Report No: P WMA 19/G10/00/2413/3

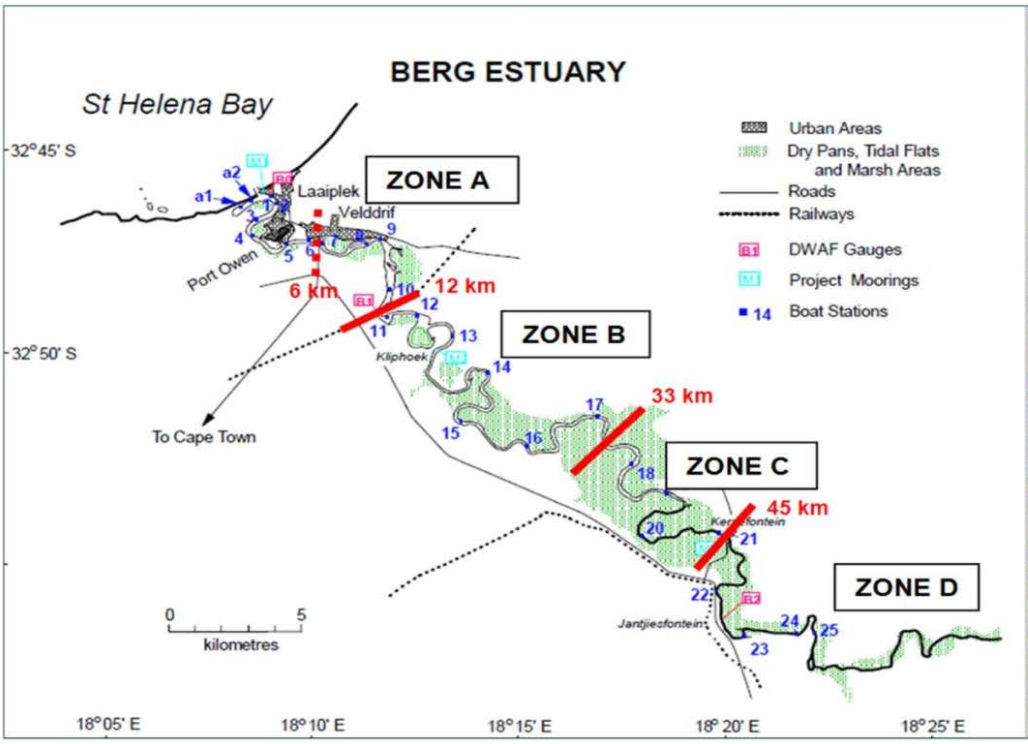
Department of Water Affairs
Directorate: Options Analysis

PRE-FEASIBILITY AND FEASIBILITY STUDIES FOR AUGMENTATION OF THE WESTERN CAPE WATER SUPPLY SYSTEM BY MEANS OF FURTHER SURFACE WATER DEVELOPMENTS

REPORT No.1 – VOLUME 3
Berg Estuary Environmental Water Requirements

APPENDIX No.H

Specialist Report - Birds




June 2012

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PWMA19 G10/00/2413/7

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1 INTRODUCTION

The Berg River is one of only three permanently-open estuaries on the west coast of South Africa. It is also in the top ten percent of South African estuaries in terms of its size. Some 127 water-associated species (passerine and non-passerine), have been recorded on the estuary and adjacent floodplain (Hockey 1993). Cooper *et al*. (1976) and Ryan *et al*. (1988) recognised the Berg River estuary, with its associated floodplain wetlands, as being of international importance for waterbirds. Indeed, the estuary and wetlands support the highest recorded density of shorebirds on the East Atlantic Seaboard (Velasquez *et al*. 1991, Hockey *et al*. 1992), as well as significant populations of several threatened bird species (Murison & Hockey 2002), including African Marsh Harrier and Caspian Tern (*Nationally threatened/vulnerable*), Lesser Flamingo, Black Harrier and African Black Oystercatcher (*Globally near-threatened*) and Eastern White Pelican, Cape Cormorant, Greater Flamingo, Greater Painted Snipe, Chestnut-banded Plover (*Nationally near-threatened*). The estuary, has been recognised as being the most important estuary in South Africa in terms of its waterbird populations (Turpie 1995), and is a top priority in terms of its overall biodiversity conservation importance (Turpie *et al*. 2002). In a recent update of the importance rating of South African estuaries, taking into account estuary type, size, biogeographic zone, habitat areas, invertebrates, fish and birds, the Berg River was rated as third in the country in terms of conservation importance (Turpie & Clark 2007).

Nevertheless, increasing demands on water for domestic, industrial and agricultural use in the Western Cape have necessitated approval of the construction of the Berg River Dam. The consequence of this will be reduced freshwater input into the lower floodplain wetlands and estuary, which may alter habitat and food resources for waterbirds.

This report was compiled as part of an Ecological Water Requirements study of the Berg River estuary commissioned by Department of Water Affairs: Resource Directed Measures. The EWR study was undertaken as part of a process to determine the future flow requirements of the estuary. The aims of this report were to (a) describe the avifauna of the lower floodplain wetlands and estuary, and (b) describe flow-related and non-flow-related factors that are key drivers of bird abundance and community composition to be taken into account in the assessment of hypothetical future flow scenarios. .

2 DATA SOURCES

This study is based on a desktop review of the literature and analysis of bird counts made under the Co-ordinated Waterbird Counts (CWAC) volunteer programme and earlier counts conducted by researchers on the estuary, recent monthly count data, as well as field visits and counts conducted as part of a baseline study conducted for the estuary (Anchor Environmental and Freshwater Consulting Group, 2007). The baseline study contains detailed reports on all biophysical aspects of the estuary, including a more comprehensive coverage on birds than is presented here (Turpie 2007).

The earliest published count of the Berg estuary is from January 1976 (Summers *et al*. 1976), though this count was restricted to wader species in the lower estuary up to the railway bridge, some 5.5 km from the mouth. Later on, a series of monthly waterbird counts were made in the lower estuary up to the railway bridge between September 1987 and April 1989 (Velasquez *et al*. 1991), spanning two austral summers and one winter. This is the part of the estuary where intertidal areas, and hence waders, are most abundant.

The first comprehensive count of the full length of the estuary and floodplain wetlands was carried out in December 1992 (Hockey 1993). The CWAC counts have been conducted twice per year (mid-summer and mid-winter) since 1994. The CWAC counting sections are described in Figure 2.1.

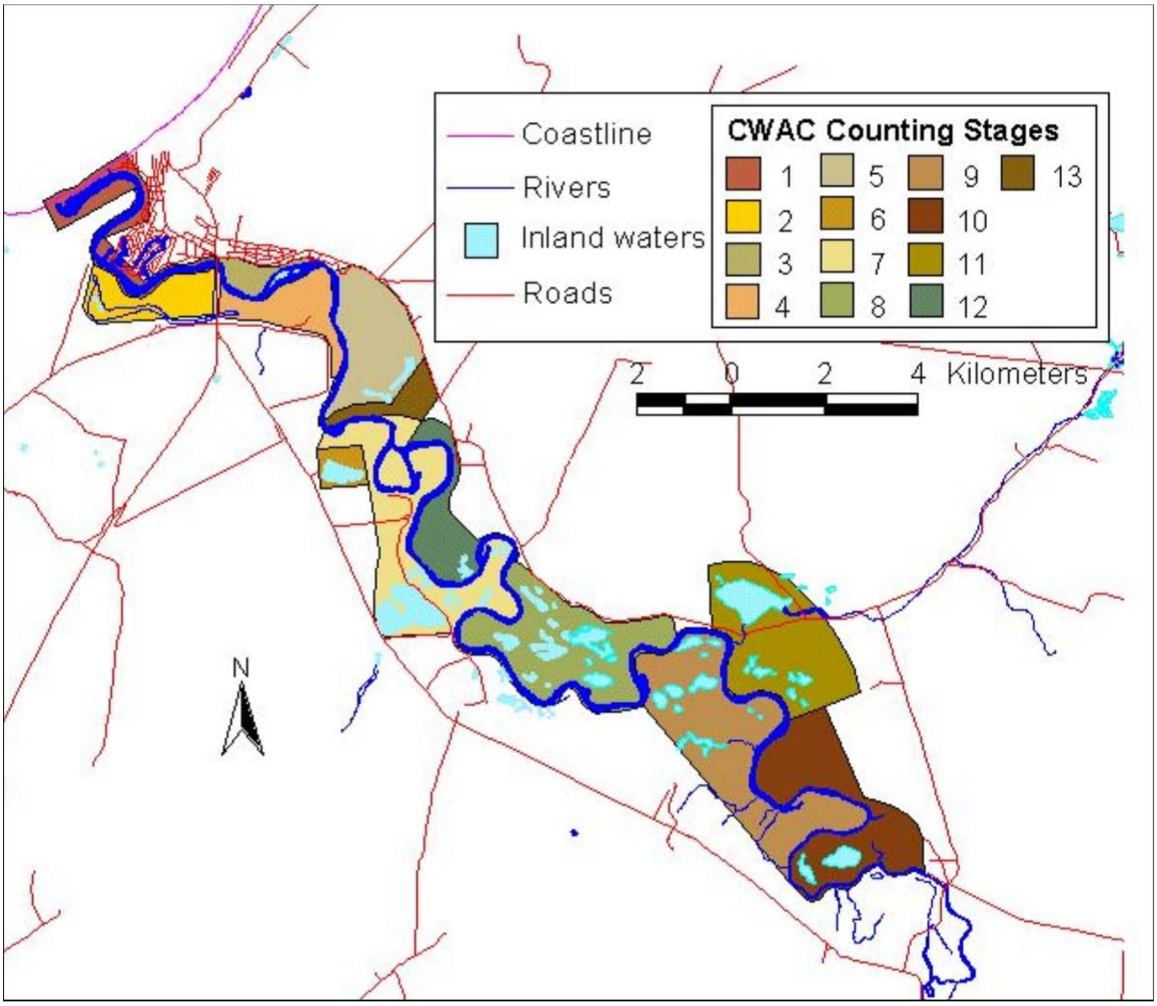


Figure 2.1 Counting sections for the bi-annual CWAC counts

Seasonal data were obtained from Murison & Hockey (2002), who conducted twice-monthly counts (at high tide and low tide each month) of the whole estuary and floodplain from March 2000 to February 2001, and augmented by counts undertaken as part of this study in September, October and November 2005 with the assistance of the usual volunteer counters of the CWAC counts.

This study concentrates on non-passerine water-associated species, and excludes exotic species (e.g. Mallard Duck), vagrant species (e.g. Rednecked Phalarope) and extralimital species (e.g. Fulvous Duck) recorded on the estuary.

3 DESCRIPTION OF WATERBIRD HABITATS

The Berg estuary is about 65km long, based on the extent of tidal influence (Slinger & Taljaard 1994), although seawater does not penetrate this far. The estuary as defined by the RDM study (and most literature) includes both an estuary proper, and the lower floodplain wetlands of the Berg River that lie adjacent to the estuarine part of the river. The floodplain wetlands are inundated by fresh floodwaters, and not reached by the salt water that occasionally penetrates to near the top of the estuary. The rest of the estuary has a salinity gradient and fluctuates in salinity from a predominantly freshwater state in winter to a predominantly saline state during the summer low flow period.

Vegetation of the estuary is described in detail by Boucher & Jones (2007) and Adams (this volume, Appendix E). The habitats for waterbirds are shown in Figure 3.1. These comprise the main river channel, intertidal mudflats[1], intertidal and floodplain saltmarsh, reed and sedge marshes, ephemeral pans and artificial salt works. Exotic trees along the river banks provide additional habitat for waterbirds.

