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Survey of Birds on Floodplain-estuarine Wetlands on the Hunter and Richmond Rivers in Northern N.S.W.

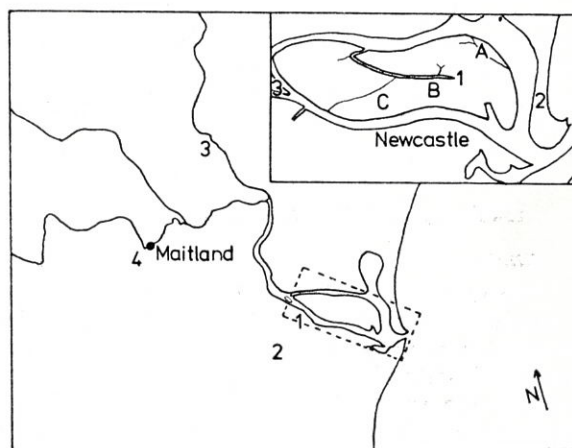
D. G. GOSPER

A systematic account of birds observed on wetlands of the Hunter and Richmond Rivers between 1970 and 1977 is given. Numbers of migratory waders and terns on the estuaries were highest between December and early March, and were lowest between late June to early August. Marked annual and seasonal variation in waterbird numbers were observed. In years of high waterbird concentration a relatively few species comprised the bulk of the population during peak periods. In seasonal terms, overall waterbird numbers showed a broad correlation with seasonal habitat availability as inferred from the normal rainfall distribution pattern.

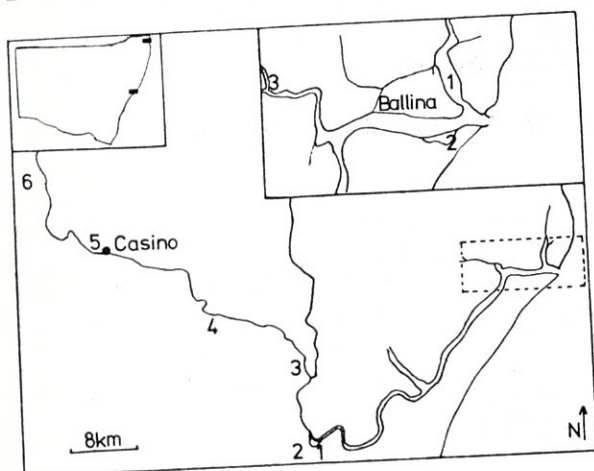
Surveys of birds utilizing floodplain-estuarine wetlands on the Hunter and Richmond Rivers on the north coast of N.S.W. were made regularly over periods between 1970 and mid 1977. The areas investigated (Figures 1, 2) comprised sections of the river estuaries together with networks of swamps distributed along the floodplains. Locations regularly visited are marked on the maps, unnamed swamps being shown by location. Durations of the main surveys were as follows:

Hunter: Kooragang Island (areas A, B and C) — 36 months from February 1970 to January 1973; Stockton — 12 months from February 1972 to January 1973.

Seaham, Minmi (portion of Hexham Swamp), Shortland and Maitland (portion of Wentworth Swamp) — 9 to 11 months between March 1972 and January 1973.



● Figure 1. Map showing locations for Hunter River area.
Legend — 1 Shortland, 2 Minmi, 3 Seaham, 4 Maitland.
Insert — Hunter Estuary, 1 Kooragang, 2 Stockton, 3 Hexham Island.



● Figure 2. Map showing locations for Richmond River area.
 Legend — 1 Swan Bay, 2 Bungawalbin, 3 Coraki, 4 Tatham, 5 Casino, 6 Stratheden.
 Insert — Richmond Estuary, 1 North Creek, 2 Mobb's Bay, 3 Emigrant Creek.

Richmond: North Creek, Mobb's Bay and Emigrant Creek — 14 months from December 1972 to January 1974.

Swan Bay, Bungawalbin, Coraki (Kennedy's Swamp), Tatham, Casino (Barling's Swamp — Golfcourse Swamp/Richmond Park) and Stratheden — 37 to 51 months between April 1973 and June 1977.

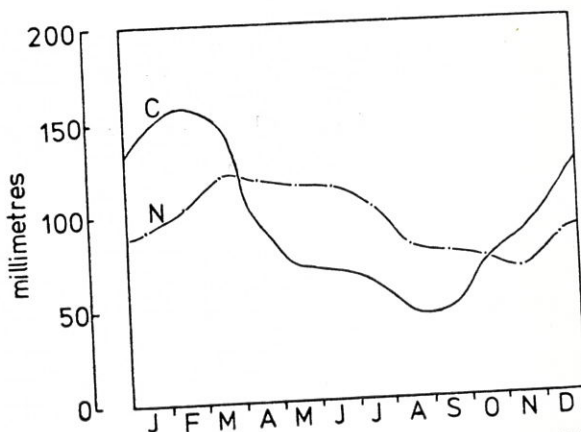
Habitats, Climate and Seasonal Effects

Habitats

The wetlands are briefly described in Table 1. Classification follows Goodrick (1970) and distinguishes eleven wetland types as occurring on floodplain-estuarine country on the rivers. All types were sampled though salt meadows, tea-tree swamps and sheoak swamps were poorly represented in the study areas.

Climate

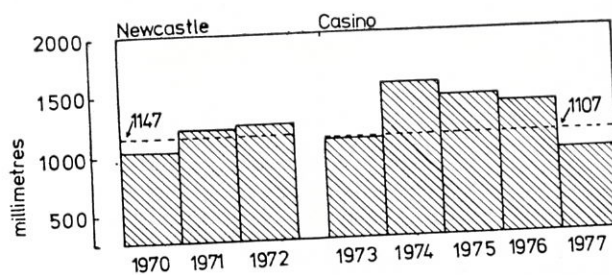
On the N.S.W. north coast there is a pronounced wet period from December to April



● Figure 3. Average monthly rainfall at Casino (C) and Newcastle (N).

(or early winter in the south where less marked — cf Fig. 3). High monthly totals can occur (e.g. 400mm + at Casino in February 1974; March 1976) at times associated with the incursion of tropical cyclones, causing the rivers to flood in most years.

Late winter and spring are markedly drier. Rainfall in the region was above average for much of the period of the study (Fig. 4). Significant dry spells occurred only in 1970 and in the latter part of 1977 after regular surveys had ceased.



● Figure 4. Annual rainfall at Newcastle (1970-72) and Casino (1973-77).

TABLE 1 — Habitat classifications; wetland types occurring in study areas. After Goodrick (1970).

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- SHALLOW ESTUARINE WATERS:** Shallower areas of estuaries and associated tidal flats. Open tidal water <3m. deep at low tide — eelgrass *Zostera* in dense swards partially exposed at low water; tidal sand/mudflats; sandspits inundated by spring tides or not at all; rocky intertidal areas — training walls, oyster leases. e.g. North Ck; Mobb's Bay; Stockton.
- MANGROVE SWAMPS:** Swamp forest/scrub, mostly a fringing belt <100m. wide, lining tidal flats, creeks.
Mangroves *Avicennia*, *Aegiceras*, *Bruguiera* e.g. Mobb's Bay to Byrnes Point; Kooragang Is.; much reduced on both estuaries.
- SALTFLATS:** Open saltmarshes on landward edge of mangroves above the regular tidal influence.
Low open samphire *Arthrocnemum*/salt couch *Sporobolus* flats; shallow unvegetated salt pans with dense algal mats in warmer months, e.g. Kooragang Is.; mostly partially debilitated.
- SALT MEADOWS:** Saltmarsh zone above tidal action, dominated by rushes.
Dense salt rush *Juncus* beds interspersed with open low ground cover; standing water slightly brackish, <0.2m. or absent, e.g. North Ck; mostly reclaimed, little importance.
- REED SWAMPS:** Reed/sedge meadows in less saline, low-lying estuarine-lower floodplain country.
Dense pure reed *Phragmites*/sedge *Scirpus* beds with up to 1m. standing water in wetter months in places, drying out in dry season; some small open water clearings occur, e.g. Kooragang Is.; widespread in semi-reclaimed/disturbed estuarine situations.
- SHEOAK SWAMPS:** Dense swamp forest in waterlogged floodplain-estuarine country.
Swamp oaks *Casuarina*; some standing water briefly after rains, e.g. Minmi; mostly cleared, remnant groves fringing other wetlands.
- TEA-TREE SWAMPS:** Dense swamp forest on wet floodplain country.
Paperbarks *Melaleuca*; Up to 0.5m. standing water in wetter months, e.g. Minmi; mostly drained, cleared; small remnant stands in some semi-permanent swamps, e.g. Tatham; Shortland, Seaham.
- FRESH MEADOWS:** Floodplain country subject to shallow seasonal flooding, typically with a ground cover of semi-aquatic herbs.
Wet pastures with rank smartweeds *Polygonum*, grasses *Paspalum*, *Panicum*, *Pseudoraphis*, *Echinochloa* and rushes; standing water up to 0.6m. in wet months, usually dry at other times and carpeted by pastures grasses in spring, e.g. Bungawalbin, Casino; Minmi; Maitland; mainly fringing seasonal swamps, extensively grazed by beef, dairy cattle.
- SEASONAL FRESH SWAMPS:** Meadows grade into shallow open seasonal swamps which carry surface water for much (and sometimes all) of the year and support a diverse herbaceous aquatic flora.
Luxuriant vegetated shallows with low emergents, e.g. water ribbons *Triglochin*, primrose *Ludwigia*, milfoil *Myriophyllum*, snowflake *Nymphoides* dominant, in conjunction with submergents, e.g. *Utricularia* and floating fern *Azolla* and duckweed *Lemna*; up to 1.3m. deep drying back rapidly in spring early summer/unseasonal dry spells, though usually drying up completely for not more than a few months of the year, e.g. Casino, Coraki, Minmi and Maitland.
- SEMI-PERMANENT SWAMPS:** Deeper backswamps on floodplain edge with standing water the year round and a characteristic vegetation of tall emergents.
Dense tall beds of spike rush *Eleocharis* or cumbungi *Typha* with a subdominant sub-emergent/floating flora, e.g. milfoil, water fern; where water hyacinth *Eichhornia* occurs it envelops large areas forming dense rafts excluding other vegetation; open water clearings occur in deeper parts and there is usually a seasonal fresh fringe of variable extent; usually 0.5-1.5m. deep, extensive drying up taking place only after a succession of dry years, e.g. Stratheden; Shortland.
- OPEN FRESH WATERS:** Deep, permanent floodplain billabongs lacking emergent vegetation.
Deep open waters with submergent aquatics, e.g. ribbonweed *Vallisneria*, pondweeds *Potamogeton*; a fringes of reed swamp occurs in some situations; mostly >1.5m. deep, permanent, e.g. Swan Bay.
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Seasonal effects

In most years the wetlands were driest by late spring or summer by which time seasonal swamps were generally dry and water levels on semi-permanent swamps lowest. One or more periods of heavy general rain, starting from as early as December to as late as March brought about a sharp transformation in habitat conditions. Once surface water was restored rapid growth of aquatic vegetation followed reaching a maximum from late summer. Seasonal wetlands were usually extensive from late summer through winter. Some drying back of meadows took place during winter as water levels fell gradually and plant growth was reduced with emergent vegetation, particularly on seasonal swamps becoming heavily grazed. In spring drying up accelerated sharply as temperatures rose. Seasonal swamps diminished and there was little surface vegetation, marginal vegetation was short and muddy fringes developed briefly. By the start of summer all but the largest seasonal wetlands had dried up completely and dry conditions intensified through summer if heavy general rain was not received. Storms occurring during this period had little effect in replenishing surface water though plant growth was stimulated with dry meadows and swamps becoming carpeted with grasses and rank smartweeds and rushes.

