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"THE BIRDLIFE OF THE BLACKWOOD RIVER ESTUARY"

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INTRODUCTION

This project was initiated in March 1974 as part of a one year environmental study of the Blackwood River Estuary conducted by the Estuarine and Marine Advisory Committee (EMAC) of the Environmental Protection Authority of Western Australia.

The environmental study had two main objectives: to determine the likely effects of dredge-mining for mineral-sand deposits located within the estuary, and to gain an understanding of the dynamics of a south-west coast estuary. EMAC sought information on the birds of the estuary because of their aesthetic value, their significant role in estuarine food chains, and because of the estuary's probable importance as a summer refuge for waterbirds.

Little is known of Australian estuaries and their avifauna. Most of the scanty information which does exist is fragmentary, and based upon infrequent, chance observations. Few estuaries have been studied in a regular and systematic manner.

The Blackwood River Estuary is no exception. Prior to 1974 no comprehensive study of the estuary or its birdlife had been made. Moreover, no articles concerning the estuary's birdlife have been published in the scientific literature.

The present study was therefore necessarily limited in scope. Its aims were:

1) to identify the species of waterbirds which inhabit the estuary;

2) to determine their abundance and changes in this throughout the year, and

3) to identify areas of the estuary which are most important as waterbird habitat.

THE STUDY AREA

For comprehensive accounts of the morphology and botany of the Blackwood River the reader is referred to Sass (1974) and Congdon and McComb (1975). The following description of the Study Area refers only to those morphological and botanical features which are relevant to a consideration of the estuary as waterbird habitat.

Approximately 10 km from its mouth the Blackwood River is connected by a narrow channel on the north side of Molloy Island to the Scott River (Figure 1). Upstream from this channel the Blackwood and the Scott are riverine in character. Both are narrow, and the Blackwood is deep (6-7 m) and steep-sided, with only a narrow fringe of rush (*Juncus*) on its banks. The Scott River is somewhat shallower and has a wider rush-zone, however this narrows within 1 km of the channel and from there on is less than 3 m wide.

Below the channel the two rivers become estuarine in character; widening and shallowing to form the Blackwood and Scott Basins and then merging to open into the Lagoon, the Channel, and finally the ocean.

The present study was confined to this lower, estuarine region, It was anticipated that, with its rushbeds and samphire marshes, wide shallow bays and extensive tidalflats, this area would support the greatest numbers and diversity of waterbirds. Occasional surveys along the upper reaches of the two rivers confirmed that the birdlife in those areas was impoverished by comparison.

The Study Area has the following features:

Deadwater and Swan Lake. Immediately east of the mouth of the estuary, and opening to it by a narrow channel, are the

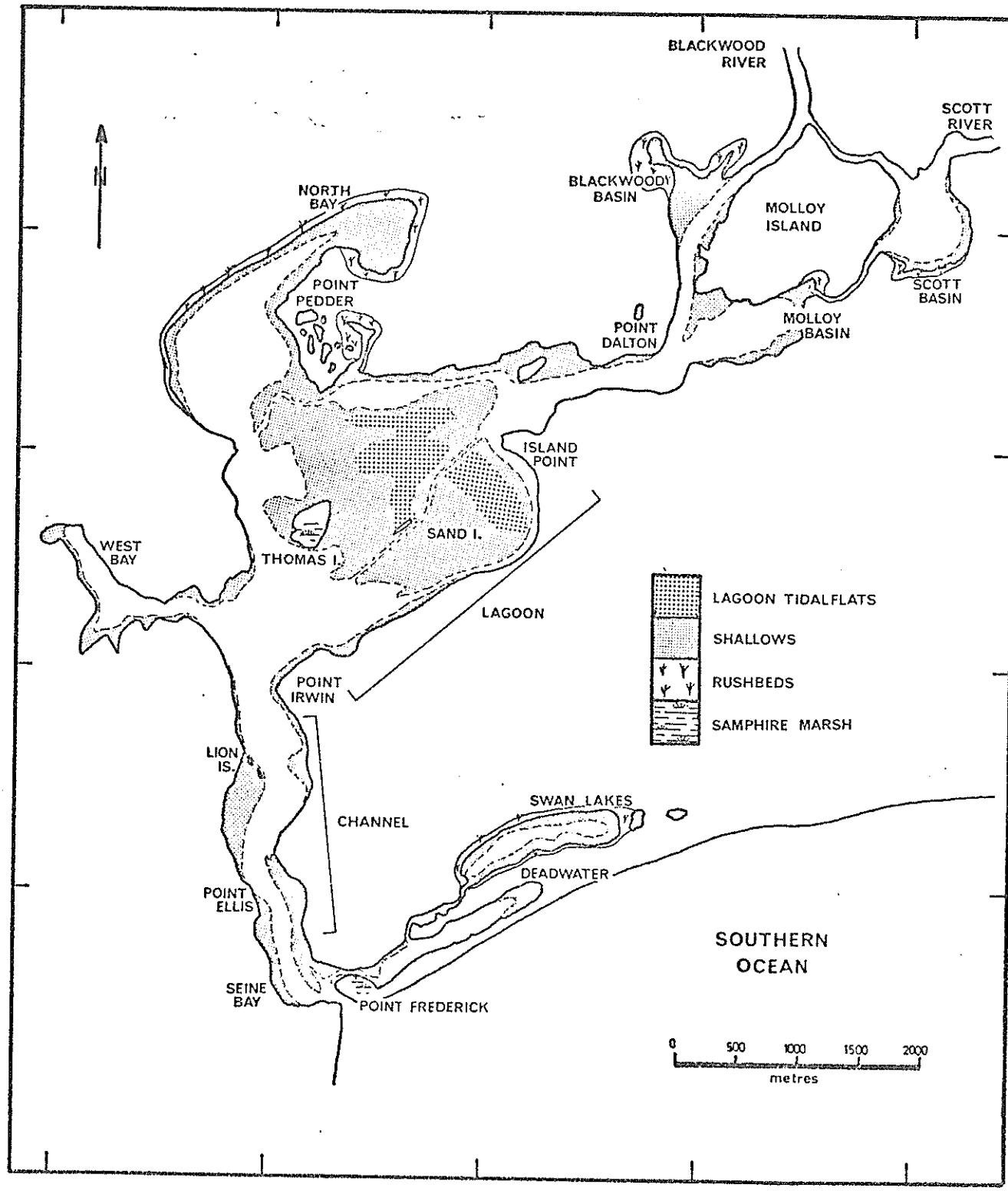

FIGURE 1. The Blackwood River Estuary.

Deadwater and Swan Lake. The Deadwater is the persistent river channel of the 1930-1945 period and for most of its length is 2-3 m deep. Towards the eastern end, however, it shallows to less than 1 m.

The dominant benthic plant of the Deadwater is a seagrass, *Ruppia maritima*. The southern shore has a narrow fringe of samphire *(Salicornia* sp.*)*, and this expands to form a small area of marsh (about 1 ha) near the mouth.

Immediately north of the Deadwater, and connected to it by a narrow, winding channel, is Swan Lake. This is less than 1 m deep throughout; has a rich growth of *Ruppia;* and a 5-20 m fringe of the shore rush *Juncus maritimus*.

Channel. This is about 3 km long and 0.5 km wide and has extensive shallows on either side of a central channel 4-6 m deep. Above Point Ellis the shallows are less than 1 m in depth and are overgrown by *Ruppia*. Below Point Ellis they may be exposed at low tide and the *Ruppia* is replaced by another benthic plant, *Zostera mucronata*.

Lagoon. The Lagoon, extending from Point Irwin to Island Point and including North and West Bays, is 660 ha in area. Almost all of it is less than 2 m deep and about half is less than 0.6 m. Extensive areas of sand (about 50 ha) are exposed at low tide. Natural channels run near the margins of the Lagoon and a 2 m deep, dredged channel cuts across its centre. Material dredged from this channel has been dumped to form a low sandy island which remains exposed during all but the highest of tides.

The dominant benthic plant of the Lagoon is *Ruppia* and the shores have a narrow fringe of *Juncus* and Paperbarks (predominantly *Melaleuca cuticularis*). The rush zone

widens around North Bay and, in particular, Point Pedder where it appears to be encroaching upon the estuary, isolating small bays to form a mosaic of ponds and vegetation.

Thomas Island is 8 ha in area and is overgrown by samphire marsh and *Juncus* - Paperbark woodland. There are small pools of open water within the marsh.

Molloy, Blackwood and Scott Basins. Upstream from Island Point the estuary becomes more riverine in appearance. The main channel of the Blackwood is clearly defined and is about 100 m wide and 4-7 m deep. There are shallow flats on either side of this channel however, and in two places these widen to form the Molloy and Blackwood Basins. The shallowest of the two basins is the Blackwood - at low tide it is less than 0.3 m deep. There is a rich growth of the benthic plants *Ruppia, Lamprothamnium papulosum* and *Potamogeton pectinatus* and the bay is surrounded by an extensive area of shore rush, *Juncus*.

Most of the Molloy Basin is deeper than the Blackwood however all is less than 1 m at low tide. The dominant benthic plants here are *Ruppia* and *Lamprothamnium*, and the shores are fringed by *Juncus* and Paperbarks.

Two narrow channels connect the Blackwood River to the Scott Basin (46 ha), another shallow water body which is nowhere more than 1 m deep. *Ruppia, Potamogeton* and *Lamprothamnium* all grow within the basin however the shores are fringed by a new type of rush - *Baumia juncea* - which prefers less saline water than does *Juncus*.

METHODS

The estuary was visited at Monthly intervals from March 1974 to June 1975 inclusive (except June 1974). Visits were of 3-6 days duration and were made during the latter half of each month.

On the second day of each visit a survey was made of the entire Study Area. The shoreline and open waters were surveyed by boat and the tidalflats and samphire marshes by foot. A list of the species of waterbirds which were encountered was compiled, and notes were made on their numbers and distribution.

Accurate absolute counts were possible for many species, particularly waders, swans, pelicans and egret. The following census methods were employed.