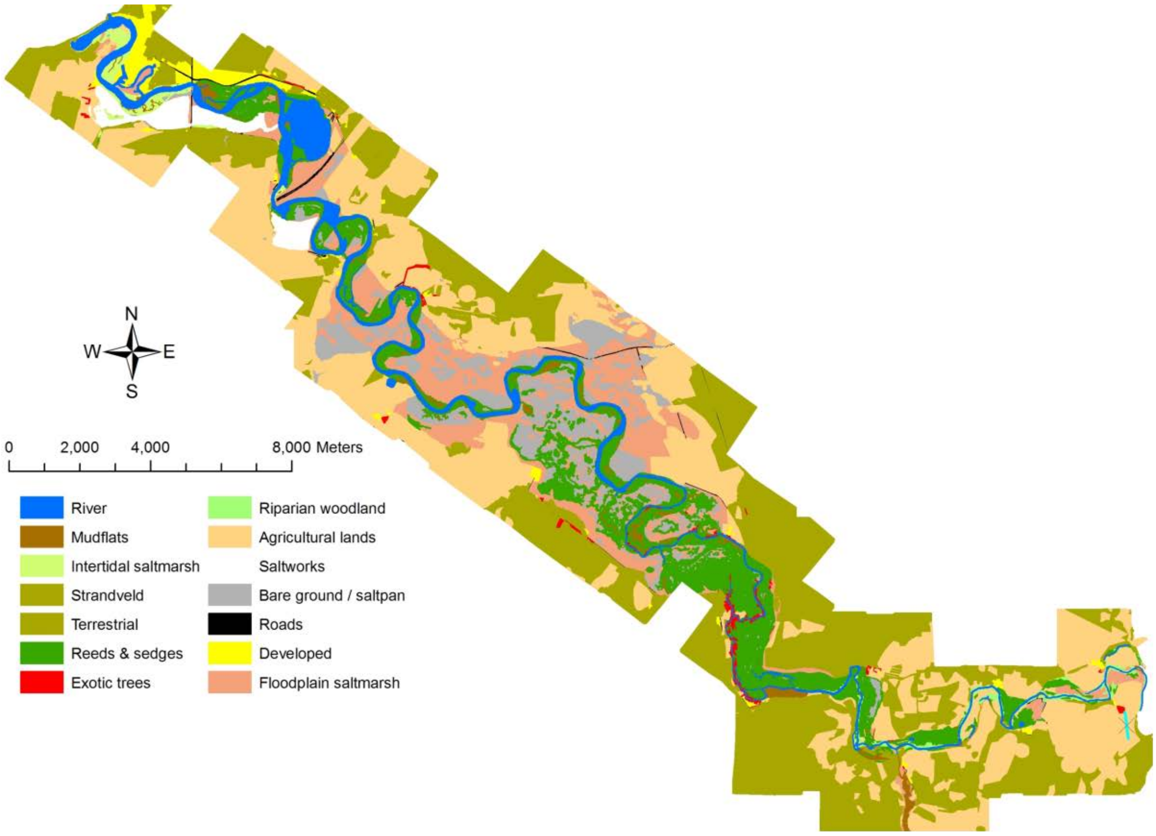


Figure 3.1 Main vegetation types of the Berg River estuary. The mouth of the estuary is at the top left.

The estuary channel varies in width from about 20 m at the head of the estuary to the widest point of 300 m in the lower estuary. The lower estuary is about 6 metres deep at its maximum. The water volume decreases upstream, as does salinity. The channel bottom is dominated by eelgrass *Zostera capensis* in the lower half of the estuary, and is replaced by fonteingras *Potamogeton pectinatus* in the upper estuary. Water hyacinth *Eichhornia crassipes* is a problem in the upper reaches.

Because of its permanently open status, the estuary supports a relatively large area of intertidal habitat which is important foraging area for waders and roosting area for a number of species. The intertidal habitat and shallow subtidal habitat has a variable cover of eelgrass *Zostera capensis* and the filamentous alga *Enteromorpha* sp. which is particularly abundant in spring and dies back during summer. The mudflats are also periodically covered by alien Water Hyacinth *Eichhornia crassipes*, which is deposited after flooding (see Clark *et al*. 2007). This cover affects the abundance and accessibility of invertebrates, and thus affects avian foraging. At least 25 species of benthic macroinvertebrates have been recorded from the intertidal mudflats of the Berg River estuary (Kalejta & Hockey 1991, Wooldridge 2007).

[1] Note that some of the intertidal mudflats are represented as river, possibly due to tidal conditions.

The estuary also contains a large area of saltmarsh which is significant at a national scale. Saltmarshes occur both intertidally and supratidally and these are characterised by different species with different tolerances. Intertidal saltmarshes are mostly found in the area below the railway bridge. The intertidal saltmarshes are dominated by *Sarcocornia perennis* (brakbos), *Bassia diffusa* (formerly *Chenolea diffusa)* (soutbos), *Spartina maritima* (cord grass) (Boucher & Jones 2007) and mainly supports gastropods, isopods and amphipods (Murison & Hockey 2002). In addition, the floodplain contains extensive areas of supratidal saltmarsh, characterised by *Sarcocornia pillansii* (brakbos) and Scattered *Salicornia meyeriana* (glasswort) shrublets (Boucher & Jones 2007).

Marshes are the most abundant habitat type on the estuary and floodplain, and are dominated by tall stands of reeds *Phragmites australis* (about 2 – 4 m). Reed marsh is typically found on saturated silty soils, particularly on the inner bends of the river.

Shorter sedge marshes (usually about 0.5 – 1m high), are characterised by biesie *Juncus krausii*, *Scirpus* spp but also include a variety of other species such as *Sarcocomia perennis* (brakbos) *Samolus porosus* (samolus), *Nidorella foetida* (nidorella) and *Sporobolus virginicus* (brakgras) Boucher & Jones 2007). . The marshes are typically adjacent to the river channel, with all of them lying under 0.5m (Hockey 1993, Boucher & Jones 2007).

These natural pans generally occur in the floodplains associated with the upper estuary. They are largely freshwater habitats and inundated during winter floods. The pans are usually flooded in June to August, and dry out by mid summer. The pans are distributed between flooding levels of 0.5 and 4m, with the majority being above the 1.5-m contour (Hockey 1993). Most pans are bare, but some contain sedges, typically *Juncus maritimus,* and waterblommetjies *Aponogeton distachyos* after rains. Scattered *Salicornia meyeriana* (glasswort) shrublets (to about 0.25 metres) are generally the only noticeable groundcover during the dry season (Boucher & Jones 2007). The pans contain very little in the way of invertebrate or fish biomass (Wooldridge 2007; Clark 2007).

There are extensive areas of commercial saltpans on the Berg River estuary, most of which have replaced saltmarsh areas. All of the artificial pans are found below the 1.5-m contour (Hockey 1993). Seawater is pumped into the saltpans and they are allowed to dry by evaporation. The saltpans are all in various stages of this process, and thus offer a variety of habitats to birds, ranging from deepwater pans to exposed shorelines and hypersaline pans. Benthic invertebrates are abundant in pans of 30 – 60 ppt, particularly chironomid fly larvae, polychaetes, amphipods and mudprawns *Upogebia africana* (Murison & Hockey 2002). Brine shrimps *Artemia* sp are abundant in extremely high salinity pans (>100 ppt).

The artificial wetlands of the study area support a variety of birds, depending on their salinity and stage of evaporation. Those that fill with freshwater attract waterfowl and some terns, while those filled with pumped seawater tend to attract gulls and terns. As the saltpans dry out, waders are attracted to the newly-exposed shorelines and shallow water habitats. When conditions favour chironomid larvae, the pans can support extraordinary densities of waders, particularly small species such as Curlew Sandpiper (Hockey *et al*. 1998). Greater Flamingos appear as salinities increase, feeding on brine shrimp. Lesser Flamingos are tolerant of a higher salinity range, and feed on phytoplankton. When dry, the pans are used by resident waders, mainly Chestnut-banded Plover, Kittlitz's Plover and Whitefronted Plover.

4 SPECIES RECORDED ON THE ESTUARY

Excluding exotic and vagrant species, some 93 non-passerine waterbird species have been recorded in seasonal counts of the estuary. CWAC counts since 1994 have gradually increased the total number recorded from about 70 to 93, with cumulative species richness levelling off after 8 years of bi-annual counts. An average of 62.6 (± 4.5) and 60.5 (± 15.7) species have been recorded in summer and winter CWAC counts, respectively (1994 – 2006). Some 42 species were recorded in at least 90% of CWAC counts, and 36 species occurred in fewer than 25% of counts. Including vagrants and exotics, Hockey (1993) recorded 79 species in a single December count. Velasquez *et al*. (1991) recorded a cumulative total of 84 waterbird species in series of 21 monthly counts, with 28 species occurring in 25% or less of all counts. In both monthly and interannual counts, the large proportion of species occurring in a small proportion of counts suggests that stand-alone counts would provide a rather unreliable indication of the species using an estuary. Nevertheless, it is arguable that the species occurring less frequently are also less reliant on the estuary. There has been no change in species richness over the CWAC count period (Figure 4.1).

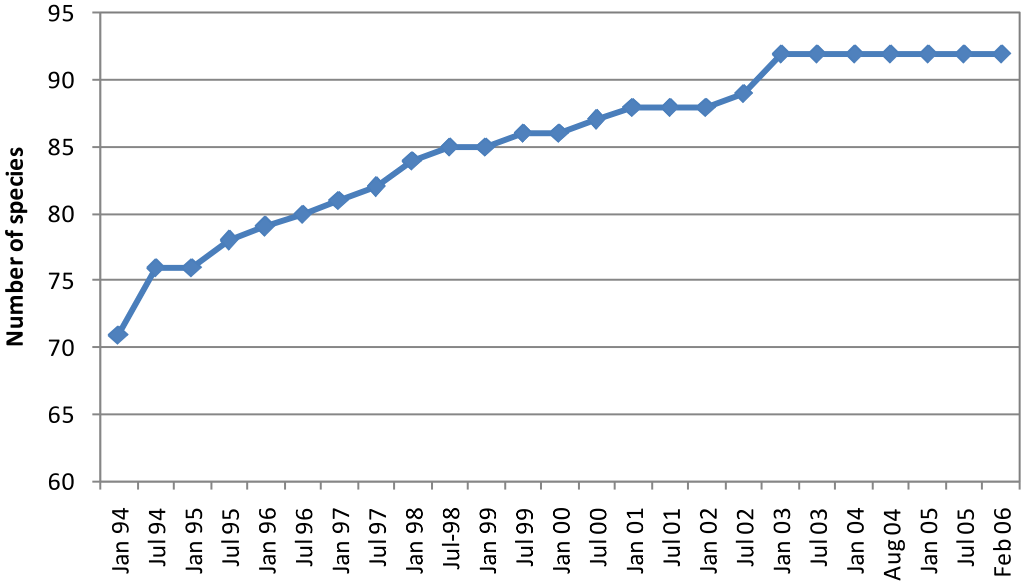


Figure 4.1. Cumulative number of non-passerine waterbird species recorded in CWAC counts of the estuary

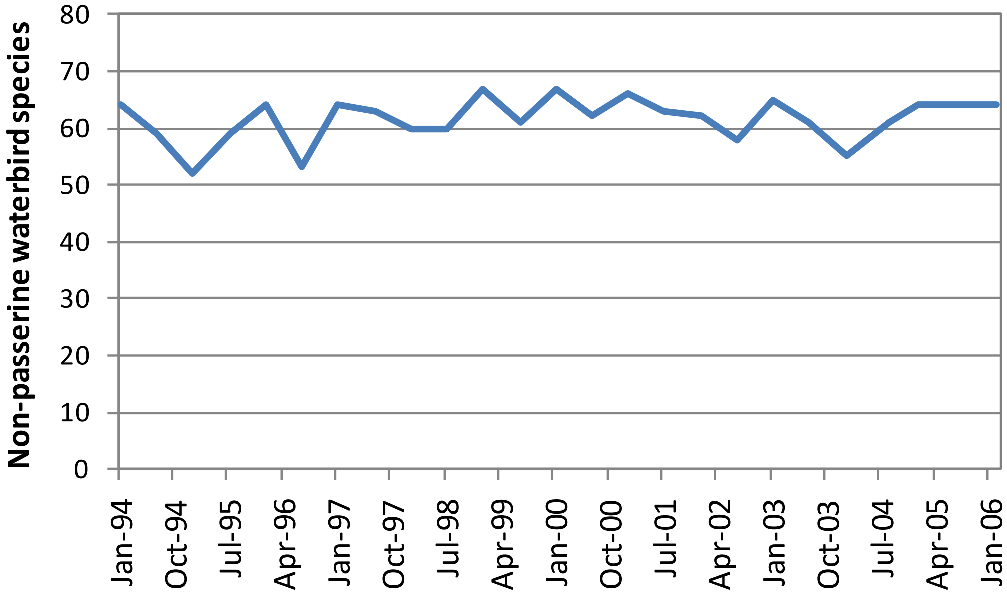


Figure 4.2 Number of non-passerine waterbird species recorded in CWAC counts of the estuary

Charadriiformes (waders, gulls and terns) account for 41% of the species recorded (Table 4.1), with most of these being wader species. More than half of the 27 wader species are Palaearctic migrants. Apart from these and two migratory tern species, the remaining species are species that breed in southern Africa, some making local or regional movements in response to rainfall. Among the resident species, the Ciconiiformes (herons, egrets, ibises, spoonbill) and Anseriformes (ducks) form the most diverse groups on the estuary, but most waterbird orders are well represented.

