AUSTRALIAN BIRD WATCHER 1994, 15, 333-350

Ten Years of Waterbird Counts in Western Port, Victoria, 1973-83. I. Waterfowl and Large Wading Birds

by RICHARD H. LOYN[1], PETER DANN[2] and PAT BINGHAM[3]

[1]Department of Conservation & Natural Resources (Flora & Fauna Branch), 123 Brown Street, Heidelberg, Victoria 3084
[2]Department of Zoology, University of Melbourne, Parkville, Victoria 3052 (Present address: Penguin Reserve Committee of Management, P.O. Box 97, Cowes, Phillip Island, Victoria 3922)
[3]2/27 Russell Street, Surrey Hills, Victoria 3127

Summary

Waterbirds have been counted five times a year at 18 sites in Western Port Bay from spring 1973 by the Bird Observers Club of Australia. This paper deals with numbers of waterfowl and large wading birds in the first ten years to 1983. The period began with two unusually wet years and ended with a series of dry years and drought. Waterbirds tended to be scarce when inland water was plentiful, and numerous as inland waters dried after such wet periods; this was reflected in various correlations with rainfall indices. Inland-breeding birds were influenced mainly by those factors whereas locally breeding birds showed more consistent seasonal patterns, often with minimum numbers in winter and spring when they were breeding in nearby swamps outside the survey area. Numbers of some locally breeding birds responded positively to rainfall in the previous year. The Bay was used as a minor drought refuge by some inland-breeding bird species. Its potential value may have been reduced as peripheral freshwater swamps dried.

Birds that declined during the study were all species that fed mainly from intertidal mudflats (White-faced Heron *Ardea novaehollandiae*, Great Egret *A. alba*, Black Swan *Cygnus atratus*, Grey Teal *Anas gracilis* and Chestnut Teal *A. castanea*) or caught fish in tidal waters (Australian Pelican *Pelecanus conspicillatus* and four species of cormorant). This may have been related to a major decline in seagrass. Birds that increased were all species that fed extensively from peripheral saltmarsh, fresh water or pasture (Cattle Egret *Ardea ibis*, Australian White Ibis *Threskiornis molucca*, Straw-necked Ibis *T. spinicollis*, Yellow-billed Spoonbill *Platalea flavipes*, Australian Shelduck *Tadorna tadornoides*, Pacific Black Duck *Anas superciliosa* and Eurasian Coot *Fulica atra*).

Numbers of all species differed consistently between sites. Some of these patterns of distribution varied with season or year, but in general they remained consistent over time. Most conclusions made in the first year about local distribution and seasonal patterns were confirmed subsequently.

Introduction

Waterbirds in Australia are highly mobile (Frith 1982, Blakers et al. 1984), with numbers varying greatly over time in south-eastern Australia. Changes at various places have been documented and related to local or inland rainfall (Morgan 1954, Briggs 1977, Corrick 1981, Whyte 1981, Gosper et al. 1983, Norman 1983, Woodall 1985, Harper 1990, White 1993). Briggs & Holmes (1988) and Norman & Nicholls (1991) have examined variation in bag size of ducks over up to 18 years, in relation to climatic events. No studies have investigated seasonal variation over many years, or changes in distribution within a complex system of habitats.

This paper presents data from the first ten years of a continuing study at a large coastal bay in southern Victoria. It deals with waterfowl (grebes, pelican, cormorants, swan, ducks and coot) and large wading birds (herons, egrets, ibis and spoonbills), from 1973 to 1983. A second paper deals with Charadriiformes (waders, gulls and terns) (Dann et al. 1994). The results are used to consider questions about consistency of seasonal and annual changes in bird numbers and local distribution, and relationships between bird numbers and rainfall.

This study of birds in Western Port Bay began in October 1973 (Loyn 1975, 1978), and is continuing as a project of the Bird Observers Club of Australia. It is now one of the longest regular series of comprehensive waterbird counts in Australia. The study period began with two of the wettest years on record, through much of Australia, and ended with two of the driest (Bureau of Meteorology, monthly rainfall reports). The period also saw an 85% decline in seagrass biomass (especially of *Heterozostera tasmanica*), which appears to have been associated with increased sediment deposition and exposure of some of the seagrass beds (Bulthuis et al. 1984); this may be a consequence of reduced input of fresh water or increased sediment. There has been some increase in recreational boating, and localised industrial development at Hastings.

Western Port lies on the southern coast of Victoria, east of Melbourne, and covers 680 km² including 270 km² of tidal mudflats. It has a coastline of 263 km of which 107 km are lined by White Mangroves *Avicennia marina* (Shapiro 1975). One large island (Phillip Island) lies in the southern entrance and a larger island (French Island) occupies the centre of the Bay.

Figure 1.

Sites counted regularly at Western Port, 1973-83. Arrows show typical movements of birds from high-tide roosts.

1. **Sandy Point/Hanns Inlet (sandy spit and mangrove-lined mudflats).**
2. **Settling Ponds, HMAS Cerberus (non-tidal sewage lagoons).**
3. **Hastings (jetties, boat harbour, mudflats, and mangroves; former rubbish tip).**
4. **Warneet (jetties and mangrove-lined mudflats in narrow channel).**
5. **Barralliar Island and mudflats mainly to north (small stony island, mangroves, extensive mudflats and mudbanks).**
6. **Bullock Swamp, Decoy Swamp and nearby coast (non-tidal swamps, saltmarsh and mangroves).**
7. **Tooradin (jetties, fishing harbour and small tidal inlet).**
8. **Bunyip River/Yallock Creek (estuaries and intervening coast; mudflats, gravel beaches, mangroves and saltmarsh).**
9. **Coast near Settlement Road (mudflats and eroding coast backed by pasture).**
10. **Stockyard Point and nearby coasts (sandy spit, saltmarsh and mudflats).**
11. **Grantville (mangrove-lined mudflats and saltmarsh from Gurdies to Queensferry).**
12. **Red Bluff Creek (small estuary from General Motors Holden drain into saltmarsh and mudflats as in 11).**
13. **Reef Island and nearby coasts (rocky reef isolated at high tide; mudflats and mangroves).**
14. **Observation Point/Rhyll Inlet (sandy spit, rocky islet, mangroves, mudflats and tidal inlet).**
15. **Tortoise Head and nearby coasts (headland with beaches, saltmarsh and mangroves; extensive mudflats).**
16. **Rams Island, Long Point and nearby coasts (stony hummock isolated at high tide; derelict jetty, mudflats and mangroves).**
17. **Bluegum Point and nearby coasts (muddy point, sandy spit and mudflats).**
18. **Swamp at Dwyers Road/Agar Road (small freshwater swamp).**

X. **Other areas counted periodically but not included in the main analysis. The most important include:**

19. **Yaringa (mangroves, mudflats and small freshwater swamp — Gordon Rolfe Reserve — on Tyabb Road).**
20. **Newhaven/San Remo (fishing harbours and mudflats).**
21. **Churchill Island (island with rocky shore and historic farm; extensive mudflats).**
22. **Fairhaven coast (mudflats, mangroves, saltmarsh and derelict jetties).**
23. **Long Island (dredge heaps, mudflats and mangroves near industrial complex).**

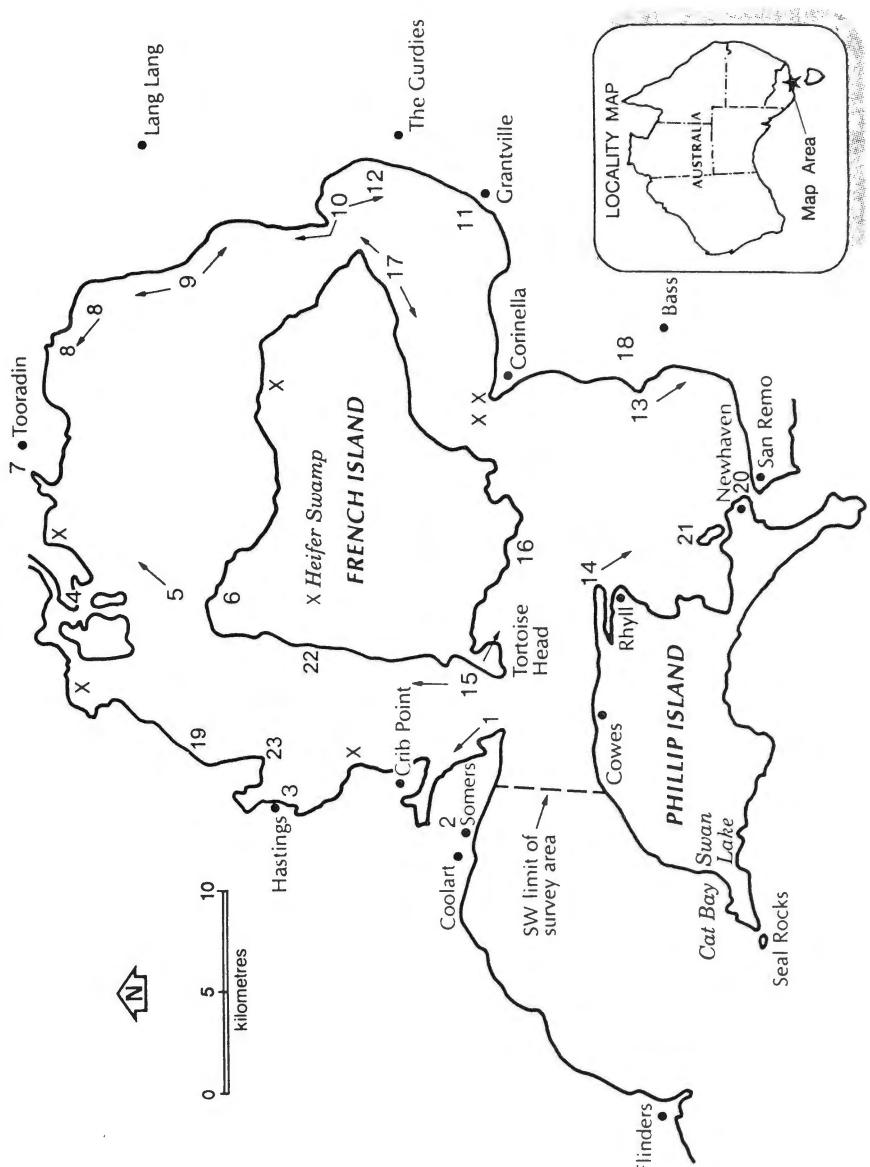

Figure 1. Sites counted regularly at Western Port, 1973-1983. See caption opposite.

