2-11 times greater than recommended. Ammonia, (N₃H-N) at site 2 (bottom waters) was also over 100 times the recommended guideline value of 0.04mg/L. Total Phosphorous and Filterable Reactive Phosphorous also exceeded the guidelines with concentrations of about 60 times the recommended values at site 2. Chlorophyll a concentrations measured in surface and bottom waters at site 2 were higher than the recommended trigger for chlorophyll a of 0.003mg/L on most sampling occasions.¹⁴

substantial source of nutrients leading to additional cycles of algal growth.

OzEstuaries Database ²⁶	Current modelled yields tonnes/year	Estimated Natural yields (pre-European) tonnes/year
Dissolved P	0.5	1.4
Fine sediment P	4	0.5
Dissolved N	84.63	34.10
Fine sediment N	15	1.4

	Data from Ribbons of Blue 1994-98 Esperance Senior High School results indicates ⁴⁴ : -Turbidity (NTU) ranged from 25-70 -pH ranged from 7.3 - 8.3 -Temperature ranged from 13 – 21 °C -PO4 (mg/L) ranged from 0.02-0.63 -NO3 (mg/L) ranged from 0.013 – 0.29 -Conductivity (µS) ranged from 45400 (8/1995) – 100000 (7/1998)																											
	Values / Condition	Threats / comments	Existing management	Suggestions for management / Information gaps																								
Tributary water quality	<p>Only a small percentage of the annual rainfall passes down the rivers as stream flow. In the case of the Lort the percentage is less than 2%. The rest evaporates, is transpired by the vegetation and recharges the groundwater.⁷ The Young River has a mean annual runoff is 1.5mm and 0.5mm for the Lort River.⁴</p> <p>Salinity The Lort and Young Rivers are naturally saline.^{3, 1, 34} some of the measurements to date are:</p> <table border="1"> <thead> <tr> <th>Date / Reference</th> <th>Lort River</th> <th>Young River</th> </tr> </thead> <tbody> <tr> <td>1971-2006⁴³</td> <td>Max:4690000 µS/m (~25795ppm) Min: 557000 µS/m (~3063ppm)</td> <td>Max: 5950000 µS/m (~32725ppm) Min: 1134000 µS/m (~6237ppm)</td> </tr> <tr> <td>8/4/85⁴⁰</td> <td></td> <td>37‰ (~37000ppm) where the river meets the Inlet and 14‰ (~14000ppm) 4km upstream</td> </tr> <tr> <td>April 1987⁴⁰</td> <td>24‰ 10km upstream (~24000ppm) 41‰ ~8.5km upstream (~41000ppm)</td> <td>30‰ 10km upstream (~30000ppm)</td> </tr> <tr> <td>1989¹</td> <td>6ppt (~ 6000ppm)</td> <td>16ppt (~16000ppm)</td> </tr> <tr> <td>1983-1992³⁴</td> <td>Neds Corner: mean salinity =15500 Mg/L TDS</td> <td>Fairfield: mean salinity = 6000 Mg/L TDS</td> </tr> <tr> <td>1993-2002³⁴</td> <td>Neds Corner: mean salinity =26900 mg/L TDS</td> <td>Fairfield: mean salinity =12100 mg/L TDS</td> </tr> <tr> <td>2001³</td> <td>1090 mS/m (~5995ppm)</td> <td>2910 mS/m (~16005ppm)</td> </tr> </tbody> </table>	Date / Reference	Lort River	Young River	1971-2006 ⁴³	Max:4690000 µS/m (~25795ppm) Min: 557000 µS/m (~3063ppm)	Max: 5950000 µS/m (~32725ppm) Min: 1134000 µS/m (~6237ppm)	8/4/85 ⁴⁰		37‰ (~37000ppm) where the river meets the Inlet and 14‰ (~14000ppm) 4km upstream	April 1987 ⁴⁰	24‰ 10km upstream (~24000ppm) 41‰ ~8.5km upstream (~41000ppm)	30‰ 10km upstream (~30000ppm)	1989 ¹	6ppt (~ 6000ppm)	16ppt (~16000ppm)	1983-1992 ³⁴	Neds Corner: mean salinity =15500 Mg/L TDS	Fairfield: mean salinity = 6000 Mg/L TDS	1993-2002 ³⁴	Neds Corner: mean salinity =26900 mg/L TDS	Fairfield: mean salinity =12100 mg/L TDS	2001 ³	1090 mS/m (~5995ppm)	2910 mS/m (~16005ppm)	<p>Gauging stations established on the Lort (immediately upstream of the South Coast highway bridge)⁷ and Young (two sites, Melaluka and Munglinup, were installed on a small tributary before local land clearing)⁷ Rivers in 1973 and 1971 respectively have recorded increase in salinity levels and in the frequency and volume at which water is draining from the catchment since clearing.³</p> <p>The high salt output/input ratios of 3.2 for the Young and 6.0 for the Lort indicate that there was a net salt export from the catchments, and another indication that salinities are raised above the</p>	<p><i>NOTE: The Young River Catchment Plan 200 preliminary Draft has been prepared</i></p>	<p>To provide greater improvements to erosion and nutrient input protection to the drainage network all streams require stock exclusion and some protection or enhancement of the fringing vegetation.²⁸</p> <p>Management advice and analysis of fringing vegetation and fencing is given for the Young²⁹ and Lort Rivers²⁸ and Yerritup Creek³⁰ in DoE reports.</p> <p><i>NOTE: The Young River Catchment Plan is being prepared and will provide guidance for targeted works in the catchment.</i></p>
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Bar breaking and estuary mouth	The bar is unusual as it is in the middle of the bay, protected by 2 lines of limestone reef. ¹ 200m long, The sandbar is 1.5-2m high, breaks infrequently and remains open briefly. ² Generally happens in spring	Clearing has led to an increase in river flow so the bar	Bar generally left to naturally open. ²	Artificial bar opening in July 1972. The rationale for opening the bar is questionable as premature openings reduce scouring																																																													