Higher than normal rainfall during the wet season (e.g. 70-80% above normal in 1974, 1976) appeared only to marginally extend the duration of meadows and seasonal swamps in the following spring; excess rain and flooding in the wet season ran off quickly (most swamps had been partially drained at some time) and did not greatly postpone subsequent drying up. Exceptionally, significant rainfall in late winter and/or spring (e.g. 1973, 1975) retained standing water in seasonal swamps throughout the year. Deficiencies in wet season rainfall, particularly when the period from February onward was drier than usual (e.g. 1970), had a marked effect. The period of drying out was effectively prolonged and waterlevels dropped sharply from the end of summer, causing severe conditions to develop by late winter. In years when heavy general rains required to restore seasonal swamps were not received until March (e.g. 1975, 1977, 1978) conditions in the preceeding summer months became very dry and only semi-permanent swamps and billabongs were available to waterbirds toward the end of summer.

Methods

Surveys were carried out on a monthly basis in all areas; additionally in most months of 1972 (Hunter) and 1973 (Richmond) all known high tide loafing sites regularly used by waders and terns feeding on the estuaries were censused. Surveys involved counts of all birds found and recording of habitats used. Exact counts or estimates were made, depending on numbers encountered. Block estimates (using a suitable number, usually 10, 20 or occasionally 50 as a unit to estimate by size and density) were sometimes employed where numbers in an aggregation exceeded 200. Birds were included in totals only when there was no suggestion that the same individuals had been counted previously. Time required to census each of the study areas was generally from two to four hours depending on the seasonal extent of swamps and abundance of waterbirds. In most situations habitats were fairly readily assigned to categories in the classification (Table 1), though some more severely disturbed and altered wetlands (notably on Kooragang Island) were harder to categorise. Boundaries of seasonal wetlands, particularly fresh meadows and seasonal fresh swamps, were sometimes difficult to determine clearly. Discrete swamps were generally categorised by the wetland type which occupied the largest area though fringe zones of other types were usually present e.g. semi-permanent swamps typically had a seasonal fresh fringe and areas of open fresh water in deeper parts.

Evidence of breeding was recorded when encountered but generally little attempt was made to search for nests, which if found, were not followed up.

Conventions

A summary of the occurrence of species recorded during the surveys (excluding land birds utilizing non-wetland components of the habitats viz. mangrove, tea-tree and sheoak swamp forest tree layers) is given in the systematic list. Species summaries are given separately for the Hunter (H) and Richmond (R) in that order, the omission of one or the other indicating species unrecorded during surveys of that area.

Frequency of observation (i.e. percentage of total surveys that each species was observed) is given in the following terms: scarce (<10%),

uncommon (10-29%), moderately common (30-59%), common (60-80%), very common (>80%).

An indication of range in numbers of birds recorded at any one time may be given, e.g. six records (1-4) or common (1-220), meaning 'six records of from one to four birds' or 'frequently encountered in numbers varying from one to 220'.

Extreme dates for migrants (i.e. first and last dates of occurrence) are for the duration of the surveys. Breeding information is given where nests were found, dates being for the month(s) in which clutches were found, unless otherwise indicated. Clutch sizes given should be regarded only as representing the number of eggs seen in a nest on one visit.

Survey sites are referred to by location, e.g. Kennedy's Swamp at Coraki is simply given as Coraki. Kooragang Island is abbreviated to Kooragang.

Habitat use is shown in Table 2 in the form of a table of frequency of observation.

SYSTEMATIC LIST

Great Crested Grebe *Podiceps cristatus*

(H) One at Kooragang on 31 July 1971.

Hoary-headed Grebe *Poliiocephalus poliocephalus*

(H) Scarce; seven records (1-2) Maitland area between 31 March and 20 August 1972.

(R) Irregular visitor; scarce; recorded as follows: None 1973 and 1974; up to seven at Casino, Bungawalbin and Tatham from 8 March to 18 October 1975; one at Tatham from 15 August to 25 September 1976 and two on 9 May 1977; at least six at Casino on 26 March and 2 April 1978; on sewerage dams at Casino (up to 29), Ballina and Emigrant Creek Dam on 26 December 1978 and 2 January 1979.

Australasian Grebe *Tachybaptus novaehollandiae*

(H) Common (1-60) on floodplain swamps; numbers increased from about March to August, mainly on swamps with open water but also on other large bodies of water, e.g. up to 150+ on dammed saltflats at Kooragang 1971, 1972; 350+ on the sewerage dam at Maitland in 1972. Breeding: Shortland, Seaham, Kooragang; October and November, February and March (C/2-6).

(R) Common (1-194) on floodplain swamps; numbers generally highest from about March or May to October. Breeding: Casino, Tatham, Bungawalbin; August to April (C/2-6).

Shearwater sp *Puffinus* sp.

(R) Occasional; single dark shearwaters seen briefly over estuary near Byrnes Point in windy overcast conditions in December 1973 and 1976.

Australian Pelican *Pelecanus conspicillatus*

(H) Recorded all months; moderately common (common 1972) on the estuary from August to January, with a marked peak during summer in all years: 300 December 1970, 270 January 1972, 450 December 1972; a few in most months of 1972 on the floodplain swamps in the Minmi and Maitland areas with a maximum of 120 in June.

(R) Recorded all months; moderately common (1-129) from June to January on the estuary, uncommon on floodplain swamps except at Swan Bay where a few were usually present; more frequent from 1976 to 1978 than in other years.

Australasian Gannet *Morus serrator*

(R) Occasional; three occurrences of single birds on the lower estuary apparently having entered the river from off shore.

Darter *Anhinga melanogaster*

(H) Uncommon; recorded most months on floodplain swamps and on the estuary from May to December; thirty-three records (1-11).

(R) Moderately common; small numbers (up to 21 at Swan Bay in July 1975) on floodplain swamps and on the estuary throughout the year.

Great Cormorant *Phalacrocorax carbo*

(H) Recorded all months; moderately common on the estuary in 1970 and 1971, common in 1972; uncommon on floodplain swamps; usually small numbers but occasionally in flocks (<68).

(R) Recorded all months; moderately common on the estuary, uncommon on floodplain swamps (1-15).

Pied Cormorant *Phalacrocorax varius*

(H) Uncommon (1-30); recorded on the estuary in all months but mainly from July to December.

(R) Common on estuary, roosting assemblages up to 200 on sandpits with numbers highest in summer; occasionally one or two at Swan Bay.

Little Black Cormorant *Phalacrocorax sulcirostris*

(H) Common on the estuary, also regularly recorded on semi-permanent floodplain swamps; largest numbers from October to March; mostly in flocks (<70); roosting assemblages of 150+ on Kooragang and up to 200 at Shortland between November 1972 and January 1973.

(R) Common on the estuary and moderately common on floodplain swamps; variable but generally largest numbers between April and November; scarce or absent on floodplain swamps from at least January to June in the wet years 1974 and 1976; feeding flocks up to 120 on the estuary in July 1976, 90 at Swan Bay in May 1975.

Little Pied Cormorant *Phalacrocorax melanoleucos*

(H) Very common on floodplain swamps and the estuary; widely distributed, occasionally large concentrations e.g. 190 in a feeding aggregation on Kooragang in March 1971; 200 roosting, on nests at Shortland in January 1973; a marked build up in numbers occurred briefly between February and May in all years in the Kooragang area. Breeding: in paperbarks at Shortland (40+ pairs) and Seaham (<12 pairs); egg laying from October with last young fledging in early April.

(R) Common (1-48) on floodplain swamps and the estuary; numbers generally highest from about May to October, decreasing in summer; became very uncommon from January to April in the wet years 1974 and 1976.

Least Frigatebird *Fregata ariel*

(R) Occasional; two over lower estuary and river entrance for at least three hours on 21 January 1976 in strong N.E. winds, following tropical cyclone 'David'.

Pacific Heron *Ardea pacifica*

(H) Recorded all months; uncommon (1-10+) on floodplain swamps.

(R) Recorded all months (1-46) on floodplain swamps but in fluctuating numbers, e.g. scarce from mid 1973 through 1974 (none from August 1973 to February 1974, and from September to December 1974), and also in first half 1976; generally moderately common in 1975 and the latter part of 1976 and 1977. Breeding: nest with young nearly fledged at Bentley, north of Casino on 19 February 1973.

White-faced Heron *Ardea novaehollandiae*

(H) Very common; widespread on floodplain estuarine wetlands; generally abundant on swamps from late summer through winter and tidal flats in winter; generally fewer from September to early December or January; singly or in loose feeding aggregations up to 100 and occasionally more, e.g. 240 on Kooragang in July 1972. Breeding: a few pairs in mangroves on Kooragang; September and October, February (C/3).

(R) Very common on floodplain swamps and the estuary; highest numbers usually from March or April to about August; generally a few on the tidal estuary from late September to December or early January; singly or in small to large aggregations (<160); estimated 400 in loose flocks in Bungawalbin — Swan Bay area after floods in March 1974. Breeding: A few pairs in mangroves at North Ck; September, December and January.

Cattle Egret *Ardeola ibis*

(H) Uncommon to moderately common on floodplain country; feeds mainly in paddocks and fresh meadows, returning to swamps proper to roost during the middle of day and evenings; generally small flocks (<30) from March to October but few from November to February; recorded all months.

