RESOURCE ASSESSMENT INFORMATION FOR THE PROPOSED WALPOLE-NORNALUP INLETS MARINE CONSERVATION RESERVE

Version 1

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Conservation
AND LAND MANAGEMENT
Conserving the nature of WA

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1. PREFACE

This report has been prepared to provide a broad assessment of the values associated with the Walpole-Nornalup Inlets to assist Focus Group members in their consideration of the issues that are relevant to the proposed marine conservation reserve planning process. This report should be read in conjunction with *Nornalup and Walpole Inlets and the estuaries of the Deep and Frankland Rivers* by E.P. Hodgkin and R. Clark (1988), as it primarily aims to summarise more recent information. Should you wish to examine the original sources referred to in this report, many are available to be borrowed from the Walpole Library and Post Office. Additional information in this report derives from unpublished university research and the records of the WA Museum. Revised versions of this report will be sent to Focus Group members as additional material becomes available.

2. STUDY AREA

The study area for the proposed Walpole-Nornalup Inlets marine conservation reserve comprises the Walpole and Nornalup Inlets and the tidal parts of the Frankland, Deep and Walpole Rivers (Figure 1). While this area does not necessarily represent the boundaries of the proposed reserve, the reserve boundaries should fall within the study area.

3. TENURE

The Nornalup Inlet, part of the Walpole Inlet and the lower reaches of the Frankland and Deep Rivers are bordered by the Walpole-Nornalup National Park (Figure 2). Tenure surrounding the Walpole Inlet also includes crown reserve vested in local government, unallocated crown land and freehold land associated with the Walpole townsite and Rest Point.

4. PHYSICAL VALUES

Benthic habitats

An Edith Cowan University survey in 2003 identified seven benthic habitat types in the Walpole-Nornalup Inlets (Figure 3). The basins of both Inlets and their connecting channel comprise unconsolidated mud, while both Inlets have fringing sand flats, which are particularly expansive on the eastern side of the Nornalup Inlet. Less abundant habitat types include deltic sand deposits, rocky shores and seagrass meadows.

5. ECOLOGICAL VALUES

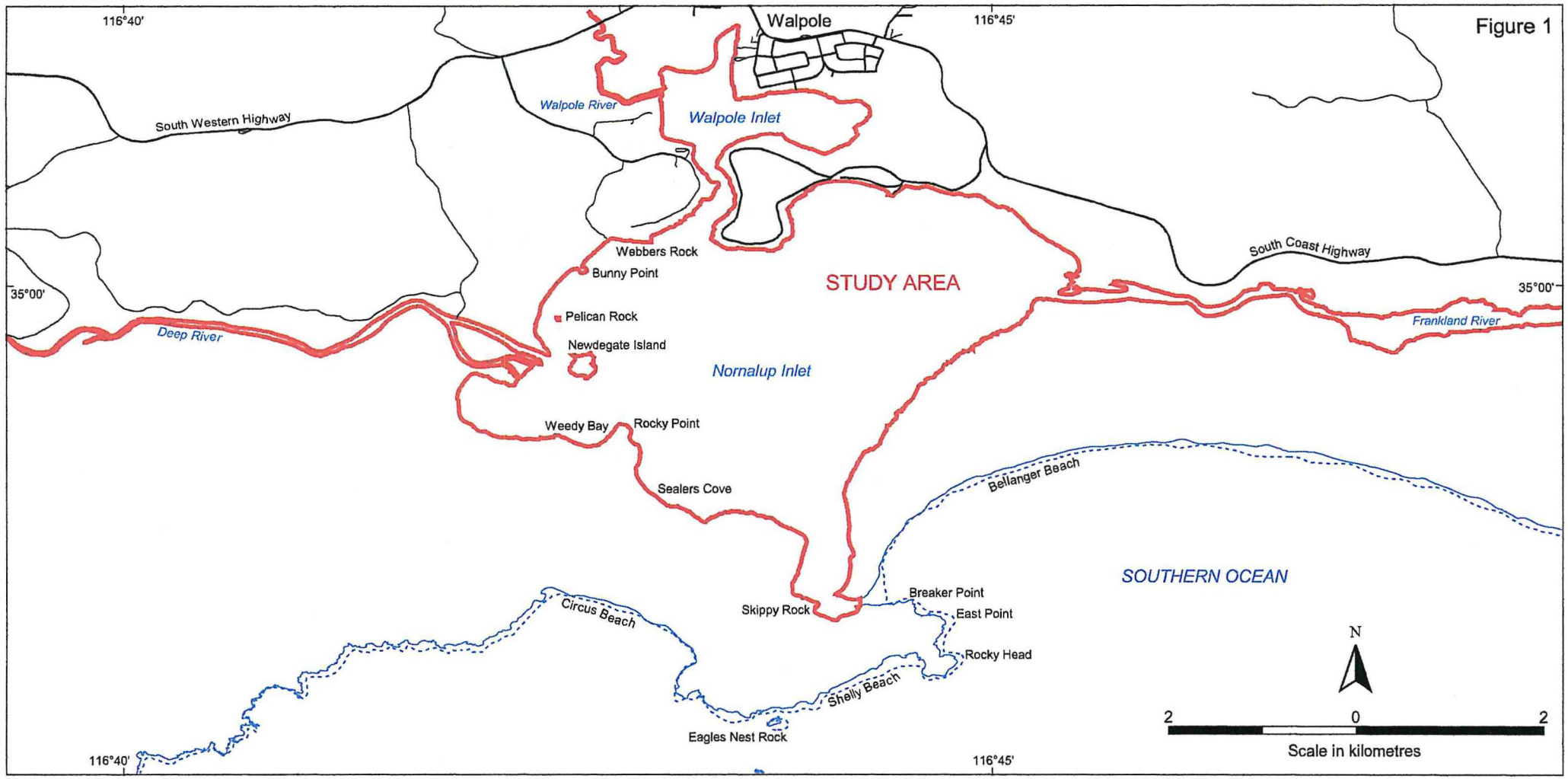
The biota of estuaries in south-western Western Australia (WA) is strongly influenced by the presence of sand-bar entrances that may prevent ocean exchange seasonally, or for extended periods. For example, while the Margaret, Gardner, Warren and Donnelly Rivers and Broke Inlet are periodically barred, the Hardy and Walpole-Nornalup Inlets are permanently open, although their shallow entrances may limit marine exchange during periods of limited freshwater flow. Estuaries are highly variable and often unpredictable physical environments. While typically creating a rich food source by concentrating nutrients from surrounding catchments, freshwater discharge means that estuaries are periodically subject to variable salinities, temperatures, turbidity and currents (Hardcastle & Cousins, 2000). Conversely, extended periods without discharge can result in hyper-saline conditions (Hodgkin & Hesp, 1998).

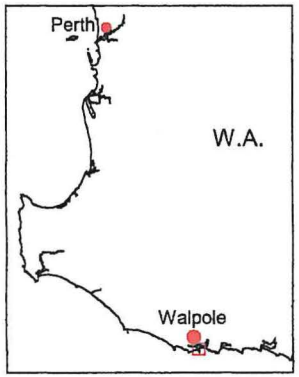
Estuarine fauna typically comprises an essentially marine assemblage near the mouth, fewer estuarine-adapted species in the middle and a small number of brackish-tolerant freshwater species in the upper estuary (Chalmer & Scott, 1984; Edgar, 2001). Benthic invertebrate and fish diversity usually diminishes rapidly with extended periods of entrance closure (Lenanton & Hodgkin, 1985; Hodgkin & Hesp, 1998). The relatively high biological diversity of the Walpole-Nornalup Inlets occurs because the system is permanently open (Hodgkin & Clark, 1988).