Methods

Simultaneous counts of all waterbirds were made by teams of observers, mainly at high tide, on selected days at up to 18 sites. The sites included major high-tide roosts and other important areas in the Bay (Figure 1). Count days were selected to be on weekends when high tide fell within four hours of midday. Movements of birds were noted, to avoid duplicate counting. Information on breeding and feeding was recorded during counts and opportunistically at other times. Counts were made every month from October 1973 to June 1976, and five times a year thereafter: twice in summer (December and February, considered as separate 'seasons') and once in autumn (between late April and early May), winter (June/July) and spring (between mid September and mid October). The 1977 autumn count was missed. Several areas were counted on other occasions, and other areas have been counted at times to check distribution patterns. Loyn (1975, 1978) referred to a larger set of sites, with correspondingly larger numbers of widespread species such as Black Swan.

Coverage

If a site could not be counted on the selected day, it was counted on a date as close as possible. No other allowance was made for sites missed from a particular count. The mean coverage was 15.6 out of the 18 sites, and the sites most frequently missed (Hastings and Dwyers Road Swamp) were important as high-tide roosts for few species. Fourteen of the sites had been counted on 50 or more of the 57 selected dates. Mean values were used in the analysis from the early years when more than one count was made in a season.

Analysis

To examine the relationship between counts and environmental variables, untransformed totals from the 18 sites on individual dates, and their annual means, were tested for correlation with a range of variables:

1. Conditions on the day of the count:
   Maximum temperature (°C), measured at Cape Schanck; rain (mm), measured at Cape Schanck; phenomena (mainly thunderstorms; also hail, sleet, fog or gale), recorded at Cape Schanck; bad weather index from 0 (fine) to 6 (foul); tide height at Stony Point (m); time of high tide at Stony Point (24-hour clock); number of sites counted (13 to 18).
2. Wetland indices:
   Local swamp index from 0 (dry) to 3 (flooded), from observers' reports; Murray riverflow (gigalitres), at Rufus River below the Murray/Darling confluence, as an index of wetness in the vast Murray/Darling Basin of northern Victoria, inland New South Wales and southern Queensland, where many waterbirds breed; annual rainfall indices calculated by Holmes & Briggs (1986) for two distinct parts of eastern Australia (southern and Murray/Darling) and for the whole of eastern Australia, published on an annual basis; Murray riverflow and annual rainfall in the previous year (i.e. lagged), as bird numbers could be influenced by previous wetness (e.g. in breeding areas, Briggs & Holmes 1988).
3. Time:
   The consecutive number of years from 1 to 10.

Time, annual rainfall indices and lagged Murray riverflows were considered only on an annual basis, to exclude seasonal effects. A final test of change was made by comparing untransformed mean counts for all individual dates in the first five years (December 1973 to spring 1978) with those for the second five years (December 1978 to spring 1983), using t-tests.

Results

Annual and seasonal mean counts of 24 selected species are given in Tables 1 and 2 respectively. Notes on species that were observed less often are given in Appendix 1.

Distribution and habitat; annual and seasonal changes in distribution

Numbers of all species differed consistently between sites. A table of mean counts at each site is available from the authors on request.

Observations showed that choice of sites by birds depended on habitats available. Some species made extensive use of intertidal mudflats (e.g. White-faced Heron *Ardea novaehollandiae*, Great Egret *A. alba*, Little Egret *A. garzetta*, Australian White Ibis *Threskiornis molucca*, Royal Spoonbill *Platalea regia*, Black Swan *Cygnus atratus*) whereas others rarely did so, and fed mainly at nearby freshwater swamps, dams and

Australian Pelicans *Pelecanus conspicillatus*, **Mud Island, Victoria, October 1993**
Plate 63 Photo: M.J. Carter

estuaries (e.g. Pacific Heron *Ardea pacifica*, Yellow-billed Spoonbill *Platalea flavipes*, Eurasian Coot *Fulica atra*) or adjacent wet or dry pasture (e.g. Cattle Egret *Ardea ibis*, Straw-necked Ibis *Threskiornis spinicollis*). White Ibis and White-faced Herons fed both in wet pasture, and from intertidal mudflats and saltmarsh. Straw-necked Ibis were observed using intertidal mudflats on only three occasions: in April 1976, when 17 fed from the water's edge near Bunyip River; in February 1977, when 15 were resting with White Ibis on mudflats near Grantville; and in February 1978 when 125 were seen feeding from mudflats near Rhyll.

Pools in flooded saltmarsh were used by White-faced Herons for feeding, and by Black Swans and Australian Shelducks for breeding. The White-faced Heron, shelduck and Royal Spoonbill also formed roosting flocks in saltmarsh, whereas Black Swans often rested at high tide in sheltered waters offshore close to mangroves, or above seagrass beds where they fed as the tide receded. Generally ducks tended to congregate close to estuaries or on fresh water, with the highest numbers at Bullock Swamp, Bunyip River/Yallock Creek and Red Bluff Creek (Figure 1). Musk Ducks *Biziura lobata* and Hoary-headed Grebes *Poliocephalus poliocephalus* formed seasonal flocks on the sea in sheltered bays and estuaries, with smaller numbers on fresh water, whereas Australasian Grebes *Tachybaptus novaehollandiae* occurred only on freshwater dams and swamps. Eurasian Coots congregated only on freshwater swamps but singles were observed on the sea on rare occasions, e.g. between Warneet and Barralliar Island 17-21 March 1975 and near Bluegum Point in February 1981 (landing on the sea after being flushed from the beach). Australian Pelicans *Pelecanus conspicillatus* and cormorants appeared to feed mainly from tidal waters and estuaries, and used ephemeral swamps mainly for breeding, though small numbers of Little Pied Cormorants *Phalacrocorax melanoleucos* also fed there. Freshwater habitats were selected for breeding by all locally breeding species except Australian Pelican (which nested on bare mud and saltmarsh at the Duck Splash) and Pied Cormorant *P. varius* (which nested irregularly in mangroves).

Patterns of local distribution were quite stable from year to year, except for species that make some use of fresh water but were denied the use of ephemeral swamps in 1982 and early 1983 when these were dry. These included Hoary-headed Grebe, Australian Pelican, Little Pied Cormorant, White-faced Heron, Yellow-billed Spoonbill, Black Swan, Grey Teal *Anas gracilis*, Chestnut Teal *A. castanea*, Musk Duck and Eurasian Coot. Numbers of Black Swans in the inner northern and western parts of the Bay declined greatly from 1981, in parallel with severe dieback of seagrass in that area. Eurasian Coots varied greatly in numbers and distribution between years. They occurred consistently at just one survey site, with up to 75 at the sewage settling ponds near Sandy Point. Even larger numbers congregated at Bullock Swamp in 1975 (up to 240), but few were seen there subsequently, perhaps suggesting an increase in salinity. Up to 28 were counted at Dwyers Road Swamp in 1975 and up to 150 in 1978-79. The species also occurred on swamps outside the usual survey area, e.g. up to 30 near Yaringa in 1975.

Some patterns of local distribution varied seasonally, as with Hoary-headed Grebe, Australian Pelican, Great Cormorant *Phalacrocorax carbo*, Little Black Cormorant *P. sulcirostris*, Little Pied Cormorant, White-faced Heron, Little Egret, Royal Spoonbill, Black Swan, Australian Shelduck, Grey Teal, Chestnut Teal, Musk Duck and Eurasian Coot. The variation related to use of different local habitats in the breeding season (mainly freshwater swamps and their vicinity), or it may have reflected seasonal movements of food resources within the Bay (especially fish which comprise the main food of grebes, cormorants, herons and egrets).