		<p>following wet winters and after late heavy rains in October/November.¹</p> <p>DoW gauging stations on both Lort Young rivers since the late 70's indicate that runoff from the catchments is small, an average of 0.9mm or less than 1% of the rainfall. The average annual discharge into the Inlet is 5 million m³ with a range from 0 to 16 m³.¹ (5.14 × 10⁶ m³ /annum in 1975.^{40??})</p> <p>It is estimated that a flow of 10 million m³ is required to break the bar naturally on this high energy coast.²</p> <p><u>Bar opening information:</u></p> <ul style="list-style-type: none"> -Opened in 1919, 1927/1932 then not until 1967.¹ when it opened in August for ~3 months.⁴⁰ then opened in 1968, 1972, 1975, 1986, 1989, 1992, 1999 & 2000.⁴⁵ -Bar open 1975, 1979.¹ bar open on 13.10.1979 and was still open 27.10.1979 with the bar broken across whole of western half.⁴⁰ -In 1982 heavy rains did not greatly raise the level in the Inlet.⁴⁰ -In 1986 the bar opened in March after heavy rains in upper catchment, the Inlet water level rose ~2m in 2 days.⁴⁰ -April 1987 River bar closed but Young R water level with top.⁴⁰ -June 1988 Inlet fairly full until January – water level fell and has risen since, fairly heavy rain on the coast but little inland and the rivers are not really running. 3.10.88 bar closed, water level 1.8m below top of bar.⁴⁰ - 15th June 1989 bar broke after heavy rain 75mm to 9am 14th plus 24 to 9am 15th. Water over the sails at the Young River bridge.⁴⁰ 	<p>breaks more frequently resulting in favourable conditions for fish recruitment.²</p>	<p>Opened artificially? by locals interested in fishing in 1976.⁴⁰</p>	<p>leading to sediment accumulation.²</p> <p>The degree of marine exchange when the bar is open is unknown as is the nature and duration of stratification given the high salinities of inlet waters compared to marine waters.¹⁴</p>
	<p>Sediment</p>	<p>The Young and the Lort Rivers flow into the upper reaches of the Inlet but, when the water level is low in summer, they are cut off from the lagoon by a wide river delta.² (1987 - River bars separate the rivers from the Inlet most of the time but Jim Moore used to boat out from the Young into the Inlet.⁴⁰)</p> <p>Sediment transport probably largely results from major floods. At such times fine sediment is washed by sheet erosion from cleared land, coarser material is eroded by gulying and from river beds and trees may be torn up and destroyed in the estuaries.¹</p> <p>Modelled fine suspended sediment yield 6.9 kilotonnes/year. Estimated natural yields (pre-European settlement) 0.3 kilotonnes/year.²⁶</p> <p>Lort catchment cleared from ~1951, the river shallowed greatly following clearing, never could get from Inlet to Young River (Charlie Moir 1988)⁴⁰</p>	<p>Sedimentation is a major threat to the Inlet.³⁹</p> <p>Shallowing of the basin could lead to hypersalinity and fish deaths and so should be avoided.¹</p> <p>More erosion and run-off in the catchment has resulted in sediment in the estuary leading to a rapidly shallowing of the basin.</p> <p>Currently the</p>		<p>Conservation of the catchment soil is as important for the estuaries as it is for good agronomic management of the catchments.¹</p> <p>Stabilisation and revegetation of the western dune with dune plants may reduce sand movement.² into the Inlet.</p> <p>Estimates of historical sedimentation could be developed from cores assuming areas of undisturbed sediment accumulation could be found. Coring for this purpose could be accomplished at the same time as the benthic chamber work. In the short term, bathymetric coverage of the inlet could be obtained which will support subsequent efforts. A sediment coring program looking at visual evidence would complement these</p>