(R) Fairly common on floodplain country from March to September or October, absent or few between November and February, recorded all months; roosting assemblages up to 500 Casino, Coraki; 1000+ (an exceptional number) at Loftville near Lismore on 12 March 1977.

Great Egret *Egretta alba*

(H) Common; widespread on floodplain swamps, usually fewer on the tidal estuary; singly or small feeding concentrations (usually <45 but up to 150); most numerous on the lower floodplain from October to March or May, apparently then dispersing after breeding; mostly small numbers at other times. Breeding: annually in mangroves on Kooragang (up to 200 pairs); egg laying commenced October (1971) or December (1970, 1972) with last young vacating nests early May (C/3-4).

(R) Moderately common; widely distributed on floodplain wetlands and estuary though not numerous; mostly singly although occasionally small feeding aggregations (<38); numbers usually increased briefly on floodplain swamps in March or April; also present around drying swamps between September and December or February in dry seasons (1974-75, 1976-77); absent or scarce from at least January to March in the wet summers of 1974 and 1976.

Little Egret *Egretta garzetta*

(H) Common about the estuary, fewer on floodplain swamps; singly or small feeding parties (mostly <10); larger aggregations (20-30) annually on Kooragang between October and March or May. Breeding: probably nested on Kooragang in 1970 and 1971 judging by movements of adults in vicinity of heronry and appearance of numbers of immatures from April to June.

(R) Uncommon; small numbers recorded in all months; (1-7) on the estuary most of year, less regularly on floodplain swamps; absent from January to April in 1974 and 1976.

Intermediate Egret *Egretta intermedia*

(H) Fairly common on floodplain swamps though generally not plentiful except at Minmi and on Kooragang; avoided tidal and saline wetlands; singly, small to large feeding concentrations (up to 250 Minmi) from October to March, before dispersing; few at other times. Breeding: in mangroves on Kooragang in 1970 and 1971 (<40 pairs); small young in some nests by mid-February.

(R) Common on floodplain swamps; singly or in loose feeding aggregations (mostly <100 but up to 270 at Casino), usually fewest in summer, increasing abruptly to a marked peak between March and May, then declining but generally remaining fairly numerous through to October or November; absent or scarce from December or January to March 1974 and 1976 but fair numbers through the dry summers of 1974-5 and 1976-77.

Striated Heron *Butorides striatus*

(H) Recorded most months; very uncommon, sixteen records (1-2) on the estuary.

(R) Recorded all months; moderately common on estuary, uncommon Swan Bay; thinly dispersed (1-4). Breeding: pair nested in swamp oak lining Swan Bay in 1974 and 1975; September to November (C/3).

Rufous Night Heron *Nycticorax caledonicus*

(H) Moderately common to common; recorded all areas though mainly on Kooragang and at Seaham and Shortland where cover occurs (mangroves, paperbarks) for roosting during the day; roosting assemblages of up to 300 on Kooragang; appeared most numerous from October to April; generally few encountered at other times except 150+ near the mouth of Iron Bark Ck. on 1 August 1970; recorded all months. Breeding: in mangroves on Kooragang during 1969-71 (up to 60 pairs); egg laying from late October or November with last young vacating heronry early May.

(R) Twenty-one records (1-12) on the estuary and floodplain swamps; records for most months; apparently uncommon but possibly more numerous than records suggest due to absence of suitable cover around most swamps; evening visits at Casino revealed Night Herons flying in at dusk apparently from roosting sites elsewhere; 55 roosting in trees along Bungawalbin Ck. on 10 July 1975.

Little Bittern *Ixobrychus minutus*

(H) Five records of single birds in reed and sedge beds on Kooragang between 23 October and 3 November 1971, 29 October to 16 December 1972. Breeding: in reeds on Kooragang 16 December 1972 (C/3).

(R) Single birds in rush beds at North Ck. on 17 March 1973 and in sedge beds at Coraki on 1 February 1976.

Black Bittern *Dupetor flavicollis*

(R) One in mangroves near Byrnes Point on 20 January 1975.

Australasian Bittern *Botaurus poiciloptilus*

(H) Scarce; six records (1-4) in sedge beds on Kooragang from 13 November 1971 to 27 February 1972 and also 13 August to 2 October 1972.

(R) One at Stratheden in tall spike rush on 4 July 1976.

Black-necked Stork *Xenorhynchus asiaticus*

(H) Single birds on Kooragang on 30 January and at Minmi on 14 October; two birds on Kooragang 11-12 December 1972.

(R) Uncommon (moderately common 1973 to mid 1975); total numbers apparently small but recorded fairly frequently (i.e. 78+ records over 54 months between 1973 and mid 1977); singly to family groups (1-5) on floodplain swamps and the estuary; recorded all months. Breeding: attending nest near Tatham between March and July 1976, 1977.

Glossy Ibis *Plegadis falcinellus*

(H) Irregular visitor, uncommon; only recorded Kooragang swamps as follows:— 1970: none; 1971: up to 8 from 13 November to 19 December; 1972: single birds 19 February, 12 June, up to 49 between 13 August and 16 December.

(R) Uncommon visitor on floodplain swamps; recorded as follows:— 1973: up to 11 at Casino from 13 May to 18 December; 1974: up to five at Coraki and Casino from 15 May to 11 July, two at Tatham 10 October; 1975: up to four at Casino from 22 March to 1 November; 1976: one near Swan Bay on 21 February, up to 19 at Bungawalbin, Casino, Stratheden and near Tatham from 13 June to 5 February 1977: up to 10 at Stratheden and Casino from 1 May at least to August; 1978: flock of 63 at Casino on 8 September.

Sacred Ibis *Threskiornis aethiopica*

(H) Common visitor on the estuary and floodplain wetlands; mostly small parties, flocks (usually <50 but up to 350+); most numerous from February to April or June, with flocks appearing abruptly in late February early March (1971 and 1972) then declining; generally moderate numbers through winter then few from September to January except in 1972 when more than usual were present throughout; from mid November 1972 up to 1500 were found to be collecting in the evening to roost in dead trees and cumbungi in semi-reclaimed mangrove swamps on Kooragang and in paperbarks near Shortland.

(R) Common visitor to the estuary, less frequent on floodplain swamps; large flocks mostly <300, but up to 650 in receding floodwaters near Swan Bay 21 February 1976) appeared briefly on floodplains between February and May in all years except 1974 when only a few were recorded (<100); generally small numbers about swamps at other times; common (1-274) on tidal habitats from late February to September, generally absent or only a few occurring from late September to January; scarce in area generally throughout 1974.

Straw-necked Ibis *Threskiornis spinicollis*

(H) Moderately common visitor on floodplain wetlands avoiding tidal areas; generally flocks (<270), usually most numerous from late February to about

September, a few in spring and summer except in 1972 when fair numbers occurred throughout; from mid November 1972 up to 500+ found to be collecting to roost with *T. aethiopica* on Kooragang, near Shortland.

(R) Moderately common visitor most years on floodplains; most numerous (flocks <450) between March and October, numbers building up from the end of February and March in 1975, 1977, 1978 and 1979, but from as late as June and July in 1974 and 1976; usually a few from November to January; scarce generally throughout 1974.

Royal Spoonbill *Platalea regia*

(H) Moderately common in 1970 and 1971, common in 1972 on floodplain swamps and estuary; mostly small parties or flocks (<40) but up to 180 at Minmi and on Kooragang in 1972 when fairly numerous throughout; apparently absent on Kooragang from November 1970 to June 1971.

(R) Moderately common (1-65) on floodplain swamps and the estuary throughout the year. Breeding: bird on nest near Emigrant Ck. on 7 April 1973, five pairs nesting at Meerchaum Vale on 8 November 1975.

Yellow-billed Spoonbill *Platalea flavipes*

(H) Uncommon visitor on floodplain swamps; avoided tidal habitats; mostly singly or small parties (1-12); infrequent in 1970 and 1971 (seven records, between April and September); small numbers on most swamps May to December 1972.

(R) Very uncommon visitor on floodplain swamps; usually singly but occasionally in pairs; but scarce most times (absent in 1974 and first half 1975); small numbers (1-11) appeared on most swamps in the area from July to December 1975, August to November 1976 and May to at least September 1978; records for all months.

Wandering Whistling-Duck *Dendrocygna arcuata*

(R) One at Tatham from 13 May to 3 November 1974, five at Casino from 6 March to 11 July 1976, two near Tatham 5 January, two at Casino 7 April 1978.

Plumed Whistling-Duck *Dendrocygna eytoni*

(H) Recorded as follows:— 1972: Seaham six on 4 March, Minmi 40 on 12 March, Maitland one on 12 June; 1973: Minmi 120+ on 10 January.

(R) Recorded as follows:— 1975: Casino 25 on 8 March, Tatham one on 8 March and 6 May; 1977: Casino up to 19 on 19-26 March; 1978: south of Kyogle at least 12 on 10 April; 1978: near Tatham 14 on 14 December.

Black Swan *Cygnus atratus*

(H) Common on floodplain and estuarine swamps, occasionally on tidal waters; pairs, small to large numbers; usually most abundant about March to August on open shallow swamps and other large bodies of water, e.g. up to 360 at Minmi, dammed salt flats on Kooragang and sewerage dam at Maitland in 1972. Breeding: Kooragang and Maitland; newly hatched broods March to September, all years.

(R) Very common (1-543) on floodplain swamps notably at Casino and at times Swan Bay; rarely on tidal estuary; marked fluctuations in numbers with most occurring from late summer to winter (generally

between February and July), fewest in late winter and spring. Breeding: all areas; common breeder in all years except 1977 (maximum 18 nests in use on unnamed swamp at Gay's Hill near Casino 13 May 1975); February to August, once November (C/1-8).

Pacific Black Duck *Anas superciliosa*

(H) Very common (1-500+) on floodplain swamps and occasionally on tidal waters; generally highest numbers from April to October, decreasing in summer. Breeding: Seaham, Shortland and Maitland; newly hatched broods March, May and December.

(R) Very common on floodplain swamps and a few on the estuary; small to large numbers (up to 1570 Swan Bay); very marked fluctuations; usually most numerous between March and October (maximum concentrations late winter, early spring), decreasing drastically in late spring and summer except in 1974-75 when abundant throughout the year. Breeding: Casino, Tatham, Bungawalbin and North Ck.; small numbers in all years; newly hatched downy young from December to May and also in September.

Mallard *Anas platyrhynchos*

(R) Scarce; recorded singly 19 times between 1973 and 1977, mainly at Coraki and Tatham but at least once at Stratheden, Swan Bay and Bungawalbin.