Year-to-year changes in numbers

Numbers of most species varied between years (Table 1). Ten of them were rare or absent in 1974, when wet conditions prevailed over most of eastern Australia. These were Hoary-headed Grebe, Great Cormorant, Little Black Cormorant, Pacific Heron, Great Egret, Yellow-billed Spoonbill, Pacific Black Duck, Grey Teal, Musk Duck and Eurasian Coot. All breed mainly further inland, with a general stronghold in the Murray/Darling Basin (Frith 1982, Blakers et al. 1984). A major influx of these species occurred in early 1975, followed by a decline later in the year as abnormal rain and flooding continued inland. A second influx was observed in late 1976, with further fluctuations for individual species at various times in 1977, which was a generally dry year inland (Figure 2). In contrast with the other species in the group, no Eurasian Coots were observed in the usual study area in 1977. Australian Shelducks were also scarce in 1976 and 1977, presumably because receding floodwaters elsewhere had left plentiful suitable habitat for this species to graze. The highest counts of Little Black Cormorant, Great Egret and Grey Teal were made in December 1977, and the highest counts of Great Cormorant and Musk Duck were respectively in spring 1976 and winter 1977. Influxes of inland-breeding birds in 1978 and subsequent years were smaller than in 1975 or late 1976 and 1977 (Figure 2). Wintering flocks of Cattle Egrets were observed in nearby pasture in most years, and at survey sites from 1979 (mainly in pasture near Dwyers Road Swamp).

Climatic conditions became increasingly dry through much of eastern Australia from 1980, as reflected in the Murray riverflows (Figure 2), which failed to show their usual spring peaks in 1980 or 1982. In Western Port, numbers of Hoary-headed Grebes were high throughout 1980 and into the first part of 1981, and Yellow-billed Spoonbills were recorded more consistently than in any other year, with groups of up to seven in saltmarsh or mangroves as their usual freshwater habitats dried out. However, numbers of other inland-breeding species were not exceptionally high (e.g. Grey Teal, Eurasian Coot), and some were rare or absent (e.g. Pacific Heron), perhaps

Table 1

Annual mean counts of waterbirds in Western Port, 1973-83 (mean of 4 or 5 seasonal counts, covering 18 sites around the Bay).

		Year									
Species		*74*	*75*	*76*	*77*	*78*	*79*	*80*	*81*	*82*	*83*
Australasian Grebe	*Tachybaptus novaehollandiae*	0	2.8	1.1	2.5	1.8	1.0	3.4	1.1	0	0.8
Hoary-headed Grebe	*Poliocephalus poliocephalus*	0	64	26	34	52	46	58	24	24	18
Australian Pelican	*Pelecanus conspicillatus*	104	127	130	134	86	83	107	72	50	45
Great Cormorant	*Phalacrocorax carbo*	5.1	21.7	47.1	32.0	13.2	8.4	18.6	9.1	6.2	6.6
Pied Cormorant	*Phalacrocorax varius*	68	77	48	111	93	81	69	51	73	44
Little Black Cormorant	*Phalacrocorax sulcirostris*	0.3	35.9	15.3	33.0	17.6	15.8	27.4	13.4	4.8	7.2
Little Pied Cormorant	*Phalacrocorax melanoleucos*	230	319	246	353	258	294	306	88	101	48
Pacific Heron	*Ardea pacifica*	0	1.9	0.1	1.0	1.4	0.6	0.6	0.4	0	0
Great Egret	*Ardea alba*	2	14	16	43	23	13	33	9	11	8
White-faced Heron	*Ardea novaehollandiae*	359	372	475	303	195	215	195	77	171	62
Little Egret	*Ardea garzetta*	0.2	0.5	1.4	0.8	0.2	0.7	0.3	0	0	0
Cattle Egret	*Ardea ibis*	0	0	0	0	0.4	34	25	17	10	11
Australian White Ibis	*Threskiornis molucca*	341	488	653	941	594	815	911	506	531	484
Straw-necked Ibis	*Threskiornis spinicollis*	17	71	11	171	111	616	223	61	159	238
Royal Spoonbill	*Platalea regia*	50	59	69	93	112	113	115	67	34	43
Yellow-billed Spoonbill	*Platalea flavipes*	0.3	2.0	0.2	2.0	3.8	0.4	6.4	2.6	1.4	2.0
Musk Duck	*Biziura lobata*	6	48	26	83	24	33	30	19	43	26
Black Swan	*Cygnus atratus*	1037	2457	2461	2296	1410	2772	1997	1305	1603	483
Australian Shelduck	*Tadorna tadornoides*	60	74	48	36	58	76	63	46	78	83
Grey Teal	*Anas gracilis*	7	332	111	524	134	291	60	79	230	142
Chestnut Teal	*Anas castanea*	188	457	580	254	249	414	320	75	419	110
Pacific Black Duck	*Anas superciliosa*	16	40	12	24	7	41	11	31	59	20
Australasian Shoveler	*Anas rhynchotis*	0.2	3.0	0.6	1.8	1.1	3.8	2.1	2.4	4.4	0
Eurasian Coot	*Fulica atra*	0.4	74	1	0	35	91	23	31	15	18

Note: Calendar years were used in this table, as they divided population peaks of few species (in contrast with migratory waders, considered in Part II, p. 351).

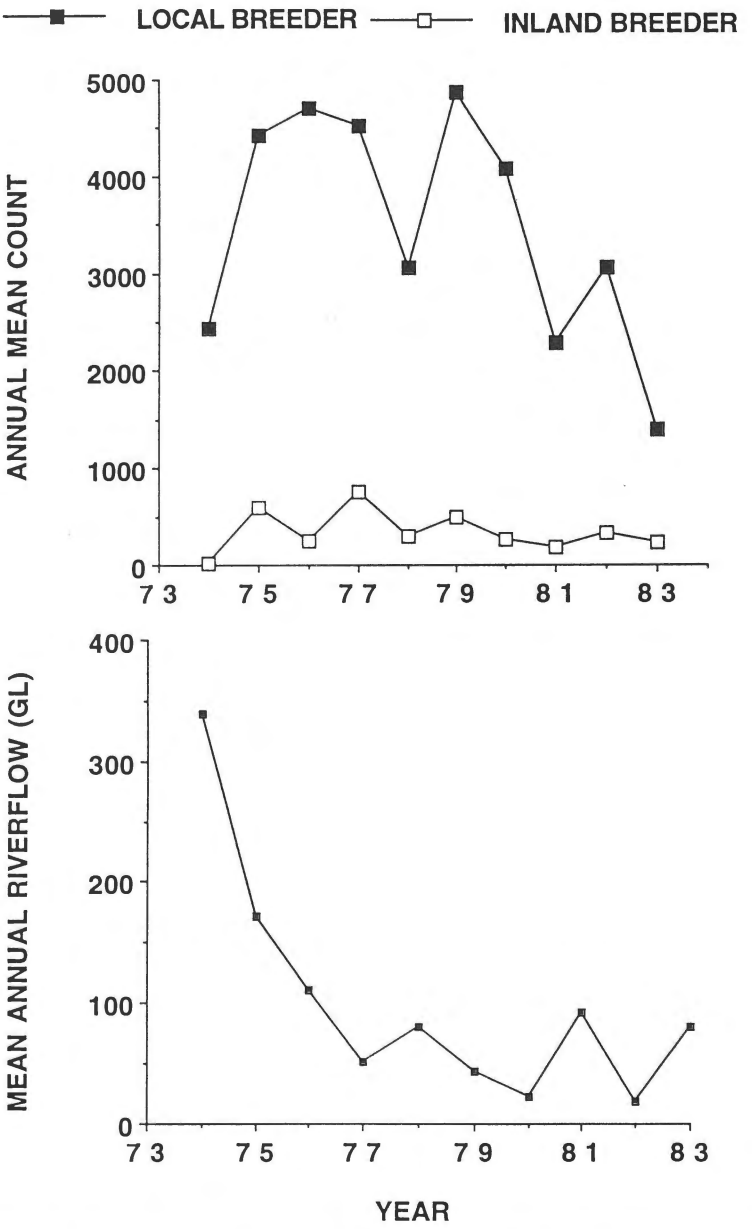

Figure 2. **Annual mean counts of inland-breeding and locally breeding waterbird species at 18 sites in Western Port, 1973-83, and annual flows of Murray River (gigalitres) at Rufus River. Species classed as inland breeders are Hoary-headed Grebe, Great Cormorant, Little Black Cormorant, Pacific Heron, Great Egret, Little Egret, Yellow-billed Spoonbill, Grey Teal, Musk Duck and Eurasian Coot. Others are classed as local breeders, except for Cattle Egret, Australasian Shoveler, Hardhead and other uncommon species which are unclassed.**

reflecting the local decline in fresh water or poor breeding success elsewhere in the birds' range. In 1982 and early 1983 the drought was at its most severe over much of eastern Australia, but there was little standing fresh water around Western Port and birds that need fresh water were scarce.

The drought broke in winter 1983; many waterbirds left Western Port and few remained in the survey area into spring. However, some flocks of Grey Teal and Australian Shelduck were present again in December 1983, and the highest count for the latter species was at that time.

Numbers of locally breeding species also changed between years (Figure 2), though without such a complete exodus in wet years. Chestnut Teal followed a similar pattern to inland-breeding birds, with low numbers in 1974 (when many local swamps outside the survey area held water), low numbers in 1981 and high numbers in 1975, 1976, 1979 and 1982 (Table 1). Royal Spoonbills were most numerous from 1978 to 1980, and least numerous in 1982 and 1983. White Ibis were most numerous from 1976 to 1980 and Black Swans from 1975 to 1979.