Swan, Pelican and Egret: The estuary's Black Swan *(Cygnus atratus)*, Pelican *(Pelecanus conspicillatus)* and White Egret *(Egretta alba)* populations were surveyed from a single-engine, high-wing aircraft (usually a Cessna 210) at 0730 hrs, 1200 hrs, and 1630 hrs on the first day of each visit. Survey flights were of 30-45 minutes duration (depending upon weather conditions and the number of birds) and were flown at an altitude of approximately 500 ft. All observations were made by the one observer and were plotted directly onto an orthophotomap of the estuary. Because the numbers of pelican and egret inhabiting the estuary were low, little difficulty was experienced in censusing all three species at the same time. Swan flocks which were too large to count from the air were photographed using a Hasselblad 500 EL/M electronic motor-driven 2¼" x 2¼" single-lens reflex camera fitted with a 70 exposure magazine, 100 mm lens, and yellow light filter. Ilford FP4 panchromatic film rated at 320 ASA was used at a shutter speed of 1/500th sec. The birds were counted off contact prints examined under a binocular microscope at x8 magnification.

Waders: During the visits of March to May 1974 three main wader feeding areas were identified. These were the tidalflats of the Lagoon, the sandflat/samphire marsh area at the mouth of the Deadwater, and the Deadwater shoreline. Throughout the study two species of wader, Greenshank *(Tringa nebularia)* and Common Sandpiper *(T. hypoleucos)* were observed to feed regularly outside these areas. They were excluded from the monthly wader surveys.

The remaining 20 species of waders were censused monthly from July 1974 to June 1975. Each census covered all three feeding areas and began with a boat survey of the Deadwater, followed by a survey by foot of the Lagoon tidalflats. During the winter months all species were censused on the same day. For the remainder of the year, however, two or more days were required. Usually the godwit, knot (both species) and plover populations were censused on the third day of the visit and the remainder on the fourth. However, from January to March, when wader numbers had reached, or were approaching, their peak, the census of all species took up to four days to complete.

Although it was intended that all censuses be made when the tide was at its lowest daytime ebb, this often proved impracticable. From December to March the area of Lagoon tidalflat exposed at low tide was often too extensive to be surveyed by a single observer. During these months counts were made on the rising tide as feeding birds were concentrated into smaller areas. Occasionally groups of birds ceased feeding and flew to the oceanfront during a census. When this occurred the survey was abandoned and resumed the following day.

Other Species: Population estimates for the remaining species were based upon the numbers of birds encountered during the one-day species surveys. For some species,

particularly those which were rare or in very low numbers, these surveys produced accurate absolute counts. (It should be noted here that, of the 57 species recorded during the study, 12 were seen on only one or two occasions and 24 had maximum populations of 10 birds or less). For others the data from the one-day surveys were sufficient on which to base estimates of population size.

The population size of a few species, however, could not be determined with any degree of accuracy due to either their habits or their habitats which frequently prevented survey by a single observer. Black, Little Black and Little Pied Cormorants and Darters, for example, were too inconspicuous to survey by plane and too shy to survey by boat. Little Grassbirds and Swamphens were also difficult to census due to their secretive habits. The Greenshank also was shy and fed over too large an area to be accurately surveyed.

RESULTS AND DISCUSSION

For a full account of the numbers, distribution, habitat preferences, nesting activity, etc. of each species the reader is referred to Appendix 1. The following includes only a brief résumé of those findings.

1. The Species: The estuary supports a wide diversity of waterbird species. 57 were recorded during the study period (March '74 - June '75) and these are listed in Table 1. 18 are summer migrants from the northern hemisphere and one is a migrant from New Zealand. The remaining 38 species all have their breeding grounds within Australia.

   In terms of both number and composition the Species List is fairly typical of the estuaries on the west coast of W.A. from Perth to Busselton. For example, 50 species of waterbirds were recorded on Leschenault Inlet (Bunbury) during a similar study by the author from July 1973 to June 1974. 55 species were recorded on the Blackwood estuary during the corresponding 12 month period. A comparison of the two Species Lists (see Appendix 2) reveals their close similarity. In fact, of the 50 species recorded on Leschenault Inlet, only 6 were not recorded on the Blackwood.

   The Blackwood Species List does, however, have several unusual and noteworthy features:

   i) Double-banded Dotterel *(Charadrius bicinctus)* : This bird is a migrant from New Zealand and is confined to the southern coast of Australia. The Blackwood estuary is the western extremity of its range. It has not been recorded on estuaries of the west coast of Australia.

TABLE 1 - BIRDS RECORDED ON THE BLACKWOOD RIVER ESTUARY MARCH 1974 - JUNE 1975 INCL.

FAMILY	SCIENTIFIC NAME	COMMON NAME
PODICIPEDIDAE	*Podiceps poliocephalus*	Hoary-headed Grebe
PELECANIDAE	*Pelecanus conspicillatus*	Australian Pelican
PHALACROCORACIDAE	*Phalacrocorax carbo*	Black Cormorant
	Phalacrocorax sulcirostris	Little Black Cormorant
	Phalacrocorax varius	Pied Cormorant
	Phalacrocorax melanoleucos	Little Pied Cormorant
	Anhinga rufa	Darter
ARDEIDAE	*Botaurus poiciloptilus*	Brown Bittern
	Nycticorax caledonicus	Nankeen Night Heron
	Egretta sacra	Reef Heron
	Egretta alba	White Egret
	Ardea novaehollandiae	White-faced Heron
THRESKIORNITHIDAE	*Threskiornis molucca*	White Ibis
ANATIDAE	*Cygnus atratus*	Black Swan
	Tadorna tadornoides	Mountain Duck
	Anas superciliosa	Black Duck
	Anas gibberifrons	Grey Teal
	Anas castanea	Chestnut Teal
	Anas rhynchotis	Blue-winged Shoveller
	Biziura lobata	Musk Duck
ACCIPITRIDAE	*Haliastur sphenurus*	Whistling Eagle
	Haliaeetus leucogaster	White-breasted Sea Eagle
	Circus approximans	Swamp Harrier
PANDIONIDAE	*Pandion haliaetus*	Osprey
RALLIDAE	*Gallinula porphyrio*	Swamphen
	Fulica atra	Coot
HAEMATOPODIDAE	*Haematopus ostralegus*	Pied Oystercatcher
CHARADRIIDAE	*Charadrius ruficapillus*	Red-capped Dotterel
	Charadrius bicinctus	Double-banded Dotterel
	Charadrius leschenaultii	Large Sand-dotterel
	Pluvialis squatarola	Grey Plover
	Pluvialis dominica	Eastern Golden Plover
SCOLOPACIDAE	*Arenaria interpres*	Turnstone
	Numenius phaeopus	Whimbrel
	Numenius madagascariensis	Eastern Curlew
	Tringa nebularia	Greenshank
	Tringa hypoleucos	Common Sandpiper
	Tringa brevipes	Grey-tailed Tattler
	Tringa cinerea	Terek Sandpiper
	Calidris canutus	Knot
	Calidris tenuirostris	Great Knot
	Calidris acuminata	Sharp-tailed Sandpiper
	Calidris melanotos	Pectoral Sandpiper
	Calidris ruficollis	Red-necked Stint
	Calidris ferruginea	Curlew Sandpiper
	Crocethia alba	Sanderling
	Limosa lapponica	Bar-tailed Godwit
RECURVIROSTRIDAE	*Himantopus himantopus*	Pied Stilt
LARIDAE	*Larus novaehollandiae*	Silver Gull
	Larus pacificus	Pacific Gull
	Larus dominicanus	Kelp Gull
	Sterna caspia	Caspian Tern
	Sterna bergii	Crested Tern
	Sterna nereis	Fairy Tern
PSITTACIDAE	*Neophema petrophila*	Rock Parrot
ALCEDINIDAE	*Halcyon sancta*	Sacred Kingfisher
SYLVIIDAE	*Megalurus gramineus*	Little Grassbird

ii) Eastern Golden Plover *(Pluvialis dominica)* : Common on the eastern coast of Australia, this species is considered rare on the west coast where it is replaced by the Grey Plover *(Pluvialis squatarola)*. The Blackwood estuary is unusual in that it has a *P. dominica* population (46 birds) which is far larger than its *P. squatarola* population (4 birds).

iii) Sanderling *(Crocethia alba)* : According to Whitlock (1939), Serventy and Whittell (1967) and McGill (1951) the Sanderling is a bird of the ocean beaches, rarely found on estuaries and never inland. It is usually seen in ones and twos and when McGill (ibid) studied what he considered to be a large population for six years the greatest number he recorded at any time was 15. A flock of approximately 60 Sanderling frequented the Blackwood estuary tidalflats from December '74 to March '75. This must be considered as one of the most unusual features of the estuary's avifauna.

iv) Avocet *(Recurvirostra novaehollandiae)* : The absence of this species is noteworthy. Avocet occur in hundreds on the west-coast estuaries, however none was recorded on the Blackwood. The normal range of this species does not appear to include the south-western corner of the state.

v) Pied Stilt *(Himantopus himantopus)* : Like the Avocet this species is common on the west coast, however its normal range does not appear to include the Blackwood. Only one bird was recorded and on one occasion only.