		<p>Carbon dating of shells in sediment cores taken in 1987 indicate an age of approx 4000yrs old.²</p> <p><i>NOTE: core data collected from Hodgkin's notes, as listed below, was incomplete and unclear, will be followed up though contact with the person who took the cores.</i></p> <p>Hodgkin's notes include 3 cores explained in detail and include Core D and L as well as Stokes Centre.⁴⁰</p> <p>Description of Stokes Core L to 198cm: 0-46cm Black organic mud-ooze. Sediment contains a very low percentage of detrital grains. Absence of skeletal carbonates. Nig 4, straf 0(?), alas 1-2, sicc 1. Low diatom count abundance of pollen. At 46cm sharp textural contact. 46-53cm Medium texture, well sorted/Sharp contact. Dark green-black mud, abundance of detrital grains in microscope "smear". Nig 2, straf 0(?), alas 1, sicc 2. At 53 sharp textural contact. 53-72 Fine textured, well sorted quartzose sand-grains well rounded. Some silt-sized opaque/heavy minerals. 72 sharp textural contact. 72-80 Dark green-black organic rich mud. Nig 3, straf 4, alas 1. Fine – medium textured sand, well sorted quartzise. Sharp textural contact. Then layers from 80-107-120-127-198cm.⁴⁰</p> <p>Stokes Core P nutrients: TP (ppm) ranged from 5 to 35 with pattern of rising and falling every 50cm. For TN (ppm) ranged from 60 to 2351 with no clear pattern with depth (to 390cm).⁴⁰</p> <p>P values decrease within the sediment from 200ppm (dry weight) at the surface to ~37 at 48 cm deep.⁴⁰</p> <p>Organic matter content ranged from 1.26% to 82.71% with the highest organic matter % at 3.5cm, 15.5cm, 25.5cm and 26.5cm deep (out of 48cm deep core).⁴⁰</p> <p>COCO3 content % ranges from 1.99 to 47.04% for a core that is 48cm deep.⁴⁰</p>	<p>greater depth of water means that it does not become hypersaline and always retains some water.²</p> <p>Relatively recent clearing within the catchment has greatly accelerated the deposition of sediment in the Inlet.¹⁵ Half a metre of soft sediment has collected in the lagoon in the last 30 years.²</p> <p>(Cores taken in 1987 show that 60-60cm of wet sediment has accumulated in the 30yrs following clearing. Assumed that a greater depth of sediment has accumulated since the estuary first flooded – proof of that awaits deep coring.²)</p> <p>Dune erosion and migration exaggerated by vehicle traffic and more frequent fires. Cascading sand on west of Inlet may lead to infilling.¹</p>		<p>studies in providing some estimates of sediment type and thickness.¹⁴</p> <p>On ground implementation of the Young River Catchment Plan will focus on perennial pastures, water way fencing, remnant vegetation fencing, surface water management, revegetation, soil health projects.³⁹ With a focus on high priority areas for sediment transferral based on slope class % and vegetation buffers.³⁹</p>
Tributaries extra informa-	Lort River	<p>Catchment area: 257000 ha³³</p> <p>Percentage of catchment cleared: 60%⁴</p> <p>Length of channels: 425 kilometres²⁹ Overall condition of channel appears good.²⁸ Over 60%of drainage channels they make up the Lort is made up of first order</p>			