Table 4.1 Taxonomic composition of non-passerine waterbirds on the Berg River estuary. Most diverse groups are highlighted in bold.

Order	SA Resident	Palearctic migrant	Total
Podicipediformes (Grebes)	3		3
Pelecaniformes (Cormorants, darters, pelicans)	7		7
Ciconiiformes (Herons, egrets, ibises, spoonbill)	17		**17**
Phoenicopteriformes (Flamingos)	2		2
Anseriformes (Ducks)	12		**12**
Falconiformes (Birds of prey)	4		4
Gruiformes (Rails, crakes, gallinules, coots)	6		6
Charadriiformes (Waders, gulls, terns): Waders	11	16	**27**
Gulls	3		3
Terns	6	2	8
Strigiformes (Owls)	1		1
Alcediniformes (Kingfishers)	3		3
Total	**75**	**18**	**93**

5 NUMBERS OF BIRDS

An average of 13 700 and 12 300 non-passerine waterbirds were recorded in summer and winter CWAC counts, respectively. Average numbers of each species are given in Table 5.1. Average instantaneous numbers do not reflect the total numbers of birds using an estuary, however. Using maximum counts of each species over a 21-month period, it was estimated that a minimum of 37 141 birds visited the *lower* estuary during the period Sep 87 to Jan 88 (Velasquez *et al*. 1991). Based on maximum counts of each species over 12 monthly counts, Murison & Hockey (2002) estimated that at least 55 612 birds used the whole estuary and floodplain in 2001. This is four times the average number recorded in a single count.

Table 5.1 Non-passerine waterbird species recorded regularly on the Berg River estuary Dec 1992 – Feb 2006, giving common and scientific names (Hockey *et al*. 2005), and the average and maximum numbers recorded. Exotic, vagrant and extralimital species are excluded.

Common name	Scientific name	Mean		Max	
		Summer	Winter	Summer	Winter
Great Crested Grebe	Podiceps cristatus	13.2	4.2	31	8
Black-Necked Grebe	Podiceps nigricollis	46.5	446.5	218	1230
Little Grebe	Tachybaptus ruficollis	8.4	27.6	25	67
Great White Pelican	Pelecanus onocrotalus	121.3	96.4	227	298
White-breasted Cormorant	Phalacrocorax lucidus	276.5	127.9	643	270
Cape Cormorant	Phalacrocorax capensis	1046.0	841.7	3 082	2949
Bank Cormorant	Phalacrocorax neglectus	3.0	1.1	30	11
Reed Cormorant	Phalacrocorax africanus	128.7	89.2	273	198
Crowned Cormorant	Phalacrocorax coronatus	1.3	7.6	5	73

Common name	Scientific name	Mean		Max	
		Summer	Winter	Summer	Winter
African Darter	Anhinga rufa	37.4	59.4	82	107
Grey Heron	Ardea cinerea	64.1	37.2	104	88
Black-headed Heron	Ardea melanocephala	5.9	5.6	20	13
Goliath Heron	Ardea goliath	0.4	0.3	2	2
Purple Heron	Ardea purpurea	11.7	5.3	21	12
Great Egret	Egretta alba	1.0	1.9	6	7
Little Egret	Egretta garzetta	72.9	50.7	131	72
Yellow-billed Egret	Egretta intermedia	4.0	2.4	28	7
Cattle Egret	Bubulcus ibis	9.6	15.0	52	36
Squacco Heron	Ardeola ralloides	0.2	0.0	2	0
Black-crowned Night-Heron	Nycticorax nycticorax	2.6	5.8	12	20
Little Bittern	Ixobrychus minutus	0.4	0.2	1	1
Hamerkop	Scopus umbretta	0.0	0.1	0	1
White Stork	Ciconia ciconia	7.5	0.0	75	0
African Sacred Ibis	Threskiornis aethiopicus	175.8	101.8	373	164
Glossy Ibis	Plegadis falcinellus	7.9	86.4	40	229
Hadeda Ibis	Bostrychia hagedash	0.3	3.2	2	14
African Spoonbill	Platalea alba	109.4	83.0	294	126
Greater Flamingo	Phoenicopterus ruber	1435.8	1631.1	3 932	3071
Lesser Flamingo	Phoenicopterus minor	422.1	1040.2	1 890	1888
Egyptian Goose	Alopochen aegyptiaca	283.7	271.2	764	585
South African Shelduck	Tadorna cana	235.9	160.3	599	405
Yellow-billed Duck	Anas undulata	329.0	187.1	1 059	307
African Black Duck	Anas sparsa	0.2	0.8	2	4
Cape Teal	Anas capensis	344.9	164.4	1 272	459
Hottentot Teal	Anas hottentota	0.3	0.0	3	0
Red-billed Teal	Anas erythrorhyncha	145.5	50.1	1 182	127
Cape Shoveler	Anas smithii	98.7	131.3	603	303
Southern Pochard	Netta erythrophthalma	2.5	13.3	16	62
Spur-winged Goose	Plectropterus gambensis	290.3	80.1	1 192	146
Maccoa Duck	Oxyura maccoa	0.6	17.1	5	119
African Fish-Eagle	Haliaeetus vocifer	2.4	2.0	8	6
African Marsh-Harrier	Circus ranivorus	4.7	9.5	14	14
Black Harrier	Circus maurus	0.1	0.1	1	1
Osprey	Pandion haliaetus	1.0	0.3	4	1
African Rail	Rallus caerulescens	0.7	1.6	4	3
Black Crake	Amaurornis flavirostris	0.0	0.1	0	1
African Purple Swamphen	Porphyrio madagascariensis	2.4	3.6	10	18
Common Moorhen	Gallinula chloropus	3.3	6.3	5	15
Red-knobbed Coot	Fulica cristata	484.5	2544.9	2 577	6614
Greater Painted-snipe	Rostratula benghalensis	0.1	0.0	1	0
African Black Oystercatcher	Haematopus moquini	3.0	7.9	13	46
Common Ringed Plover	Charadrius hiaticula	163.9	2.2	475	4
White-fronted Plover	Charadrius marginatus	9.7	41.5	22	182
Chestnut-banded Plover	Charadrius pallidus	53.6	134.7	90	254
Kittlitz's Plover	Charadrius pecuarius	357.5	209.1	1 187	297
Three-banded Plover	Charadrius tricollaris	15.9	37.2	32	77
Grey Plover	Pluvialis squatarola	193.6	26.2	471	73
Blacksmith Lapwing	Vanellus armatus	174.9	168.2	232	306
Ruddy Turnstone	Arenaria interpres	0.7	3.8	3	19
Terek Sandpiper	Xenus cinereus	0.1	0.1	1	1
Common Sandpiper	Actitis hypoleucos	16.7	27.4	50	204
Wood Sandpiper	Tringa glareola	10.2	1.2	39	6

Common name	Scientific name	Mean		Max	
		Summer	Winter	Summer	Winter
Marsh Sandpiper	Tringa stagnatilis	79.6	12.9	195	66
Common Greenshank	Tringa nebularia	331.0	79.3	566	217
Red Knot	Calidris canutus	4.0	0.2	19	1
Curlew Sandpiper	Calidris ferruginea	5 295.8	410.4	16 881	769
Little Stint	Calidris minuta	1 608.8	68.6	6 428	410
Sanderling	Calidris alba	1.0	0.4	4	4
Ruff	Philomachus pugnax	214.2	1.4	1 087	9
Bar-tailed Godwit	Limosa lapponica	14.7	4.5	41	19
Eurasian Curlew	Numenius arquata	20.7	7.1	42	18
Common Whimbrel	Numenius phaeopus	45.2	4.7	73	11
Red-necked Phalarope	Phalaropus lobatus	0.3	0.0	2	0
African Snipe	Gallinago nigripennis	2.7	0.3	12	1
Pied Avocet	Recurvirostra avosetta	285.8	228.8	2 273	318
Black-winged Stilt	Himantopus himantopus	278.3	475.1	518	751
Water Thick-knee	Burhinus vermiculatus	2.6	2.8	21	8
Kelp Gull	Larus dominicanus	303.6	560.2	459	850
Grey-headed Gull	Larus cirrocephalus	49.5	2.2	443	8
Hartlaub's Gull	Larus hartlaubii	422.8	490.9	829	937
Caspian Tern	Sterna caspia	40.8	16.4	72	49
Swift Tern	Sterna bergii	49.6	54.8	186	199
Sandwich Tern	Sterna sandvicensis	122.3	0.6	365	3
Common Tern	Sterna hirundo	382.2	1.5	1 561	8
Arctic Tern	Sterna paradisaea	2.0	0.2	20	2
Little Tern	Sterna albifrons	10.8	0.1	67	1
Whiskered Tern	Chlidonias hybrida	7.2	0.4	37	2
White-winged Tern	Chlidonias leucopterus	28.9	1.0	131	7
Marsh Owl	Asio capensis	0.3	0.1	2	1
Pied Kingfisher	Ceryle rudis	48.4	41.7	67	68
Giant Kingfisher	Megaceryle maximus	0.1	0.1	1	1
Malachite Kingfisher	Alcedo cristata	1.0	1.4	5	5

6 DIETARY GUILDS

The waterbirds of the estuary belong to several dietary guilds (Table 6.1). The most common of trophic group is the predominantly piscivorous group, with most of these species also taking other vertebrates and invertebrates. This group is represented by 41 species belonging to eight taxonomic groups. All the waders are benthic invertebrate feeders, as is one of the flamingo species. Ducks are either herbivores or omnivores, while the rallids (dominated by Redknobbed Coot) are herbivores. Lesser Flamingo filter-feeds on phytoplankton.

Table 6.1. Representation of different dietary guilds among different taxomonic groups on the estuary.

	Dietary guild				
Taxonomic group	**Fish/ vertebrates/ invertebrates**	**Benthic invertebrates**	**Invertebrates/ Plant matter**	**Plant matter**	**Phyto-plankton**
Grebes	2				
Ducks			7	5	
Rallids				5	
Corm/darter/pelican	7				
Heron/egret etc	14				
Birds of prey	3				
Kingfishers	3				
Flamingos		1			1
Waders		27			
Gulls	3				
Terns	8				
Owls	1				

Herbivores, invertebrate feeders and piscivores are estimated to account for 25%, 55% and 20% of total energy consumption by birds on the estuary, respectively. An estimated total of 7 343 kJ per ha per day is consumed during summer (based on total intertidal plus subtidal area; Hockey & Turpie 1999).

The different dietary guilds are discussed in more detail below.

6.1 Piscivores/Vertebrate Feeders

The vertebrate feeders include gulls, terns, grebes, cormorants, darters, pelicans, herons, egrets, kingfishers and birds of prey. Most of these birds eat fish, and are loosely referred to as piscivores, but amphibians, invertebrates and the young of other birds may also constitute an important part of the diet in floodplain habitats. Some, such as Osprey, are exclusively fish eaters.

Piscivorous birds forage in a variety of habitats from shallow intertidal areas and pans to deep channel areas. Wading birds such as herons and egrets forage by wading, usually using a sit and wait strategy. These species perch in reedbeds, particularly Purple Heron, but more often frequent vegetated and unvegetated pans in the floodplain as well as intertidal mudflats. Species such as Eastern White Pelican, Reed Cormorant and Darter swim in the channel while foraging. Kingfishers perch in marginal vegetation such as reedbeds, or hover over the water, while terns fly over or hover while foraging. Great Crested Grebes forage for fish by diving in large deep water areas, and Little Grebe prefer deep water areas that are close to emergent reedmarsh which affords them some cover for safety.

Marsh Owl and Marsh Harrier are non-piscivorous vertebrate feeders which hunt for prey such as rodents in low to medium-height marshes.