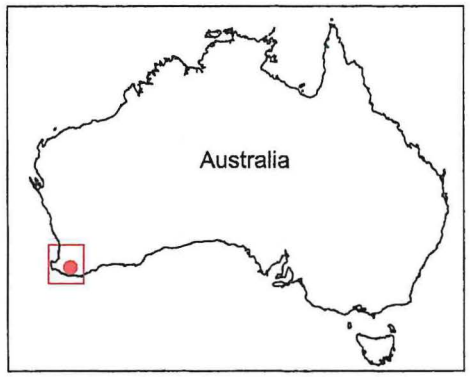
Although there are relatively few totally estuarine-adapted organisms, densities of benthic molluscs, polychaetes and small crustaceans can be very high (CALM, 1994) and larger fauna like fish and birds are often attracted to this concentrated food resource.

Aquatic vegetation

Figure 1







Study Area
Proposed Walpole - Nornalup Inlets Marine Conservation Reserve

Legend
- Study Area
- Mean High Water Mark
- Low Water Mark

Cartographic design by Ray Lawrie and Stephen Widjaja

Produced by CALM, Marine Conservation Branch, 1 December 2003

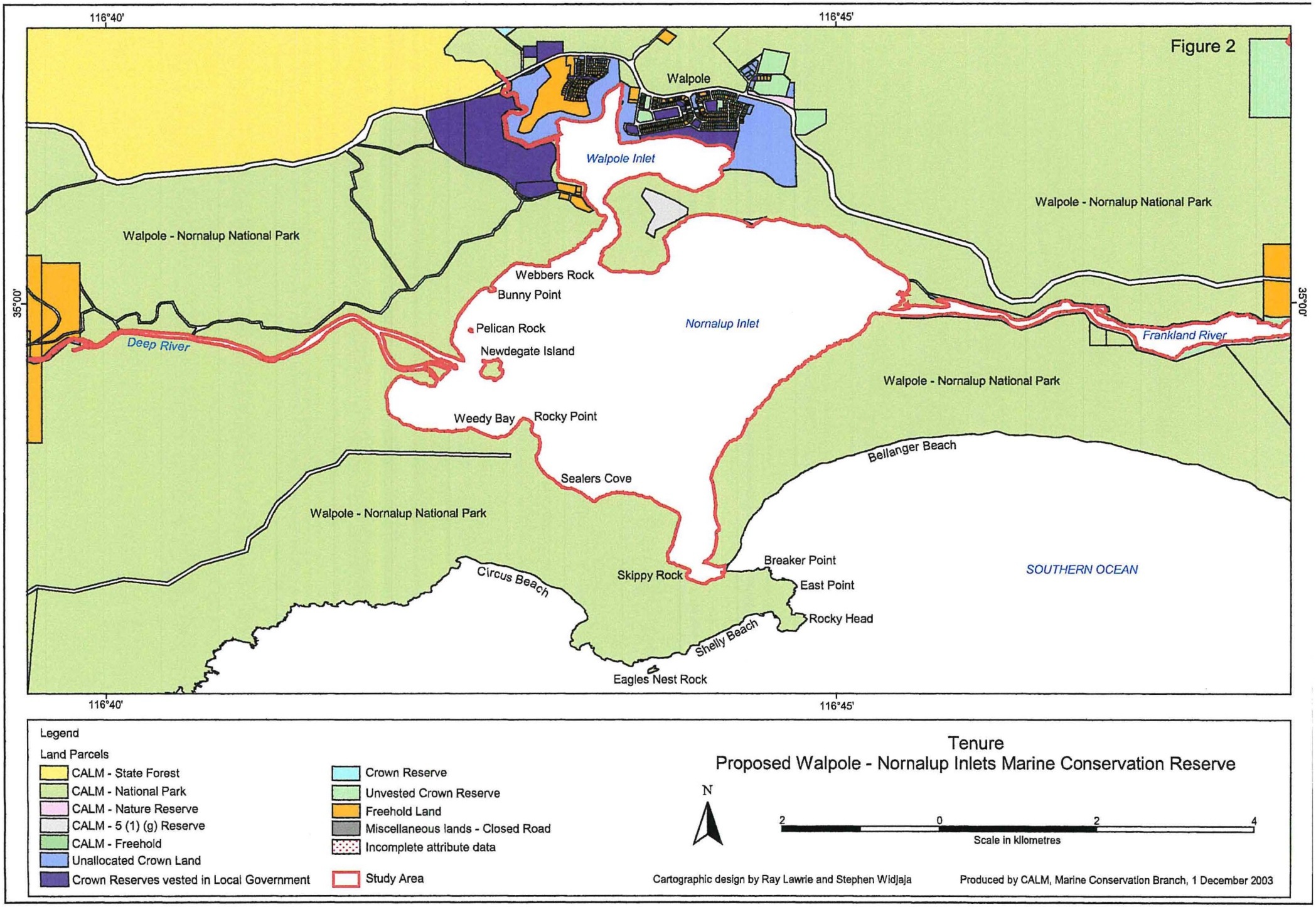
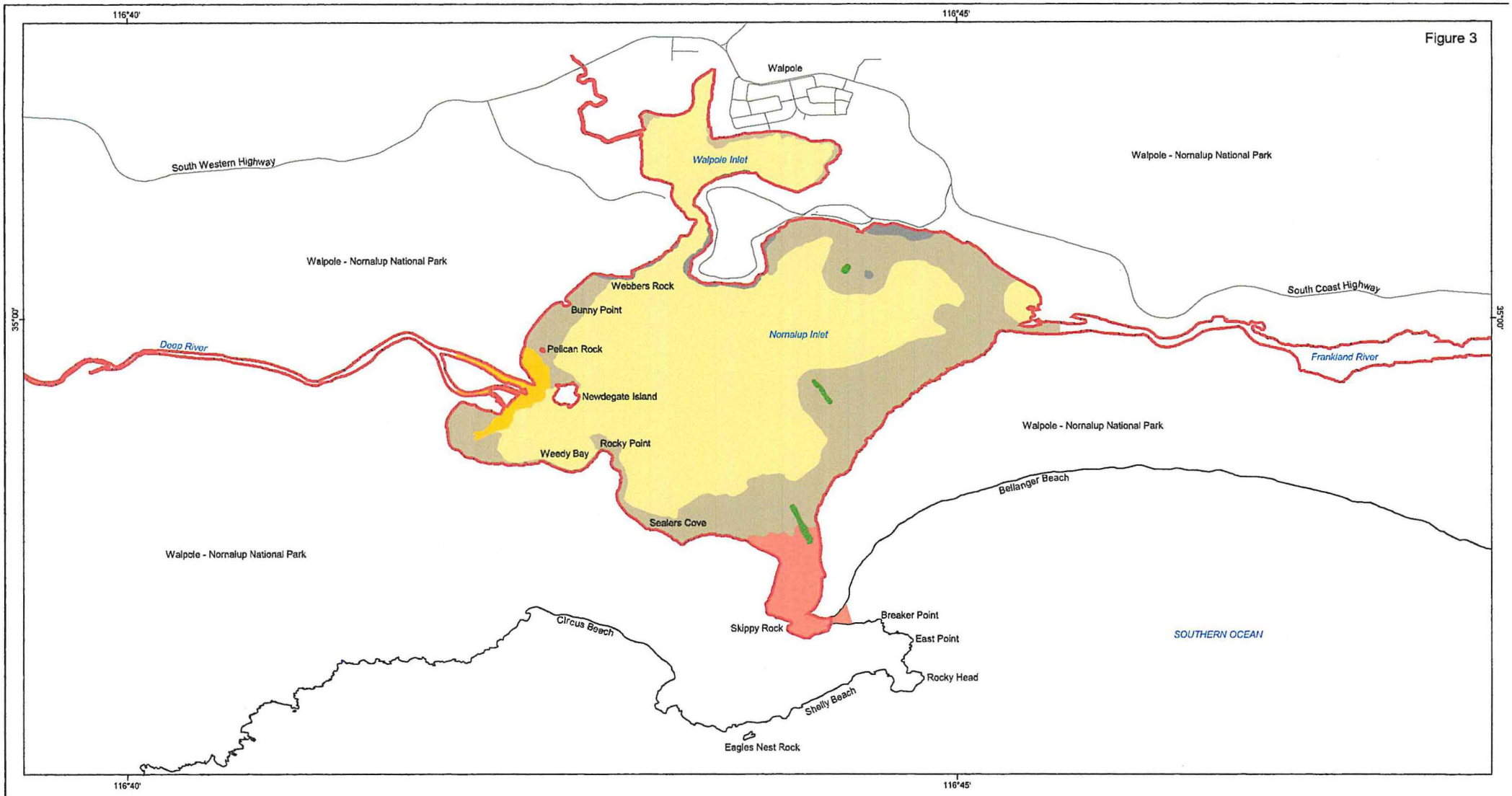