2. Seasonal Occurance : A majority of species inhabited the estuary on a seasonal basis only (see Table 2). In fact only 16 species were recorded on every visit whereas 21

TABLE 2 - SEASONAL OCCURRENCE OF BIRDS

SPECIES:	1974 Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	1975 Jan	Feb	Mar	Apr	May	Jun
Hoary-headed Grebe			x									X				
Australian Pelican	x	x	x		X	X	X	X	X	X	X	X	X	X	X	X
Black Cormorant	x	x	x		X	X	X	X	X	X	X	X	X	X	X	X
Little Black Cormorant	x	x	x		X	X	X	X	X	X	X	X	X	X	X	X
Pied Cormorant	x	x	x		X	X	X	X	X	X	X	X	X	X	X	X
Little Pied Cormorant	x	x	x		X	X	X	X	X	X	X	X	X	X	X	X
Darter	x	x	x		X	X	X	X	X	X	X	X	X	X	X	X
Brown Bittern	x												X			
Nankeen Night Heron	x										X	X	X	X		
Reef Heron	x	x	x		X	X						X	X	X	X	X
White Egret	x	x	x		X								X	X	X	X
White-faced Heron	x	x	x		X	X	X	X	X	X	X	X	X	X	X	X
White Ibis														X		X
Black Swan	x	x	x		X	X	X	X	X	X	X	X	X	X	X	X
Mountain Duck	x	x	x			X	X	X	X	X	X	X	X	X	X	
Black Duck	x	x	x		X	X	X	X	X	X	X	X	X	X	X	X
Grey Teal	x	x	x				X	X	X	X	X	X				
Chestnut Teal		x										X	X			
Blue-winged Shoveller			x													X
Musk Duck	x	x	x		X	X	X	X	X	X	X	X	X	X	X	X
Whistling Eagle	x	x	x		X	X	X	X	X	X	X	X	X	X	X	X
White-breasted Sea Eagle		x	x		X	X	X	X	X	X	X	X				X
Swamp Harrier	x	x	x		X	X		X	X		X	X	X		X	
Osprey	x	x	x		X	X	X	X	X	X	X	X	X	X	X	
Swamphen	x											X	X			
Coot											X	X	X			
Pied Oystercatcher	x	x	x		X	X	X	X	X	X	X	X	X	X	X	X
Red-capped Dotterel	x	x	x				X	X	X	X	X	X	X	X		
*Double-banded Dotterel	x	x											X	X		
*Large Sand-dotterel	x	x					X	X	X	X	X	X	X	X		
*Grey Plover	x	x						X	X	X	X					
*Eastern Golden Plover									X	X	X	X				
*Turnstone							X	X								
*Whimbrel	x	x	x		X	X	X	X	X	X		X	X			
*Eastern Curlew			x		X							X				X
*Greenshank	x	x					X	X	X	X	X	X	X	X		X
*Common Sandpiper	x				X	X	X	X	X	X	X	X	X	X		
*Grey-tailed Tattler								X	X							
*Terek Sandpiper									X							
*Knot	x	x	x					X	X	X	X	X	X	X	X	
*Great Knot	x	x	x					X	X	X	X	X	X	X	X	X
*Sharp-tailed Sandpiper	x									X	X	X				
*Pectoral Sandpiper	x															
*Red-necked Stint	x	x					X	X	X	X	X	X	X	X		
*Curlew Sandpiper	x	x					X		X	X	X	X	X			
*Sanderling	x							X	X	X	X	X	X			
*Bar-tailed Godwit	x	x	x					X	X	X	X	X	X	X	X	X
Pied Stilt		x														
Silver Gull	x	x	x		X	X	X	X	X	X	X	X	X	X	X	X
Pacific Gull						X										
Kelp Gull					X	X										
Caspian Tern	x	x	x		X	X	X	X	X	X	X	X	X	X	X	X
Crested Tern	x	x	x		X	X	X	X	X	X	X	X	X	X	X	X
Fairy Tern	x						X	X	X	X		X				
Rock Parrot		x	x									X	X	X	X	X
Sacred Kingfisher		x	x		X	X						X		X	X	X
Little Grassbird	x	x	x		X	X	X	X	X	X	X	X	X	X	X	X
TOTALS : 57 species	41	38	33	-	26	26	29	35	37	35	36	44	39	33	26	27

* Summer migrants either from the northern hemisphere or, in the case of the Double-banded Dotterel, from New Zealand.

species were recorded on 6 or less occasions.

The number of species inhabiting the estuary was lowest (26) during the winter months, rose to 37 in November, levelled until January, rose again to 44 in February, then declined steadily to the winter condition in late May (Figure 2). Dividing the total into migratory and non-migratory species reveals that the August to November rise in species number was due entirely to the arrival of migratory waders from their breeding grounds in the northern hemisphere. The January to February rise was due to a net influx of resident species. The departure of both migrant and resident birds to their breeding grounds produced the steady decline in total species number from February to May.

3. Numbers of Birds : The maximum population size of each species during the period July 1974 to June 1975 is shown in Table 3. For 37 species, regular absolute counts of population were possible and the maxima attained are given. The remaining 20 species have been placed in one or another of the various categories (1-10, 11-100, etc.) according to estimates of population size based upon the numbers of birds encountered during the monthly surveys. Within each category the species are in taxonomic rather than numerical order. Two species, the Pectoral Sandpiper and Pied Stilt, which were recorded during the study, but not during the July-June period, have been included for completeness.

Comparisons between the Blackwood estuary and other estuaries of the south-west, in terms of numbers of birds, are difficult. The only other estuary on which regular counts of bird numbers over a 12 month period have been made is Leschenault Inlet near Bunbury. These counts were during the 12 months prior to the present study, however, and so are not directly comparable. Notwithstanding this, some comparison may be instructive.

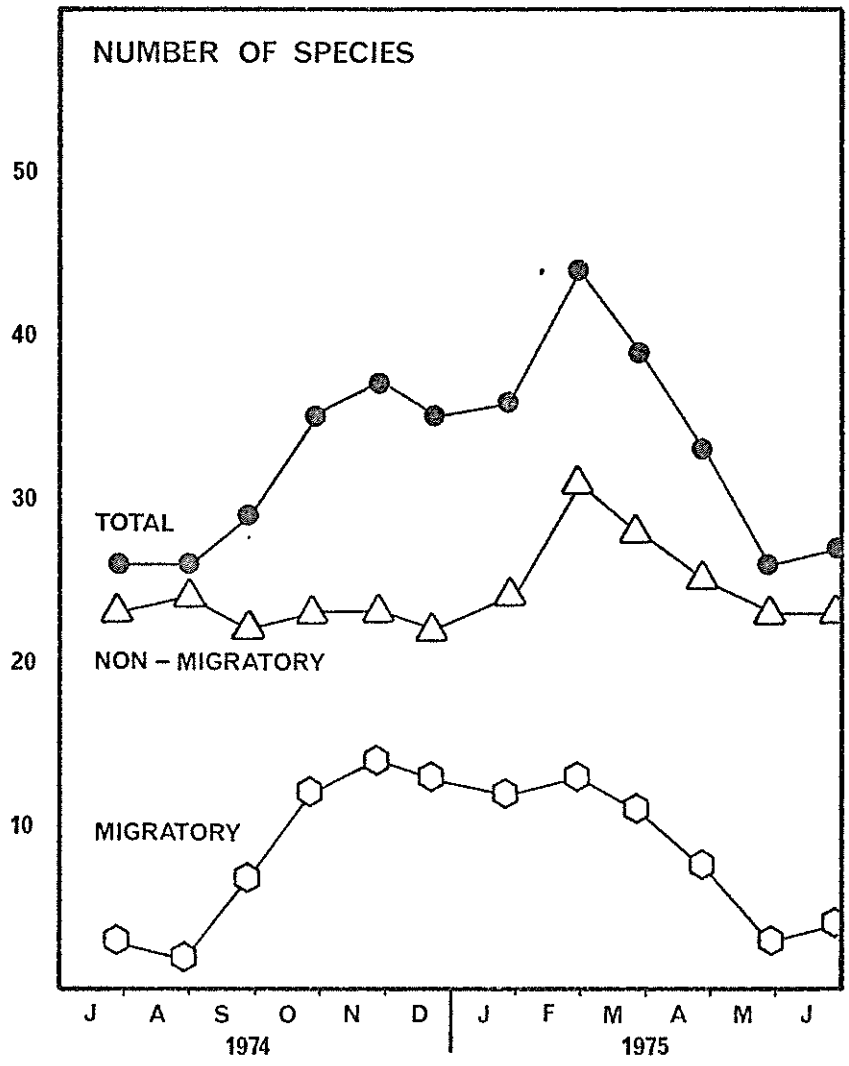

FIGURE 2. Monthly variation in number of waterbird species inhabiting the Blackwood River Estuary.

TABLE 3 - MAXIMUM POPULATIONS OF WATERBIRDS
JULY 1974 - JUNE 1975

10,000 - 1,001 : 1 SPECIES		
	Black Duck	est. 1 100
1,000 - 101 : 10 SPECIES		
	Little Black Cormorant	
	Little Pied Cormorant	
	White-faced Heron	
	Black Swan	700
	Musk Duck	est. 250
	Red-capped Dotterel	220
	Red-necked Stint	700
	Curlew Sandpiper	110
	Crested Tern	
	Silver Gull	
100 - 11 : 22 SPECIES		
	Australian Pelican	60
	Black Cormorant	
	Darter	
	Nankeen Night Heron	
	White Egret	12
	Mountain Duck	14
	Grey Teal	
	Whistling Eagle	
	Swamphen	
	Large Sand-dotterel	50
	Eastern Golden Plover	46
	Greenshank	
	Common Sandpiper	
	Knot	23
	Great Knot	31
	Sharp-tailed Sandpiper	23
	Sanderling	60
	Bar-tailed Godwit	39
	Caspian Tern	
	Fairy Tern	
	Rock Parrot	50
	Little Grassbird	
10 - 1 : 24 SPECIES		
	Hoary-headed Grebe	2
	Pied Cormorant	10
	Brown Bittern	1
	Reef Heron	2
	White Ibis	2
	Chestnut Teal	3
	Blue-winged Shoveller	4
	White-breasted Sea Eagle	1
	Swamp Harrier	
	Osprey	2
	Coot	8
	Pied Oystercatcher	10
	Double-banded Dotterel	2
	Grey Plover	4
	Turnstone	1
	Whimbrel	6
	Eastern Curlew	1
	Grey-tailed Tattler	2
	Terek Sandpiper	1
	Pectoral Sandpiper	(1)
	Pied Stilt	(1)
	Pacific Gull	1
	Kelp Gull	1
	Sacred Kingfisher	

Table 4 presents the 13 species of migratory waders which were most abundant on the Blackwood, and the numbers recorded on Leschenault Inlet during the 1973/74 study. Wader numbers for the Swan River estuary during the period September to November 1972 are also shown.

TABLE 4. NUMBERS OF MIGRATORY WADERS RECORDED ON THE BLACKWOOD, LESCHENAULT AND SWAN ESTUARIES.