6.2 Benthic invertebrate feeders

Waders are the most abundant birds on the estuary, and are all invertebrate feeders. Thus the estuarine fauna is highly dependent on the productivity of invertebrates in the estuary. Waders feed predominantly on intertidal mudflats and shallow water during the low tide period, by night and day, moving to saltmarshes and saltpans at high tide. Waders are generally highly opportunistic in their diet and feeding methods, with larger species concentrating on larger prey (Turpie & Hockey 1997). At the Berg estuary, the Nereid worms *Ceratonereis erythraeensis* and *C. keiskama* are the principal food of five species

(Curlew Sandpiper, Grey Plover, Blacksmith Plover, Kittlitz's Sandplover and Whitefronted Plover), while Greenshank and Whimbrel feed mainly on the crown crab *Hymenosoma orbiculare* (Kalejta 1993, Turpie 1994). Predation pressure by waders at the Berg River estuary is described as among the highest on the East Atlantic seaboard, and represents approximately 26% of the annual invertebrate production (Kalejta 1992, 1993).

Intertidal mudflats support an average of 75% of birds in the lower estuary (sites 1 – 5) during low tide, with densities averaging 74 (± 14) birds per ha in summer (November – March) and 31 (± 14) birds per ha in winter (May – Aug) (based on data in Velasquez *et al*. 1991). Summer densities can exceed 100 birds per ha (Hockey 1993). Saltmarshes support a relatively low density of birds, averaging 11 (± 2) birds per ha during low tide in summer and 4 (± 2.5) in winter (Velasquez *et al*. 1991). However, they are important as roost sites and feeding areas during high tide. They are mainly used by waders. Waders are also attracted to the floodplain pans and artificial salt pans as their water levels drop, feeding on the newly exposed shorelines and in shallow water. Densities of birds can reach extremely high levels in these pans (Hockey *et al.* 1998).

A few of the larger wading birds are invertebrate feeders. These include the Ibises, which feed on intertidal mudflats and in floodplain pans, and Greater Flamingos, which feed on benthic or epibenthic invertebrates, which they disturb and filter from the water. Blackheaded Heron and Cattle Egret forage on terrestrial invertebrates and do not depend on the estuary or floodplain wetlands for feeding.

6.3 Ominivores

The majority of the waterfowl species on the estuary are omnivorous, feeding on a mixed diet of invertebrates such as small crustaceans, and plant material, including seeds. These include Cape Teal, Hottentot Teal, Redbilled Teal and Cape Shoveller. These species forage in the river channel, but also make extensive use of the floodplain pans when they are inundated. These species tend to be found more commonly in fresher or slightly brackish habitats. In the upper estuary, low salinities allow the development of aquatic plants such as *Potamogeton* that are consumed by waterfowl.

6.4 Herbivores

Some ducks and all of the rallids are herbivores. Herbivorous waterfowl such as Egyptian Goose, Spurwinged Goose probably feed mainly in terrestrial areas away from the estuary and floodplain. Most of the rail species are skulking species which forage in and around dense marshes, such as African Purple Swamphen, African Rail and Black Crake. However, the most common rallid on the estuary is Redknobbed Coot, which frequents open water areas with dense submerged aquatic plant growth.

The Lesser Flamingo feeds on phytoplankton in saline habitats, and hence is particularly common in the artificial salt pans.

7 ROOSTING AND BREEDING

7.1 Roosting

Some species of birds roost in different habitats to their feeding habitats. These include most of the herons, egrets and ibises, which tend to roost in fringing trees or tall marsh. Indeed the alien trees lining the upper estuary have probably played an important role in attracting many species through the provision of suitable roosting sites.

Many waterfowl species require bare or grassy banks or short marsh areas for roosting or 'loafing'. This includes terrestrially-feeding waterfowl such as Egyptian Goose, Spurwinged Goose and South African Shelduck. For the latter species, the availability of suitable safe roosting areas is the main reason for their presence.

Waders require roosting areas away from their intertidal feeding areas at high tide. Bare or grassy islands and supratidal saltmarshes are the preferred roosting habitat for these species, but pans in the floodplain are also used. Indeed, high tide counts on saltmarsh and sedgemarsh areas and the floodplain in general are consistently higher than at low tide due to the influx of birds that forage on intertidal areas (Murison & Hockey 2002). There is no evidence that they move into salt pans on the floodplain, but certain species do make significant use of saltpans in the lower estuary.

Thousands of Cape Cormorants roost on the artificial islands in the commercial saltpans, as well as on sandy shores near the mouth, together with gulls and terns. The influx of Cape Cormorants is a relatively recent phenomenon. Terns and flamingos also make extensive use of the saltpans in the floodplain for roosting.

7.2 Breeding and breeding habitats

Most of the non-migratory species recorded on the estuary are likely to breed there, though records of breeding are incomplete. Resident species that do *not* breed on the estuary include colonial nesters such as Great White Pelican and Cape Cormorants, which breed on nearby offshore islands, and flamingos.

Breeding activity is highly seasonal and closely linked to flooding, with most birds breeding during spring, coinciding with the drawdown of water levels (when food availability peaks) on the floodplain (Figure 7.1).

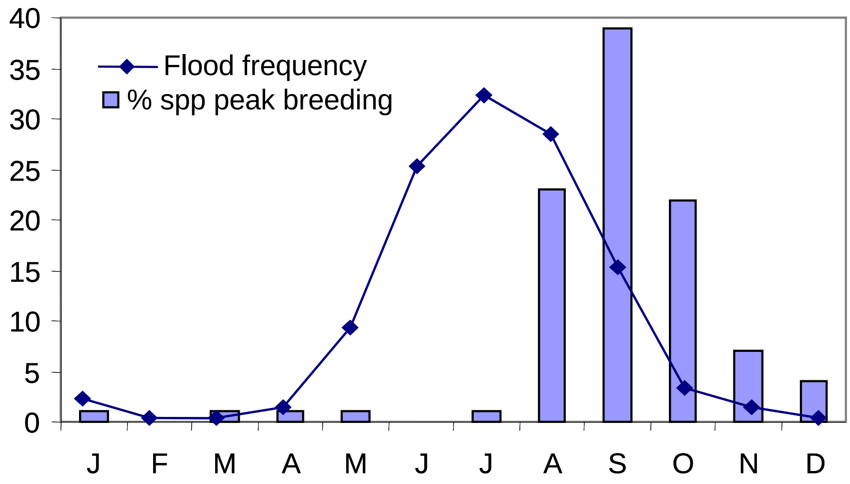


Figure 7.1 Seasonal distribution of peaks in waterbird breeding activity relative to the average seasonal frequency of flood events. Redrawn from Hockey (1993).

Waterfowl and waders favour pans (both natural and man-made) and marshes for breeding. Many waterfowl, such as ducks and Blackwinged Stilts, breed in sedges or grassy areas around the edges of pans as water levels recede. Resident waders such as Kittlitz's Plover breed in open dry pans. At least 50 pairs of Chestnutbanded Plovers breed on the saltpans. Shelducks breed in burrows near open pans. These breeding activities are inconspicuous and often pass unobserved or unrecorded.

Gulls and terns are colonial nesters which breed on bare ground in the lower estuary. Near the estuary mouth, there is a mixed breeding colony of about 350 pairs of Hartlaub's Gulls together with Swift Terns and Gelp Gulls. At least 15 pairs of Caspian Terns breed with Kelp Gulls at the Veldrif Salt works. The Berg River Estuary is an important breeding area for

Caspian Terns (*Sterna caspia*), listed as “rare” in the national Red Data Book (Velasquez *et al.* 1990).

Egrets, ibises, cormorants and spoonbills breed in mixed species colonies, usually in reedbeds or flooded trees in the upper estuary. At least 13 species breed in the Kersefontein heronry (Hockey 1993), which has been known for more than 80 years. This heronry is one of the most important in the Western Cape, especially since the demise of major heronries on the Cape Flats and at Blouvlei (Century City). The Kersefontein heronry supports thousands of pairs of breeding birds (Table 7.1). Note that these include terrestrially-foraging species such as Blackheaded Heron and Cattle Egret. Goliath Heron has also been recorded breeding at Kersefontein, a first record for the Western Cape (Murison & Hockey 2002). Other heronries have also existed on the estuary, but the current number of heronries is unknown, and thought to be only one.

Table 7.1 Estimated number of breeding pairs in the heronry at Kersefontein (Murison & Hockey 2002)

Species	Breeding pairs
Reed Cormorant	200-300
Darter	25-40
Cattle Egret	800 – 1000
Little Egret	30 – 40
Yellow-billed Egret	50 – 60
Black-crowned Night Heron	20 – 30
Sacred Ibis	300 – 400
Glossy Ibis	30 – 40
African Spoonbill	150 - 180

Flamingos have been recorded building nests at the salt pans, but have never bred at this estuary.

Reedbeds also provide breeding habitat for several rails (e.g. Purple Gallinule) and other passerines (e.g. Cape Reed Warbler) and support colonies of Red Bishops, Cape and Masked Weavers.

8 FUNCTIONAL GROUPS

For the purposes of this study, birds were grouped into functional groups based on diet, foraging behaviour and habitat preferences (Table 8.1).

Table 8.1 Major bird groups found in the Berg estuary, and their defining features.

Bird groups	Defining features, typical/dominant species
Herbivorous waterfowl	This group is dominated by species that tend to occur in low salinity or freshwater habitats and are associated with the presence of aquatic plants such as *Potamageton* and *Phragmites*. The group includes some of the ducks (e.g. Southern Pochard), and all the rallids (e.g. Redknobbed Coot, African Purple Swamphen). Some herbivorous waterfowl such as Egyptian Goose, Spurwinged Goose and South African Shelduck probably feed in terrestrial areas away from the estuary and floodplain as well as in the estuary. Note that the algae found in the lower estuary is not consumed by birds.
Omnivorous waterfowl	This group comprises ducks which eat a mixture of plant material and invertebrate food such as small crustaceans - Yellow-billed Duck, African Black Duck, Cape Teal, Hottentot Teal, Red-billed Teal and Cape Shoveller. Although varying in tolerance, these species are fairly tolerant of more saline conditions, but African Black Duck tends to be restricted to areas of higher flow.
Piscivorous waterfowl	This group comprises the grebes – Great Crested, Black-necked and Little Grebe. The first two tend to be restricted to lower salinities and

Bird groups	**Defining features, typical/dominant species**
	deeper water, and Little Grebe tends to be found where there is abundant marginal vegetation.
Wading/swimming piscivores	This group comprises the largest birds on the estuary – the wading and swimming birds (ciconiiformes and pelicaniformes), such as Reed Cormorant, Little Egret, Grey Heron. Loosely termed piscivores, their diet varies in plasticity, with fish usually dominating, but often also includes other vertebrates, such as frogs, and invertebrates. The ibises were included in this group, though their diet mainly comprises invertebrates and is fairly plastic. They tend to be tolerant of a wide range of salinities.
Perching/aerial piscivores	This group comprises the kingfishers and birds of prey, such as African Fish Eagle and Marsh Harrier. They are not confined to a diet of fish, also taking other vertebrates and invertebrates. These species are tolerant of a wide range of salinities but require marginal vegetation, particularly trees or shrubs, or marsh in the case of Marsh Harrier and Marsh Owl.
Lesser Flamingos	This species is unique in its diet (phytoplankton) and salinity tolerance, tolerating high salinity to hypersaline conditions.
Greater Flamingos	Greater Flamingos feed on benthic invertebrates in a wide range of salinities.
Macrobenthos-feeding waders	This group includes all the waders (e.g. Greenshank, Curlew Sandpiper). They are the smallest species and most numerous group on the estuary, and feed on benthic macroinvertebrates in exposed and shallow intertidal areas.
Piscivorous gulls & terns	This group comprises the rest of the Charadriiformes, and includes all the gull and tern species using the estuary. These species are primarily piscivorous, but also take invertebrates. Most are euryhaline, but certain tern species on the estuary tend to be associated with low salinity environments.
Marine cormorants	This group comprises cormorants that feed in marine environments and uses the estuary to roost – Cape, Bank and Crowned Cormorants. This group is neither directly nor indirectly sensitive to flow, and is thus not given much attention in this study.

9 COMMUNITY COMPOSITION

Waders dominate the estuary in summer, with piscivores being the second-most abundant group. In winter, there is a far more even spread of numbers among different groups (Figure 9.1).

Waders dominate the estuarine avifauna during summer, making up about 53 – 64% of bird numbers. Based on the December 1992 count, 89% of waders occurring in summer are Palearctic migrants and 57% of all birds on the estuary are migrants. Other numerically important groups during summer are the flamingos and ducks, and to a variable extent, pelecaniformes (cormorants, darters and pelicans).