Figure 2
116°40'
116°45'
35°00'
Walpole
Walpole Inlet
Walpole - Nornalup National Park
Webbers Rock
Bunny Point
Pelican Rock
Newdegate Island
Nornalup Inlet
Deep River
Frankland River
Weedy Bay
Rocky Point
Sealers Cove
Bellanger Beach
Circus Beach
Skippy Rock
Breaker Point
East Point
Rocky Head
Shelly Beach
Eagles Nest Rock
SOUTHERN OCEAN
Legend
Land Parcels
CALM - State Forest
CALM - National Park
CALM - Nature Reserve
CALM - 5 (1) (g) Reserve
CALM - Freehold
Unallocated Crown Land
Crown Reserves vested in Local Government
Crown Reserve
Unvested Crown Reserve
Freehold Land
Miscellaneous lands - Closed Road
Incomplete attribute data
Study Area
Tenure
Proposed Walpole - Nornalup Inlets Marine Conservation Reserve
N
2 0 2 4
Scale in kilometres
Cartographic design by Ray Lawrie and Stephen Widjaja
Produced by CALM, Marine Conservation Branch, 1 December 2003

Figure 3



Legend

Habitat

- Coarse Fluvial Sands
- Deltic Sands
- Rock
- Rubble
- Sand Flats
- Seagrass Meadows
- Unconsolidated Mud

Study Area

Data surveyed by Edith Cowan University, 2003

Habitat
Proposed Walpole - Nornalup Inlets Marine Conservation Reserve

N

2 0 2 4

Scale in kilometres

Cartographic design by Ray Lawrie and Stephen Widjaja

Produced by CALM, Marine Conservation Branch, 1 December 2003

Aquatic vegetation in the Inlets is generally sparse (Hodgkin & Clark, 1988). The distribution and persistence of seagrasses and algae is most likely to be opportunistic and probably varies in relation to changes in salinity, turbidity and temperature caused by freshwater discharge. Hence, only fast growing seagrasses that do not form the dense meadows characteristic of coastal marine waters occur in this, and most other estuaries in the south-west.

Hodgkin & Clark (1988) summarise two surveys (1976 & 1987), which found the seagrasses *Ruppia megacarpa* on sandflats near the Deep River delta and *Heterozostera tasmanica* towards the entrance channel. A recent (2003) unpublished survey by Edith Cowan University identified three small meadows of *H. tasmanica* on the eastern side of the Nornalup Inlet (Figure 3), while some *R. megacarpa* and *Halophila decipiens* also occurred on sand-flats, rubble and rocky substrates (Table 1). This survey found that most species of algae occurred on sand-flat, seagrass and rock substrates of the Nornalup Inlet.

Invertebrate fauna

More invertebrate species occur in the Walpole-Nornalup Inlets compared to many other SW estuaries because it is permanently open. This maintains suitable marine-like conditions for much of the time, and enables pelagic larvae to enter the Inlets. The diversity of benthic invertebrates, comprising mainly polychaetes, crustaceans and molluscs, is greater in the Nornalup Inlet compared to the Walpole Inlet, and is greater on sand-flats than mud habitats (Hodgkin & Clark, 1988; Edith Cowan University, 2003) (Table 2). Planktonic copepods occur throughout the Inlets, as do pelagic mollusc and fish larvae, many of which are probably passively transported (*ie* on tidal flows) into the inlets from the ocean (Hodgkin & Clark, 1988; Neira & Potter, 1994). Many of these fish larvae are of species that do not utilise the Inlets as adults.

Table 1. Presence (+) or absence of flora among habitats of the Walpole-Nornalup Inlets (UM=unconsolidated mud, SF=sand flat, CSF=coarse fluvial sand, DS=deltaic sand, SG=seagrass, RO=rock, RU=rubble) (Edith Cowan University survey, 2003)

Species	*Nornalup*						*Walpole*			
	UM	SF	CFS	DS	SG	RO	UM	SF	RO	RU
Seagrass										
Ruppia megacarpa									+	+
Heterozostera tasmanica		+			+					
Halophila decipiens		+				+				
Algae										
Cystoseira trinodis	+	+				+			+	
Cladophora sp.						+		+	+	
Antithamnionella sp.						+			+	+
Gracilaria sp.		+				+				
Oscillaria sp.					+	+				+
Unid brown algae					+	+				
Enteromorpha paradoxa		+								
Zosterocarpus sp.									+	
Rhizoclonium sp.		+			+					
Sphacelaria sp.					+					
Chaetomorpha linum		+						+		
Chaetomorpha aurea		+								
Unid sp. (A15)						+				
Unid. sp. (SM)						+				
Unid. sp. (1)	+									

Table 2. Relative abundance of benthic fauna among habitats of the Walpole-Nornalup Inlets. Mean numbers of organisms/0.0254 m^2 (+=1-10, ++=11-50, +++=51-100, ++++=>100) (UM=unconsolidated mud, SF=sand flat, CSF=coarse fluvial sand, DS=deltaic sand, SG=seagrass, RO=rock, RU=rubble) (Edith Cowan University survey, 2003).