SPECIES	BLACKWOOD (Jul '74 - Jun '75)	LESCHENAULT (Jul '73 - Jun '74)	SWAN (Sep '72 - Dec '72)
Red-necked Stint	700	1,900	4,000
Curlew Sandpiper	110	500	600
Greenshank	<100	230	<20
Sanderling	60	0	0
Large Sand-dotterel	50	7	2
Eastern Golden Plover	46	0	5
Bar-tailed Godwit	39	147	92
Great Knot	31	47	?
Knot	23	71	?
Sharp-tailed Sandpiper	23	44	70
Common Sandpiper	<100	?	?
Whimbrel	6	1	2
Grey Plover	4	72	67

With only three notable exceptions (Sanderling, Large Sand-dotterel and Eastern Golden Plover) wader numbers on the Blackwood estuary were lower than those occurring on Leschenault Inlet and substantially lower than those occurring on the Swan.

Although no actual figures are available for the Peel, Harvey, Wonnerup and Vasse estuaries, each of these (with the possible exception of the Harvey) is believed to have wader populations in excess of 2-3 thousand birds. It would appear therefore, that, in general terms, the number

of migratory waders inhabiting the Blackwood estuary is low compared with the numbers found on the west-coast estuaries from Perth to Busselton.

No comparisons may be made between the Blackwood and the other major estuaries of the south coast of W.A. The size of their wader populations is not known, though they are believed to be smaller than those of the Swan and the Peel.

4. Habitats: The habitat preferences of each species are given in Table 5.

TABLE 5 - FEEDING-HABITAT PREFERENCES.

SPECIES	FEEDING-HABITATS				
	Tidal Flats	Samphire Marsh	Rush Beds	Shallows (<1 metre)	Open Waters (including shallows)
Hoary-headed Grebe					X
Australian Pelican				X	
Black Cormorant					X
Little Black Cormorant					X
Pied Cormorant					X
Little Pied Cormorant					X
Darter					X
Brown Bittern			X		
Nankeen Night Heron				X?	
Reef Heron				margins	
White Egret		X	X		
White-faced Heron		X		X	
White Ibis		X			
Black Swan				X	
Mountain Duck				X	
Black Duck				X	
Grey Teal				X	
Chestnut Teal				X	
Blue-winged Shoveller				X	
Musk Duck					X
Whistling Eagle					X
White-breasted Sea Eagle					X
Swamp Harrier			X		
Osprey					X
Swamphen			X		
Coot				X	
Pied Oystercatcher	X				
Red-capped Dotterel	X				
Double-banded Dotterel	X				
Large Sand-dotterel	X				
Grey Plover	X				
Eastern Golden Plover	X				
Turnstone	X				
Whimbrel		X			
Eastern Curlew		X			
Greenshank	X	X			
Common Sandpiper	margins				
Grey-tailed Tattler	X				
Terek Sandpiper	X				
Knot	X				
Great Knot	X				
Sharp-tailed Sandpiper	X	X			
Pectoral Sandpiper		X			
Red-necked Stint	X				
Curlew Sandpiper	X				
Sanderling	X				
Bar-tailed Godwit	X				
Pied Stilt		X			
Silver Gull	X	X			X
Pacific Gull					X
Kelp Gull					X
Caspian Tern					X
Crested Tern					X
Fairy Tern					X
Rock Parrot		X			
Sacred Kingfisher				margins	
Little Grassbird			X		
TOTALS: 57	19	11	5	12	16

POSSIBLE EFFECTS OF DREDGING

Clearly, it is not possible to predict with certainty the effects which dredge-mining would have upon the Blackwood River Estuary's ecosystem without a thorough and detailed knowledge of the total biology of the plant and animal communities which that estuary contains. Equally obvious is the fact that this depth of knowledge could not be gained from an environmental study of only 12 months duration.

The extent to which dredging would affect each of the estuary's 57 species of waterbirds cannot, therefore, be stated with certainty. It is possible however, on the basis of knowledge gained from this and other related studies, to make some predictions as to which species or groups of species are most likely to be affected, and in what way.

Thus those species of birds which feed only in the samphire marshes and rushbeds of the estuary are unlikely to be adversely affected by dredging provided actual destruction of those habitats is not involved.

The effects which dredging would have on the feeding grounds and food supply of the tidalflat birds are more difficult to predict. Studies by other workers (e.g. Bent 1927, 1929; Reeder 1951; Thomas and Dartnall 1971) have shown that waders, like most other birds, are largely opportunistic feeders and will eat all suitable prey items as they are encountered. Thus the prey species taken are closely related to their abundance (Prater 1972).

Wallace (1975) found that only two species of macroinvertebrates were abundant in the surface sediments of the Lagoon tidalflats. They were the small bivalve mollusc, *Arthritica helmsii*, and the polychaete worm, *Ceratonereis erythraeensis*. Although *Arthritica* is large enough to be preyed upon by Red-necked Stint (Thomas and Dartnall ibid.), the much larger *Ceratonereis* would almost certainly have formed the bulk of the diet of the estuary's waders. In fact, polychaetes were often observed being dragged from their burrows by waders of all sizes from stint to plover.

Since dredge-mining would result in shoaling of the Lagoon shallows (Sass 1974), such activity might benefit the estuary's wader population by producing an increase in area of suitable feeding habitat - that is, an increase in area of the intertidal zone. On the other hand, increased sedimentation in the Lagoon could bury existing tidalflats, producing barren sandy wastes - exposed during all but the highest of tides and devoid of suitable invertebrate prey species.

Of all the species of waterbirds found on the estuary, the one which could be most seriously affected by implementation of the dredge-mining proposal is the Black Swan.

Although swan numbers are low during winter and spring, many hundredsmove to the estuary during summer, and at the end of February 1975, 700 birds were counted. This represented 9% of the total number of swans found on all estuaries of the south-west coast from Perth to Bremer Bay at that time. Clearly the Blackwood River Estuary is an important summer refuge for this species.

The swans of the Blackwood are almost entirely dependent upon the seagrass meadows of Swan Lake, the Channel, the Lagoon and the Blackwood Basin for their food supply (see Figure 3). When at peak numbers their food consumption was calculated at approximately 1.7 tonnes of *Ruppia* per day (Appendix 3). *Ruppia* consumption for the period July 1974 to June 1975 was estimated at approximately 230 tonnes.

If the Blackwood River Estuary is to continue to serve as an important refuge for the Black Swan, the all-important seagrass meadows will need to be maintained in their present productive condition. If dredge-mining were to seriously damage these meadows, either by preventing light penetration of the waters through increasing turbidity, or by burying the meadows under a layer of sediments, existing swan numbers could not be maintained.

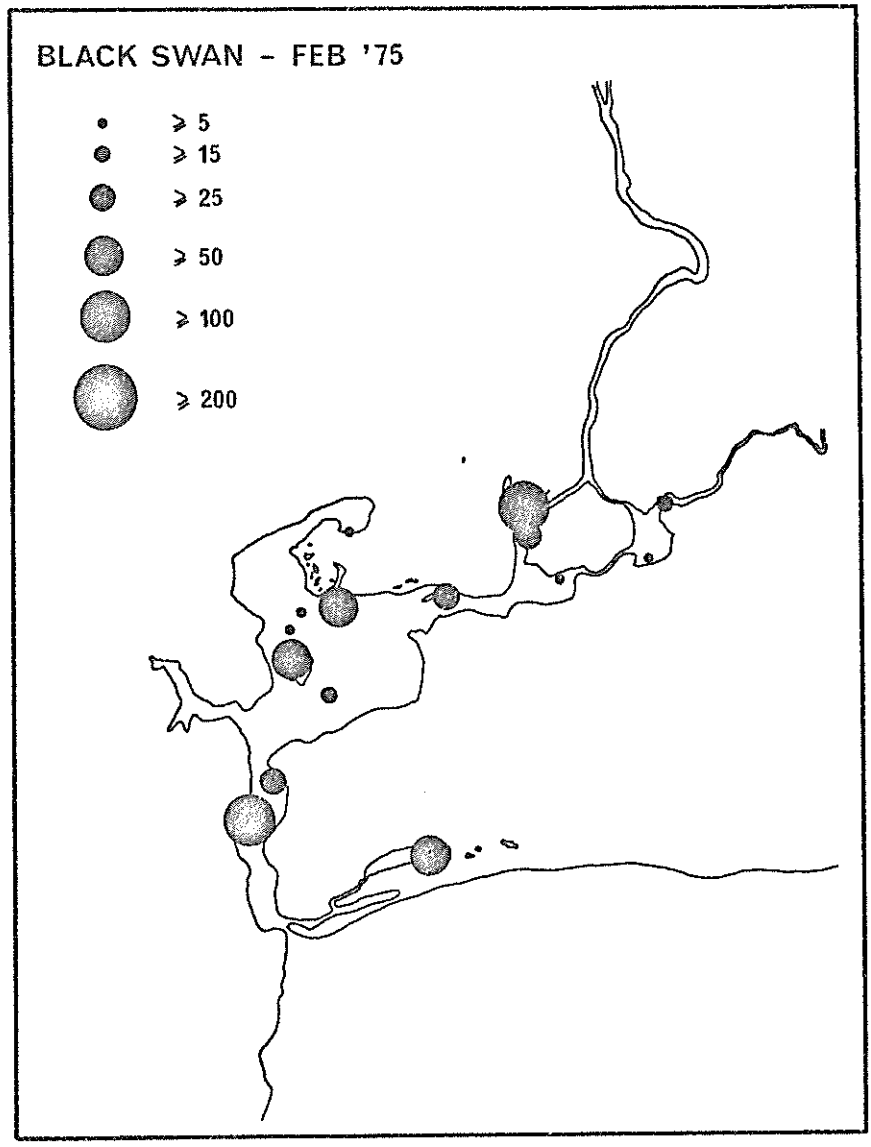

FIGURE 3. Numbers and distribution of Black Swans on 25th February 1975

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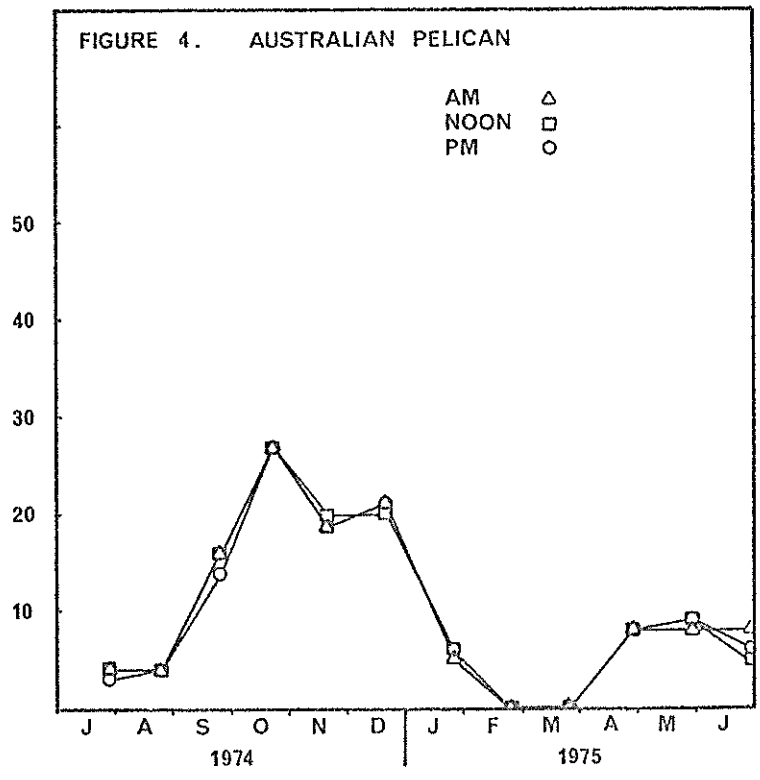
APPENDIX 1.