Grey Teal *Anas gibberifrons*

(H) Visitor; moderately common (1-820) overall on floodplain swamps and occasionally tidal waters; mainly between April and October with highest numbers in late winter, declining to a few in late spring and summer; generally scarce 1970, abundant 1972. Breeding: Maitland; small downy young on 12 January 1973.

(R) Visitor; common overall on floodplain swamps and rarely on the estuary; scarce to numerous (up to 1610 Casino) with rapid fluctuations in populations; generally small numbers in 1973, 1974 (scarce) and 1977; abundant in 1975 and 1976; mainly from March to October with maximum concentrations in winter, early spring. Breeding: Tatham and Casino; small numbers all years; small downy young from October to December, March and April, once in August.

Chestnut Teal *Anas castanea*

(H) Locally common on the estuary and at Shortland; rarely elsewhere; mostly pairs or small flocks through summer but large concentrations from March to August with up to 1200 on Kooragang in June and July 1971, 1972. Breeding: Kooragang and Shortland; annually in small numbers from September to March, mainly in holes in mangroves (C/7-12).

(R) Very uncommon visitor on floodplain swamps and estuary; 37 occurrences (males 1-7) of which 25 were in 1975 and 1976, and all but five records were between April and October.

Australasian Shoveler *Anas rhynchos*

(H) Scarce visitor, recorded as follows:— 1971: Two on Kooragang on 31 July; 1972: Up to 6 on Kooragang between 19 March and 5 August, on sewerage dam near Maitland 12 on 6 June and 40 on 12 August. (R) Uncommon visitor on floodplain swamps; recorded all years between February and September (no records outside this period); scarce 1973, 1974; small numbers on most swamps (up to 33 Casino) 1975-77.

Pink-eared Duck *Malacorhynchus membranaceus*

(H) Two on Kooragang 16 April and at Shortland 26 August; up to 20 on Kooragang from 1 October to 14 November 1972.

(R) One at Casino 13 May and 1 June, two at Tatham 22 June 1975; one on sewerage dam Casino 26 December 1978.

Hardhead *Aythya australis*

(H) Uncommon (1-50+) mainly on semi-permanent swamps at Maitland, Shortland, Kooragang; records for all months (throughout 1972).

(R) Moderately common on floodplain swamps; small numbers (1-75) throughout year (usually fewest in summer) 1973, 1974, 1976; in 1975 numbers increased dramatically between May and November, mainly on Swan Bay where a maximum of 980 was recorded in June; a similar build-up occurred on Swan Bay in latter part 1977 with 280 in November and 400+ by early January 1978. Breeding: Tatham; small downy chicks on 21 April 1974.

Maned Duck *Chenonetta jubata*

(H) Uncommon; small number (mostly <35, once 150) about floodplain swamps in winter (June to August) and occasionally at other times.

(R) Uncommon; periodically small numbers (1-40) about floodplain swamps; most frequent in winter but records for all months. Breeding: Tatham, small downy chicks on 27 December 1975.

Green Pygmy-Goose *Nettapus pulchellus*

(R) One on Swan Bay 2-3 February 1975 (Gosper 1976).

Musk Duck *Biziura lobata*

(H) Very uncommon; few (1-4) on semi-permanent swamps at Maitland and on Kooragang; occasionally (twice) on the tidal estuary; recorded all months (throughout 1972).

(R) Uncommon; small numbers (1-9) on semi-permanent swamps and billabongs; rather scarce (except at Stratheden where fairly regular) most of 1974, 1976 and 1977 but increased numbers throughout 1975 when also regular on Swan Bay and at Tatham.

Osprey *Pandion haliaetus*

(R) Scarce; ten records (1-2) on the estuary, August to January.

Brahminy Kite *Haliastur indus*

(R) Locally moderately common resident about the estuary; singly or pairs (up to four adults simultaneously over North Ck); also occasionally up river at Swan Bay (three times) and near Coraki (once). Breeding: In mangroves on North Ck; July (C/2).

Whistling Kite *Haliastur sphenurus*

(H) Moderately common; mostly singly or pairs (1-5) about the estuary and floodplain swamplands throughout the year.

(R) Common to very common; most plentiful bird of prey about floodplain-estuarine wetlands; singly or in pairs but occasionally concentrations (up to 17) around drying swamps in summer. Breeding: Stratheden, Tatham, North Ck, Emigrant Ck most years; March, April and August (C/2), also once attending nest in December.

White-bellied Sea-Eagle *Haliaeetus leucogaster*

(H) Moderately common on the estuary throughout the year, occasionally over swamps at Minmi, Maitland; singly or up to five (adult pair and immatures).

(R) Moderately common; singly or up to four (adult pair and immatures) on floodplains and estuary at all times of year but generally less frequent in winter (May to August).

Marsh Harrier *Circus aeruginosus*

(H) Moderately common (1-3) on floodplain and brackish estuarine swamps; recorded throughout all years.

(R) Moderately common visitor on floodplain, occasionally near estuarine swamps; singly or pairs between March and October; usually absent from November to February (except summer 1975-76 when recorded throughout), e.g. absent 15 September 1974 to 8 March 1975, 6 November 1976 to 5 March 1977.

Peregrine Falcon *Falco peregrinus*

(H) Occasional; singly (seven records, April to November) over swamps on Kooragang and at Minmi.

(R) Occasional; singly (five records, March to November) over North Ck, Tatham, Stratheden.

Australian Hobby *Falco longipennis*

(H) Occasional; singly over swamps on Kooragang, and at Minmi three times in June 1972.

(R) Occasional; singly (seven records, March to November) at Casino and Tatham.

Brown Falcon *Falco berigora*

(H) Uncommon; singly or pairs over fresh meadows and saltflats; occasionally over swamps alarming waterbirds; recorded in vicinity of wetlands most times of year.

(R) Uncommon about wetlands; singly or pairs over meadows and grasslands fringing swamps on floodplain country; sometimes sweeping over swamps causing considerable disturbance amongst waterbirds; occurred anytime but more frequent in autumn and winter.

Stubble Quail *Coturnix novaezelandiae*

(H) Five records (1-3, between October and March) in wet grassy swamp fringes on Kooragang (1970), at Maitland and Minmi (summer 1972-73).

(R) Nine records (1-4, all months November to June) in wet meadows and fringes of floodplain swamps; none in 1974, apparently locally plentiful in area in summer of 1975-76.

Buff-banded Rail *Rallus philippensis*

(H) Three records on Kooragang; singly 27 February 1972 and 14 January 1973. Breeding: Pair with newly hatched young 19 December 1972.

(R) Sixteen records (1-4), probably more plentiful than number of observations suggest; appeared moderately common in rank swampy areas about the estuary, occasional only around floodplain swamps; most frequently encountered in summer. Breeding: In Ballina area, small young in August and September, larger juveniles in December and February.

Baillon's Crake *Porzana pusilla*

(H) Very uncommon visitor (1-4) on vegetated floodplain swamps; 20 records (none 1970) on Kooragang and at Shortland and Seaham; extreme dates 13 August and 27 February.

(R) Scarce visitor (1-4) on floodplain swamps all years; ten records from Stratheden, Casino, Coraki and Bungawalbin; extreme dates 29 August and 6 April (no records October-November), also once 10 July 1976.

Australian Crake *Porzana flaminea*

(H) Scarce; irregularly recorded in small numbers (1-8) on brackish swamps on Kooragang; seen most months from February to September 1970, then unrecorded (except once December 1971) until 1972 when present from June to November; seventeen records in all. Breeding: Two nests 11 November 1972 (C/1-3).

Spotless Crake *Porzana tabuensis*

(H) Two on Kooragang from 3 June to 11 September 1972.

Dusky Moorhen *Gallinula tenebrosa*

(H) Common on floodplain swamps, particularly semi-permanent types (up to 460 at Shortland), numbers generally highest from late summer to end of winter, decreasing in spring. Breeding: Maitland, Minmi, Shortland and Kooragang; September to March (C/1-9).

(R) Common on floodplain swamps; overall numbers increased substantially between April and August in all years (most markedly in 1974 and 1976), decreasing in spring and summer; numbers fairly stable on semi-permanent swamps but fluctuated widely on Swan Bay and larger seasonal swamps (e.g. 0-1032 Casino). Breeding: Casino, Tatham, Coraki and Stratheden; small numbers in most years; October to March (C/3-9).

Purple Swampen *Porphyrio porphyrio*

(H) Common on vegetated floodplain swamps; numbers increased between about April and August on larger seasonal swamps (up to 300+ Minmi). Breeding: Seaham, Minmi, Shortland, Kooragang; August to February (C/2-6).

(R) Common on vegetated floodplain swamps; overall numbers highest (up to 800 at Casino) between about March and August in all years, most of the increase occurring on larger seasonal swamps; generally declining in spring and summer. Breeding: Coraki, Tatham, Casino and Stratheden; most years, October to February (C/2-6).

Eurasian Coot *Fulica atra*

(H) Moderately common overall; mainly a visitor on the deeper floodplain swamps, recorded in all months but fluctuating irregularly; e.g. not recorded on Kooragang in 1970 or the first half of 1971; subsequently small numbers (<40) increasing sharply from April 1972 to a peak (700) in November, then declining abruptly. Breeding: Solitary nests (birds sitting) Shortland and Maitland in November 1972.

(R) Moderately common visitor on deeper floodplain swamps; recorded throughout but numbers on all swamps fluctuated continuously; abundant in 1975 when population on Swan Bay built up from nil in December 1974 to a peak of 1150 in July, all were gone again by following December; overall numbers increased, usually between March and July or August in all years, then declined sharply with generally few in spring and summer.

Brolga *Grus rubicundus*

(R) Scarce; seven records (1-6, between March and October) on fresh meadows and recently flooded lower floodplain country at Swan Bay, Tatham and Bungawalbin in 1974, 1975 and 1976.

Comb-crested Jacana *Irediparra gallinacea*

(H) One at Minmi 19 November, two 10 December 1972.

(R) Common on floodplain swamps with surface vegetation; usually <50 on most swamps but up to 100+ at Casino in all years (except dry year 1977) with a maximum of 273 in June 1976; numbers increased mainly from April or May to about September (generally on larger seasonal swamps) and were fewest in summer (December to March). Breeding: Casino, Stratheden; all years except 1977; September to November, January to April (C/3-4).

Painted Snipe *Rostratula benghalensis*

(H) Five to seventeen at Minmi between 19 November and 16 December 1972. Breeding: Minmi; two nests 10-16 December 1972 (C/3-4).