Species	Habitat									
	Nornalup						Walpole			
	UM	SF	CFS	SG	DS	RO	UM	SF	RO	RU
Crustaceans										
Tanaid sp. 1	++	+++	++++		++	++	+++	++++	+++	++++
Pilumnus sp. (Decapoda)										++
Amphipod sp. 1	++	++		+++			++++	++++		+++
Ovalipes australienis (Decapoda)	+		++							
Carid shrimp sp. 1 (Decapoda)		+								
Palaemonetes australis (Decapoda)				++					++	++
Amphipod sp. 2	+	++	++	++						
Halicarcinus ovatus (Decapoda)		+				+			++	++
Amphipod sp. 3	+									+++
Balanus variegates (Cirripedia)		+				++				++++
Mysid sp. 1	+	+						+		
Amphipod sp. 4		+						+		
Amphipod sp. 5		+								
Stomapoda	+									
Polychaetes										
Neredidae sp. 1 *(Neanthes)*	+++	++	++++	++		++		+++	+++	++++
Errant sp. 1	++++	+++	+++	++++	+++	++	+	+++		
Capitella capitata (Capitellidae)		++	++++							
Sedentary sp. 1	++	+++	++++							
Sedentary sp. 2	+	+	++							
Sedentary sp. 3		+	+++							
Sedentary sp. 4	++	++++			+++		++	+++		
Errant sp. 2	++	++		+++						
Neredidae sp. 2	+						+			++
Sedentary sp. 5							+++		+++	++
Errant sp. 3	+	++								
Errant sp. 4	++	++								
Errant sp. 5	+	+			+++					
Errant sp. 6	+	++								
Errant sp. 7	+	++								
Errant sp. 8	+	+								
Errant sp. 9		+				++	++			
Errant sp. 10		+								
Terebellidae	++	++								
Errant sp. 11		+								
Sedentary sp. 6							+			

Gastropods										
Nassarius burchardi (Nassaridae)	+	+	+++	++			+		+++	++
Opisthobranch sp. 1	+	++	++		+++					
Opisthobranch sp. 2	++	+								
Philine sp. (Philinidae)	+	+		++						
Oligochaetes										
Oligochaete sp. 1								+		
Oligochaete sp. 2								+		
Bivalves										
Soletellina sp.		+						++		
Lutraria sp. 1		+	+++	++						
Bivalve sp. 1		+		++++						
Spisula sp. 1		++			++++	++	+			
Bivalve sp. 2										
Bivalve sp. 3										
Nemerteans										
Nemertean sp. 1	+	+								
Nemertean sp. 2										

Vertebrate fauna

Fish

The majority (*ca* 70%) of fish species that inhabit estuaries of south-west WA do so irregularly and usually remain in essentially marine waters close to the estuary mouth (*ie* 'stragglers') (Potter *et al.*, 1990). A smaller proportion (*ca* 15%), which typically comprise mullets, gerreids, terapontids and whitings, opportunistically enter estuaries as juveniles, when seasonal openings permit, where they exploit opportunities to forage and evade predators (*ie* 'opportunists'). Less than 10% of the south-west estuarine fish fauna actually breed and complete their lifecycles in estuaries (*ie* 'estuarine), although these typically small species, such as gobids and atherinids, often occur in very high densities (Potter *et al.*, 1990; Potter & Hyndes, 1999). Only one truly anadromous fish (*ie* which moves from the sea to spawn in freshwater), the pouched lamprey *Geotria australis,* occurs in the south-west and is most abundant in waterways between the Margaret and Denmark Rivers (Morgan *et al.*, 1996).

Approximately 40 fish species commonly occur in the Walpole-Nornalup inlets (Hodgkin & Clark, 1988; Potter & Hyndes, 1994) (Table 3). Additional, rarer species recorded in the Inlets by the WA Museum include some tropical species (Table 4). Estuarine spawning species include very abundant small gobies atherinids and syngnathids, and larger species, such as black bream *Acanthopagrus butcheri* and cobbler *Cnidoglanis macrocephalus* (Neira & Potter, 1994). Numerous marine species enter the Inlets, where they particularly utilise the deeper waters of the Nornalup Inlet. Unlike many other estuaries, this fauna includes five elasmobranch species, including large numbers of gummy shark *Mustelus antarcticus* and eagle rays *Myliobatis australis*. Use of the Inlets by these marine species is most likely to be opportunistic and transient. Many marine species, for example, would leave the Inlets during periods of freshwater discharge. Unlike some other south-western estuaries, the Walpole-Nornalup Inlets (and the Wilson Inlet) do not appear to be important juvenile habitats for marine fishes. This may reflect differences in the compositions of coastal marine fish communities between the WA lower west and southern coasts (Potter & Hyndes, 1994; Ayvazian & Hyndes, 1995). Among those species recorded by Potter & Hyndes (1994), only the smooth hammerhead shark (*Sphyrna zygaena*) occurs on the IUCN (2003) *Red List* of threatened species.

Black Bream, which are common in most south-west river systems, are one of the most important recreational fishes in the Inlets. This species completes its entire lifecycle in riverine and estuarine habitats (Figure 4), and a high level of genetic divergence exists between populations in different estuaries (Chaplin *et al.*, 1998). For this reason, black bream are vulnerable to localised depletion (DOF, 2001). Differences in the growth rates and reproductive biology of *A. butcheri* in different estuaries may reflect differences in temperature, trophic resources and environmental conditions in the systems (Sarre & Potter, 1999; Sarre & Potter, 2000; Sarre *et al.*, 2000). Lower temperatures, for example, may cause the relatively slow early growth of this species in the Walpole-Nornalup Inlets. Black bream spawn in the Walpole-Nornalup Inlets during the spring and early summer, when water temperature and salinity range from *ca* 18-23 °C and 16-31 gL^{-1}, respectively (Sarre & Potter, 1999). The ages (A_{50}) and lengths (L_{50}) at sexual maturity of populations of this species in the Inlets are 4.3 yrs and 201 mm for females and 2.8 yrs and 158 mm for males. They take longer to mature in the Inlets compared to some other WA estuarine systems (Norriss *et al.*, 2002). Reproductive black bream may aggregate to spawn in deep riverine pools.

Table 3. Fish species recorded from the Walpole-Nornalup Inlets by Potter & Hyndes (1994) and lifecycle category (* denotes IUCN listing of Low Risk/near threatened)