Avifaunal composition is completely different in winter (Figure 9.1), with a far more even representation of taxonomic groups. The most dominant groups are flamingos, gruiformes, the latter numbers being dominated by Redknobbed Coots (99.4%), and waders (mostly resident species, but also the subadults of some migratory species), while ducks and pelecaniformes are also numerous.

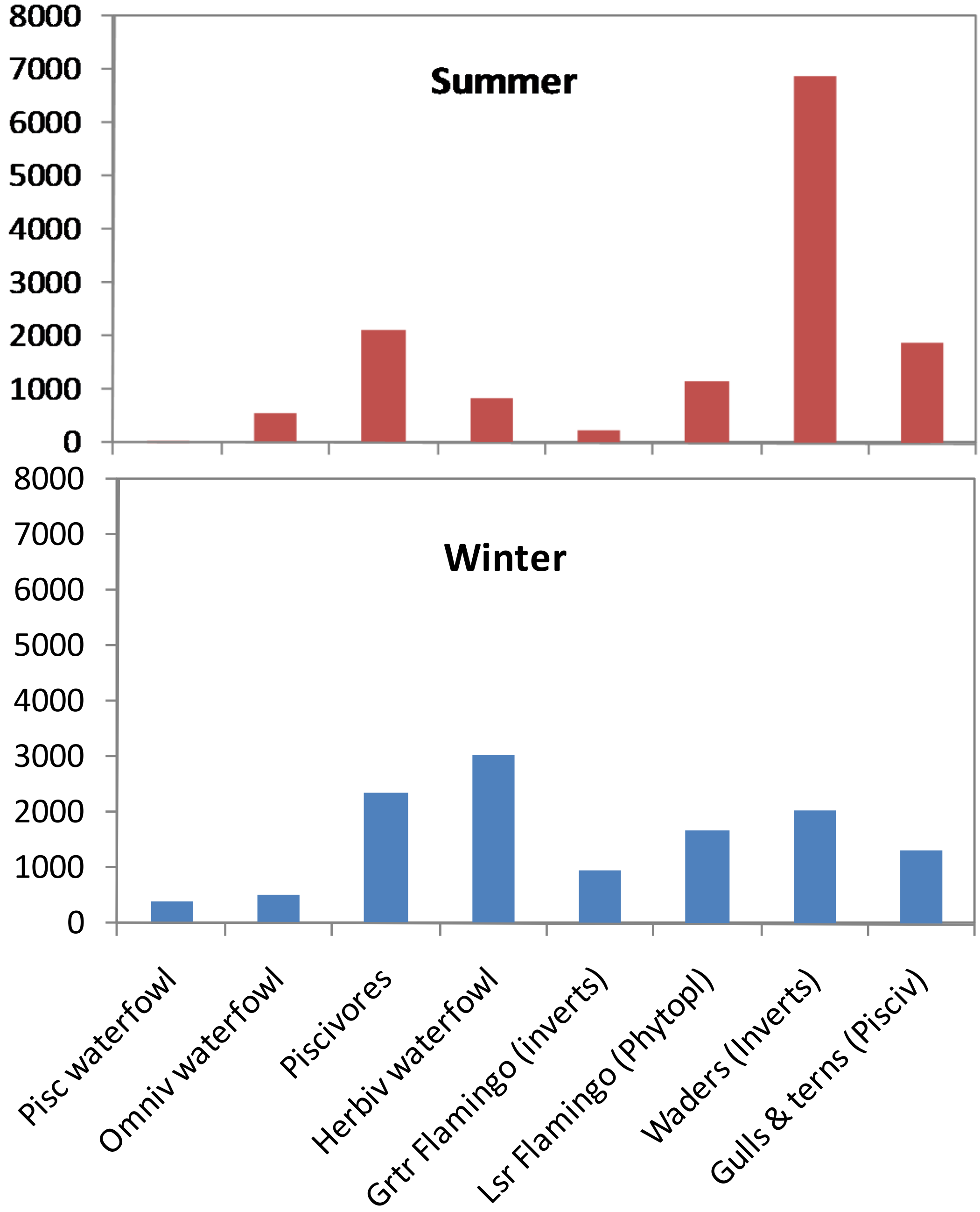


Figure 9.1 Average summer and winter numbers of different groups of bird on the estuary

10 PATTERNS OF DISTRIBUTION

10.1 Species distributions along the estuary

Individual bird species tend to be highly consistent in their distribution along the estuary, although some may shift their distribution seasonally. Certain birds are highly site specific. For example, the majority of Great-Crested Grebes and Dabchicks and all Maccoa Ducks are found in one particular pan.

Cape Cormorants and Crowned Cormorants are almost entirely confined to the mouth, and Whitebreasted Cormorants concentrate at the mouth but are found all the way up the estuary (Table 10.1). Several species are confined or largely confined to the lower estuary.

Table 10.1 Species typical of different parts of the estuary or common throughout

	Mouth	Lower estuary	Upper estuary
All or nearly all here	Cape Cormorants, Crowned Cormorants	Blacknecked Grebe, African Black Oystercatcher, White-fronted Plover, Grey Plover, Ruddy Turnstone, Terek Sandpiper, Knot, Bartailed Godwit, Eurasian Curlew, Common Whimbrel	Ethiopian Snipe, African Black Duck, Goliath Heron, African Black Duck, Marsh Owl
Most common here	Whitebreasted Cormorant	African Spoonbill, Redknobbed Coot, Kelp Gull, Swift Tern, Greater Flamingo Lesser Flamingo Ringed Plover, Chestnutbanded Plover, Kittlitz's Plover, Threebanded Plover Blacksmith Plover, Common Sandpiper, Marsh Sandpiper, Greenshank, Curlew Sandpiper, Little Stint, Sanderling, Ruff, Avocet, Blackwinged Stilt.	Egyptian Goose, Redbilled Teal, Spurwinged Goose, African Fish Eagle, Moorhen, Wood Sandpiper
Common throughout	White Pelican, Reed Cormorant and Darter, Glossy Ibis, South African Shelduck, Yellowbilled Duck, African Marsh Harrier, Pied Kingfisher, Sacred Ibis, Little Egret, herons		

These are mostly migrant waders such as Grey Plover, but also include resident waders (e.g. African Black Oystercatcher, White-fronted Plover), Kelp Gull, Swift Tern and flamingos.

Almost all other waders are generally more common in the lower than the upper estuary. This pattern also holds for African Spoonbill and Redknobbed Coot.

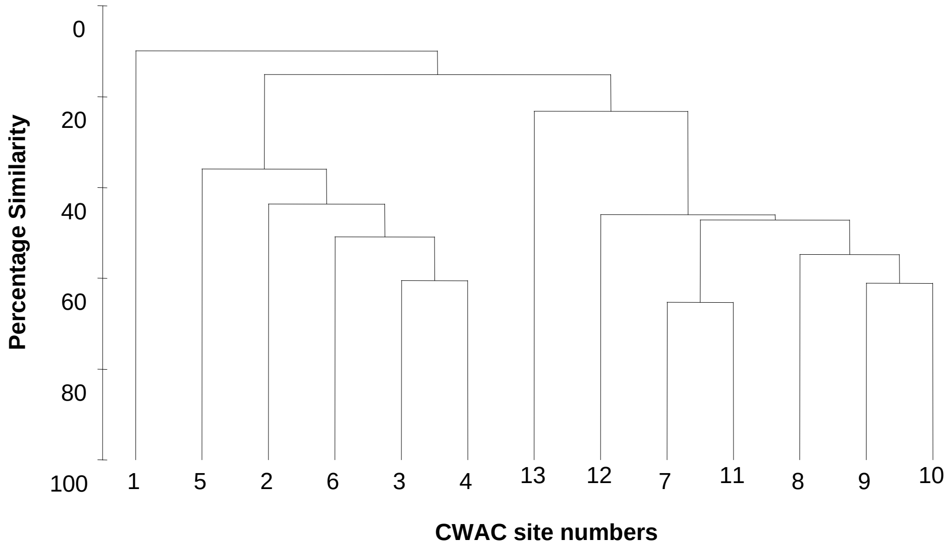
Several species are fairly evenly distributed throughout the estuary (Table 10.1). These are mostly piscivorous species such as White Pelican, Reed Cormorant and Darter, but also include some waterfowl and African Marsh Harrier. Pied Kingfisher, Sacred Ibis, Little Egret and most herons are found throughout the estuary, tending to be slightly more common towards the mouth.

Some species distributed throughout the estuary tend to be more common in the upper estuary. These are mostly waterfowl, but also include African Fish Eagle, Moorhen and Wood Sandpiper (Table 10.1).

Very few species are confined to the upper estuary. These include Ethiopian Snipe, plus several species that are only occasionally recorded on the estuary, such as African Black Duck, Goliath heron, and Marsh Owl.

10.2 Patterns in community composition

At a broad scale, there is marked spatial variation in bird community composition along the estuary. Multidimensional scaling analysis revealed four clear groups in terms of community structure (Figure 10.1). These corresponded to the mouth, lower estuary and upper estuary, and a fourth area adjacent to the railway line (site 13). The latter site contained less than 1% of the birds on the estuary, however. The mouth, lower and upper estuary contained 16%, 71% and 12% of the estuaries birds in summer and 17%, 66% and 16% in winter, respectively (based on CWAC count data).



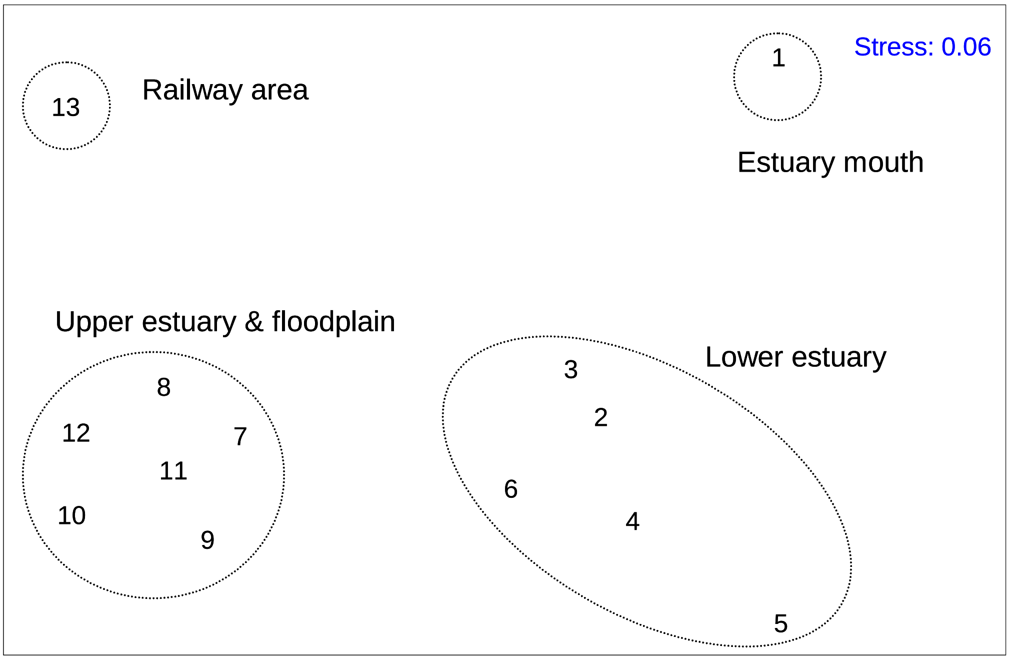


Figure 10.1 Similarity dendrogram and MDS plot showing grouping of counting sites based on community composition, using untransformed data.