(R) Three at Coraki; 16 October and one 20 November 1976; three near Tatham 7 January 1977.

Pied Oystercatcher *Haematopus longirostris*

(H) Moderately common; small numbers (1-24) on lower estuary (regular Stockton), usually increasing late summer to winter; recorded all months.

(R) Moderately common; few (1-17) on the lower estuary throughout the year (moving freely between estuary and adjacent beaches), though usually absent October and November when nesting on dunes behind beaches.

Sooty Oystercatcher *Haematopus fuliginosus*

(R) Six records (1-3) on the lower estuary.

Masked Lapwing *Vanellus miles novaehollandiae*

(H) Common resident (1-53) about floodplain-estuarine swamps and also to a lesser extent on tidal areas (mainly late summer to winter). Breeding: Shortland, Minmi; August to October (C/3-4).

(R) Common resident about floodplain-estuarine swamps, loose flocks (<136) usual from summer to early winter and during prolonged dry spells when concentrated about drying swamps; also estuarine tidal flats from late summer to autumn. Breeding: Coraki, Bungawalbin, Casino, Stratheden; annually March to October (C/3-4).

Banded Lapwing *Vanellus tricolor*

(H) Occasional; one on Kooragang 1 August 1970, four 26 August 1972; two at Maitland 20 August 1972.

(R) Occasional; one at Stratheden 7 August, two 5 September 1976.

Lesser Golden Plover *Pluvialis dominica*

(H) Common (1-370) visitor on the estuary from October to April, a few (1-5) from May to September; recorded in all months.

(R) Common (1-133) visitor on the estuary from October to April, a few (1-12) from May to September; occasionally recorded on floodplain swamps; one at Bungawalbin 21 September 1974; one at Coraki from 5 October to 3 November 1974 and two 2 January 1975; one at Casino 10 October 1976; two 22 October 1977.

Red-kneed Dotterel *Erythrogonys cinctus*

(H) Irregular visitor on floodplain and estuarine swamps; recorded as follows: At Kooragang at least from 1 November 1969 to 2 May 1970 (1-22); 7 November 1970 (6); 19 December 1971 (3); 19 March to 16 December 1972 (1-49); at Maitland at least from 30 April 1972 to 26 August (1-67) and 5 November (1). Breeding: Kooragang; October 1972; five nests (C/1-4) in association with *H. himantopus*.

(R) Irregular visitor; (1-14) Coraki, Bungawalbin, Tatham and Stratheden between 12 April and 18 October 1975; single birds at these areas and at Casino between 20 November 1977 and 20 May 1978.

Mongolian Plover *Charadrius mongolus*

(H) Common (1-288) visitor on the estuary mainly from October to April; 1-70 from May to September; recorded all months.

(R) Common (1-105) visitor on the estuary from October to April; a few (1-8) from May to September; recorded all months.

Double-banded Plover *Charadrius bicinctus*

(H) Moderately common (1-85) winter visitor on the estuary; extreme dates 11 March and 29 August; up to 31 at Maitland between 12 June and 20 August 1972.

(R) Uncommon (1-19) visitor on the estuary, March to August; extreme dates 3 February and 4 September.

Large Sand Plover *Charadrius leschenaultii*

(H) Two at Stockton 21 October, one 4 November 1972.

(R) Moderately common (1-45) visitor on the estuary from September to March; a few (1-10) from April to August, recorded all months except June.

Red-capped Plover *Charadrius ruficapillus*

(H) Common on the estuary; usually small numbers (1-20) in spring and summer, increasing in winter with loose flocks (up to 130) from March to August; three at Maitland 9 July 1972. Breeding: Kooragang and Stockton; all years from August to March (C/2).

(R) Moderately common on the estuary; small numbers (1-28) throughout year.

Black-fronted Plover *Charadrius melanops*

(H) Uncommon to moderately common about floodplain swamps and semi-reclaimed estuarine marshes; small numbers fluctuating throughout; recorded on Kooragang in all months, increasing in autumn, winter (1-21); up to 40+ at Maitland and Shortland at least from April to July 1972 but few or absent for rest of the year. Breeding: Kooragang; December (C/3).

(R) Uncommon; records for most months around floodplain swamps but erratic; small numbers (1-24) 1973, 1974, 1975 (mostly from April to October), generally few or absent in 1976 and 1977 (e.g. none in December 1975 to April 1976) few on disturbed salt marshes near North Ck throughout 1976. Breeding: Coraki; young two-thirds grown 21 September, 3 November 1974.

Black-winged Stilt *Himantopus himantopus*

(H) Moderately common to common at times; mainly a visitor on estuarine marshes and extensive seasonal swamps; recorded in all months but numbers fluctuate

widely; fairly common on Kooragang in first half 1970, becoming scarce in latter part of year and most 1971 (absent November to April), subsequently increasing sharply from about March 1972 becoming numerous (up to 300+); at Minmi in 1972 numbers increased from 300 in April to 970 in July before dispersing abruptly with none by November. Breeding: Kooragang; two nests October 1971, twenty-five nests October to December 1972 (C/1-4).

(R) Uncommon overall; visitor all years on floodplain wetlands (mainly larger seasonal swamps); recorded all months but variable; appeared in numbers on swamps (up to 400 at Casino) mainly between May and November, absent for intervening periods of up to five months; a few (1-48) on the estuary at most times. Breeding: Casino; seven nests July, August 1973, also five nests near Casino September 1978; Coraki; one nest September 1976 (C/2-4).

Banded Stilt *Cladorhynchus leucocephalus*

(H) One on Kooragang 20 May, also 9-23 September 1972; apparently an immature (possibly same individual, outline of brownish breast band evident at time of last observation).

Red-necked Avocet *Recurvirostra novaehollandiae*

(H) Irregular visitor; 1-19 at Stockton 25 May to 4 November 1972, also one 10 January 1973.

Ruddy Turnstone *Arenaria interpres*

(H) Uncommon visitor on the estuary; small numbers (1-24) annually from October to April; extreme dates 19 August and 16 April.

(R) Moderately common (1-24) visitor on the estuary from September to April, few (1-5) from May to August; recorded all months.

Eastern Curlew *Numenius madagascariensis*

(H) Common (1-191) visitor on the estuary mainly from September to April; 1-94 May to August; recorded all months.

(R) Common (1-75) visitor on the estuary mainly from September to April, 1-38 from May to August; recorded all months.

Whimbrel *Numenius phaeopus*

(H) Uncommon (1-16) visitor on the estuary; recorded all months.

(R) Moderately common (1-45) visitor on the estuary mainly from September to April; 1-10 May to August; recorded all months.

Little Curlew *Numenius minutus*

(R) Five at Casino 6 November 1976.

Wood Sandpiper *Tringa glareola*

(H) One to three on Kooragang from 9 November 1969 to 18 April 1970, three 7 February 1971.

(R) Singly at Coraki from 29 August to 18 October 1975, also 15 August and 20 November 1976.

Grey-tailed Tattler *Tringa brevipes*

(H) Moderately common (1-45) visitor on the estuary; recorded all months.

(R) Common visitor on the estuary, mainly from September to April (1-157); fewer (1-52) from May to August; recorded all months.

Common Sandpiper *Tringa hypoleucos*

(H) Very uncommon summer visitor on the estuary; annually in small numbers (1-11), mainly on upper estuary (western end of Kooragang, Hexham Is.); extreme dates 6 August and 4 March.

(R) Scarce summer visitor on the estuary; few (1-3) annually; extreme dates 27 August and 7 April.

Greenshank *Tringa nebularia*

(H) Fairly common visitor (1-70) on the estuary; recorded all months.

(R) Uncommon summer visitor (1-12) on the estuary in all years; extreme dates 31 August and 7 April; also one at Casino 10 October 1976.

Marsh Sandpiper *Tringa stagnatilis*

(H) Scarce visitor; two on Kooragang 5 August 1972, up to 103 between 29 October 1972 and 11 January 1973.

(R) One at Casino 12-13 September 1976.

Terek Sandpiper *Tringa terek*

(H) Moderately common visitor on the estuary, mainly from October to April (1-290); few (1-5) from May to September; recorded all months.

(R) Moderately common visitor on the estuary, mainly from October to April (1-79); extreme dates 1 August and 10 May.

Latham's Snipe *Gallinago hardwickii*

(H) Moderately common (1-30) visitor from September to February on floodplain swamps and estuarine marshes; 84 at Shortland 12 January 1973 exceptional, possibly a localized concentration as conditions in area became dry; extreme dates 26 August and 18 March.

(R) Moderately common (1-28) visitor from August to February on floodplain swamps and estuarine marshes; extreme dates 15 August and 3 April.

Black-tailed Godwit *Limosa limosa*

(H) Moderately common (1-350+) visitor on the estuary, mainly from September to April, 1-80 from May to August; recorded all months.

(R) Five at Casino 9 November 1974, three at Mobb's Bay 23 December 1976.

Bar-tailed Godwit *Limosa lapponica*

(H) Common visitor (1-1050) on the estuary, mainly from September to March; 1-180 from April to August; recorded all months.

(R) Common visitor (1-330) on the estuary, mainly September to March, 1-135 April to August; recorded all months.

Red Knot *Calidris canutus*

(H) Uncommon to moderately common visitor on the estuary; mostly in small numbers (1-50) but up to 550 at Stockton between September and early November 1972, apparently in passage; recorded all months.

(R) Uncommon visitor (1-15) on the estuary, extreme dates 12 September and 20 January.

Great Knot *Calidris tenuirostris*

(H) Uncommon (1-30) summer visitor on the estuary; extreme dates 26 August and 6 June.

(R) Uncommon (1-13) summer visitor on the estuary; extreme dates 14 October and 24 March.

Sharp-tailed Sandpiper *Calidris acuminata*

(H) Common visitor from September to March on the estuary (1-510), also on floodplain swamps at Maitland and Minmi (1-112); extreme dates 6 August and 30 April.

(R) Moderately common visitor (1-98) from September to March on the estuary and floodplain swamps; extreme dates 17 August and 12 April.

Pectoral Sandpiper *Calidris melanotos*

(R) Two located near Emigrant Ck. 16 February 1975 by W. D. Watson, still present five days later; one, possibly up to three at Stratheden 28 February and 1 March 1978; associated with *C. acuminata* in both instances.

Red-necked Stint *Calidris ruficollis*

(H) Common visitor (1-540) on the estuary, mainly from September to April; few (1-30) remained into winter; extreme dates 19 September and 17 July.