Counts of 17 species differed significantly between the first and second five-year periods ($P < 0.05$). Ten appeared more numerous in the first period (Australian Pelican, all four cormorants, White-faced Heron, Great Egret, Black Swan, Grey Teal and Chestnut Teal), and seven appeared more numerous in the second period (Cattle Egret, White Ibis, Straw-necked Ibis, Yellow-billed Spoonbill, Australian Shelduck, Pacific Black Duck and Eurasian Coot). The largest apparent declines were shown by Little Pied Cormorant and White-faced Heron (to 61% and 42% of levels in the first period). The main declines of many species occurred between 1980 and 1981 (Table 1).

Seasonal changes in numbers

Seasonal mean counts for each species are shown in Table 2. They usually fell into unimodal patterns, changing between high and low levels just once per year. Minimum numbers generally coincided with times when birds were observed breeding in swamps and farmland outside the study area, e.g. on French Island (Loyn 1975, Lowe 1981). Most breeding activity was observed from late winter through to spring. No species except Great Cormorant showed minimum numbers in autumn, and no waterbirds were observed breeding locally at that time.

Consistent seasonal patterns were observed for all common species except Pied Cormorant and Grey Teal. Pied Cormorants were probably resident (though some flocks roosted on mangroves outside the survey sites, hence counts varied), whereas Grey Teal visited the Bay in highly varying numbers at different times of the year. The highest counts of Grey Teal were in summer (December and February counts), but flocks were more consistently present in autumn and winter.

The commonest seasonal pattern in Western Port was for minimum numbers to be counted in spring and maximum in February or autumn; this was displayed by Hoary-headed Grebe, Australian Pelican, Little Pied Cormorant, White-faced Heron, White Ibis, Chestnut Teal and Eurasian Coot. Numbers of these species generally remained high into winter.

Another pattern was shown by Great Egret and Black Swan, with minimum numbers in winter and high numbers from December to autumn. Many Black Swans began breeding in flooded saltmarsh in winter. Egrets do not breed locally (Blakers et al. 1984, Emison et al. 1987), and may have been responding to abundance of young fish in the Bay (Robertson 1978).

Numbers of Royal Spoonbill and Musk Duck were at a minimum in December

Table 2

Seasonal mean counts of waterbirds in Western Port, 1973-83 (mean of 9 or 10 annual counts, covering 18 sites around the Bay).

		Season				
Species		*February*	*Autumn*	*Winter*	*Spring*	*December*
Hoary-headed Grebe	*Poliocephalus poliocephalus*	31	54	39	21	24
Australian Pelican	*Pelecanus conspicillatus*	137	119	75	57	81
Great Cormorant	*Phalacrocorax carbo*	11.0	8.6	8.9	34.8	18.4
Pied Cormorant	*Phalacrocorax varius*	81	68	73	64	67
Little Black Cormorant	*Phalacrocorax sulcirostris*	6.4	16.4	20.8	29.3	10.8
Little Pied Cormorant	*Phalacrocorax melanoleucos*	179	327	274	166	172
Pacific Heron	*Ardea pacifica*	0.5	0.4	0.4	1.3	0.3
Great Egret	*Ardea alba*	17	21	8	12	25
White-faced Heron	*Ardea novaehollandiae*	328	418	248	117	122
Little Egret	*Ardea garzetta*	0.1	0.6	0.9	0	0.5
Cattle Egret	*Ardea ibis*	0	6.2	29.4	13.7	0
Australian White Ibis	*Threskiornis molucca*	821	813	701	261	516
Straw-necked Ibis	*Threskiornis spinicollis*	42	56	114	146	470
Royal Spoonbill	*Platalea regia*	67	104	118	60	29
Yellow-billed Spoonbill	*Platalea flavipes*	2.1	3.3	1.9	0.9	2.1
Musk Duck	*Biziura lobata*	34	50	68	10	5
Black Swan	*Cygnus atratus*	2984	2082	601	784	2438
Australian Shelduck	*Tadorna tadornoides*	31	60	81	58	83
Grey Teal	*Anas gracilis*	246	107	134	138	279
Chestnut Teal	*Anas castanea*	383	586	427	84	107
Pacific Black Duck	*Anas superciliosa*	25	56	25	8	20
Australasian Shoveler	*Anas rhynchotis*	1.1	1.7	4.9	1.5	0.6
Hardhead	*Aythya australis*	3.3	1.4	1.0	0.8	3.0
Eurasian Coot	*Fulica atra*	16	58	37	16	18

and highest in winter. Royal Spoonbills were observed to start breeding slightly later than ibis, and to feed mainly outside the usual survey area while breeding.

Numbers of Straw-necked Ibis and Australian Shelduck were at a minimum in February and maximum in December. In contrast with other species, these were observed in high numbers while breeding in spring, and increased further before they and their young departed to feed in pastures outside the survey area. Australian Shelducks gather and moult on large saline lakes in late summer (Norman 1973, Frith 1982, Hewish 1988), but apparently not on bays such as Western Port.

The two black cormorants were the only species for which maximum numbers were recorded in spring (Table 2). Spring is when mature fish are most abundant in the Bay (Robertson 1978). Flocks of Great Cormorants were sometimes seen flying south at that time. Numbers of Great Cormorants sometimes remained high until December, but otherwise were low throughout the year. Numbers of Little Black Cormorants were generally lowest in summer, and rose through autumn and winter to the small spring maximum. Flocks of many hundreds of Little Black Cormorants occur in Port Phillip Bay, but were not observed in Western Port.

Cattle Egrets behaved as classic winter visitors, arriving in autumn and departing in spring. They were never observed in December or February counts, and no other species exhibited such a regular migratory pattern.

Annual changes in seasonal pattern

The seasonal pattern differed between years for three inland-breeding species (Great Egret, Yellow-billed Spoonbill and Grey Teal) more than for locally breeding species (e.g. White-faced Heron, both ibis, Royal Spoonbill, Chestnut Teal) or five inland-breeding species (Hoary-headed Grebe, Great Cormorant, Little Black Cormorant, Musk Duck and Eurasian Coot) that feed in relatively predictable habitats (deep fresh water or the sea). Generally waterbirds were most numerous early in the year in 1975 and 1978, late in the year in 1977 and in the middle of the year (winter) in 1979. In other years, the pattern differed greatly between species, or no influx was observed (1974 and 1981). The combined seasonal pattern for inland-breeding species was similar to that for locally breeding species (Figure 3), but less stable between years.

Correlations with wetland indices, tide height, number of counts and time

Negative correlations (*=P<0.05, **=P<0.01, ***=P<0.001) were found between Murray riverflows and counts on individual dates for Hoary-headed Grebe ($r = -0.28$**), Great Egret ($r = -0.37$**), White Ibis ($r = -0.44$**), Royal Spoonbill ($r = -0.29$*), Yellow-billed Spoonbill ($r = -0.33$*), Grey Teal ($r = -0.32$*) and Musk Duck ($r = -0.35$*). These birds were least numerous in Western Port when water was plentiful in the Murray/Darling Basin. The Murray/Darling rainfall index was negatively correlated with annual means for Pacific Black Duck ($r = -0.63$*) and Australasian Shoveler ($r = -0.84$**).

No species showed a significant positive correlation with any of the wetness indices tested, unless those indices were lagged by a year. Positive correlations were found between the southern or eastern rainfall index for the previous year and annual mean counts of Australian Pelican ($r = 0.66$*), Little Pied Cormorant ($r = 0.63$*), White-faced Heron ($r = 0.82$**), Black Swan ($r = 0.69$*) and Chestnut Teal ($r = 0.62$*). These species were most numerous in Western Port, presumably as a result of successful local breeding, when there had been substantial rain in south-eastern Australia in the previous year. No species showed a significant negative correlation with any of the wetness indices for the previous year. One species (White Ibis) showed

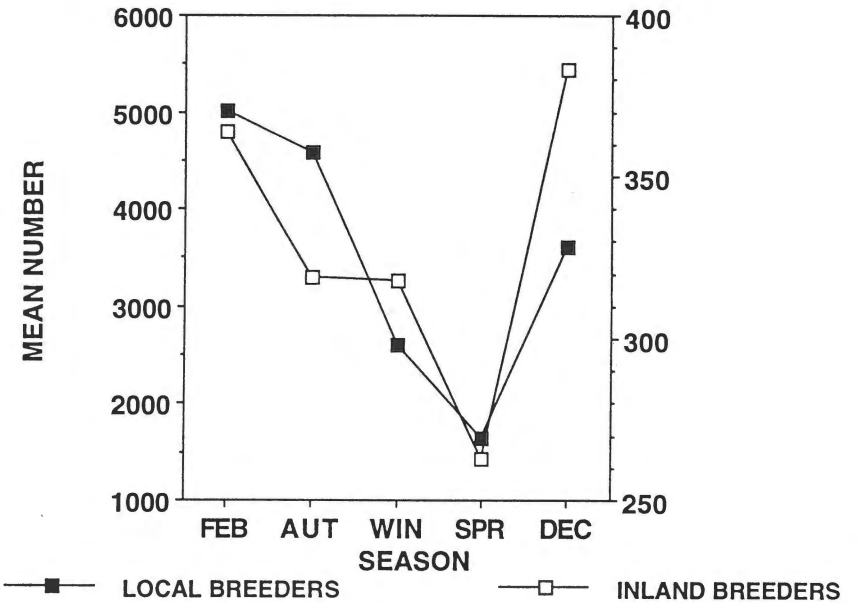

Figure 3. Seasonal mean counts of inland-breeding and locally breeding waterbird species at 18 sites in Western Port, 1973-83.

a negative correlation with the rainfall index for the current year (r = -0.64*). These ibis may have made more use of the Bay when local pasture was dry.