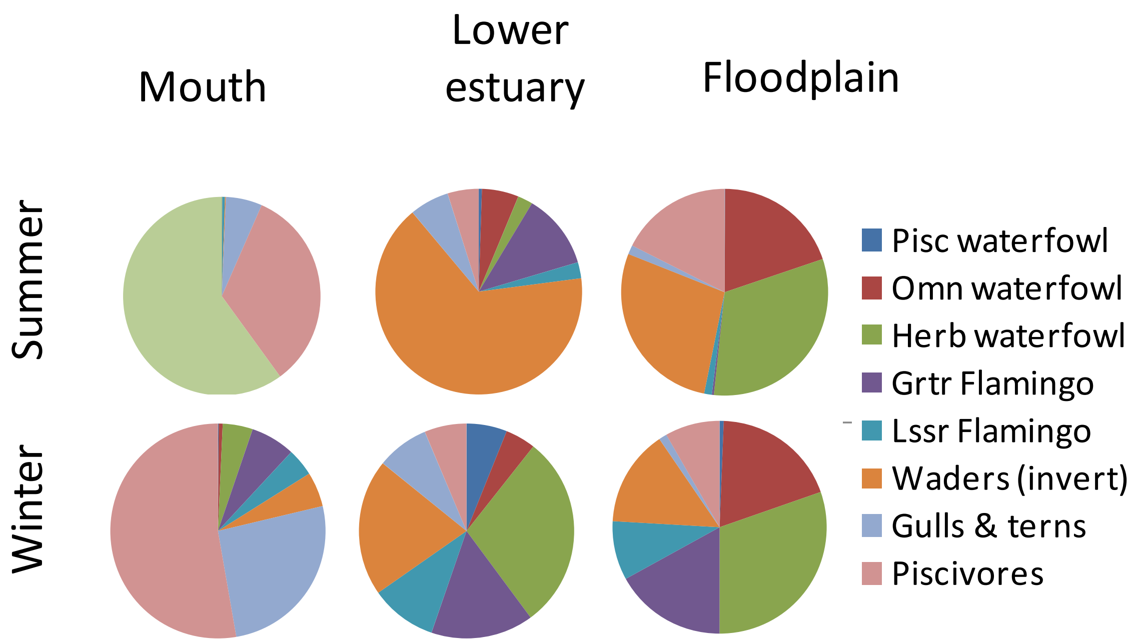


Figure 10.2 Differences in community composition along the estuary during winter and summer.

In summer, the mouth area is dominated by cormorants (Pelicaniformes), terns and gulls (totalling 88%), plus a few egrets, ibises and waders. Terns are replaced by flamingos and coots in winter (Figure 10.2).

The lower estuary is dominated by waders during summer, with flamingos making up about 14% of birds. There is a high diversity of other groups but in relatively small numbers. Less than a quarter of the waders remain in winter (resident species plus immature migrants), while flamingos increase in number and large numbers of coots appear in the lower estuary. These three groups make up about three-quarters of birds (Figure 10.2).

While relatively few ducks occur in the lower estuary, they make up nearly half of the birds counted in CWAC counts in the upper estuary during summer. Waders are also a dominant group, probably more so than indicated in Figure 10.2. The pelicaniformes (cormorants, pelicans) and ciconiformes (herons, egrets, ibises, spoonbills) are far more prevalent in the upper estuary than lower sites. Both of these groups are found breeding in heronries in the upper estuary during summer, and their numbers drop dramatically in winter. Numbers of ducks also drop slightly in winter, while flamingos and coots increase in abundance.

11 SEASONAL VARIATION IN ABUNDANCE

11.1 Overall numbers

Detailed counts by Murison & Hockey (2002) of the whole lower floodplain and estuary for the 12 months from March 2000 to February 2001 showed that there are marked seasonal changes in the abundance of many species.

Total waterbird numbers were highest during October-December and in March. Numbers in spring peaked at over 25 000 birds, compared with about 15 – 20 000 birds in mid-summer. Bird numbers were higher in spring than in July or February counts when CWAC counts are normally carried out. Species whose numbers peaked during spring included the grebes, most ciconiiformes (herons, egrets etc), Egyptian Goose, South African Shelduck and most of the less abundant duck species, Avocet, and most migratory wader species.

The October 2000 peak was largely due to a massive influx of herons, egrets etc., to breed at the heronry. The December high was due to the arrival of large numbers of migratory waders. Their numbers were also high in March, just prior to northward migration in April. Minimum overall bird numbers were recorded in June to August, though numbers of rails (mainly Redknobbed Coot) were maximal during this period, and there was also an increase in the number of marine cormorants (mainly Cape Cormorant) during this period.

Palearctic migrants show the biggest seasonal changes in numbers. Their main influx is in September and October, although the first migrants arrive in August. Numbers of migrants peaked in December, and in 2001-2002 there was another peak in their numbers prior to northward migration in March. The majority of migrants departed in March and April, but immature birds of certain species remained over the winter. There were far fewer migrants in 2005-6, with numbers no longer climbing after the early spring influx.

Resident wader numbers tended to peak in the winter months when most of the migrants are absent.

Waterfowl were more abundant during winter. Murison & Hockey (2002) reported that hundreds of waterfowl moved into the floodplain wetlands during 2000 at the usual time for the first winter flood, despite the lack of rainfall and flooding.

Resident gulls and terns tended to be more abundant in summer. The influx of juvenile Kelp Gulls during autumn suggested that the area is important as a post breeding habitat for this species (Murison & Hockey 2002). Swift terns are more abundant in winter, arriving to breed with Hartlaub's Gulls in colonies near the estuary mouth.

Heronry species fluctuated through the year but with a tendency for increased numbers in spring.

Numbers of **flamingos**, which do not breed at the estuary, did not show a consistent seasonal pattern and were far higher in the second period than the first. It is possible that the higher number of Greater Flamingos in the second period was linked to the greater degree of flooding of the floodplain.

11.2 Comparison between estuary and floodplain wetlands

An analysis of the count data presented in Murison & Hockey (2002) clearly shows the difference in seasonal patterns observed on the lower estuary *versus* the upper estuary and floodplain (Figure 11.1). Numbers on the estuary were strongly seasonal with a summer peak, mostly driven by the influx of migratory waders in spring and summer.

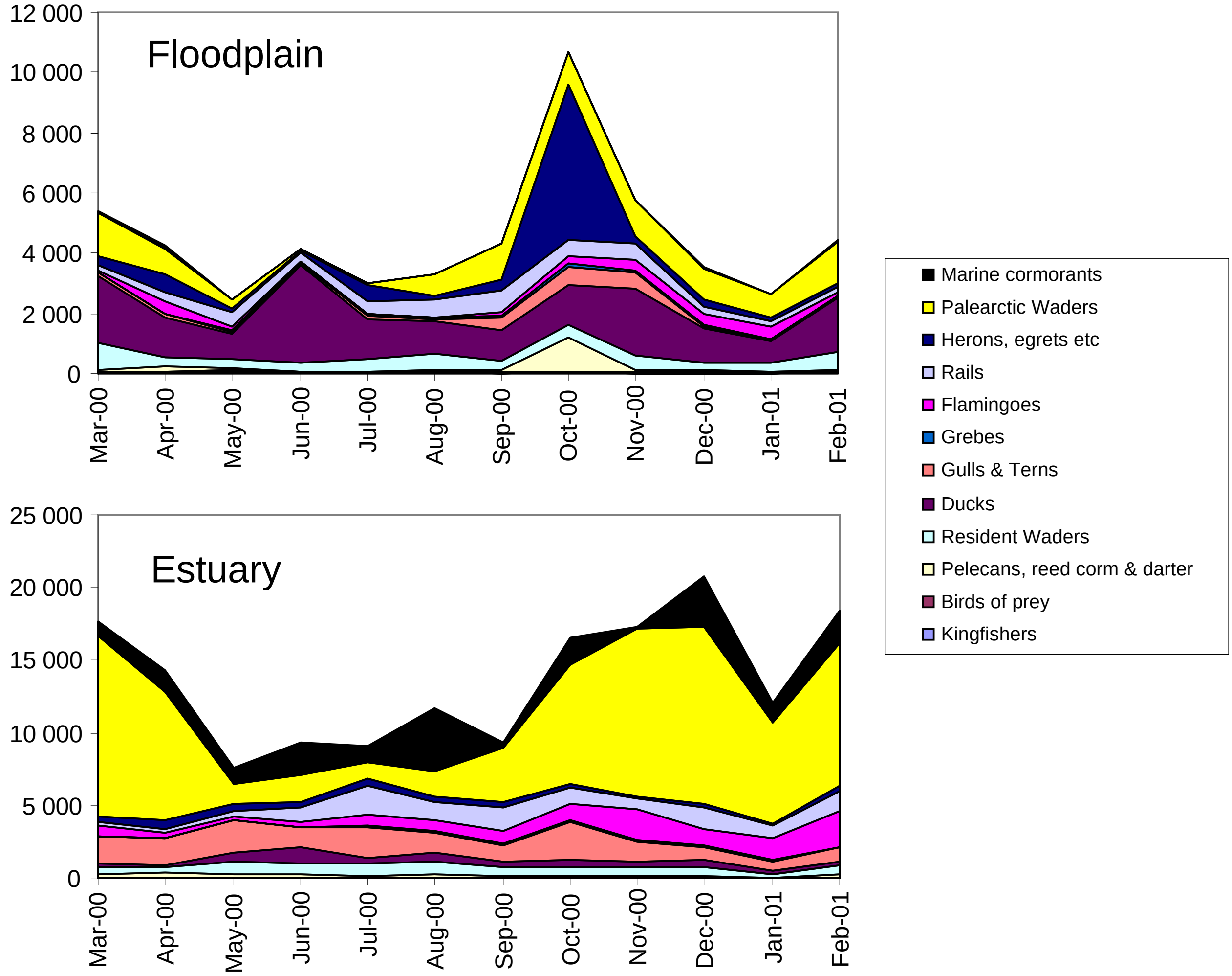


Figure 11.1 Seasonal variation in numbers of waterbirds on the lower Berg River floodplain (a) and estuary proper (b) from Mar 2000 to Feb 2001 (raw data from G. Murison).

Marine **cormorants** remain on the lower estuary, mostly near the mouth, and their numbers peak during winter and mid-summer. **Herons, egrets, ibises, spoonbills and the remaining pelicaniformes** (the pelicans, reed cormorants and darters), are most abundant on the floodplain during spring. Although some birds clearly move away from the estuary at this time, presumably to breed, the vast majority of breeding birds apparently arrive from other areas. For the rest of the year, the population of these birds is relatively constant.

The **migratory waders** are very strongly seasonal on the estuary, with very low numbers occurring in winter and very high numbers in summer. In contrast, their abundance on the floodplain shows very little seasonal variation, apart from a virtually complete absence in early winter. This suggests an upper limit to the suitability of floodplain habitat for these birds. Indeed the floodplain only provides favoured feeding conditions for a few of these species. The **resident waders** show an apparently inverse seasonal pattern between the floodplain and estuary. Numbers are highest in the estuary during winter, and lowest during summer, while apparently moving onto the floodplain during summer. Kittlitz's plovers arrived on the floodplain before the estuary, demonstrating a preference for the floodplain.

Rail numbers (mainly Redknobbed Coot) are seasonal in both the floodplain and estuary, peaking in winter, though numbers are considerably higher on the estuary. All the rails on the estuary are Redknobbed Coots, whereas the other rail species are predominantly found in the floodplain. The latter species are not seasonal in their abundance.

Kingfishers do not follow strongly seasonal trends, but were counted in higher numbers on the floodplain in April-May. Other resident piscivores such as Fish Eagles are largely constant, though only sporadically counted.

Flamingos are predominantly found in the lower estuary, but this is mainly in the artificial salt pans. There were no flamingos in the floodplain during winter, but they moved into the floodplain after the pans were flooded. The relative numbers in the two areas suggests that the floodplain was not particularly important for flamingos in 2001-2, but this was a dry year.

Grebes followed a similar seasonal trend both in the estuary and floodplain.

Gull and tern numbers were erratic in the estuary, and only showed a clear seasonal pattern in the floodplain, in that small numbers of gulls are found in the floodplain only during spring.

Numbers of **ducks** increase generally during autumn. The seasonal pattern is similar in the estuary and floodplain, but much more pronounced on the floodplain.

12 INTER-ANNUAL VARIATION IN ABUNDANCE

12.1 Trends in flow

Counts of birds have been made over the past 20 years. Since this study is particularly concerned with the possible links between bird abundance and flow, it is useful to examine how flow has varied over this time. Measured flow data for the period 1992 to 2006 are shown in Figure 12.1. Peak flow years were in 1996 and 2001, corresponding with peak rainfall years (2523 and 2091 mm at Franschoek, respectively). 2002 and 2005 were also years of relatively high flow over this period.

12.2 Trends in overall bird numbers

There is substantial inter-annual variation in the number of birds recorded on the estuary, some of which is natural and some of which is an artefact of counting methods. There is roughly equal variation in the summer and in the winter counts (Figure 12.2). Counts may be affected to some extent by their timing, e.g. January vs. February. In general, the count data suggest that there is no increasing or decreasing trend in overall bird numbers on the estuary.