Family	Species	Common name	Lifecycle	Abund.
Triakidae	*Mustelus antarcticus*	Gummy shark	Opportunist	M
Sphyrnidae	*Sphyrna zygaena*	Smooth hammerhead shark*	Straggler	L
Rhinobatidae	*Aptychotrema vincentiana*	Southern shovelnose ray	Straggler	L
Dasyatididae	*Dasyatis thetidis*	Black stingray	Straggler	L
Myliobatidae	*Myliobatis australis*	Eagle ray	Opportunist	M
Elopidae	*Elops machnata*		Straggler	L
Engraulididae	*Engraulis australis*	Australian anchovy	Estuarine	M
Gonorynchidae	*Gonorynchus greyi*	Beaked salmon	Opportunist	L
Plotosidae	*Cnidoglanis macrocephalus*	Cobbler	Estuarine	H
Atherinidae	*Leptatherina wallacei*		Estuarine	H
Atherinidae	*Atherinosoma elongata*	Elongate hardyhead	Estuarine	M
Atherinidae	*Leptatherina presbyteroides*	Silverfish	Estuarine	L
Platycephalidae	*Platycephalus speculator*	Blue-spot flathead	Estuarine	H
Terapontidae	*Pelates sexlineatus*	Six-lined trumpeter	Opportunist	M
Sillaginidae	*Sillaginodes punctata*	King George whiting	Opportunistic	H
Sillaginidae	*Sillago bassensis*	Sand whiting	Opportunistic	M
Pomatomidae	*Pomatomus saltatrix*	Tailor	Opportunistic	M
Carangidae	*Pseudocaranx dentex*	Skipjack trevally	Opportunistic	M
Arripididae	*Arripis georgianus*	Herring	Opportunistic	H
Arripididae	*Arripis trutta*	Australian salmon	Opportunistic	L
Sparidae	*Rhabdosargus sarba*	Tarwhine	Opportunist	L
Sparidae	*Acanthopagrus butcheri*	Black bream	Estuarine	H
Sparidae	*Pagrus auratus*	Snapper	Opportunist	M
Mugilidae	*Mugil cephalus*	Sea mullet	Opportunistic	H
Mugilidae	*Aldrichetta forsteri*	Yelloweye mullet	Opportunistic	H
Gobiidae	*Favonigobius lateralis*	Longfin goby	Opportunistic	H
Gobiidae	*Pseudogobius olorum*	Bluespot goby	Estuarine	L
Pleuronectidae	*Ammotretis rostratus*	Longsnout flounder	Opportunistic	M
Paralichthyidae	*Pseudorhombus jenynsii*	Smalltooth flounder	Opportunistic	L

Table 4. Additional fish species listed by the Western Australian Museum from the Walpole-Nornalup Inlets

Family	Species	Common name	collected
Petromyzontidae	*Geotria australis*	Pouched lamprey	?
Muraenidae	*Gymnothorax prasinus*	Green moray eel	1973
Aulopodidae	*Aulopus purpurissatus*	Sergeant Baker	1942
Bathysauridae	*Saurida undosquamis*	Large-scaled grinner	1982
Syngnathidae	*Urocampus carinirostris*	Hairy pipefish	1976
Serranidae	*Acanthistius serratus*	Western wirrah	?
Serranidae	*Caesioperca rasor*	Barber perch	1982
Serranidae	*Epinephelides armatus*	Breaksea cod	1942
Sillaginidae	*Sillago schomburgkii*	Yellowfin whiting	1974
Glaucosomatidae	*Glaucosoma hebraicum*	Dhufish	1942
Scorpididae	*Neatypus obliquus*	Footballer sweep	1942
Scorpididae	*Scorpis aequipinnis*	Sea sweep	1942
Labridae	*Coris auricularis*	Western king wrasse	1942
Labridae	*Notolabrus parilus*	Brown-spotted wrasse	1942
Tripterygiidae	*Lepidoblennius marmoratus*	Jumping blenny	1966
Clinidae	*Heteroclinus roseus*	Rosy weedfish	1949
Gobiidae	*Acentrogobius bifrenatus*	Bridled goby	1982
Ostraciidae	*Caprichthys gymnura*	Rigid boxfish	1960
Ostraciidae	*Capropygia unistriata*	Black-banded pygmy boxfish	1980
Tetraodontidae	*Contusus brevicaudus*	Prickly toadfish	1986
Tetraodontidae	*Torquigener pleurogramma*	Banded toadfish	1974
Diodontidae	*Tragulichthys jaculiferus*	Longspine burrfish	?

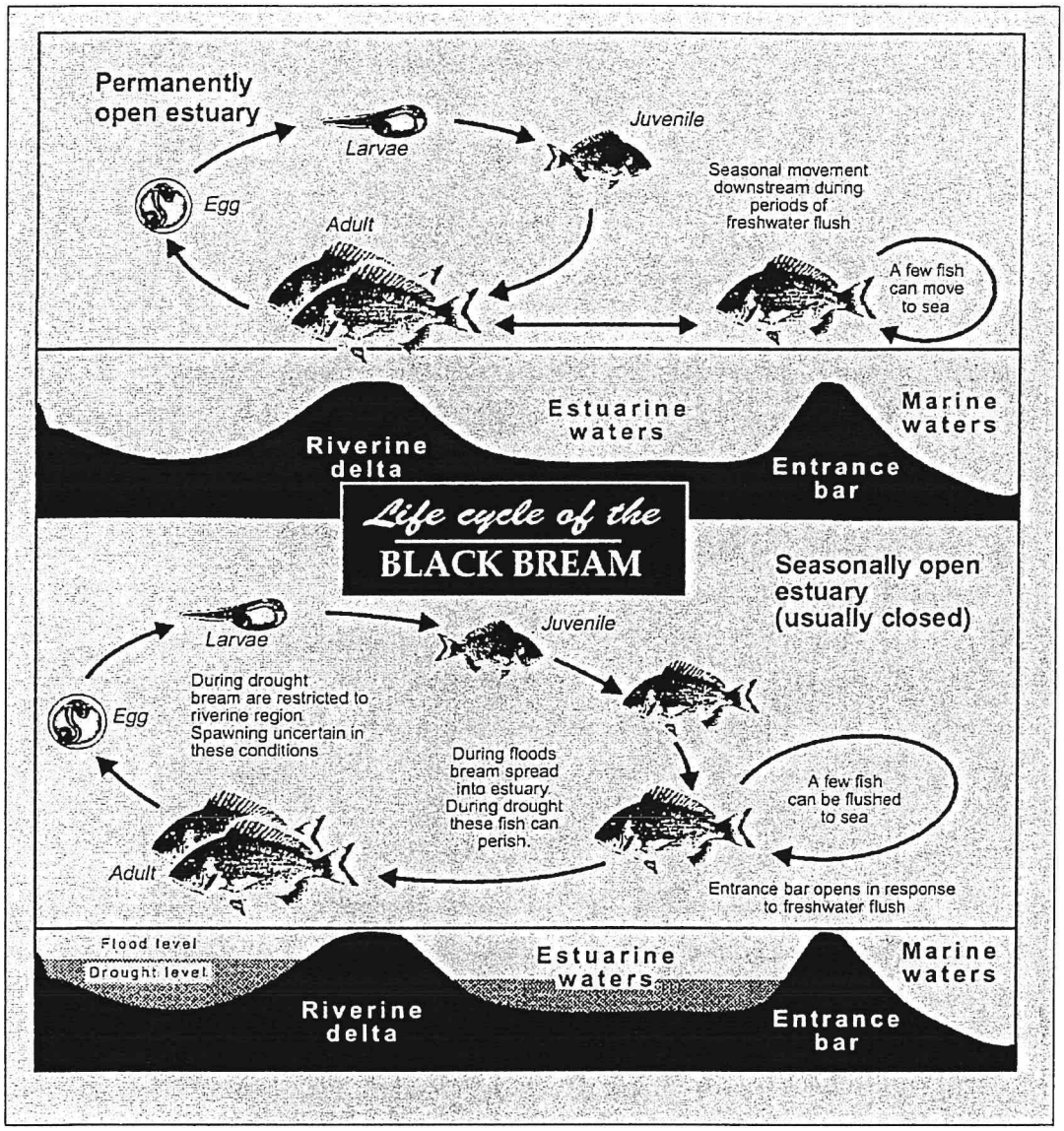


Figure 4. Lifecycle of the black bream *Acanthopagrus butcheri* (Norriss *et al.*, 2002)

Unlike black bream, King George whiting *Sillaginoides punctata* spawn in oceanic waters and their pelagic larvae settle into sheltered sand habitats when 60-80 days old and 15-18 mm in length (Kailola *et al.*, 1993). Juveniles typically remain in shallow inshore seagrass habitats before then moving into deeper areas as adults (Hyndes *et al.*, 1996; Hyndes *et al.*, 1998).