Time (i.e. the consecutive number of years) was negatively correlated with annual mean counts of Australian Pelican (r = -0.80**), Little Pied Cormorant (r = -0.69*) and White-faced Heron (r = -0.89***), suggesting a steady decline in numbers of those species (Table 1). No other species showed a significant correlation with time.

Numbers of sites counted were correlated with counts on individual days or annual mean counts of few species, confirming that the most important sites were covered consistently. Exceptions were Hoary-headed Grebe, Australian Pelican, three cormorants, Great Egret and Royal Spoonbill, which can occur in small groups at many sites within the Bay. Counts of Royal Spoonbill on individual dates were correlated with heights of high tides on count days (r = 0.30*), suggesting that when tides were insufficiently high, some birds did not need to congregate at roost sites included in the counts. The local swamp index was negatively correlated with counts on individual dates of Black Swan and Pacific Black Duck (r = -0.28*). Other indices of conditions on days of count explained little variation. No species showed a significant negative correlation with rain, phenomena or bad weather on the count days; this may be a tribute to the perseverance of observers under all conditions.

Discussion

The study has shown some changes in bird populations over the ten-year period, and has also documented a basic consistency from year to year. Seasonal patterns varied between species and years and were more regular for locally breeding species than for inland-breeding species. The seasonal patterns involved changes in numbers

rather than consistent absences at a particular season, suggesting that the Bay could provide at least some habitat for most of the species considered here at any time of year. Apart from two species observed in very low numbers (Great Crested Grebe *Podiceps cristatus* and Little Egret) the only exception was the Cattle Egret, which was a winter visitor. This is a recent colonist in Australia and has established a regular migration between its breeding colonies in northern New South Wales and southern Queensland, and winter areas which are, oddly, further south (McKilligan 1984, Woodall 1986, Maddock 1990). Pastures in southern Australia may provide a more seasonal (winter) food source for that species than the natural habitats of the Bay do for a wide range of waterbirds.

Studies near the coast elsewhere in eastern Australia have also shown minimum numbers of waterbirds in spring, and have related the pattern to dispersal for breeding (e.g. Morgan 1954, Norman 1983, Gosper et al. 1983). Maximum numbers have been reported at various times, from summer (Lavery 1972, Davis & Reid 1974, Frith 1982 for ducks) to autumn (Ambrose & Fazio 1989) or autumn/winter (Gosper et al. 1983, Norman 1983).

The most conspicuous changes observed between years relate to the group of inland-breeding birds that were rare or absent in wet years (notably 1973/74), and more numerous at various other times. The group included Hoary-headed Grebe, Great Cormorant, Little Black Cormorant, Great Egret, Pacific Heron, Yellow-billed Spoonbill, Grey Teal, Musk Duck and Eurasian Coot. Numbers of this group were low when water was plentiful inland. In contrast, the locally breeding species were always present; they responded more regularly to season, and some responded positively to the wetness of the previous breeding season. A similar division of waterbirds into two groups was recognised by Briggs (1977), Gosper et al. (1983) and Woodall (1985), from work in coastal northern New South Wales and southern Queensland.

In Western Port, numbers of inland-breeding birds were higher from 1975 to 1977 (after the wet years 1973-75) than during the drought of 1980-83. It seems that these birds came to the Bay as inland waters dried to a greater extent when populations were high after good breeding than during drought after poor breeding. A similar observation was made in nearby Corner Inlet (F.I. Norman pers. comm.), where numbers of duck were no higher during the drought than in previous years. Most of these birds need fresh water, either as their main habitat (e.g. Yellow-billed Spoonbill) or for drinking and bathing (e.g. ducks, Norman 1983). Several local swamps were dry at the end of the period and this may have reduced the value of the Bay as drought refuge. Before European settlement the hinterland contained extensive freshwater marshes (e.g. Kooweerup Swamp) which have been drained (Corrick 1981). However, several landholders are now attempting to recreate freshwater habitats, on a small scale.

Despite the conspicuous arrivals and departures of inland-breeding birds, their numbers were small compared with locally breeding species (Figure 3). With the possible exception of Great Egret, they were also small in a wider context (e.g. see Braithwaite et al. 1986; Martindale 1988; Hewish 1988; Norman & Brown 1988; Peter 1989, 1990 for counts of waterfowl at many sites in south-eastern Australia). No influx of Australian Pelicans was observed, despite high production of young in central Australia in 1973/75 and subsequent dispersal as far as New Zealand, Fiji and Indonesia (Woodall 1985). The habitat in Western Port may be fully occupied by its resident population of pelicans, and that population did not move inland in response to rain. Some species that became common elsewhere in southern Victoria

during dry years were rarely observed in the study area at Western Port, e.g. Pink-eared Duck *Malacorhynchus membranaceus* and Blue-billed Duck *Oxyura australis*. These species inhabit lakes but not the sea (Frith 1982, Emison et al. 1987, Marchant & Higgins 1990). It seems that bays such as Western Port can provide refuge for limited numbers of inland-breeding birds, of a limited range of species.

The Bay is more important for its numbers of locally breeding species (notably White Ibis, Royal Spoonbill and Chestnut Teal). Most of these birds breed in freshwater swamps near the Bay but outside the survey area. Separate studies of breeding birds have shown that numbers of White Ibis and Royal Spoonbill at local colonies exceeded or equalled those counted by air in the whole Bay (Lowe 1981, 1982), whereas numbers of breeding Black Swans (600) were not sufficient to account for maximum numbers recorded (10 800 by fast boat in February 1980) (Dann 1980). Numbers of all locally breeding species may have been supplemented at times by birds from further away.

Changes in abundance of species may have been affected by events which were not monitored on a regular basis. One important observed change was an 85% loss in seagrass biomass, especially of *Heterozostera tasmanica*, which occurred between 1973 and 1984, and became most obvious from 1982 (Bulthuis et al. 1984). Seagrass is a major source of primary production in the Bay (Shapiro 1975, Bulthuis 1981, Bulthuis & Woelkerling 1983), and is used directly by Black Swans as their main food on tidal mudflats. The relationship between birds and seagrass deserves further study. It is possible that regular counts of birds could provide a convenient indicator of seagrass production.

The seagrass dieback could affect all species that feed from intertidal mudflats. Among those discussed here, the ten that were less numerous in the second five-year period than in the first all fed primarily, while they were in the area, on fish or invertebrates taken from intertidal waters or mudflats. In contrast, the seven species that became more numerous fed in pasture, saltmarsh or fresh water, and only the White Ibis made regular use of intertidal mudflats.

The main conclusions of the first year's work (Loyn 1975, 1978) have been confirmed. This gives encouragement that short-term studies can provide useful data. Long-term monitoring of areas such as Western Port is needed to detect further changes and begin to understand them. Further analysis of the continuing counts may provide clues about the possible timing and distribution of changes in habitat such as seagrass dieback and recovery.

Acknowledgements

This study has been a co-operative effort from a large number of dedicated observers, who have maintained a high standard of coverage and accuracy in all conditions including occasional bad weather and rough seas. Many people took part regularly throughout the 10-year period and beyond. Grateful thanks to all.

The Bird Observers Club of Australia has supported the project at all stages, and has provided voluntary participants, convenors, financial assistance for hiring boats and, through the Australian Bird Environment Fund, funds for processing data. The study began as a project of the Westernport Bay Environmental Study (then Ministry for Conservation, Victoria).

Several landholders have allowed regular access to their properties, and have provided accommodation and transport. Land transport on French Island has been provided regularly by Alan Chandler and family, and by rangers from the Department of Conservation, Forests & Lands (now Conservation & Natural Resources).

Expert help in computing was generously provided by Graham Hepworth and Simon Bennett (CNR). The laborious job of data preparation and entry was carried out by Alison Livermore, Mollie Perkes and staff of the Victorian Government Computing Centre. This paper was typed by Kae Winch and Irene Prentice (CNR). Valuable comments were made by Ian Norman (Wildlife Section, CNR),

Valerie Curtis, Ailsa Swan, Mike Carter and Ren Millsom (BOCA), Peter Woodall, Kate Creed, Gerry Quinn, Ian Rowley and anonymous referees.

The enthusiastic contributions of all these people and organisations are gratefully acknowledged.

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Received 10 May 1994

Appendix 1

Species which were recorded infrequently or in low numbers at the survey sites in Western Port between 1973 and 1983. Some of these species were fairly common in the vicinity but outside the area surveyed.