1. Hoary-headed Grebe *(Podiceps poliocephalus)* - Two birds were seen on the Scott Basin in May '74. A single bird was there in February '75.

2. Australian Pelican *(Pelecanus conspicillatus)* - Recorded on every visit, with a peak in numbers from September to December (Figure 4). Fewer birds were seen during autumn and winter. The late-summer exodus shortly preceded commencement of breeding in the north of the state (Shark Bay to the Joseph Bonaparte Gulf), and was probably related to that event. 60 birds which K. Back observed landing on the estuary at 1100 hours on 12th March '75 departed later the same day.



3. Black Cormorant *(Phalacrocorax carbo)* - Usually seen in flocks of 3 - 8 birds. In August 22 birds were observed fishing together in the Island Point area. Not an abundant cormorant.

4. Little Black Cormorant *(Phalacrocorax sulcirostris)* - The second most abundant cormorant. Usually seen in flocks of 10-40 birds. One flock of 85 birds was seen near Island Point in April '74.

5. Pied Cormorant *(Phalacrocorax varius)* - The least abundant cormorant. Single birds were often seen fishing in the Channel. Not recorded elsewhere on the inlet. Roosts either singly or in small groups at the mouth, Lion Islands, and rocks near Point Ellis. The largest fishing flock comprised 2 birds. Population reached a maximum of 10 birds in March '75.

6. Little Pied Cormorant *(Phalacrocorax melanoleucos)* - The most abundant cormorant; scattered over the entire inlet. Although usually seen feeding singly, feeding-flocks were occasionally formed, the largest of which comprised 90 Little Pied and 8 Little Black Cormorants. The total estuary population is thought to have been 250-400 birds.

7. Darter *(Anhinga rufa)* - Usually encountered around the deeper parts of the estuary, particularly where trees overhang the water's edge. Often seen resting on Lion Islands and rocks at Point Ellis; usually

single birds; however, on occasions as many as 5 were perching together. Appears to vacate the lower reaches of the estuary (Point Dalton and below) during late summer. Not an abundant species.

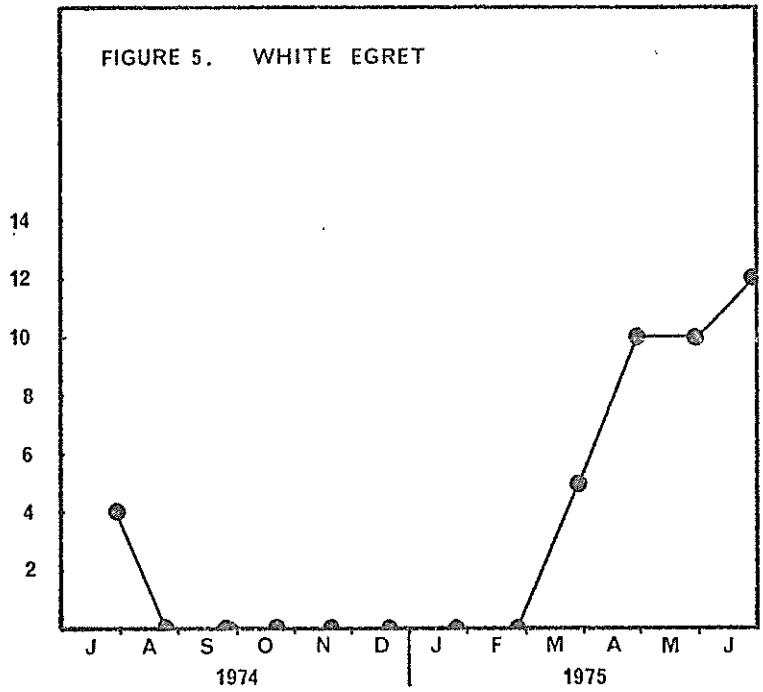
8. Brown Bittern *(Botaurus poiciloptilus)* - Appears to be a regular March visitor to the estuary. A single bird was flushed from the rushbeds of the Scott Basin in March '74 and again in March '75.

9. Nankeen Night Heron *(Nycticorax caledonicus)* - In March '74 about 20 birds were flushed from the *Melaleuca* which overhang the water's edge at Island Point. Not recorded again until January '75 when a similar number of birds was flushed from the same locality. A few birds continued to roost there until the end of April.

10. Reef Heron *(Egretta sacra)* - A single, grey-phase bird inhabited the entrance area from March to August '74 and from February to June '75. Recorded as far upstream as Point Irwin and the east end of the Deadwater. Usually seen resting or fishing around the shores of Seine Bay and the mouth. A second grey-phase bird was noted at the mouth in April '75.

11. White Egret *(Egretta alba)* - A regular autumn-winter visitor (Figure 5). The larger rushbeds

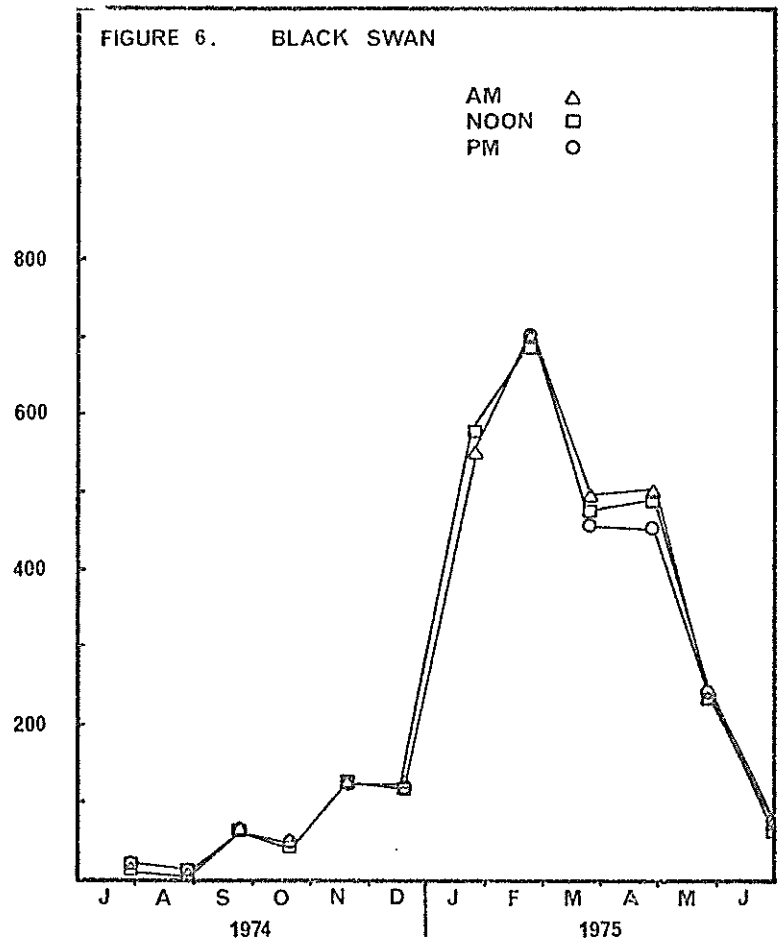
and the samphire marshes are preferred habitats.



12. White-faced Heron *(Ardea novaehollandiae)* - Seen around the entire shoreline of the estuary. Appeared to be most abundant from December to May, when flocks of 20-30 birds were common in the samphire marsh at the mouth of the Deadwater. A sudden influx of birds in December contained many juveniles. Very few birds were seen in July.

13. White Ibis *(Threskiornis molucca)* - A single bird was observed feeding in the samphire marsh at the mouth of the Deadwater in April '75. Two birds were feeding in the marsh of Thomas Island in June '75.

14. Black Swan *(Cygnus atratus)* - Recorded throughout the year with a peak in numbers from December to April (Figure 6). Numbers dropped sharply with the onset



of winter rains as most birds left the estuary for their breeding grounds. Only four pairs of swans nested on the inlet during 1974. Two nests were found in the swamps at the eastern end of Swan Lake, one near North Bay and another at Point Dalton. A single downy chick appeared on North Bay in September. The two cygnets of Point Dalton and three of Swan Lake left their nests in October. A further two cygnets left their nest on Swan Lake in November. Thus eight cygnets were raised to the downy stage.

15. Mountain Duck *(Tadorna tadornoides)* - Not abundant; the largest numbers recorded were 14 in September and January. All birds were observed in the Lagoon usually loafing near Sand Island. No ducklings were seen.

16. Black Duck *(Anas superciliosa)* - The most abundant bird on the estuary. Numbers were generally low from July to November, with 40 birds in the largest flock observed. A sudden influx occurred in December with 745 birds being counted (from photographs) during that month's air survey. One flock alone contained 277 birds. Numbers continued to rise during January and a single flock of 900-1000 birds was seen loafing on the northern edge of the Lagoon tidalflats at the end of the month. The total estuary population at that time was estimated to be 1,100 birds. Numbers dropped sharply during February. From March to June numbers continued to fall with the largest flocks being found in West Bay (120 in March, 70 in April and 9 in May). No ducklings were seen.