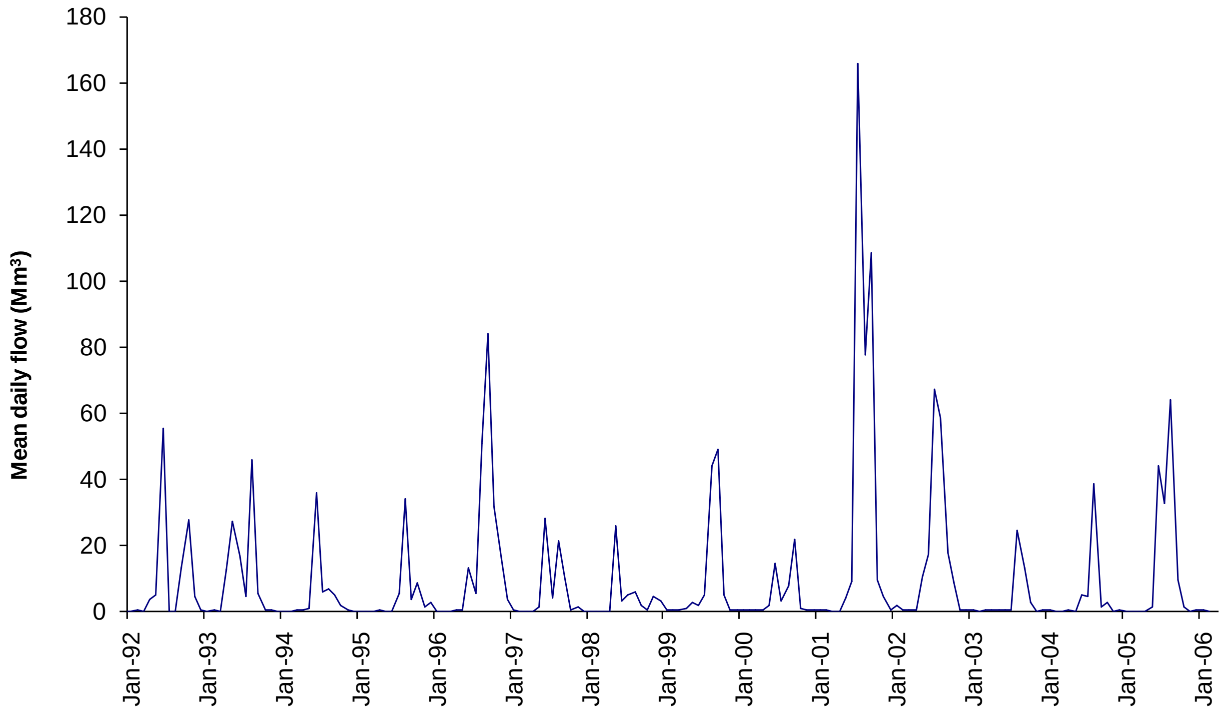


Figure 12.1 Pattern of monthly flows into the Berg River estuary from 1992 to 2006, measured at Misverstand (Data from DWAF).

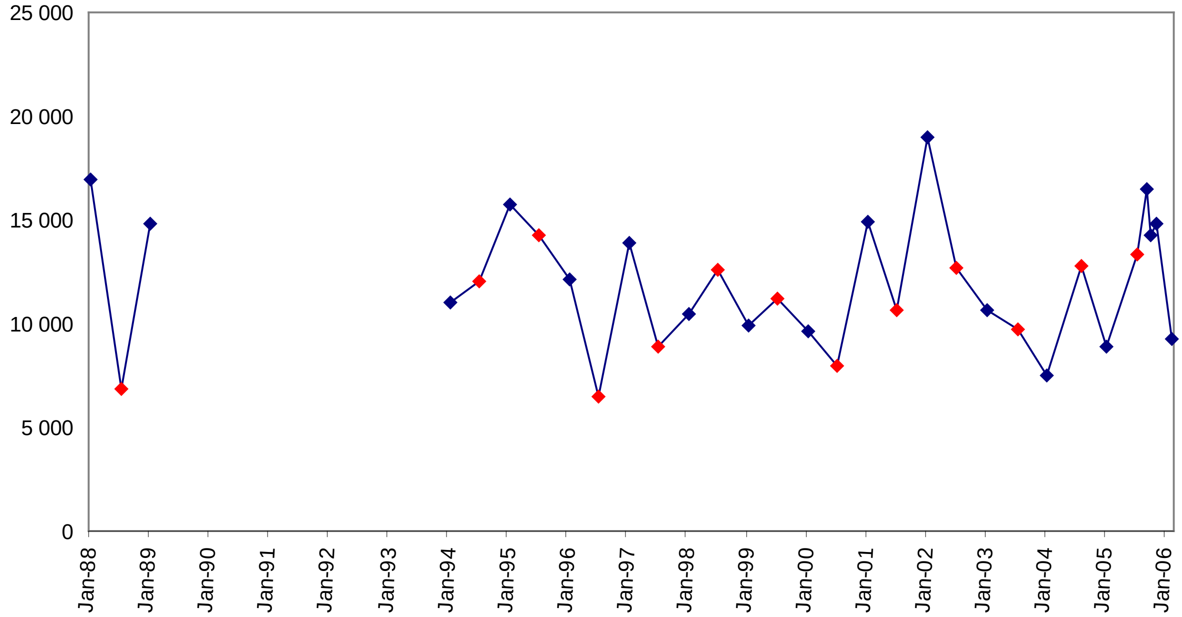


Figure 12.2 Total numbers of waterbirds (excluding marine cormorants) counted on the Berg River estuary during mid-summer and mid-winter counts. CWAC counts begin in Summer 93/94. Preceding counts are from Velasquez *et al*. (1991). Mid-winter counts are marked red.

12.3 Variation in abundance of different groups of birds

All three groups of waterfowl were more abundant in years of higher flows. Some relationship to flow can also be discerned for gulls and terns, and piscivores. Piscivorous wading and swimming birds have shown a marked increase over the period of counts, wheras numbers of waders have decreased, probably due to a combination of conditions on their palearctic breeding grounds and disturbance on the estuary.

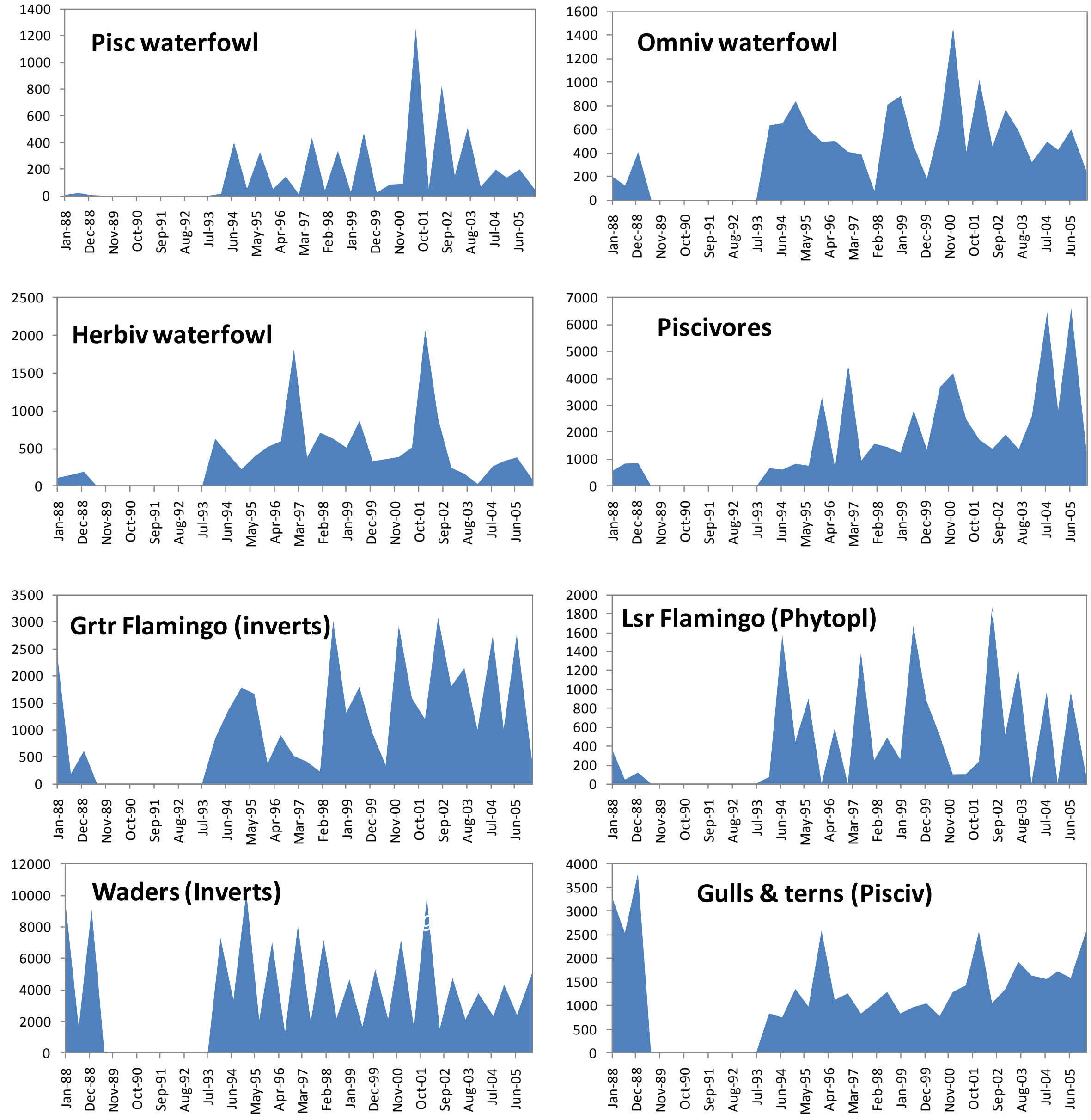


Figure 12.3 Interannual variation in abundance of different bird groups on the estuary

12.4 Variation in abundance of individual species

Certain species have shown a steady or recent increase in numbers since 1988 (Turpie 2007). These include: Cape Cormorant, Darter, Grey Heron (Figure 12.4) and Hadeda Ibis, as well as Pied Avocet, Knot and Black-crowned Night Heron. Others have decreased steadily or in recent years. This is apparent for Egyptian Goose, Yellowbilled Egret, Southern Pochard, African Rail and possibly Common Moorhen. Numbers of some wader species also appear to have decreased, including Ruddy Turnstone, Ruff (Figure 12.5), Bartailed Godwit and the resident White-fronted Plover.

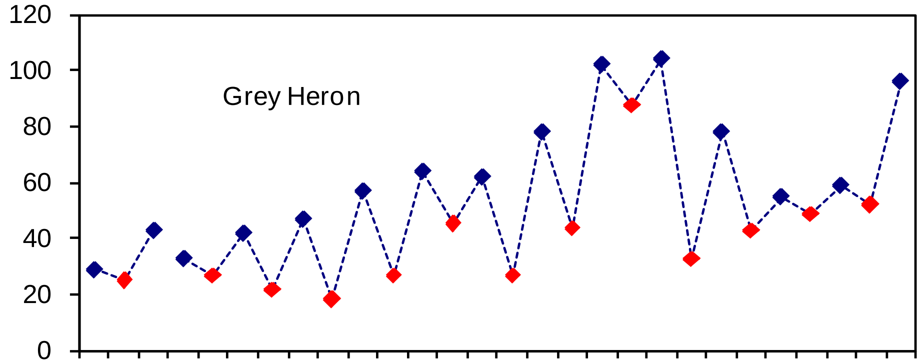


Figure 12.4 Trends in the numbers of Grey Heron on the estuary.

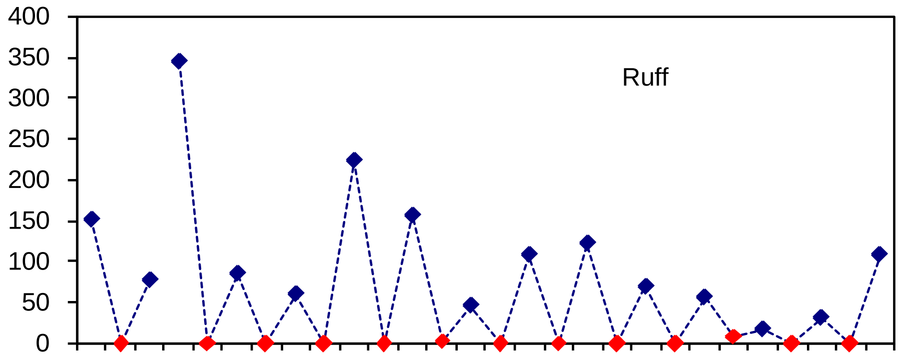


Figure 12.5 Trends in the numbers of Ruff on the estuary.