Seabirds are not listed here, though four species were observed quite often in the Bay (Little Penguin *Eudyptula minor*, Short-tailed Shearwater *Puffinus tenuirostris*, Australasian Gannet *Sula serrator* and Arctic Jaeger *Stercorarius parasiticus*) and albatrosses and other pelagic species were often seen in the deeper seaward parts of the Bay or found beach-washed at survey sites (e.g. a Southern Fulmar *Fulmarus glacialoides* at Bluegum Point and a Fairy Prion *Pachyptila turtur* at Reef Island, both found dead on 16 September 1978). Short-tailed Shearwaters often entered the survey area in large numbers in late April/early May. Various freshwater species were recorded at sites outside the usual survey area (e.g. Rhyll Swamp, Swan Lake and Coolart), and they are not documented here. Many uncommon land birds were recorded during the survey and two species of parrot are included here because of their association with saltmarsh habitats.

Great Crested Grebe *Podiceps cristatus*
A few on sea, mainly in sheltered bays such as Bass Bay, max. nine off Red Bluff Creek in September 1978 (when there were also three off Reef Island), seven off Yallock Creek estuary in June 1979 and four off Stockyard Point in October 1980. Most records (14, of 37 birds) were from June to September but there were two at Sandy Point Settling Ponds in April 1979 and February 1982, one off Sandy Point and two off Grantville in February 1980 and one off Churchill Island in December 1983.

Black-faced Shag *Phalacrocorax fuscescens*
Singles occasionally seen at Tortoise Head, Tankerton Jetty, Sandy Point, Long Point Jetty near Rams Island (three in December 1975) and Newhaven (max. three in October 1976). Otherwise mainly found in the seaward part of the Bay outside the survey area, with varying numbers in Cat Bay, Seal Rocks and the south coast of Phillip Island.

Intermediate Egret *Ardea intermedia*
Singles reported at Bunyip River and Sandy Point in April 1975 and Long Island in February 1981 (roosting on mangroves), though descriptions were inadequate for positive acceptance. Also one record near Rhyll Swamp in November 1980 (Lowe 1981). This species usually inhabits grassy freshwater marshes inland, and has not been seen using intertidal mudflats.

Little Egret *Ardea garzetta*
One or two quite often at Barralliar Island, Bunyip River/Yallock Creek or Long Island, feeding from mudflats or roosting on beaches with waders or on mangroves with cormorants (see tables). Occasionally seen elsewhere, max. three at Red Bluff Creek in June 1976; no records from freshwater swamps.

Rufous Night Heron *Nycticorax caledonicus*
Up to about 50 roosting regularly in pines at Warneet, and fewer at Yaringa; occasional records elsewhere, e.g. Rhyll, Stony Point and Long Island.

Dusky Moorhens
Gallinula tenebrosa
Plate 64 Photo: N. Male

Australasian Bittern *Botaurus poiciloptilus*
One at Bunyip River October 1973 and five outside the survey area at Long Swamp on French Island December 1982.

Blue-billed Duck *Oxyura australis*
One at Bullock Swamp November 1975 and a male with five young at Sandy Point Settling Ponds December 1977. Often seen at teatree swamps outside the usual survey area, including Heifer Swamp, Rhyll Swamp and Coolart.

Cape Barren Goose *Cereopsis novaehollandiae*
Occasional records in pasture, e.g. three at Settlement Road July 1978, and a breeding population has been established from feral and probably wild stock on Phillip Island where they now breed on both sides of fox-proof fences (A. Swan pers. comm. 1994).

Domestic Goose *Anser* sp.
A feral pair inhabited the south coast of French Island near Rams Island from February 1975 to 1983, rearing young in at least one year. A pair was also seen off Churchill Island in December 1983. The species is unfortunately common in farmland on Phillip Island (e.g. has bred Swan Lake).

Maned Duck *Chenonetta jubata*
Scarce, presumably because this species avoids saline water (Marchant & Higgins 1990). Up to 22 were seen on a freshwater dam at Grantville and there were 12 at Dwyers Road Swamp on just one occasion (May 1981). No more than two were seen together at any of the other survey sites, with records from Sandy Point Settling Ponds (two on five occasions), Bullock/Decoy Swamps (one in March 1975) and Bunyip/Yallock (two in June 1976). None was reported in 1977, 78 or 79. Many more have been seen subsequently on dams and water storages outside the survey area (M. Carter pers. comm. 1994).

Pink-eared Duck *Malacorhynchus membranaceus*
Two at Bullock Swamp March 1978 and one there April 1979; three on sea off Stockyard Point September 1980. Outside the usual survey area, a few were seen at Rhyll Swamp and Coolart.

Mallard *Anas platyrhynchos*

One on Cerberus ornamental pond May 1976, one at Tortoise Head saltmarsh December 1978 and three at Yaringa (Gordon Rolfe Reserve) July 1980. Also observed at Hastings marina. Most or all were feral hybrids or escaped domestic ducks.

Hardhead *Aythya australis*

Up to five regular at Sandy Point Settling Ponds, with 8-11 on four occasions (including some young in December 1978) and 15 in February 1981. In April 1975, eight were seen there and a flock of 14 landed on the sea off Warneet Channel; this was during the duck-hunting season. Only a few records from other survey sites, with up to four at Bullock Swamp, four at Yaringa, ten at Observation Point, five at Tankerton (May 1980), one at Fairhaven in December 1979 and a young bird at Dwyers Road Swamp in July 1975. More numerous at larger swamps outside the survey area, e.g. Rhyll Swamp and Coolart.

White-bellied Sea-Eagle *Haliaeetus leucogaster*

Pairs and young birds often seen, mainly on the coasts of French Island where at least one pair breeds.

Buff-banded Rail *Gallirallus philippensis*

One at Rhyll February 1983, seen twice in a garden overlooking Observation Point.

Lewin's Rail *Dryolimnas pectoralis*

Occasionally seen and heard in heaths on French Island and in saltmarsh and swamps, e.g. one at Tankerton Creek February 1975, one in mangroves at Reef Island May 1976, one near Bluegum Point February 1980 and several in northern saltmarshes in summer and winter, e.g. two at Bunyip River June 1979; probably resident but cryptic.

Australian Crake *Porzana fluminea*

Occasionally observed at freshwater swamps and creeks, e.g. two at Tankerton Creek February 1975 and one at Yaringa May 1978, and more rarely in saltmarsh, e.g. one near Reef Island May 1975. One unidentified crake seen and wings of two others found in mangroves near Tortoise Head, April 1975. One crossed a road between dry paddocks near Rams Island, March 1975.

Spotless Crake *Porzana tabuensis*

One at lagoon mouth, Bass Bay near Reef Island, February 1980.

Purple Swamphen *Porphyrio porphyrio*

Common on teatree swamps especially on French Island, max. 25 at Bullock and Decoy Swamps July 1975, 16 at Yaringa May 1978 and 15 Dwyers Road Swamp October 1981, but numbers difficult to estimate.

Dusky Moorhen *Gallinula tenebrosa*

Observed regularly on freshwater swamps (e.g. Queensferry Road near Grantville, Sandy Point Settling Ponds and Dwyers Road Swamp), but not at Bullock or Decoy Swamps which may be too brackish, max. 15 at Yaringa May 1978.

Blue-winged Parrot *Neophema chrysostoma*

Flocks occurred mainly from March to October in saltmarsh and nearby grazed pasture, with maxima of 220 at Bunyip River in June 1977 and 277 at Settlement Road in August 1979. A few singles and pairs were seen later in spring/summer, mainly in heathy forest near Grantville, with eight near Red Bluff Creek 1981/82.

Orange-bellied Parrot *Neophema chrysogaster*

Small flocks of this endangered species were seen in saltmarsh and adjacent shrubland, mainly between March and June with fewer in later years of the survey. Records came from Barralliar Island (six on 17 March 1974, five on 21 March and four still there on 6 July 1974; one on 13 April 1975), Settlement Road (three on 31 March and four on 6 April 1974), Stockyard Point (two on 21 March 1982), Reef Island/Bass River (two on 3 and 8 May 1980, and one still there on 24 May 1980; probably 14 on 4 June 1977), Bullock/ Decoy Swamps (14 in *Melaleuca* on 3 April 1976 and four in dry swamp June 1981), and several sites on French Island that were not regularly counted (max. seven near Clump Lagoon on 3 April 1982). Probable records also came from Bunyip River (e.g. one on 1 June 1975 and three on 3 June 1979) and near Flinders (each October 1978-80).