tion	<p>steams²⁸ Main channel is ~100km long⁴⁸ Average slope of the river: 0.002m/m²⁸ Mean annual flow: 9900ML⁴ 6000ML⁴⁸ Water quality: Saline⁴⁸ Farmland: 173600 ha³³ Number of established agricultural properties: 75³³ Rainfall range: 400-600mm³³ 375 mm (median rainfall)⁴⁸ Waterlogging hazard rating low-high, Salinity hazard rating low-medium, Water hazard erosion rating low-medium, Soil hazard rating low-medium, Wind erosion hazard rating medium, Drainage line vegetated - yes, Level of remnant vegetation on farmland extremely low < 5%.³³</p> <p>Rivers headwaters initiate ~95km from coast in Peak Charles NP. Narrow strip of river foreshore reserve stretching over ~45km between Stokes NP and Vacant Crown Land. Most of the reserve ranges from 200m – 2km wide. The river has very few pools that are permanent through summer.¹¹ <u>River Corridor survey:</u> (answered by 12 landowners) 90-100% said river corridor had conservation value for flora and fauna, fire and feral animal control rated as most important management concerns in the reserve. 82% said they would like to be involved with management decisions for the reserve.¹¹ <u>Degraded areas:</u> the length of the river 3km south of the highway and 8km north had been cleared to within a few metres of the waters edge and stock grazing has left very little native veg remaining, weed intrusion is bad here though little evidence in other areas of the reserve.¹¹ <u>Fauna survey:</u> at site 1, 5 native mammals, 3 feral mammals, 64 avifauna (birds), one amphibian, 17 reptiles and 14 invertebrates.¹¹ Recent fires have burnt areas along the Lort 1980, 1985, 1990/91.¹¹</p> <p>-The catchment has regionally significant wetlands that have been assigned the Conservation class management category.³ -Calculations (based on drilling in July 2001 in upper Lort Catchment) indicate that groundwater levels could rise by 20cm/yr and a shallow (<1m) watertable could develop along the entire length of the waterway within 45 years.³ -No noticeable trend in flow rates 1973-1999 based on trend analyses. Median discharge volume 1973-1999 was 0.46m³/sec with annual medians ranging from 0.006m³/sec (1980) to 0.262m³/sec (1992).²⁸</p>
Young River	<p>Catchment area: 170000 ha³³ Percentage of catchment cleared: 75%⁴ Length of main channels: ~12 kilometres and length of the channel network is 790 kilometres²⁹ The Young River drainage system is broader and more complex than that of the Lort.²⁹ Main channel length ~120km⁴⁸ Average slope of river: 1 in 430 (or 0.0023 m/m)²⁹ Mean annual flow: 8400ML⁴ 5880ML⁴⁸ Water Quality: Brackish/Saline⁴⁸ Farmland: 112600 ha³³ Number of established agricultural properties: 38³³ Rainfall range: 350-550mm³³ Median rainfall 400mm⁴⁸ Waterlogging hazard rating low-high, Salinity hazard rating low-medium, Water hazard erosion rating low-medium, Soil hazard rating low-medium, Wind erosion hazard rating medium, Drainage line vegetated - yes, Level of remnant vegetation on farmland low 11-20%.³³</p> <p>The rivers foreshore reserve extends as a strip of remnant veg with varying widths ranging over a length of 50kms through agricultural land linking UCL and Frank Hann NP with Stokes NP. Width of reserve ranges from 200m to over 1km. A vermiculite deposit is located on the river 23km NE of Munglinup. The river has large pools, permanent in summer. Early surveyor records from 1848 record the water as nearly salt 10 miles from its mouth.¹¹ <u>River Corridor survey:</u> (answered by 5 landowners) 60% said the river corridor had value for flora, fauna and linkage. 60% listed fire management as important and weed control as not important. 60% said they would like to be involved with management decisions for the reserve.¹¹ <u>Degraded areas:</u> (lower section more degraded) south of the South Coast Hwy the reserve is 100-200m wide and 6km long and the veg is very disturbed. Predominant veg is open Yate woodland over open scrub. <i>Acacia saligna</i> – <i>Acacia cyclops</i> over exotic grassland. 8km north of the highway has been cleared to within metres of the waters edge, grazing and weed invasion has occurred. Further north there is also weed invasion.¹¹</p>