It appears that some birds may have been affected by the “black tide” event of 1994, which resulted in large fish kills. Numbers of piscivores such as Reed Cormorant and Darter were particularly low the following summer, African Fish Eagle disappeared altogether, and numbers of Little Egret and Purple heron were also depressed. However, this pattern can also be observed for species such as Egyptian Goose and Spurwinged Goose, and may have been influenced by the relatively low rainfall in the preceding season.

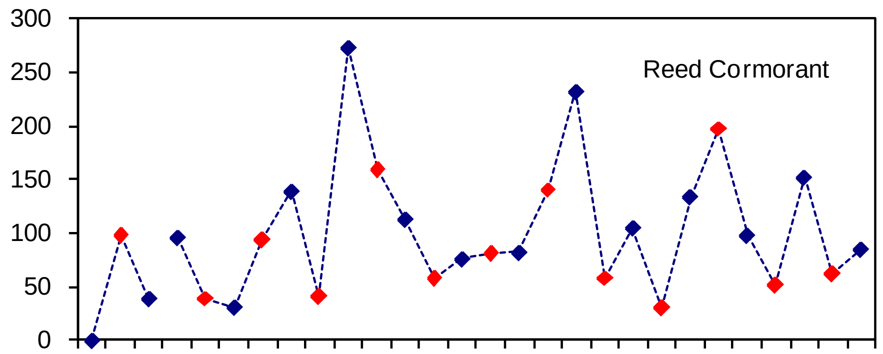


Figure 12.6 Example of a species that was affected by the Black Tide event.

Wader numbers are highly variable. In the case of migrants, this is at least partly due to variability of success on their distant breeding grounds.

In general, the numbers of waterbirds are probably influenced not only by local conditions but by conditions in surrounding wetlands and coastal areas. There is probably considerable movement between the Berg and Langebaan Lagoon, for example, although this has not been proven.

Several floodplain species such as Egyptian Goose, South African Shelduck, Yellowbilled Duck and Spurwinged Goose showed marked increases in numbers in the high flow years, probably because some of the lower pans remained inundated by the time of the summer CWAC counts in those years (see Figure 12.7 for examples). Another noticeable trend is that the numbers of several piscivorous species such as White Pelican, Reed Cormorant and even Cape Cormorant are particularly high in high-rainfall years. Other birds that followed this trend include African Spoonbill, Sacred Ibis, and Glossy Ibis. The only wader to show this trend was the Knot, possibly because of their use of open pans. In addition, large numbers of Greyheaded Gull were recorded after the 1996 floods, whereas they are usually not recorded on the Berg River estuary. Whitewinged terns were numerous after the 1996 floods, and Whiskered Terns were more numerous after the 2001 floods. The remaining species appear to be little affected by flow levels *per se*.

While a number of positive correlations were found with flow, most of these relationships were weak, due to the high level of variability. It is likely that there would be a greater correlation with extent of flooding each year (which is not necessarily strongly related to the size of the flow peak – see Beck & Basson 2007), but these data were not available for the corresponding time series.

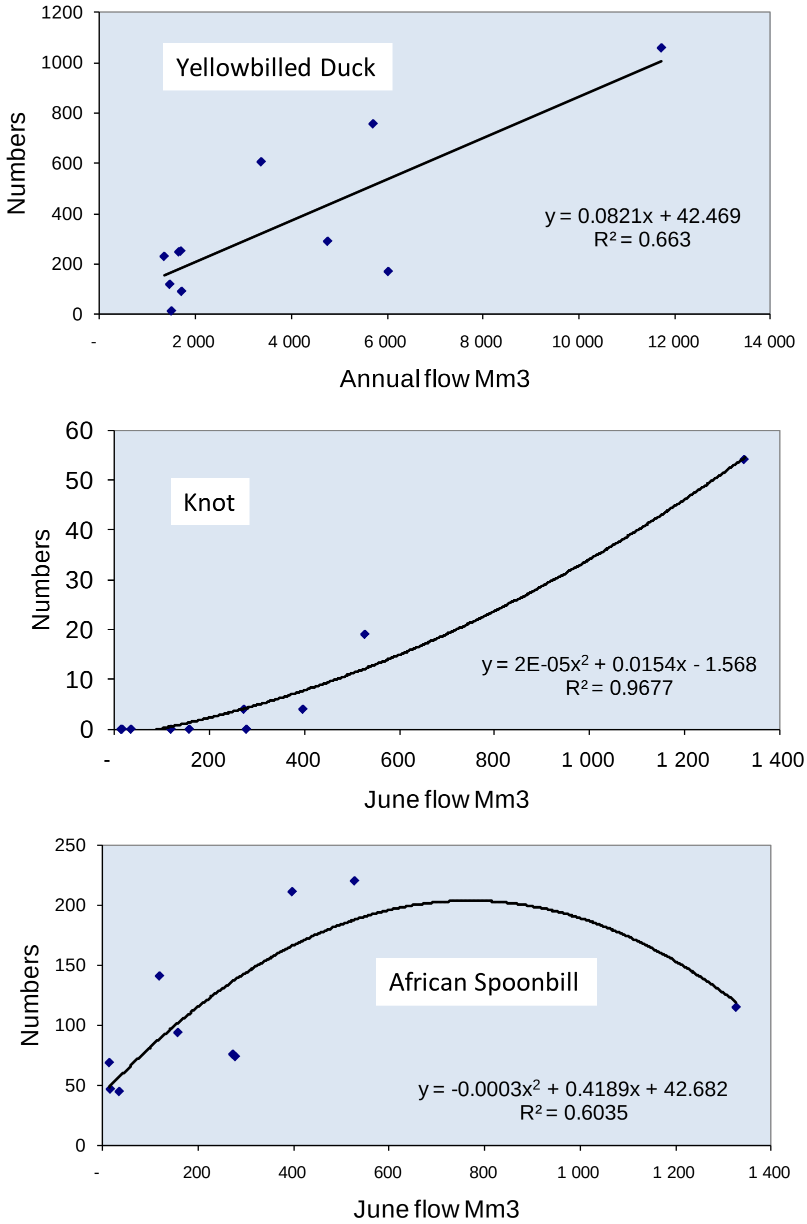


Figure 12.7.Positive relationships of different species to flow

13 CONCLUSIONS

13.1 Factors affecting the distribution and abundance of birds

A number of factors affect the composition of bird communities along the estuary, through their influence on the distribution and abundance of individual species.

The **primary factors** are the availability of *food* and *habitat* for feeding, roosting and breeding. While some species are fairly catholic in their choice of habitats or food, most are restricted to certain food and habitat types. These preferences align to a broad extent with taxonomic grouping, and are discussed in detail above.

In turn, these primary factors are affected by **secondary factors**. For example, abundance of certain food or habitat types may be linked to *salinity*, with the result that certain bird species are only found in more or less saline conditions. The latter links are often easier to ascertain than the primary links. Another example is the link between food availability or habitat type and aspects of *flow or flooding*. This is explored in more detail below.

In addition to these natural factors, anthropogenic factors also influence bird communities on the estuary. These factors include:

- Increase in *primary productivity* or eutrophication, e.g. through fertiliser runoff from the catchment. This may result in the increase of species that are attracted by weed, such as certain waterfowl, and the decrease of species that require deep, clear water for feeding, e.g. diving piscivores.
- Creation of *new habitats*, e.g. by construction of artificial salt pans. This attracts species such as flamingos and resident waders that prefer dry or saline pans, e.g. Chestnut-banded Plovers.
- *Human disturbance*, e.g. through recreational activities, which flush birds from feeding, roosting and breeding areas. This has been shown to be a major issue in some estuaries, resulting in significant decreases in numbers of birds. Although not significant at present, this could become a major problem if development of the area continues unchecked.
- *Degradation of habitats*, e.g. through trampling. This is not a major issue for birds on the Berg River.
- *Loss of habitats*, e.g. through reclamation of wetland and estuary areas for developments. This usually has a direct impact on bird numbers. In general, it has been found that reduction in habitat results in a proportional loss of birds, rather than an increased concentration of bird, suggesting that these areas are used at their full carrying capacity.
- *Reduction in food*, e.g. through fishing activities. Fishing activities can have a significant effect on the average size and density of fish or invertebrates. This would affect the number of birds that the estuary could support.

13.2 Influence of flow on different groups of birds

While no statistically strong correlations were found to explain interannual variability in bird numbers, both seasonal and interannual patterns of abundance of different groups of birds can be directly or indirectly linked to flow to different extents.

In the case of the **heronry species** (egrets, herons, darters, cormorants, ibises, spoonbills), which dominate waterbird numbers during spring, breeding activity could be related to flow inasmuch as the suitability of the breeding area is influenced by the extent to which the bases of the reed beds and trees that are used for nesting are flooded. These areas would not be safe for breeding if they are high and dry. Breeding success may also be flow-related (via food abundance), and current breeding numbers will reflect past breeding success to a certain extent.

The **rail species**, which are all resident, have fairly stable numbers year-round, apart from Redknobbed Coot, the most abundant rail species, which is more abundant in winter. However, their abundance is not linked to flow, and may be more directly related to the availability of *Potamageton*, the abundance of which is quite dynamic and influenced by multiple factors.

Numbers of other **waterfowl species** fluctuate enormously, but are probably fairly strongly linked to flow, mainly in terms of the degree to which the floodplain is flooded. The timing of flooding is also important for breeding.

Flamingo numbers fluctuate widely from year to year, and these fluctuations are at least partly linked to conditions on breeding and feeding grounds elsewhere. At the Berg River, artificial salt pans constitute one of the most important habitats for flamingos. Nevertheless, the extent of flooding appears to play an important role in attracting flamingos to the area, probably especially when some of the larger bare pans are flooded.

Migratory wader species that make use of freshwater wetlands are influenced by the availability of habitat in the floodplain. These include some of the most abundant species such as Little Stint and Greenshank. Those that tend to be restricted to coastal intertidal habitats, such as Eurasian Curlew, are less likely to be directly affected by flow conditions, since there would be little immediate change in habitat availability, but may ultimately be affected by more gradual changes in habitat or indirectly by changes in food availability.

Many **resident wader species** are highly dependent on the freshwater wetlands of the floodplain, and their numbers are directly influenced by the availability of habitat due to extent of flooding. The timing of flooding is also important for breeding. There are some resident wader species, however, that would be little affected by flow, since they are more numerous on the estuary (e.g. African Black Oystercatcher) or on the artificial saltpans (e.g. Chestnutbanded Plover).

Numbers of those species of **gulls and terns** that make extensive use of freshwater habitats (e.g. Greyheaded Gull, Whitewinged Tern) are clearly influenced by the degree of flooding in the floodplain. The more marine species, e.g. Kelp Gull, Common Tern, are unlikely to be affected by flow changes, except ultimately due to gradual changes in food supply, as for all other foraging species.

Most of the more direct flow related changes described above are due to changes in the degree of flooding of the floodplain wetlands, rather than flow *per se*. Species that use the floodplain pans, in particular, for feeding and breeding, are most likely to be particularly responsive to changes in the degree of flooding, as this affects the availability of suitable or productive habitat. Other changes may occur more gradually, if longer term changes in flow affect the productivity of the estuary or the configuration of habitats.

13.3 The functional role of the floodplain wetlands

The Berg River estuary is fairly unique in that it is functionally linked to a major floodplain area with freshwater wetlands, as well as major artificial saltpans.

Both the natural and man-made pans add considerable diversity to the estuary as well as the area as a whole. In other words these habitats probably allow the estuary to support more birds than it would be able to support in isolation. Both the floodplain wetlands and saltworks provide high-tide roosting habitat for birds that forage in the estuary, with different species being prevalent in each. These supplementary habitats are thus probably a significant part of the reason for the particularly high density of birds on the estuary.

The floodplain area also offers additional habitat for waterbird species that also use intertidal foraging areas, as well as providing habitat for species that are relatively rare or absent in intertidal areas. When inundated and during the drawdown period, the floodplain also attracts additional breeding birds that forage elsewhere during the rest of the year. Thus the floodplain plays a significant role in contributing to the overall species richness and abundance of birds on the lower Berg River, and its overall conservation importance.

Thus the floodplain area, whose productivity is highly dependent on degree of flooding, forms a critical component of the wetland area as a whole, and is a strong factor in determining the overall conservation importance of the estuary.

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