Birds

All major estuaries in SW WA are significant waterbird habitats, especially during summer months when they provide refuge for birds as inland water bodies dry up (Raines *et al.*, 2000).

Hodgkin & Clark (1988) list 21 waterbird species that have associated with the Inlets, while Birds Australia (2001a, b) list *ca* 150 species that inhabit the diverse habitats of the Walpole district.

6. SOCIAL VALUES OF THE WALPOLE-NORNALUP INLETS AND ASSOCIATED WATERWAYS

Aesthetic

The natural and relatively pristine Inlets environment is an important recreational and tourist attraction (WANISAC, 1999; WANISAC, 2000). Mostly surrounded by predominantly forested National Park, the Inlets are among the most scenic locations of southern WA. The spectacular landscapes and forest of the region were recognised as being worthy of conservation as early as 1910 (CALM, 1992), and the Inlet waters were included in the 1972 gazettal of the Walpole-Nornalup National Park before it was determined that their inclusion could not be supported under the legislation of the day. The outstanding scenic qualities of the Inlets were among the reasons that the Marine Parks and Reserves Selection Working Group recommended that they be made a marine conservation reserve (CALM, 1994).

Recreation

The Inlets and the Deep and Frankland Rivers are popular recreational destinations, especially for fishing and boating (Madden, 1995). All of the large south coast estuaries are important recreational fishing locations and popular species are black bream, King George whiting, flathead and cobbler (DOF, 2002). Various other, mainly marine, fish species are also caught in the lower estuary during periods of low freshwater discharge. A number of boat ramps are located around the Inlets, and boating activity ranges from water skiing and jet skis to canoeing. Coalmine Beach is a popular swimming location, while nature-based recreational activities, such as bird watching and bushwalking, are also popular around the Inlets. Visitors to the Walpole Tourist Bureau have increased from <20 000 to >70 000 *per* year since 1994 (Dry & Hoefler, 2003).

Commercial/Tourism

Houseboats and boat tour businesses operate on the Inlets, while tourist parks located at Coalmine Beach and Rest Point also rely on the recreational and scenic values of the Inlets to attract visitors. The Inlets are also utilised for canoeing tours (www.capricornkayak.com.au). There is no commercial fishing in the Inlets, although Australian salmon fishing occurs on the adjacent coast from February to April and catches are transported across the Inlets.

Scientific/education.

The relatively pristine condition of the Inlets enhances their value as a scientific and educational resource. The other permanently open south coast estuaries (*ie* Hardy Inlet and Oyster Harbour) are adjacent to larger townships and are significantly more disturbed by catchment degradation. Furthermore, the accessibility of the Inlets and their proximity to township facilities present excellent training opportunities for tertiary institutions. Various scientific studies, which have examined diverse topics, such as fish and benthic ecology and nutrient dynamics, have been carried out in the Inlets. While not all of these studies have been published at this time, their data and results are being collated to contribute to the marine conservation reserve planning process.

Indigenous and European cultural history.

Artefact scatters, midden sites and stone fish traps adjacent to the Inlets and in the surrounding region provide evidence of Aboriginal camp-sites and hunting activity (Dortch, 1992). Some believe that acknowledgement of Aboriginal heritage in the area is low, as is recognition of the significance of the area to Aboriginal people (WANISAC, 1999).
The first regular use of the Inlets by Europeans probably occurred during the early 1800's, when the area was used as a base to carry out sealing and whaling. By 1911, the Bellanger and Thompson families became the first permanent settlers when they built properties on the Frankland and Deep Rivers, respectively. The townships of Walpole and Nornalup were developed during the group settlement schemes of the 1930s.

Urban

The water supply for Walpole townsite and surrounding areas derives from a weir on the Walpole River, and in summer months also from Butler's Creek dam, which is located to the north-east of the town (WRC, 2000).

7. ISSUES IN THE WALPOLE-NORNALUP INLETS AND ASSOCIATED WATERWAYS IDENTIFIED BY WANISAC (1999) *An Action Plan for the Walpole-Nornalup Catchment Area: Issues and Stakeholder Report*

This report was produced for the Walpole Nornalup Inlets System Advisory Committee (WANISAC) and the Shire of Manjimup by Ecotones & Associates. Consultation was based on interviews with local community groups and businesses, Local Government, and State Government agencies, but comprised limited direct contact with the broader public.

Concerns for the health of the Inlets:

- The possible impacts of pollution, eutrophication and salinity on water quality. While salinity is an issue related to the condition of catchments, some sources of pollution and eutrophication may exist in close proximity to the Inlets.
- The erosion of shorelines caused by speeding boats.
- Declining abundances of some fauna in the Inlets and associated waterways, such as oyster and mussel beds and some fishes.

Conflict between recreational use of the inlets and conservation:

- The need for improved boating management to, for example, prevent shoreline erosion and maintain aesthetic values.

The need to improve management of the Inlets:

- By delegating management responsibility for the Inlets to an adequately resourced single authority, and by integrating management with foreshores and catchments.

Inadequate assessment and monitoring of the Inlets.

Degradation of waterways:

- The loss of fringing vegetation, and the occurrence of shoreline erosion and sedimentation.

REFERENCES

Ayvazian S.G. & Hyndes G.A. (1995). Surf-zone fish assemblages in south-western Australia: do adjacent nearshore habitats and the warm Leeuwin Current influence the characteristics of the fish fauna? *Marine Biology* **122**, 527-536.

Birds Australia (2001a) *Birdwatching around Walpole.* Bird Guides of Western Australia, Number **28a**, 1-2.

Birds Australia (2001b) *Walpole district bird list.* Bird Guides of Western Australia, Number **28b**, 1-2.

CALM (1992) *Walpole-Nornalup National Park Management Plan 1992-2002.* Department of Conservation and Land Management, Western Australia.

CALM (1994) *A representative marine reserve system for Western Australia.* Report of the Marine Parks and Reserves Selection Working Group, Department of Conservation and Land Management.

Chalmer P.N. & Scott J.K. (1984) *Fish and benthic faunal surveys of the Leschenault and Peel-Harvey estuarine systems of south-western Australia in December 1974.* Report **149**, Department of Conservation and Environment, Perth, 1-40.

Chaplin J.A., Baudains G.A., Gill H.S., McCulloch R. & Potter I.C. (1998) Are assemblages of black bream *Acanthopagrus butcheri* in different estuaries genetically distinct? *International Journal of Salt Lake Research* **6** (4), 303-321.

DOF (2001) *A five-year management strategy for recreational fishing on the west coast of Western Australia.* Fisheries Management Paper **153**, Department of Fisheries, Perth.

DOF (2002) *State of the Fisheries Report 2000-2001.* Department of Fisheries, Perth, Western Australia.