17. Grey Teal *(Anas gibberifrons)* - Usually seen in association with Black Duck, along the north shore of the inlet from Island Point to the Blackwood Basin. A few birds were noted from March to May '74. 4 were seen in September and 2 in October and November. About 60 birds were feeding in the Blackwood Basin in December, with similar numbers there in January. 10 birds were noted in February and none from March to June.

18. Chestnut Teal *(Anas castanea)* - A few birds were recorded occasionally. A male and 17 other "teal" were observed loafing on Sand Island in April '74.

Another male and 10 "teal" were loafing in the shallows to the north of Island Point in February '75. (The "teal" were either *gibberifrons* or female *castanea*; they were too far away for positive identification). Two females and a male were seen with a single Black Swan on the north-eastern side of the Lagoon in March '75.

19. Blue-winged Shoveller *(Anas rhynchotis)* - 3 Shovellers and 2 Grey Teal were loafing together at the edge of Sand Island in May '74. Two pairs of Shoveller were near Thomas Island in June '75.

20. Musk Duck *(Biziura lobata)* - Few birds were seen except during the months February to May '75 when 100, 180, 170 and 100 birds inhabited the Scott Basin. No other large flocks were encountered.

21. Whistling Eagle *(Haliastur sphenurus)* - Single birds and pairs were commonly observed around the estuary. Although this species is a carrion-eater, it also captures live fish. In January a "whistler" was seen to swoop low over the water near Point Irwin and grasp a fish about 20 cm in length in its talons. On another occasion a bird which was startled from its perch dropped a freshly killed Black Bream *(Mylio butcheri)*, the entrails of which it had eaten.

Two nests were found, one on Molloy Island and the other at Point Irwin. Both were situated high-up in vertical forks of trees.

22. White-breasted Sea Eagle *(Haliaeetus leucogaster)* - A single, adult bird was recorded from April to November '74 and again in February '75. It was usually seen on two or three occasions during each visit. An immature bird was observed flying over the inlet in December and January. An adult bird was observed again in June '75.

Two separate attempts to catch fish, one of which was successful, were noted.

23. Swamp Harrier *(Circus approximans)* - Single birds were recorded on one or two occasions during most visits. Almost invariably the bird would be seen sweeping low over the rushbeds of the Scott or Blackwood Basins, North Bay or Swan Lake. In March '74 a harrier was seen attacking a White-faced Heron. The harrier swept low over its quarry, knocking it into the water with its outstretched talons. No sooner did the heron regain flight than the harrier returned and knocked it to the water again. After almost ten minutes of repeated attacks the harrier apparently lost interest and flew off leaving a somewhat bedraggled heron perched mournfully on a log.

24. Osprey *(Pandion haliaetus)* - A pair of birds inhabited the estuary. Their nest was found in the fork of a dead Marri tree on Molloy Island in September. The nest is of stick construction, about 0.8 metres wide and deep, and approximately 10 metres above ground level. One or both birds were seen in the vicinity of the nest from August to January and were sitting on the nest from October to December.

25. Swamphen *(Gallinula porphyrio)* - Apparently frequents the estuary at the end of summer only. Two birds were seen in March '74: one in the rushes of the Blackwood Basin, the other on the banks of the Blackwood-Scott channel. In February '75 a bird was observed feeding in the rushes lining the south-west shore of Molloy Island. Another was seen feeding in the rushbeds of the Scott Basin in March '75.

26. Coot *(Fulica atra)* - 2 were seen in the Blackwood Basin in January and 8 in February; and 4 in the Scott Basin in March.

27. Pied Oystercatcher *(Haematopus ostralegus)* - Oystercatchers inhabited the estuary in low numbers throughout the year. Usually no more than 6 birds were recorded; however during January and February 10 were commonly observed feeding and resting on the Lagoon tidalflats.

A nest found near the samphire marsh at the mouth of the Deadwater on 25th September was inspected the following day. It was positioned on top of a small clump of samphire and was constructed from dry strands of seaweed. It contained two eggs, both of which had commenced pipping. Two chicks hatched and were banded on 30th October, at which time one was able to fly over short distances. The nest and chicks were attended by both parent birds, one of which was readily identified by its hobbling gait, caused by a deformed right foot.

A second pair of oystercatchers frequented the southern shore of the Deadwater from August to December and are

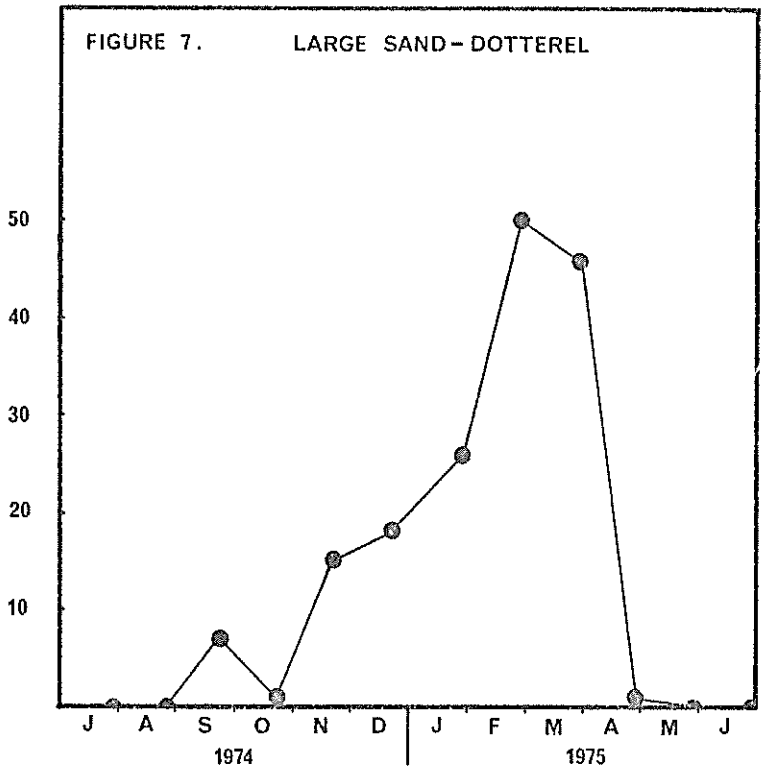
believed to have nested in that area. On one occasion (November) both birds were seen pursuing a White-breasted Sea Eagle which had flown over their territory. Their nest was not located.

28. Red-capped Dotterel *(Charadrius ruficapillus)* - The most abundant dotterel. Plentiful on the Lagoon tidalflats during the summer months, particularly February when the estuary population was estimated at 220 birds. Feeds over the exposed flats at low tide in mixed flocks with other dotterel, stint and sandpiper. Rarely seen elsewhere on the inlet. Winter exodus was complete. Only one bird was recorded in May '74 and two in September '74.

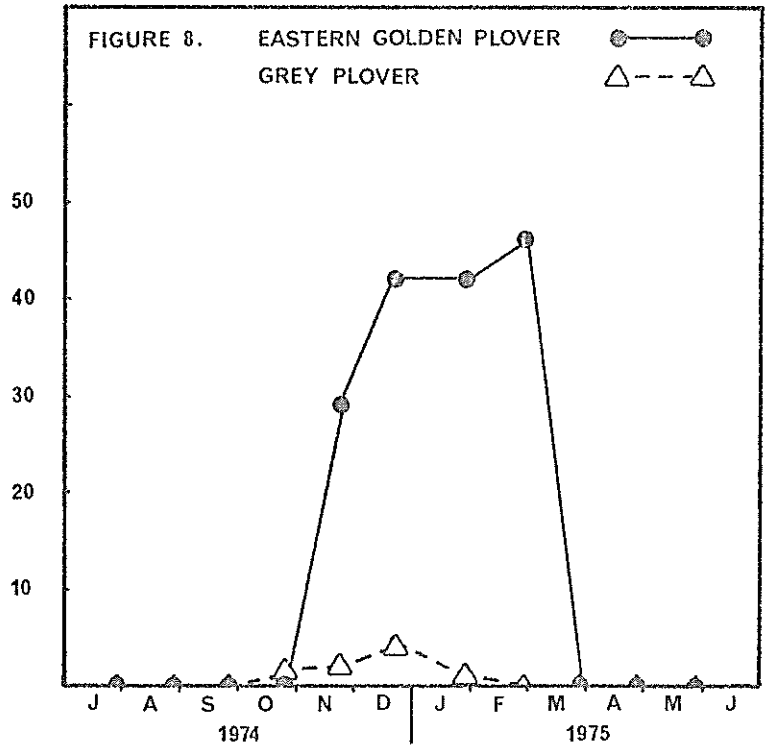
29. Double-banded Dotterel *(Charadrius bicinctus)* - Appears to be a regular March - April visitor to the estuary. One bird was seen on Sand Island in March '74, and two on the Lagoon tidalflats in April '74. Single birds were seen at the mouth and on Sand Island in March and April '75.

30. Large Sand-dotterel *(Charadrius leschenaultii)* - Most abundant during February and March '75 when about 50 birds frequented the Lagoon tidalflats (Figure 7). Rarely seen elsewhere on the inlet. One bird observed in February was in breeding plumage: black band through the eye, rufous crown

and nape, and a narrow rufous band across the chest.



31. Grey Plover *(Pluvalis squatarola)* - A few birds were recorded (Figure 8). These were usually seen on the Lagoon tidalflats or Sand Island with *P. dominica*.



32. Eastern Golden Plover *(Pluvialis dominica)* - The most abundant plover. Inhabited the estuary from November to February when the population reached a peak of 46 birds (Figure 8). Plover were only encountered on the Lagoon tidalflats, usually in a single flock. At high tide the birds gathered on Sand Island.

33. Turnstone *(Arenaria interpres)* - One bird was observed with a small party of stint and Large Sand-dotterel on the south-west shore of the Deadwater on 24th September. Another was noted with a Grey Plover on the Lagoon tidalflats, 23rd October.

34. Whimbrel *(Numenius phaeopus)* - Recorded on most visits with a maximum of 6 birds in July. Usually observed feeding in the samphire marsh at the mouth of the Deadwater although occasionally birds were seen on the south shore of the Deadwater or on the tidalflats of the Channel.