■

AUSTRALIAN BIRD WATCHER 1994, **15**, 351-365

Ten Years of Waterbird Counts in Western Port, Victoria, 1973-83. II. Waders, Gulls and Terns

by PETER DANN[1], RICHARD H. LOYN[2] and PAT BINGHAM[3]

[1]Department of Zoology, University of Melbourne, Parkville, Victoria 3052 (Present address: Penguin Reserve Committee of Management, P.O. Box 97, Cowes, Phillip Island, Victoria 3922)
[2]Department of Conservation & Natural Resources (Flora & Fauna Branch), 123 Brown Street, Heidelberg, Victoria 3084
[3]2/27 Russell Street, Surrey Hills, Victoria 3127

Summary

Waders, gulls and terns (Charadriiformes) were counted five times a year from 1973 to 1983 (and beyond) at 18 sites in Western Port, as part of a continuing survey by the Bird Observers Club of Australia. Numbers of all species varied between sites, showing that some sites were consistently favoured or avoided by each species during the ten-year period. Of the 20 species which occurred regularly, annual means were correlated with time (all negatively) for only three species: Red-capped Plover *Charadrius ruficapillus*, Grey-tailed Tattler *Tringa brevipes* and Pacific Gull *Larus pacificus*. In comparisons between the first and second five-year periods, increases were significant for Pied Oystercatcher *Haematopus longirostris*, Masked Lapwing *Vanellus miles* and Caspian Tern *Sterna caspia*, and decreases were significant for Double-banded Plover *Charadrius bicinctus*, Red-capped Plover, Eastern Curlew *Numenius madagascariensis*, Grey-tailed Tattler, Red-necked Stint *Calidris ruficollis*, Curlew Sandpiper *C. ferruginea* and Pacific Gull.

Generally, the Australasian-breeding species showed a pattern of low counts in spring and high counts in late summer and autumn. The seasonal pattern for Palearctic-breeding species was a consistent one of low autumn and winter counts and high spring and summer counts. Only three of the nine species that use inland habitats as well as the coast showed significant correlations between indices of wetland availability elsewhere and numbers in Western Port.

Introduction

Annual and seasonal fluctuations in numbers of waders, gulls and terns result from movements and variations in breeding success and survival. Long-term surveys of relatively large areas, such as Western Port, are valuable because local movements do not cause undue variation in total counts, thus allowing some indication of demographic trends and seasonal variation.

It is important to understand these annual and seasonal changes because the availability and productivity of food resources of many charadriiform species (waders, gulls and terns) have been altered by human activity throughout their ranges, and opportunities to ensure adequate protection of these resources are diminishing. Predation by humans, particularly on migratory flyways, may have reduced the survival of some Palearctic species (Lane & Parish 1991). During the period of this survey there were significant changes in land-use practices and disturbance in and around the Bay and its catchment.

Monthly or seasonal counts of waders, and (less often) of gulls and terns, have been documented at various sites in south-eastern Australia, although most of these concern fewer sites and shorter periods of time (Wheeler 1955; Thomas 1970; Loyn 1978; Corrick & Norman 1980; Corrick 1981; Martindale 1982; Jones 1984a,b; Close & McCrie 1986; Chapman et al. 1987). Counts of waders were made at numerous sites around the Australian coastline as part of the national wader studies program (Lane 1987, Hewish 1990). Many questions remain about regularity of seasonal patterns

and how these relate to climatic or environmental factors. In addition, annual variation in local distribution is rarely considered.

Western Port is a coastal bay with a coastline of 263 km and includes an area of 680 km² of which 40% is tidal mudflats (Shapiro 1975). Its importance as habitat for waterbirds was noted by the early European explorers (e.g. Bass in Flinders 1814). In wader surveys of coastal Victoria in 1979 and 1981, Western Port was ranked fourth in Victoria in terms of numbers and species diversity behind Port Phillip Bay, Corner Inlet and Bellarine Peninsula (Martindale 1982, Dann 1994). The current survey started in October 1973. Results from the first 18 months (Loyn 1975, 1978) and for the first ten years for waterfowl, large wading birds, pelicans and cormorants (Loyn et al. 1994) have been published. This paper reports on annual and seasonal variations in numbers and on distributions of waders, gulls and terns (Charadriiformes) in Western Port between 1973 and 1983.

Methods

Simultaneous counts of all waders, gulls and terns (and other waterbirds) were made at all major high-tide roosts and other important areas throughout the Bay. Counts were made at monthly intervals from October 1973 to June 1976, and then at intervals of two or three months to October 1983 and beyond. Eighteen sites were counted on a regular basis. These included all the most important roosts for birds of intertidal habitats (Loyn 1978) and the locations are shown in Loyn et al. (1994). Birds at fourteen of these sites had been counted on at least 50 of the 57 survey dates; for two there were 46 counts and for the other two there were 35 counts (Hastings and Dwyers Road Swamp, which were important as high-tide roosts for few species). 'Total numbers' and means are derived from the 18 main sites.

Each year, 'seasonal' counts were made in February (late summer), late April or early May (autumn), June or July (winter), September or October (spring) and December (early summer), except in 1977 when there was no autumn count. In the early years when there was more than one count in some seasons, mean values were used. This paper deals mainly with the 20 most numerous species (15 waders, two gulls and three terns, Table 1). Other, less numerous, species are noted in Appendix 1. Each year began with the spring counts from the previous year as this avoided the division of population peaks into two calendar years. No allowance was made for missing counts in this analysis. A mean of 15.6 sites was covered in each count and total numbers quoted are the numbers actually counted at the sites on that particular date.

Annual and seasonal counts were compared with indices of wetland availability around the periphery of Western Port [local swamp index from 0 (dry) to 3 (flooded) on the count day], the Murray/Darling Basin [annual Murray River flows (gigalitres) at Rufus River below the Murray/Darling confluence] and annual rainfall indices calculated for south-eastern Australia and the Murray/Darling Basin (Holmes & Briggs 1986).

Results

Of the 44 species of waders, terns and gulls that were recorded during the survey, 20 occurred regularly (Tables 1 and 2) and 24 were seen infrequently or in low numbers (Appendix 1). Eight species were recorded breeding in the area (Pied Oystercatcher *Haematopus longirostris*, Masked Lapwing *Vanellus miles*, Red-capped Plover *Charadrius ruficapillus*, Hooded Plover *Thinornis rubricollis*, Black-fronted Plover *Elseyornis melanops*, Silver Gull *Larus novaehollandiae*, Fairy Tern *Sterna nereis* and Caspian Tern *S. caspia*).

Distribution and habitat

Some sites were consistently favoured or avoided by each species during the ten-year period. The main patterns revealed in the first year remained constant, e.g. with Bar-tailed Godwit *Limosa lapponica* and Whimbrel *Numenius phaeopus* favouring the seaward southern part of the Bay, at least in summer, and Common Greenshank *Tringa nebularia* favouring the mangrove-lined northern shores. Some widespread species avoided particular sites, e.g. Pied Oystercatchers were rare at Bunyip River/Yallock Creek and Red-capped Plovers were rare at Barralliar Island.

Table 1

Annual mean counts of waders, gulls and terns in Western Port, 1973-83 (mean of 4 or 5 seasonal counts, covering 18 sites around the Bay).

		Year									
Species		*74*	*75*	*76*	*77*	*78*	*79*	*80*	*81*	*82*	*83*
Pied Oystercatcher	*Haematopus longirostris*	122	66	85	72	72	101	85	99	131	126
Pacific Golden Plover	*Pluvialis fulva*	9	24	21	37	16	27	26	35	26	14
Red-capped Plover	*Charadrius ruficapillus*	197	160	120	78	77	73	84	79	87	69
Double-banded Plover	*Charadrius bicinctus*	584	309	126	300	149	136	134	79	152	321
Masked Lapwing	*Vanellus miles*	323	232	314	258	222	373	291	250	254	309
Ruddy Turnstone	*Arenaria interpres*	17	41	49	74	43	46	50	49	43	52
Eastern Curlew	*Numenius madagascariensis*	535	725	706	852	643	660	386	426	486	491
Whimbrel	*Numenius phaeopus*	14	10	7	6	13	11	10	3	10	2
Grey-tailed Tattler	*Tringa brevipes*	35	36	32	33	27	8	10	10	13	9
Common Greenshank	*Tringa nebularia*	108	54	123	105	84	64	77	87	80	54
Bar-tailed Godwit	*Limosa lapponica*	123	152	123	118	161	132	122	147	194	118
Red Knot	*Calidris canutus*	10	14	24	17	0	5	9	10	29	23
Sharp-tailed Sandpiper	*Calidris acuminata*	58	156	116	64	58	88	150	159	60	274
Red-necked Stint	*Calidris ruficollis*	2282	3437	3694	2930	3073	2223	3289	1872	2668	2711
Curlew Sandpiper	*Calidris ferruginea*	1495	2675	2030	2610	1634	1980	2295	1597	1333	1705
Silver Gull	*Larus novaehollandiae*	3104	1973	2996	2405	2910	4592	2372	2099	2750	2016
Pacific Gull	*Larus pacificus*	328	285	323	275	247	277	272	157	141	62
Caspian Tern	*Sterna caspia*	10	8	13	17	21	14	20	19	19	12
Fairy Tern	*Sterna nereis*	8	16	14	5	14	7	8	33	15	15
Crested Tern	*Sterna bergii*	162	89	159	122	133	154	170	205	153	135

Note: Each year was defined as running from spring of the preceding year to winter of the year indicated, to avoid dividing population peaks of migratory species. Hence the column 76, for example, refers to the period spring 75 to winter 76. This differs from Part I (p. 333), where calendar years were used.

The most numerous waders (Red-necked Stint *Calidris ruficollis*, Curlew Sandpiper *C. ferruginea* and Eastern Curlew *Numenius madagascariensis*) were widespread, but consistently congregated in greater numbers at some sites than others. Three species (Pacific Golden Plover *Pluvialis fulva*, Ruddy Turnstone *Arenaria interpres* and Grey-tailed Tattler *Tringa brevipes*) often occurred together, roosting among rocks or nearby grass tussocks. Grey-tailed Tattlers continued to roost by perching on isolated stands of mangroves south of Barralliar Island until 1978, but numbers declined and the site was then abandoned. They were sometimes joined on the mangroves by other waders, especially Pacific Golden Plover and Terek Sandpiper *Tringa terek*.