Dortch C. E. (1992) *Draft report on archaeological investigations at the Coalmine Beach, S02720, Walpole, WA.* Department of Conservation and Land Management, Western Australia.

Dry B. & Hoefler H. (2003) *Synopsis of Information about the Walpole-Nornalup Inlet: A candidate Marine Protected Area in Western Australia.* Murdoch University, Perth, Western Australia.

Edgar G.J. (2001) *Australian marine habitats in temperate waters.* Reed New Holland, Sydney.

Hardcastle K. & Cousins M. (2000) *The Hardy Inlet – Water quality sampling, Annual Report (January 1999-January 2000).* Waters and Rivers Commission, Perth, Western Australia.

Hodgkin E.P. & Clark R. (1988) *Nornalup and Walpole Inlets and the estuaries of the Deep and Franklin Rivers.* Estuarine Studies Series **2**, Environmental Protection Authority, Perth, Western Australia.

Hodgkin E.P. & Hesp P. (1998) Estuaries to salt lakes: holocene transformation of the estuarine ecosystems of south-western Australia. *Marine and Freshwater Research* **49**, 183-201.

Hyndes G.A., Potter I.C. & Lenanton R.C.J. (1996) Habitat partitioning by whiting species. *Environmental Biology of Fishes* **45**, 21-40.

Hyndes G.A., Platell M.E., Potter I.C. & Lenanton R.C.J. (1998) Age composition, growth, reproductive biology and recruitment of King George whiting, *Sillaginodes punctata* , in southwestern Australia *Fishery Bulletin, U.S.* **96**, 258-270.

Huisman J.M. (2000) *Marine plants of Australia.* University of Western Australia Press, Perth.

IUCN (2003) *http://www.redlist.org/*

Kailola P.J., Williams M.J., Stewart P.C., Reichelt R.E., McNee A. & Grieve C. (1993) *Australian fisheries resources.* Bureau of Resource Sciences and the Fisheries Research and Development Corporation.

Lenanton R.C.J. & Hodgkin E.P. (1985) Life history strategies of fish in some temperate Australian estuaries. In Yanez-Arancibia A. (Ed.) *Fish community ecology in estuaries and coastal lagoons: towards an ecosystem integration.* Universidad NacionalAutonoma de Mexico, Mexico, 267-284.

Madden S. (1995) *Recreational use of Water Bodies in the Busselton-Walpole Region.* Water Authority of Western Australia.

Morgan D., Gill H. & Potter I. (1996) *The distribution of freshwater fish in the south-western corner of Australia.* Water Resource Technical Report WRT4, Waters and Rivers Commission, Perth.

Neira F.J. & Potter I.C. (1994) The larval fish assemblage of the Nornalup-Walpole estuary, a permanently open estuary on the southern coast of Western Australia. *Australian Journal of Marine and Freshwater Research* **45**, 1193-1207.

Norriss J.V., Tregonning J.E., Lenanton R.C.J. & Sarre G.A. (2002) *Biological synopsis of the black bream,* Acanthopagrus butcheri, *(Munro) (Teleostei: Sparidae) in Western Australia with reference to information from other southern states.* Fisheries Research Report **93**, 1-48.

Potter I.C. & Hyndes G.A. (1994) Composition of the fish fauna of a permanently open estuary on the southern coast of Australia, and comparisons with a nearby seasonally closed estuary. *Marine Biology* **121**, 199-209.

Potter I.C. & Hyndes G.A. (1999) Characteristics of the ichthyofaunas of southwestern Australian estuaries, including comparisons with holarctic estuaries and estuaries elsewhere in temperate Australia: a review. *Australian Journal of Ecology* **24**, 395-421.

Potter I.C., Beckley L.E., Whitfield A.K. & Lenanton R.C.J. (1990) Comparisons between the roles played by estuaries in the lifecycles of fishes in temperate Western Australia and southern Africa. *Environmental Biology of Fishes* **28**, 143-178.

Raines J., Youngson K. & Unno J. (2000) Use of the Leschenault Inlet estuary by waterbirds. *Journal of the Royal Society of Western Australia* **83**, 503-512.

Sarre G.A. & Potter I.C. (1999) Comparisons between the reproductive biology of black bream *Acanthopagrus butcheri* (Sparidae) in four estuaries: with widely differing characteristics. *International Journal of Salt Lake Research* **8** (3), 179-210.

Sarre G.A. & Potter I.C. (2000) Variation in age compositions and growth rates of *Acanthopagrus butcheri* (Sparidae) among estuaries: some possible conflicting factors. *Fisheries Bulletin* **98**, 785-799.

Sarre G.A., Platell M.E. & Potter I.C. (2000) Do the dietary compositions of *Acanthopagrus butcheri* in four estuaries and a coastal lake vary with body size and season and within and amongst these water bodies? *Journal of Fish Biology* **56**, 103-122.

WANISAC (1999) *An action plan for the Walpole-Nornalup catchment area. Issues and stakeholders views report.* Walpole Nornalup Inlet Systems Advisory Committee, Shire of Manjimup.

WANISAC (2000) *An action plan for the Walpole-Nornalup catchment area. Final Report.* Walpole Nornalup Inlet Systems Advisory Committee, Shire of Manjimup.

WRC (2000) *Draft Walpole Weir Catchment Area, Butler's Creek Dam Catchment Area Water Source Protection Plan.* Water Resource Protection Series, Waters and Rivers Commission, Perth, Western Australia.

Appendix 1 Pages from CALM (1994) that refer to the Walpole-Nornalup Inlets

Previous recommendations
None.

Working Group recommendation
The Working Group considers that the inlets of the Donnelly and Gardner Rivers have considerable scientific and recreational value and should be managed as part of the surrounding D'Entrecasteaux National Park. It is unclear whether these areas are already included within the national park. Accordingly the Working Group recommends that:

> "Legal advice should be taken on the status of the tidal parts of the Donnelly and Gardner Rivers and if they are not already reserved within the D'Entrecasteaux National Park under the Land Act, consideration should be given to reserving them under the Conservation and Land Management Act for conservation and recreational purposes."

3.3. Walpole-Nornalup (Map V-1)

The Walpole-Nornalup estuarine system consists of two connected lagoons, that is Nornalup and Walpole Inlets, and the tidal reaches of the Deep, Frankland and Walpole Rivers. The estuary has been described by Hodgkin & Clark (1988a) and Smith *et al.* (1990).

Tenure
In 1972 the Government gazetted the Walpole-Nornalup National Park under the Land Act as a Class A reserve and included the inlets within the park. But it was later discovered that areas below low tide cannot be reserved under that Act and that inclusion of the tidal waters of the inlets within the park was not valid. When the marine reserves provisions of the CALM Act were introduced the Government directed that the inlets be reserved as marine park under the powers of this legislation. This has not yet been done.

Nornalup Inlet is entirely surrounded by the Walpole-Nornalup National Park. A small area of the park on the north-eastern shore of Nornalup Inlet is leased to the Coalmine Beach Sailing Club. The south-eastern shore of Walpole Inlet is also national park but the north eastern shore is occupied by the Walpole townsite and the north-western shore is a recreation reserve vested in the Shire of Manjimup.

The tidal parts of the Frankland and Deep Rivers are also contained within the national park except for a portion of the former in the vicinity of the Nornalup townsite.