(R) Common visitor (1-210) on the estuary, mainly from September to April; 1-25 May to August; recorded all months; one at Casino 12-13 September 1976.

Curlew Sandpiper *Calidris ferruginea*

(H) Common visitor (1-1200+) on the estuary from September to April; 1-120 May to August; recorded all months; one at Maitland 20 August 1972.

(R) Fairly common visitor (1-200+) on the estuary, mainly from September to April; 1-80 May to August; recorded all months; occasionally on floodplain swamps (nine records, 1-22) at Coraki, Casino and Bungawalbin September and October, also June.

Sanderling *Calidris alba*

(R) Two at Mobb's Bay 1 December 1973, three 7 January 1974, ten 23 December 1976; three at North Ck 13 April 1974.

Broad-billed Sandpiper *Limicola falcinellus*

(H) Uncommon summer visitor (1-58+) on the estuary; extreme dates 8 October and 29 April.

Ruff *Philomachus pugnax*

(H) One at Stockton 27 February 1972 (Holmes 1972).

Silver Gull *Larus novaehollandiae*

(H) Very common (1-2000) on the estuary at all times; usually least abundant from August to early October, with juveniles appearing from late November; numbers also at times on swamps on edge of Newcastle, e.g., up to 300 at Shortland in most months from April to October 1972, probably attracted by dumping of refuse; up to 260 at Minmi from April to August 1972.

(R) Common on the estuary; up to 400 from December to May, fewer (1-50) at other times; small numbers of juveniles appeared from late December; one near Swan Bay 21 February 1976, two at Casino 19 March 1977.

Whiskered Tern *Chlidonias hybrida*

(H) Irregular visitor on floodplain swamps and estuarine marshes; occurrence mostly transitory; scarce 1970 and 1971 with large numbers briefly in spring 1972; recorded as follows:— 1970: one on Kooragang 21 November; 1971: two 26 June to 24 July, three 16 October; 1972: two at Minmi 9 April and up to 400 at Minmi and on Kooragang from 16 September to 16 December.

(R) Irregular visitor on floodplain swamps; scarce or absent 1973, 1974 and 1977; moderately common (1-220, numbers highest in spring), 1975 and 1976 when present continuously over 22 month period. Breeding: Casino; January to March 1976; estimated 30 nests (C/1-3).

White-winged Tern *Chlidonias leucoptera*

(H) Uncommon summer visitor (16 records, 1-46) mainly on estuarine marshes; few in spring and summer but small flocks from late February to April; extreme dates 16 October and 7 April.

(R) Scarce visitor, recorded as follows: Mobb's Bay two 18 January 1972, one 16 November 1974; Casino eight 23 January, two 6 March 1976.

Gull-billed Tern *Gelocholidon nilotica*

(H) Visitor on the estuary and floodplain swamps; records for all months (1-40), numbers greatest in winter; uncommon on the estuary 1970, 1971, fairly common from March 1972 at least to January 1973; up to eight at Minmi from 9 April to 12 August 1972, one 10 January 1973.

(R) Uncommon to moderately common visitor on the estuary and floodplain swamps; small numbers (1-18) on the estuary most times of year, generally more frequent in winter except in 1973 when absent from late February to early July; nine records (1-5) Swan Bay, Bungawalbin, Casino, Coraki March to September.

Caspian Tern *Hydroprogne caspia*

(H) Irregular visitor on the estuary; single birds July 1970 and from April to September 1971; in 1972 present continuously (1-12) from March to December.

(R) Scarce visitor on the estuary; fifteen occurrences of single birds over six consecutive summers (1970-71 to 1975-76); recorded all months from August to January; extreme dates 29 August and 21 January.

Common Tern *Sterna hirundo*

(H) Common visitor on the estuary from October to April with peak concentrations between December and February (500+ each summer), numbers declining abruptly after mid February; extreme dates 7 October and 24 July; on 2 December 1972, shortly after sunrise, estimated 2100 congregated in dead mangroves and on banks in the gypsum dam at the Green Leaf Fertilizer Co. plant on the eastern end of Kooragang.

(R) Moderately common summer visitor (1-209) on the estuary; extreme dates 4 October and 7 May.

White-fronted Tern *Sterna striata*

(H) One at Stockton 19 March 1972.

Little Tern *Sterna albifrons*

(H) Common visitor on the estuary from October to April (1-600) and a few (1-15) from May to September; recorded all months. Breeding: pair exhibiting courtship behaviour on Kooragang 21 November 1972; 14 January 1973 a pair feeding newly fledged young at Stockton.

(R) Fairly common visitor (1-122) on the estuary from October to April and a few (1-4) from May to September; recorded all months; up to 20 at Swan Bay and one at Bungawalbin between 27 March and 10 April 1977.

Crested Tern *Sterna bergii*

(H) Common (1-70) on the estuary throughout the year.

(R) Common on the estuary (1-1200+) throughout the year; largest concentrations from March to September; fledged young being fed by adults appeared from late February; fifteen records (1-4) from Swan Bay all months except December and January.

Common Noddy *Anous stolidus*

(R) Occasional; one at Mobb's Bay 2 January 1973.

Red-rumped Parrot *Psephotus haematonotus*

(H) Uncommon; small numbers (1-20+) Kooragang, Stockton throughout the year about saltflats, fringes of mangroves and sandy waste (reclaimed wetland) areas; feeds on Samphire *A. australasicum*.

White-throated Needletail *Hirundapus caudacutus*

(H) Occasional; four records (<300) over wetlands on Kooragang and at Minmi between 30 October and 21 November.

(R) Occasional; seven records (up to 60+) over floodplain swamps and the estuary in summer; most occurrences associated with unstable weather conditions; extreme dates 20 November and 8 March.

Azure Kingfisher *Ceyx azurea*

(H) Four records (2-4) on Kooragang.

(R) Moderately common on estuary, occasionally recorded about tree-lined billabongs at Swan Bay, Tatham and once at Stratheden; singly or pairs, recorded all months but scarce or absent from these habitats in spring (October and November).

Laughing Kookaburra *Dacelo novaeguineae*

(H, R) Occasional; singly or pairs about mangroves and tree-lined swamps, dives from perch to pick up prey from floating vegetation (e.g. water hyacinth).

Forest Kingfisher *Halcyon macleayii*

(R) Uncommon; singly, pairs or small parties (<8), mainly about floodplain swamps with trees; fairly regular at Tatham and Stratheden, occasional elsewhere; recorded all months (50 records), most frequent from February to August; around swamps takes prey from water, surface vegetation.

Sacred Kingfisher *Halcyon sancta*

(H) Fairly common; throughout the year on the estuary, increasing from late summer to early winter, fewer in spring and summer; pairs about floodplain swamps with trees from October to April; singly or small parties (<8). Breeding: On Kooragang; attending holes in mangroves 24 October and (feeding young) 5 February.

(R) Fairly common; throughout year on the estuary, most numerous from February to September (with peaks in autumn and late winter-early spring), a few only from late September to early summer; pairs about floodplain swamps with trees October to March or April and occasionally at other times.

Welcome Swallow *Hirundo neoxena*

(H) Very common over all wetlands, increasing in winter; large concentrations (up to 350) over open water anytime but mainly from April to August. Breeding: Kooragang; under railway culverts September and October.

(R) Common over all wetlands carrying surface water; mostly small numbers (<30) with larger concentrations (up to 150+) anytime of year but more frequently in winter; estimated 3300 counted congregating to roost under Missingham Bridge over North Ck. 8 January

1974 during watch maintained for about an hour up to sunset. Breeding: Stratheden, Mobb's Bay; August to January, also March to May (C/1-5), under bridges, culverts.

Tree Martin *Cecropis nigricans*

(H) Uncommon; recorded all months over floodplain and estuarine swamps; mainly small flocks (up to 100) from August to April, a few only in winter.

(R) Moderately common; throughout year about floodplain swamps (particularly with Eucalypt trees in vicinity), occasionally over estuarine wetlands; mostly small numbers (<60) but 700+ at Bungawalbin 15 May 1974. Breeding: Stratheden, Casino and Tatham; attending holes in dead trees between July and December, once May; carrying mud to holes July, September; newly fledged young October, early January.

Fairy Martin *Cecropis ariel*

(H) Locally moderately common over wetlands in vicinity of nesting sites (under railway culverts) on Kooragang in spring and summer; one at Shortland 1 July 1972; migrant, arrived from mid-August remaining to January or February, apparently departing on completion of breeding; no records in March or April, small numbers from May to July 1972 are only winter records; extreme dates 27 May and 14 February. Breeding: attending nests at least from September to February, probably maximum 50 nests in use at any time.

(R) Locally uncommon over wetlands in vicinity of nesting sites (under culverts over flood mitigation drains) at Swan Bay in spring and summer; elsewhere occasional only in winter or early spring; migrant, usually present from August to January, apparently leaving immediately after breeding; no records March or April, few (<20) occasionally over seasonal swamps in winter; extreme dates 13 May and 2 February. Breeding: attending nests at least from September to December; up to 30 nests.

Richard's Pipit *Anthus novaeseelandiae*

(H) Common on meadows and flats on floodplain swamps and estuarine marshes; pairs or small numbers in loose association. Breeding: Kooragang; November, also nest building in December.

(R) Common. Breeding: Casino, North Ck., December (C/2).

Willie Wagtail *Rhipidura leucophrys*

(H) Common; mainly about wetlands with trees and mangroves, also open marshes and swamps in autumn and winter. Breeding: Kooragang, Shortland, Minmi, Seaham; common breeder attending nests from September to November.

(R) Moderately common; mostly pairs throughout year around mangroves and semi-permanent swamps with fringing trees, in autumn and winter (mainly April to August) small numbers (<11) regularly on open swamps and meadows devoid of trees. Breeding: Swan Bay and Tatham, attending nests September and December.

Clamorous Reed-Warbler *Acrocephalus stentoreus*

(H) Migrant; common in brackish, fresh swamps with tall emergent vegetation (*Phragmites*, *Typha*) from late August to February or March, few through winter; recorded all months. Breeding: Kooragang, Shortland; September to December, also collecting nest material in February after rain (C/3).

(R) Moderately common migrant on floodplain swamps and near-estuarine marshes with suitable vegetation cover; August to February, apparently scarce in winter but records for all months. Breeding: Coraki; December, January (C/1-3).

Tawny Grassbird *Megalurus timoriensis*

(R) Uncommon; a few present all year in drier reed swamps and salt meadows near the estuary; also records (16) for most times of year in rank vegetation fringing floodplain swamps at Swan Bay, Tatham and Coraki.