The burrowing shore crab, *Leptograpsodes ostodentatus*, abounds in the samphire marsh and appeared to form a large part of the Whimbrels' diet.

35. Eastern Curlew *(Numenius madagascariensis)* - A single bird was feeding in the Deadwater samphire marsh during the surveys of May and July '74. The species was not recorded again until February '75

when another bird was observed, firstly in Seine Bay, and then on the Lagoon tidalflats. One bird was feeding in the samphire marsh again in June '75.

36. Greenshank *(Tringa nebularia)* - Greenshank were common on the Lagoon tidalflats, Lion Islands, and the eastern end of the Deadwater. During exceptionally low tides they were also found around the muddy shores of Swan Lake, the Channel, the Lagoon, the Blackwood Basin and Molloy Island - in fact, wherever there was exposed mud or water sufficiently shallow to wade in.

Most birds were extremely wary and an accurate census was impossible. Some idea of their numbers could be gained, however, from the size of flocks and the frequency at which they were encountered. No birds were seen from May to August '74. Maximum flock sizes during succeeding months were: September - 6, October - 8, November - 18, December - 45, January - 32. Numbers were still high in February; fewer birds were seen in March, and only four in April. None were recorded in May and only one in June. The total estuary population in December '75 was estimated to be no more than 90 birds.

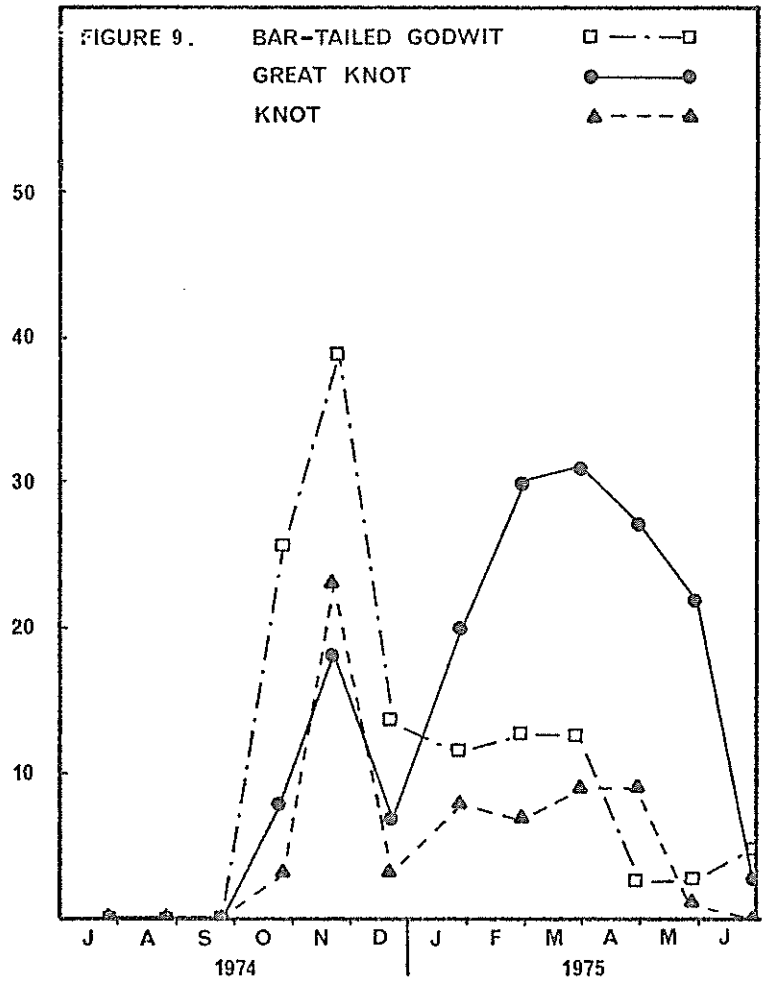
37. Common Sandpiper *(Tringa hypoleucos)* - Present in low numbers during most months of the year. The largest flocks encountered were: October - 6, November - 4, and January - 9. Occasional sightings were made in West Bay and the Channel, however most birds were seen on the shores and samphire marsh of the Deadwater. The total population is unlikely to have numbered more than 20 birds at any time.

38. Grey-tailed Tattler *(Tringa brevipes)* - One bird was collected in the Deadwater on 23rd October. Another Tattler was noted later the same day on the man-made gravel spit just north of Lion Islands. Two Tattlers were resting on the spit in November. Although only the collected bird could be positively identified as *T. brevipes*, it is probable that the other three birds observed were also of that species, and not *T. incana* (Wandering Tattler).

39. Terek Sandpiper *(Tringa cinerea)* - One bird was noted on the Lagoon tidalflats with a flock of stint on 20th November. It was also seen there the following day with a flock of 29 Eastern Golden Plover.

40. Knot *(Calidris canutus)* - Always observed in mixed flocks with *C. tenuirostris*. Birds of both species fed on the Lagoon tidalflats at low tide and rested on Sand Island or the ocean beach at high tide. Population reached a peak in November when 23 birds inhabited the estuary (Figure 9).

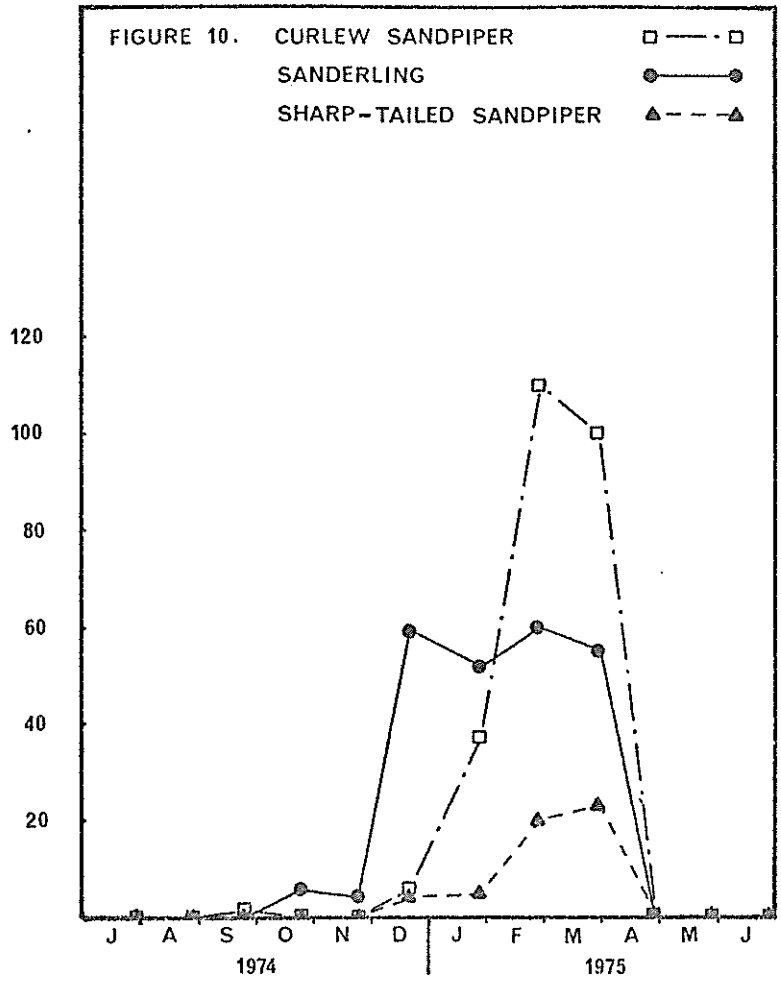
41. Great Knot *(Calidris tenuirostris)* - See Knot comments above. Population reached a maximum of 31 birds in March '75 (Figure 9). On 29th January it was noticed that 2 of 20 birds feeding on the Lagoon tidalflats wore leg-bands. One of these birds was collected later that day. Examination of the band number revealed that it was one of 20 Great Knot banded by the author on the Swan River



(Perth) on 28th March '74. On each succeeding visit until (and including) May '75, a single bird was observed to be wearing a band on its right leg. Since only 33 Great Knot have been banded in Western Australia during the past 15 years (all on the Swan River) it is almost certain that all sightings were of the same bird.

42. Sharp-tailed Sandpiper *(Calidris acuminata)* - Three birds were noted in the Thomas Island samphire marsh in March '74. Small numbers were observed on the Lagoon tidalflats, usually in mixed flocks with

stint, from December to March (Figure 10).



43. Pectoral Sandpiper *(Calidris melanotos)* - One bird was feeding in the Thomas Island samphire marsh with 3 *C. acuminata* and 1 *C. ferruginea* on 22nd March '74. It was there again two days later. This species is easily distinguished from *acuminata* by the yellow base of its bill (*acuminata's* bill is all black), and the sharp border between its heavily streaked breast and white abdomen (*acuminata's* border is less distinct).

44. Red-necked Stint *(Calidris ruficollis)* - The most abundant sandpiper. 700 birds inhabited the estuary in February and March (Figure 11). During September and October many birds fed on the mudflats at the eastern end of the Deadwater as well as on those of the Lagoon. From November to April the only feeding area was the Lagoon tidalflat, except for rare occasions when a few birds were seen on the shores of the Deadwater. At high tide the stint rested either on Sand Island or on the ocean beach. The beach at Point Frederick, with its many windbreaks of washed-up seaweed, was a popular resting place during late summer.