Geomorphology and hydrology
Walpole-Nornalup is a relatively large lagoonal estuary which has two basins and a permanently open entrance. It lies between forested, granitic hills fringing the Albany-Frazer Oregon and the high Pleistocene dunes of the coast. It consists of two basins which together cover an area of about 13.2 km^2. Walpole Inlet is connected to the much larger and deeper Nornalup basin by a narrow channel between steep granite headlands. The entrance channel from the sea into Nornalup Inlet lies against a granite headland on its western side and the sand dunes which flank Bellanger Beach on its eastern side. The ocean bar limits tidal flow but it is always open and the estuary is always tidal.

Both the Deep and Frankland Rivers have well-defined channels, rather large deltas and discharge over shallow sand banks into Nornalup Inlet. The channels have been dredged and the rivers are navigable for some distance upstream. Their upper catchments are in agricultural lands but for much of their length they flow through State forest or national park. Rainfall in the catchment is high, with an annual fall of up to 1 400 mm near the coast.

Deep River is tidal for a distance upstream of about 6 km and the Frankland for about 12 km. The much smaller Walpole River is tidal for only a very short distance. Except for the dredged channels, Walpole Inlet is shallow with depths less than 1 m. There are shallow sand banks around the perimeter of Nornalup Inlet which shelve steeply to a central basin between 3 and 5 m deep.

The salinity regime in the estuary was studied in some detail by CSIRO from 1944 to 1951 (for references see Hodgkin & Clark, 1988a). Throughout the summer the salinity of the water in both inlets is approximately that of seawater. Marine water of oceanic salinity also penetrates far upstream in the two larger rivers during summer. In winter, when the rivers flood, a thermocline develops and the fresh water flows downstream over salty water which usually remains in the deeper parts. The saline bottom water may become deoxygenated under those conditions.

Flora and fauna

As may be expected, this permanently open estuary has a relatively rich flora and fauna. The seagrasses *Ruppia megacarpa* and *Heterozostera tasmanica* both occur in Nornalup Inlet, the latter mainly near the entrance channel. A brown alga, *Cystoseira trinodes,* is common on rocks around the shore. Green algae of the genera *Chaetomorpha* and *Cladophora* are abundant on the muddy flats, and the green alga *Acetabularia calyculus* is common, living attached to stones and shells in the shallows. The epiphytic algae *Chaetomorpha billardieri* and *Monosporus australis* sometimes overgrow the *Ruppia,* although there is no evidence of eutrophication.

The estuarine copepod *Gladioferens imparipes* dominates the plankton of the riverine parts of the estuary but also occurs abundantly in the inlets. The marine euryhaline copepod *Acartia tonsa* is the dominant plankter in the higher salinities of the inlets. Hodgkin & Clark (1988) list other copepods taken in plankton samples within the estuary.

All of the South Coast obligate estuarine invertebrate animals occur in the estuary and there is a larger number of marine invaders than is found in any other estuary in the region (except Oyster Harbour). A faunal list is given in Hodgkin & Clark (1988a).

The fish fauna also is relatively diverse. Many species targeted by recreational fishers are present, often in large numbers, including most of the common inshore marine species. Nornalup Inlet in particular is a popular location for recreational fishing. Net fishing is prohibited.

Recreation

Ablone *et al.* (1990) summarised recreational use of the Walpole-Nornalup National Park.

The Walpole-Nornalup estuary is surrounded in many places by tall forest. It is scenically and aesthetically one of Western Australia's most spectacular estuarine environments (Hodgkin & Clark, 1988). Much of its shore remains in its natural condition and the waters are unpolluted. For these reasons the Walpole-Nornalup National Park has long been a popular area for recreational pursuits, with the inlets as a central focus. Boating and especially fishing are among the most common recreational activities. Sailing from the Coalmine Beach Sailing Club attracts visitors as well as local people. Windsurfing is becoming another popular watersport on the inlets.

The Walpole-Nornalup National Park Management Plan notes the current rate of increase in the number of visitors to the park, including those indulging in water sports, with the corresponding need for increased management to prevent degradation of the environment.
Management of boat launching sites is seen to be of particular concern. Prevention of pollution and conservation of fish stocks are also important.

Previous recommendations

Although in its report on Conservation Reserves in Western Australia (1976, System 2) the EPA did not specifically recommend marine park status for the Walpole-Nornalup Inlets, it recommended as follows:

> "(7) until legislation is enacted to allow conservation reserves to include submarine lands, the Fisheries Act be employed to protect the Broke and Walpole-Nornalup Inlets and the Director of Fisheries and Wildlife be made responsible for their protection;".

The CALM Walpole-Nornalup National Park Management Plan (Smith *et al.*, 1990) noted that the Minister for the Environment had directed that the inlets should be reserved under the CALM Act and that declaration of the marine park was "expected to occur early within the life of this [management] plan".

Working Group recommendations
The Working Group believes that the Walpole-Nornalup estuarine system has very high conservation and recreational values. Although in size it is similar to Broke and Wilson Inlets, it is quite different in that it is naturally permanently open to the sea. It is the only permanently open lagoonal estuary on the South Coast and, apart from the partly estuarine Oyster Harbour, it has the most diverse estuarine flora and fauna of any estuary in the region. It also has outstanding scenic qualities and is largely surrounded by National Park.

The Working Group notes that in 1972 the Government included Walpole-Nornalup Inlets within the national park until it was discovered later that this was not possible under the Land Act. Accordingly the Working Group recommends that:

> "declaration of Walpole and Nornalup Inlets and the tidal parts of the Deep, Frankland and Walpole Rivers as marine park be implemented as a matter of high priority, and its management integrated with that of the surrounding national park."

3.4. William Bay (Map V-2)

Tenure
William Bay National Park extends to the low tide mark in the area under consideration.

Geomorphology
This is a granite shore with beaches alternating with smooth rock surfaces. There is a chain of large, near-shore boulders and rock islets protecting the beaches and deep pools from the full force of the swells. This type of situation is uncommon on the South Coast where most open ocean rocky shores are exposed to heavy wave action.

Flora and fauna
There is very little information about the marine flora and fauna at this locality. However, the sublittoral habitats are diverse with extensive tide pools and boulders. A diverse flora and invertebrate fauna is certain to occur there. The locality is the type locality for the gastropod (cowry) *Cypraea hadnightae*. Seagrasses, mainly species of *Posidonia* and *Amphibolis*, grow in most of the sheltered areas in the lee of the islets.

Recreation
This is one of the South Coast's most attractive sections of coast, particularly because of its relatively protected waters suitable for swimming, diving and fishing. It is of such scenic quality that photographs of it often appear in tourist promotion and other publications.

Previous recommendations
None.

Working Group recommendation
Noting the high scenic and recreational values of the locality and its likely diverse marine flora and fauna representative of the South Coast rocky shore habitat, the Working Group recommends that:

> "the State waters adjacent to the William Bay National Park be surveyed and assessed for their conservation values, with a view to possible reservation as a marine reserve for dual conservation and recreation purposes."

3.5. West Cape Howe (Map V-2)

Tenure
West Cape Howe National Park extends to the low water mark along most of the coast under consideration. At the eastern boundary of the park, that is at the western end of Torbay (Port Harding), there is a Shire reserve at the shore.