Little Grassbird *Megalurus gramineus*

(H) Common resident in brackish and fresh swamps with dense emergent vegetation (particularly *Scirpus* beds); locally abundant on Kooragang, also regular at Shortland and parts of Minmi; not recorded elsewhere. Breeding: Kooragang, Shortland; common breeder August to March (C/1-4).

(R) Uncommon (42 records) about floodplain swamps and brackish swamps near the estuary (Emigrant Ck.); recorded all months; fairly regular at Stratheden with irregular appearance at other swamps when suitable rank cover developed. Breeding: Stratheden; large young 19 December 1975, also observed carrying nest material at the same site 1 February 1976.

Golden-headed Cisticola *Cisticola exilis*

(H) Moderately common in rank ground cover and dense emergent vegetation about swamps, meadows on lower floodplain and estuarine country at all times. Breeding: Kooragang; December (C/4).

(R) Common on floodplain estuarine wetlands wherever suitable vegetation cover; abundant about meadows and seasonal swamps when ground cover rank and lush, absent when heavily grazed. Breeding: Casino; October, November and March (C/3-4).

Brown Songlark *Cinchorhamphus cruralis*

(H) Irregular visitor on floodplain, estuarine meadows and saline flats; three on Kooragang 7 November 1970; twelve records (1-10) Kooragang and Maitland from 1 October 1972 to 13 January 1973.

(R) Irregular visitor about floodplain meadows and seasonal swamps at Bungawalbin, Coraki, Casino, also near Stratheden and Swan Bay; uncommon, twenty-five records as follows: none 1973; continuously over 16 months from 8 August 1974 to 29 November 1975 (1-4), one 10 July, 10 October 1976, one 19 March 1977.

Superb Fairy-wren *Malurus cyaneus*

(H) Fairly common about mangroves, adjoining marshes and semi-permanent type swamps with dense emergent cover (and usually fringing shrubbery). Breeding: Kooragang; September to November (C/3). (R) Uncommon about wetlands; mainly estuarine reed, rush beds, mangroves and edges of semi-permanent swamps where suitable cover.

Variegated Fairy-wren *Malurus lamberti*

(R) Occasional; salt rush meadows and edge of mangroves about the estuary.

Red-backed Fairy-wren *Malurus melanocephalus*

(R) Occasional; salt rush meadows on the estuary and rank swamp vegetation usually where fringing cover.

White-fronted Chat *Ephthianura albifrons*

(H) Locally common on estuarine marshes on Kooragang, also fairly regular in small number on seasonal swamps and meadows at Minmi, a few at Maitland in winter (30 April to 9 July); pairs or small parties throughout year and occasionally loose flocks (up to 60) from April to August. Breeding: Kooragang, Minmi; September to March (C/1-3).

Chestnut-breasted Mannikin *Lonchura castaneothorax*

(R) Infrequent; seventeen records, mainly summer, autumn; parties, small flock (mostly <50 but up to 300) in rank vegetation (e.g. *Phragmites*, *Polygonum*) about floodplain and near-estuarine swamps.

Common Starling *Sturnus vulgaris*

(H) Very common about estuarine and floodplain wetlands; small to large flocks (up to 300 autumn). Breeding: Kooragang, Shortland, Minmi; in holes in mangroves and trees in and around swamps; common breeder, attending holes from 26 August to 11 December; fledged young from 4 November.

(R) Very common; abundant all year round with flocks up to 550 in autumn and winter on meadows and seasonal swamps. Breeding: North Ck, Mobb's Bay, Stratheden, nest building from 29 September, fledged young from 20 November; also attending holes in mangroves Mobb's Bay 3 March 1973.

Australian Magpie-lark *Grallina cyanoleuca*

(H) Common resident about wetlands on floodplain-estuarine country; pairs, with loose flocks (<45) on open swamps mainly from April to August but from summer onwards if conditions dry. Breeding: Shortland, Minmi, Kooragang; common breeder from September to December, also February, March (C/1-5).

(R) Common resident about wetlands; pairs, with loose flocks (up to 86) on open floodplain swamps in autumn and winter (largest aggregations May to July). Breeding: North Ck, Casino, Tatham; September, nest building February (C/4).

White-breasted Woodswallow *Artamus leucorhynchus*

(R) Moderately common migrant on the estuary about mangroves and floodplain swamps with dead trees; pairs, loose flock (<20) usually present from August to early May; extreme dates 11 August and 12 May, except once at Bungawalbin 10 July 1976. Breeding: Mobb's Bay, Tatham; October to December (C/4).

Australian Raven *Corvus coronoides*

(H) Common about the estuary and swamps on Kooragang and at Shortland, occasionally elsewhere; dumping of refuse, burning and filling probably contributed to local abundance around Newcastle; also scavenged for dead fish, waterfowl carcasses and refuse left by fishermen; pairs, small flocks (<30). Breeding: Kooragang in mangroves, sheoaks; probably from late July, fledged young from 3 October, nest building to as late as 26 September; also pair feeding fledged young 5 February 1972.

Torresian Crow *Corvus orru*

(R) Moderately common; small numbers regularly about the estuary and in vicinity of floodplain swamps where occasionally flocks (up to 150) occur on wet meadows (e.g. feeding on army worms at Bungawalbin March, April 1976), or on drying swamps. Breeding: North Ck, in mangroves, September (C/5).

TABLE 2 – Habitat use: frequency of observation of individual species in each wetland type ie. percentage of total surveys of each wetland type that each species was recorded (including surveys of seasonal wetlands at times when dry).

	Wetland types (habitats)										
Bird species	Shallow estuarine waters	Mangrove swamps	Salt flats	Salt meadows	Reed swamps	Sheoak swamps	Teatree swamps	Fresh meadows	Seasonal fresh swamps	Semi-permanent swamps	Open fresh waters
Great Crested Grebe	•										
Hoary-headed Grebe											
Australasian Grebe			•		•				•	•	•
Shearwater sp.	•							••	••••	••••	••••
Australian Pelican	•••		•		•				•	•	••
Australasian Gannet	•••										
Darter	•••	•					•				
Pied Cormorant	••••								••	•••	••••
Little Pied Cormorant	••••	••	••	•	•••	•	••			•	•
Great Cormorant	••••		••							•••	••
Little Black Cormorant	••••	•	••		•			•	••	••	••
Least Frigatebird	•						•		••	••••	••••
Pacific Heron											
White-faced Heron	••••	••	•••	••	•••	•	••	•••	•••	••	•
Cattle Egret							•	•••	••••	••••	•••
Great Egret	••••	••	••	•	••		•	••••	•••	••	
Little Egret	••••	•	•••	•	••		•	•	••••	••	•••
Intermediate Egret					•		•	•	••	••	
Striated Heron	•••	•••		•			•	•••	••••	••••	•
Rufous Night Heron		•••		•	••	•	••	•	••	••••	•
Little Bittern				•	•						
Black Bittern		•							•		
Australasian Bittern					•					•	
Black-necked Stork	••		•							••	
Glossy Ibis					•			•	••	•	•
Sacred Ibis	••••	••••	•••	•••	•••		•	•	••	•	
Straw-necked Ibis	•		•		••		•	•••	•••	•••	•
Royal Spoonbill	•••	•	••	•	••	•	••	•••	•••	•••	
Yellow-billed Spoonbill			•		•			•	••	•••	•••
Wandering Whistling-Duck							•	•	•	•	•
Mumed Whistling-Duck								•	•	•	
Pumud Whistling-Duck								•	•	•	
Black Swan	•		•••		••			••	•	•	•
Pacific Black Duck	••		••	••	•••	•	•••	••••	•••	••••	••••
Mallard								•	•••	••••	••••
Grey Teal	•		••	•	••	•		•	•	•	•
Chestnut Teal	•••	•••	••••	•	••	•	••	•••	•••	•••	•••
Australasian Shoveller						•		•	••	••	•
Pink-eared Duck			•					•	•	•	•
Hardhead					•			•	•	•	
Maned Duck			•					•	••	•••	•••
Green Pygmy Goose									•	••	•
Musk Duck	•									•	•
Osprey	••	••							•	••••	••••
Brahminy Kite	••		•	•							
Whistling Kite	••••	••••	•••	••	•••	•	•	•••	•••	•••	•
White-bellied Sea-Eagle	•••	•••	••	•	••	•	•	••	•••	•••	•••
Marsh Harrier		•	•	•	•••	•		•	•	••	•
Peregrine Falcon	•		•		•	•		••	••	•••	•
Australian Hobby			•			•				•	
Brown Falcon			••		•				•	•	
Stubble Quail							•	••	•	•	
Buff-banded Rail		•		••				•	•	•	
Baillon's Crake					••			•		•	
Australian Crake				•	••				•		
Spotless Crake					•						
Dusky Moorhen		•			•••			••	••••	••••	••••
Purple Swamphen					•••		•	•••	•••	•••	••
Eurasian Coot			•		•				•••	•••	••
Brolga									•••	•••	•••
Comb-crested Jacana								•			
Painted Snipe						•		•	••••	••••	•
Pied Oystercatcher	•••							•	•	•	
Sooty Oystercatcher	•										