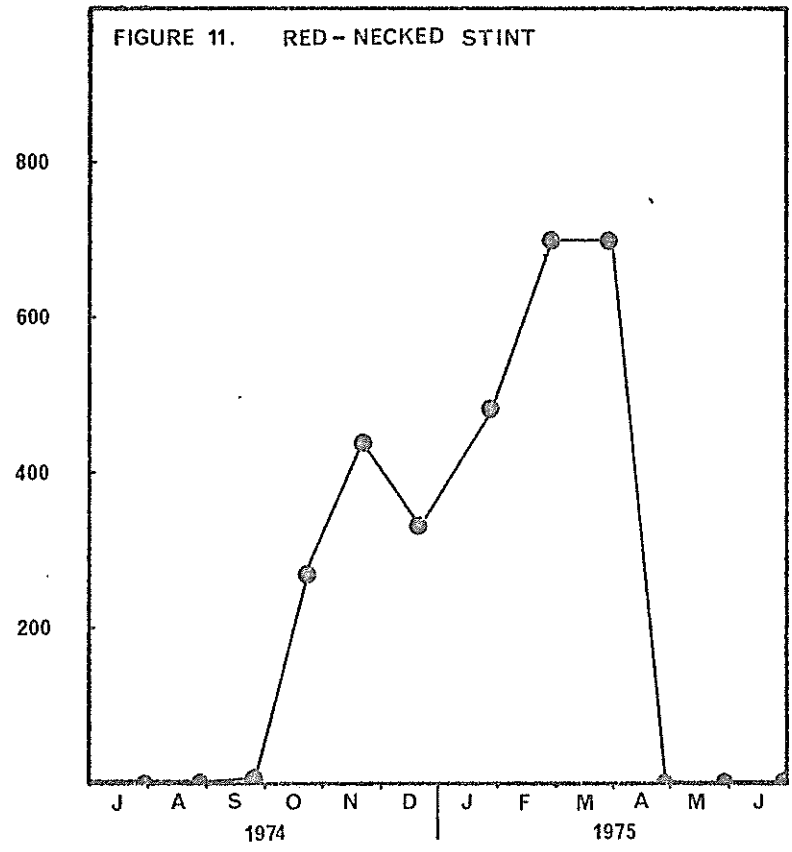


FIGURE 11. RED-NECKED STINT

45. Curlew Sandpiper *(Calidris ferruginea)* - Recorded in low numbers until late summer when more than 100 birds inhabited the estuary (Figure 10). Usually seen in mixed flocks with stint and dotterel, either on the Lagoon tidalflats, or resting on Sand Island or the beach at Point Frederick.

46. Sanderling *(Crocethia alba)* - A flock of approximately 60 Sanderling inhabited the inlet from December to March (Figure 10). At low tide they fed on the Lagoon tidalflats with stint and dotterel. When feeding activities ceased the birds usually rested in a compact flock on Sand Island. During late summer they also rested on the beach at Point Frederick along with many other small waders of the estuary.

47. Bar-tailed Godwit *(Limosa lapponica)* - Reached peak abundance in November when 38 birds inhabited the inlet (Figure 9). From September to April godwit fed on the Lagoon tidalflats and rested in the shallows near Sand Island. During May '75 and April - May '74 they also fed along the water's edge at Point Frederick and the samphire marsh at the mouth of the Deadwater.

48. Pied Stilt *(Himantopus himantopus)* - One bird was noted in the Deadwater samphire marsh on 27th April '74.

49. Silver Gull *(Larus novaehollandiae)* - Plentiful. The only large influx of juvenile birds occurred during September and October.

50. Pacific Gull *(Larus pacificus)* - A single adult bird was observed resting at the mouth on 28th August. When put to flight the bird's black, sub-terminal tail-band was conspicuous.

51. Kelp Gull *(Larus dominicanus)* - An immature bird was observed washing and preening in the shallows at the mouth on 31st July. On the 27th and 28th August, another immature was observed resting at the mouth and flying over the Deadwater in search of food. The slender, uniform-blackish bill of this bird was compared with the more robust bill of the adult Pacific Gull standing nearby.

52. Caspian Tern *(Sterna caspia)* - Commonly seen fishing around the estuary. Rests on Sand Island and at the mouth. Many juvenile birds appeared during September and October. Not as abundant as the Crested Tern; resting flocks rarely exceeded 20-25 birds.

53. Crested Tern *(Sterna bergii)* - The most abundant tern. Seen fishing over the entire estuary. 220 birds were roosting with Caspian Terns and Silver Gulls at the mouth on 29th April '75.

54. Fairy Tern *(Sterna nereis)* - Present in low numbers for a few months of the year. Most abundant in October when 15 birds were noted resting at the mouth. Of the 10 birds recorded in February, 4 were juveniles being fed by adults.

55. Rock Parrot *(Neophema petrophila)*- This species was commonly observed feeding in the samphire marsh at the mouth of the Deadwater. 13 birds were there in April '74 and about 50 in May. Rock Parrots vacated the estuary until February '75 when 50 birds were noted. Similar numbers were there in March; however numbers subsequently dropped to 5 in April and 2 in May and June.

56. Sacred Kingfisher . *(Halcyon sancta)* - Single birds were seen fishing or perching near the water's edge. Usually encountered around the western shores of the Deadwater and the entrance to Swan Lake. Also seen near Lion Islands and Point Ellis. A group of 3 was noted on the north bank of the Deadwater mouth in May '75. Appears to vacate the estuary in spring and summer.

57. Little Grassbird *(Megalurus gramineus)* - Recorded all year round in the rushbeds of Thomas Island and Point Pedder. Two nests found on Thomas Island in September appeared to have been recently constructed, however they did not contain eggs or young. In October and November they were unattended and collapsing. Another empty nest was found in the rushes of Point Pedder in September '74.

APPENDIX 2.

A COMPARISON OF THE BLACKWOOD RIVER ESTUARY AND LESCHENAULT INLET SPECIES LISTS.

SPECIES	BLACKWOOD (Jul '74 - Jun '75)	LESCHENAULT (Jul '73 - Jun '74)
Hoary-headed Grebe *(Podiceps poliocephalus)*	X	X
Australian Pelican *(Pelecanus conspicillatus)*	X	X
Black Cormorant *(Phalacrocorax carbo)*	X	X
Little Black Cormorant *(Phalacrocorax sulcirostris)*	X	X
Pied Cormorant *(Phalacrocorax varius)*	X	X
Little Pied Cormorant *(Phalacrocorax melanoleucos)*	X	X
Darter *(Anhinga rufa)*	X	X
Brown Bittern *(Botaurus poiciloptilus)*	X	
Nankeen Night Heron *(Nycticorax caledonicus)*	X	X
Reef Heron *(Egretta sacra)*	X	
White Egret *(Egretta alba)*	X	X
White-faced Heron *(Ardea novaehollandiae)*	X	X
White Ibis *(Threskiornis molucca)*	X	
Straw-necked Ibis *(Threskiornis spinicollis)*		X
Black Swan *(Cygnus atratus)*	X	X
Mountain Duck *(Tadorna tadornoides)*	X	X
Black Duck *(Anas superciliosa)*	X	X
Grey Teal *(Anas gibberifrons)*	X	X
Chestnut Teal *(Anas castanea)*	X	X
Blue-winged Shoveller *(Anas rhynchotis)*	X	X
Musk Duck *(Biziura lobata)*	X	X
Whistling Eagle *(Haliastur sphenurus)*	X	X
White-breasted Sea-Eagle *(Haliaeetus leucogaster)*	X	
Swamp Harrier *(Circus approximans)*	X	X
Osprey *(Pandion haliaetus)*	X	X
Dusky Moorhen *(Gallinula tenebrosa)*		X
Swamphen *(Gallinula porphyrio)*	X	X
Coot *(Fulica atra)*	X	
Pied Oystercatcher *(Haematopus ostralegus)*	X	X
Red-capped Dotterel *(Charadrius ruficapillus)*	X	X
Double-banded Dotterel *(Charadrius bicinctus)*	X	
Large Sand-dotterel *(Charadrius leschenaultii)*	X	X
Grey Plover *(Pluvialis squatarola)*	X	X
Eastern Golden Plover *(Pluvialis dominica)*	X	
Turnstone *(Arenaria interpres)*	X	X
Whimbrel *(Numenius phaeopus)*	X	X
Eastern Curlew *(Numenius madagascariensis)*	X	X
Greenshank *(Tringa nebularia)*	X	X
Common Sandpiper *(Tringa hypoleucos)*	X	X
Grey-tailed Tattler *(Tringa brevipes)*	X	X
Terek Sandpiper *(Tringa cinerea)*	X	X
Knot *(Calidris canutus)*	X	X
Great Knot *(Calidris tenuirostris)*	X	X
Sharp-tailed Sandpiper *(Calidris acuminata)*	X	X
Red-necked Stint *(Calidris ruficollis)*	X	X
Curlew Sandpiper *(Calidris ferruginea)*	X	X
Sanderling *(Crocethia alba)*	X	
Bar-tailed Godwit *(Limosa lapponica)*	X	X
Pied Stilt *(Himantopus himantopus)*		X
Avocet *(Recurvirostra novaehollandiae)*		X
Silver Gull *(Larus novaehollandiae)*	X	X
Pacific Gull *(Larus pacificus)*	X	
Kelp Gull *(Larus dominicanus)*	X	X
Caspian Tern *(Sterna caspia)*	X	X
Crested Tern *(Sterna bergii)*	X	X
Whiskered Tern *(Sterna hybrida)*		X
Fairy Tern *(Sterna nereis)*	X	
Rock Parrot *(Neophema petrophila)*	X	
Sacred Kingfisher *(Halcyon sancta)*	X	X
Little Grassbird *(Megalurus gramineus)*	X	X
White-faced Chat *(Epthianura albifrons)*		X
TOTALS:	61	55	50

APPENDIX 3.

FOOD CONSUMPTION OF THE BLACK SWAN *(Cygnus atratus)*.

1. Standard Metabolic Rate of Black Swan = 287 Kcal/bird day (using data of Zar, J.H. 1968. Standard metabolism comparisons between orders of birds. *Condor* 70 (3) : 278).

2. Assuming energy consumption of wild swan is 2 x SMR = 574 Kcal/bird day.

3. Calorific value of *Ruppia maritima* = 3.24 Kcal/g dry wt. (Congdon *pers. comm.*).

4. Assuming 50% digestibility of *Ruppia* by swan

5. Then wild swan required 354 gms dry wt *Ruppia*/day

6. Wet wt. *Ruppia* = 7 x dry wt.
   = 2.48 kg wet wt. *Ruppia*/swan/day.

7. Therefore consumption of 700 swans
   = 1.7 tonnes wet wt. *Ruppia*/day.

8. Consumption from 1 Jul '74 to 30 Jun '75
   = 2.48 x 94,727
   = 230 tonnes wet wt. *Ruppia*.

   (94,727 is number of swan Days, and is calculated by multiplying each monthly count by the number of days since the last count and then summing).