Fauna survey at site 1: 6 mammals, 8 amphibians, 16 reptiles, 13 invertebrates, 60 birds. Healthy populations.¹¹
Recent fires have burnt areas along the Young River in 1984, 1990 and 1991.¹¹

Significant reaches of the primary channel appear to have a riparian zone in near pristine condition. While the main channel is the most obvious section of river, the many smaller tributary streams actually account for the greatest linear length of channel in the entire drainage system. Typically these appear in much poorer condition. Many feeder tributaries appear severely degraded and may be contributing excessive sediment to the system, as well as salt and nutrients.²⁹
Sediment movement along the main river channel does not appear to be excessive, but it is important to assess the future risk of massive sediment input from the tributaries. This can be partly achieved by undertaking a stream condition audit.²⁹

Salinity: Water quality data suggests that water salinity is increasing in the general river flows and that feeder tributaries are likewise experiencing increased salinisation, or at are risk of substantial salinisation and corresponding erosion of the fringing vegetation.²⁹
The median TDS concentration for the entire monitoring period was 6 ppt. For comparison, seawater is approximately 35 ppt., with annual medians ranging between 30 ppt (1976) and 32 ppt (1996) . TDS concentrations in the Young River varied between extremes of 0.4 ppt and 33 ppt.
The trend analysis indicated that there was no trend in TDS concentrations in the Young River over the 1973 to 1995 monitoring period. If there had been more data available it is quite likely that an increasing trend in TDS concentrations would have been observed.²⁹
The median discharge rate for the entire monitoring period was 0.05 cubic metres (50 L) per second, with annual medians ranging between 0.002 (1983) and 0.17 cubic metres per second (1992). Discharge rate in the Young River varied between extremes of 0 (river not flowing) and 133 cubic metres per second.
The conclusion? The trend analysis indicated that there was no trend in discharge rates in the Young River over the 1973 to 2002 monitoring period.²⁹

Water Quality data collected by CENRM 2006, site 1 is closest to the Inlet⁴²

Site	TP (µg/L)	TN (µg/L)	Chlorophyll a (µg/L)	Phaeophytin (µg/L)	Conductivity (ms/cm)	Salinity (ppt)	DO (%sat)	pH	Turbidity (NTU)
1 -	12	1200	0.6	0.1	29.6	18.3	106	8.18	18.1
2 – Yerritup Creek	24	1100	2.3	0.4	56.9	37.9	87.4	6.1	34.5
3	25	1300	0.6	0.2	18.2	10.8	66.6	5.97	35.1
4	31	1200	0.7	<0.1	35.5	22.3	118	6.52	13.2
5	140	2300			0.4	0.19	76.8	7.65	90.7

Yerritup Creek

Catchment area: 150 square kilometres (15000 Ha)³⁰
Length of catchment: 26 kilometres³⁰
Length of natural channels: 142 kilometres³⁰
Catchment altitude: 5 – 125 metres above sea level³⁰
Farmland: 14400 ha³³
Number of established agricultural properties: 5³³
Approximate farmland area cleared: 12,800 Ha³⁰
Percentage of catchment cleared: 87%³⁰
Rainfall range: 500-600mm³³
Waterlogging hazard rating low-high, Salinity hazard rating low-medium, Water hazard erosion rating low-medium, Soil hazard rating low, Wind erosion hazard rating medium, Drainage line vegetated - yes, Level of remnant vegetation on farmland very low 5-10%.³³
The stream reaches immediately upstream of the estuary have the most direct impact on the health of the estuary and for this reason the condition of the Yerritup Creek, being the largest such sub-catchment in this area, is most important to the conservation of the lower waterways system.
The condition of the Yerritup creek is relatively easy to describe in broad terms, the lower one third of stream reaches in the catchment are in good condition, being well vegetated, but the channels in the upper two-thirds of the catchment are highly eroded and bare. The poor condition of these areas has also had adverse effects on farming, extending broadly across the riparian areas and has meant there is little benefit to farm productivity in the base of the valleys. The smaller first order streams account for 72% of the total catchment stream length.³⁰

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