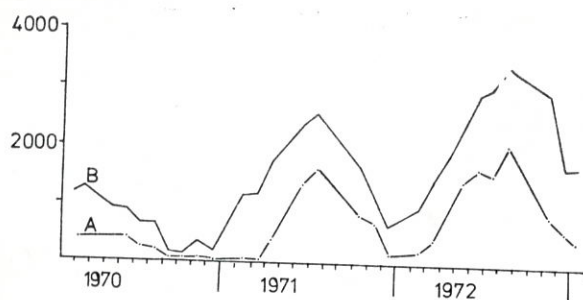
Wetland types (habitats)											
Bird species	Shallow estuarine waters	Mangrove swamps	Salt flats	Salt meadows	Reed swamps	Sheoak swamps	Teatree swamps	Fresh meadows	Seasonal fresh swamps	Semi-permanent swamps	Open fresh waters
Masked Lapwing	••••		••••	••	••						
Banded Lapwing	••••		••••	••	••						
Lesser Golden Plover	••••	•	••••	•	•			••••	••••	••••	•
Red-Kneed Dotterel	••••		••••	•	•			••••	••••	••••	•
Mongolian Plover	••••		••••	•	•			••••	••••	••••	•
Double-banded Plover	••••		••••	•	•			••••	••••	••••	•
Large Sand Plover	••••		••••	•	•			••••	••••	••••	•
Red-capped Plover	••••		••••	•	•			••••	••••	••••	•
Black-fronted Plover	••••		••••	•	•			••••	••••	••••	•
Black-winged Stilt	••••		••••	•	••			••••	••••	••••	•
Banded Stilt	••••		••••	•	••			••••	••••	••••	•
Red-necked Avocet	••••		••••	•	•	•		••••	••••	••••	•
Ruddy Turnstone	••••	•	••••	•	•			••••	••••	••••	•
Eastern Curlew	••••	•	••••	•	•			••••	••••	••••	•
Whimbrel	••••	••	••••	•	•			••••	••••	••••	•
Little Curlew	••••	••	••••	•	•			••••	••••	••••	•
Wood Sandpiper	••••	•	••••	•	•			••••	••••	••••	•
Grey-tailed Tattler	••••	••	••••	•	•			••••	••••	••••	•
Common Sandpiper	••••	•	••••	•	•			••••	••~•	••~•	•
Greenshank	••~•	•	••~•	•	•			••~•	••~•	••~•	•
Marsh Sandpiper	••~•	•	••~•	•	•			••~•	••~•	••~•	•
Terek Sandpiper	••~•	•	••~•	•	•			••~•	••~•	••~•	•
Latham's Snipe	••~•	•	••~•	•	•			••~•	••~•	••~•	•
Bar-tailed Godwit	••~•	•	••~•	•	•			••~•	••~•	••~•	•
Black-tailed Godwit	••~•	•	••~•	•	•			••~•	••~•	••~•	•
Knot	••~•	•	••~•	•	•			••~•	••~•	••~•	•
Great Knot	••~•	•	••~•	•	•			••~•	••~•	••~•	•
Sharp-tailed Sandpiper	••~•	•	••~•	•	•			••~•	••~•	••~•	•
Pectoral Sandpiper	••~•	•	••~•	•	•			••~•	••~•	••~•	•
Red-necked Stint	••~•	•	••~•	•	•			••~•	••~•	••~•	•
Curlew Sandpiper	••~•	•	••~•	•	•			••~•	••~•	••~•	•
Sanderling	••~•	•	••~•	•	•			••~•	••~•	••~•	•
Broad-billed Sandpiper	••~•	•	••~•	•	•			••~•	••~•	••~•	•
Ruff	••~•	•	••~•	•	•			••~•	••~•	••~•	•
Silver Gull	••~•	•	••~•	•	•			••~•	••~•	••~•	•
Whiskered Tern	••~•	•	••~•	•	•			••~•	••~•	••~•	•
White-winged Tern	••~•	•	••~•	•	•			••~•	••~•	••~•	•
Gull-billed Tern	••~•	•	••~•	•	•			••~•	••~•	••~•	•
Caspian Tern	••~•	•	••~•	•	•			••~•	••~•	••~•	•
Common Tern	••~•	•	••~•	•	•			••~•	••~•	••~•	•
White-fronted Tern	••~•	•	••~•	•	•			••~•	••~•	••~•	•
Little Tern	••~•	•	••~•	•	•			••~•	••~•	••~•	•
Crested Tern	••~•	•	••~•	•	•			••~•	••~•	••~•	•
Common Noddy	••~•	•	••~•	•	•			••~•	••~•	••~•	•
Red-rumped Parrot	••~•	•	••~•	•	•			••~•	••~•	••~•	•
White-throated Needletail	••~•	•	••~•	•	•			••~•	••~•	••~•	•
Azure Kingfisher	••~•	•	••~•	•	•			••~•	••~•	••~•	•
Laughing Kookaburra	••~•	•	••~•	•	•			••~•	••~•	••~•	•
Forest Kingfisher	••~•	•	••~•	•	•			••~•	••~•	••~•	•
Sacred Kingfisher	••~•	•	••~•	•	•			••~•	••~•	••~•	•
Welcome Swallow	••~•	•	••~•	•	•			••~•	••~•	••~•	•
Tree Martin	••~•	•	••~•	•	•			••~•	••~•	••~•	•
Fairy Martin	••~•	•	••~•	•	•			••~•	••~•	••~•	•
Richard's Pipit	••~•	•	••~•	•	•			••~•	••~•	••~•	•
Willie Wagtail	••~•	•	••~•	•	•			••~•	••~•	••~•	•
Clamorous Reed-Warbler	••~•	•	••~•	•	•			••~•	••~•	••~•	•
Tawny Grassbird	••~•	•	••~•	•	•			••~•	••~•	••~•	•
Little Grassbird	••~•	•	••~•	•	•			••~•	••~•	••~•	•
Golden-headed Cisticola	••~•	•	••~•	•	•			••~•	••~•	••~•	•
Brown Songlark	••~•	•	••~•	•	•			••~•	••~•	••~•	•
Superb Fairy-wren	••~•	•	••~•	•	•			••~•	••~•	••~•	•
Variegated Fairy-wren	••~•	•	••~•	•	•			••~•	••~•	••~•	•
Red-backed Fairy-wren	••~•	•	••~•	•	•			••~•	••~•	••~•	•
White-fronted Chat	••~•	•	••~•	•	•			••~•	••~•	••~•	•
Chestnut-breasted Mannikin	••~•	•	••~•	•	•			••~•	••~•	••~•	•
Common Starling	••~•	•	••~•	•	•			••~•	••~•	••~•	•
Australian Magpie Lark	••~•	•	••~•	•	•			••~•	••~•	••~•	•
White-breasted Wood-swallow	••~•	•	••~•	•	•			••~•	••~•	••~•	•
Australian Raven	••~•	•	••~•	•	•			••~•	••~•	••~•	•
Torresian Crow	••~•	•	••~•	•	•			••~•	••~•	••~•	•

Discussion

Migrant shorebirds

Numbers of migratory waders and terns on the estuaries were highest between December and early March, and were lowest from late June to early August. Maximum and minimum census totals obtained for the Hunter estuary were 6 450 (1-12 December 1972) and 403 (8-15 July 1972), and for the Richmond estuary 1 530 (1-2 December 1973) and 175 (14-15 July 1973).

The sum of the maximum count of all Palaearctic shorebirds on the Hunter estuary in 1972 was 8 620+, showing that at least this number of individuals was using the estuary at one time or another in that year. Comparative numbers for the Richmond estuary in 1973 were 1 870. These data emphasise the importance of the Hunter estuary as a wintering area for migrant shorebirds. The totals are probably conservative and may significantly underestimate the numbers using the Hunter estuary in particular, as no examination was made of the Fullerton Cove area on the northern side of the estuary for wader loafing sites, nor were monthly censuses of known sites sufficient to monitor possible movements through the area during migration. Observed fluctuations in counts of some species (e.g. Reg Knot, Curlew Sandpiper) on the Hunter estuary during the 1972 post breeding migration period (mainly between late September and early December) involving several thousands of birds, may have been attributable to such movements. No suggestion of similar movements of large numbers of birds through the Richmond estuary was detected.

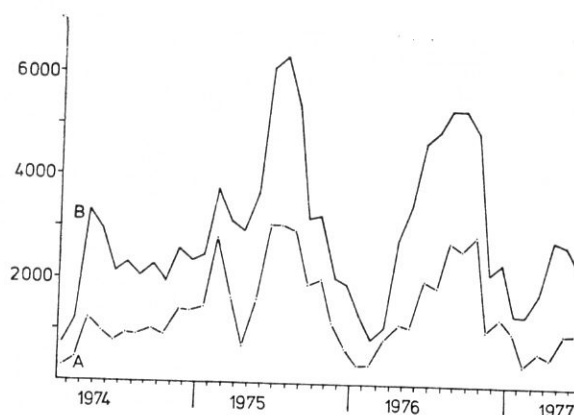


● Figure 5. Numbers of waterbirds at Kooragang Island 1970-72. (A) Anatidae, (B) Total all waterbirds.

Waterbirds

Marked annual and seasonal variations in waterbird numbers were observed (Figures 5, 6; paper in preparation). In annual terms concentrations of waterbirds in the districts were high in 1971 (?), 1972, 1975 and 1976, all years of above to well above average rainfall on the north coast of N.S.W. Significantly fewer waterbirds were present in the areas in 1970, 1973 (?), 1974, 1977 and 1978, years of below normal to well above normal rainfall. In years of high waterbird concentrations a relatively few species comprised the bulk of the population during peak periods. Of 8 424 waterbirds present on the six survey swamps on the Richmond floodplain in June 1975, Grey Teal, Hardhead, Eurasian Coot and Pacific Black Duck comprised 6 039 (71%), of 3 365 waterbirds on Kooragang wetlands in August 1972, 2 556 (76%) were Chestnut Teal, Grey Teal, Black-winged Stilt, Pacific Black Duck and Eurasian Coot. Observations suggest that almost none of these species populations was bred (or in turn bred themselves) locally and must therefore have originated from outside the region, indicating large scale movements to and from the N.S.W. north coast.

In seasonal terms, overall waterbird numbers showed a broad correlation with seasonal habitat availability (habitat availability being a function of rainfall and evaporation) as inferred from the normal rainfall distribution pattern (Figure



● Figure 6. Numbers of waterbirds at Swan Bay, Bungawalbin, Casino and Stratheden 1974-77. (A) Anatidae, (B) Total all waterbirds.

3). Numbers were lowest in late spring or summer, correlating closely with the period when habitat was most limited, and were highest between the end of summer and spring (March to October) broadly corresponding with the period of maximum habitat availability (i.e. availability of seasonal swamps). This seasonal pattern was maintained even in years of abnormal rainfall distribution (and therefore habitat availability). In 1975 heavy spring, summer rainfall resulted in extensive seasonal swamps throughout the spring and summer but numbers of waterbirds on the survey swamps on the Richmond floodplain declined from 7 916 in July to 1 208 by February 1976 before increasing again to 7 306 by the following June. Some species (e.g. Australasian Shoveler) were seasonally present, possibly in response to predictable seasonal wetland availability.

In years of large waterbird concentrations, pronounced population peaks occurred in winter, early spring and were primarily attributable to influxes of one or several, species e.g. Grey Teal in all such years, Hardhead, Eurasian Coot in only one or two years), presumably from outside the region. In other years numbers were highest between March and May (corresponding closely with local habitat availability) and mainly comprised such species as Dusky Moorhen, Black Swan, Pacific Black Duck, Purple Swamphen, Intermediate Egret, Comb-crested Jacana and White-faced Heron. Of 3 313+ waterbirds on the survey swamps on the Richmond in April 1974, the above seven species comprised 2 834 (85%); of 3 626 in May 1977, the same species made up 2 296 (63%).

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