Even the uncommon wader species were consistent in their choice of sites. A few Mongolian Plovers *Charadrius mongolus* regularly roosted at just two sites (Tortoise Head and Rams Island), sometimes accompanied by even fewer Large Sand Plovers *C. leschenaultii*. Hooded Plovers only occurred on the most seaward sandy beaches (Observation and Sandy Points, and others outside the survey area). Red-kneed Dotterel *Erythrogonys cinctus* and Black-fronted Plover occurred only at fresh water, occasionally including rainwater pools in saltmarsh (Red-kneed Dotterel) or behind mangroves (Black-fronted Plover).

The largest flocks of Silver Gulls occurred at coastal towns and fishing harbours where they fed on human refuse, especially from the rubbish tip at Hastings. They fed from mudflats mainly in summer after breeding. Silver Gulls declined at Hastings when the tip was closed in late 1979, and the new tip further inland was not included in the survey.

Pacific Gulls *Larus pacificus* also concentrated at towns including Hastings but flocks of up to 200 were found elsewhere, especially at Settlement Road in the early years of the survey. Pacific Gulls appeared to depend on intertidal habitats throughout the year, although they supplemented their diet with refuse and also foraged in pasture on the windiest days.

Crested Terns *Sterna bergii* roosted in flocks of hundreds mainly in the seaward southern part of the Bay, and Fairy Terns were commoner in the south (where they bred at Rams Island) than in the north. Caspian Terns were more common in the shallow northern part, where their main roost was on dredge spoil at Long Island. Single pairs bred at Rams Island in the south.

Among uncommon species, a few Gull-billed Terns *Sterna nilotica* were observed in spring, feeding over mudflats or making oblique dives into shallow water in the north and east of the Bay. Kelp Gulls *Larus dominicanus* were rarely observed away from the seaward entrance of the Bay near the Nobbies and Seal Rocks, outside the survey area.

Seasonal changes in distribution

Some Palearctic-breeding species made greater relative use of the northern parts of the Bay in winter than in summer; for example the wintering flock of Bar-tailed Godwits was often found at Stockyard Point or Bunyip River/Yallock Creek, whereas the larger summer flock was much more consistent in its use of roosts at Observation Point and Rams Island, with just a few birds being seen elsewhere. Only Whimbrel retained a constant distribution in relative numbers throughout the year, occurring mainly at Observation Point on Phillip Island (Dann 1993), with occasional records elsewhere.

Large variations in distribution were found for some species, e.g. Double-banded Plover *Charadrius bicinctus*. The greater part of the population was found at different

Black-fronted Plover *Elseyornis melanops*

Plate 65 Photo: G.A. Cumming

sites in different years and seasons, usually either at Bunyip/Yallock Creeks, Settlement Road and Stockyard Point in northern Western Port; or Reef Island, Observation Point, Tortoise Head and Rams Island in southern Western Port. In 1975, the population shifted from the northern roosts to the southern ones between autumn and winter, whereas in 1979 the opposite movement occurred between the same seasons.

Human disturbance

Disturbance influenced choice of roost sites in all species, particularly waders. Gulls and terns had various alternative roosting sites in the vicinity of the major roosts and moved to these when disturbed. The waders tended to fly around the major roosts when disturbed and, because their roosting requirements were more specific, if the disturbance continued eventually they moved up to 8 km to other major roosts. This occurred most often in spring and summer when recreational activity was greatest. It was noted at most sites, particularly at Observation Point, Sandy Point and Barralliar Island, especially when tidal levels were very high and few suitable roosting sites were available. Counts were made on weekends when recreational activity at these sites was relatively high. From Observation Point, the waders flew 8 km north to Rams Island when disturbed; from Barralliar Island, the birds moved 6 km south-west to Long Island Point; and from Sandy Point, they moved 2 km east to Tortoise Head.

Annual changes in numbers

Annual means (Table 1) were correlated with time for only three species (all negatively): Red-capped Plover (Figure 1), Grey-tailed Tattler (Figure 2) and Pacific

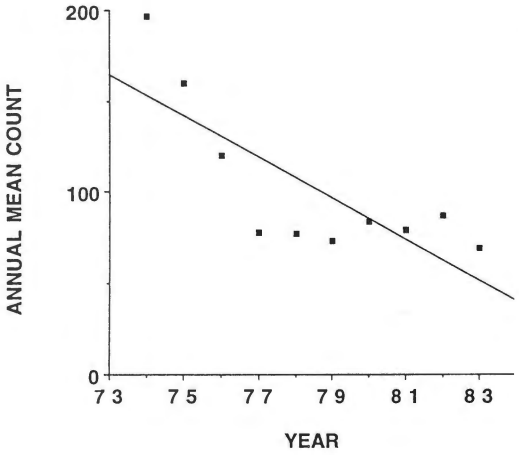

Figure 1.
The relationship between annual mean numbers of Red-capped Plovers 1973-83 and time ($r = 0.78$, $P<0.01$).

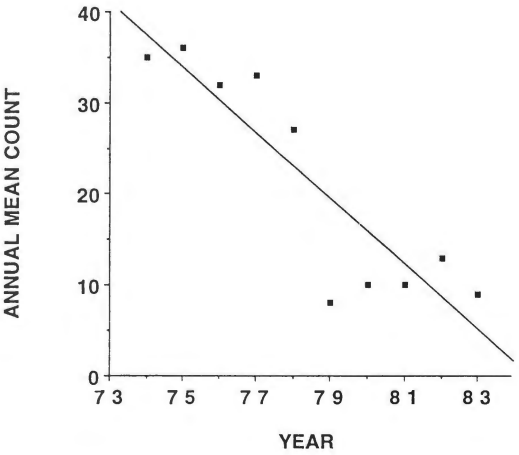

Figure 2.
The relationship between annual mean numbers of Grey-tailed Tattlers 1973-83 and time ($r = 0.89$, $P<0.01$).

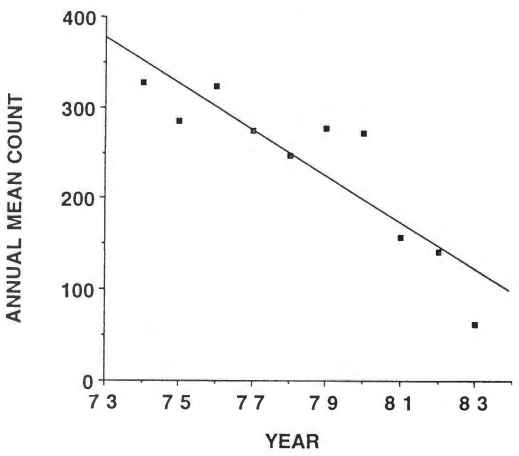

Figure 3.
The relationship between annual mean numbers of Pacific Gulls 1973-83 and time ($r = 0.89$, $P<0.01$).

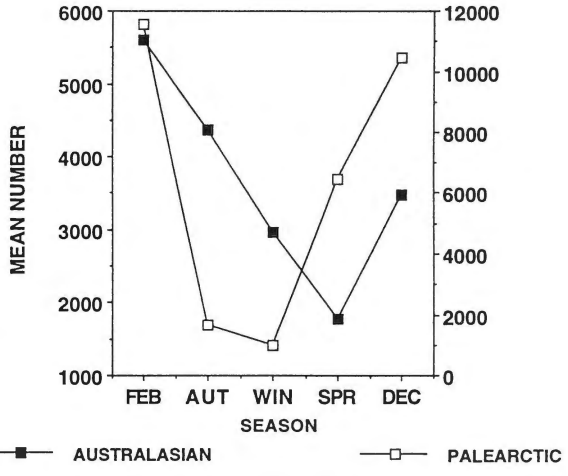

Figure 4. The seasonal patterns of abundance (total numbers) of Australasian and Palearctic waders in Western Port (1973-83).

Gull (Figure 3). In comparisons of the two halves of the survey, increases were significant for Pied Oystercatcher, Masked Lapwing and Caspian Tern, and decreases were significant for Double-banded and Red-capped Plovers, Eastern Curlew, Grey-tailed Tattler, Red-necked Stint, Curlew Sandpiper and Pacific Gull ($P < 0.05$).

The increases of Pied Oystercatcher and Masked Lapwing were especially evident between 1978 and 1979. Red-capped Plovers were more numerous in the first three years (to 1976) than subsequently, and Double-banded Plovers were particularly numerous in 1974, 1975 and 1977 and scarce in 1981. The main decline in Eastern Curlews was between 1979 and 1980, and of Grey-tailed Tattlers between 1978 and 1979. More complicated patterns of annual variation were shown by other species (Table 1).

Seasonal patterns of abundance

The seasonal patterns of Australasian and Palearctic species were different [also see Jones (1984a)]. Generally, the Australasian species were in low numbers in spring (Figure 4), when they were dispersed for breeding, and high numbers in late summer or autumn, when they fed on mudflats and congregated at high-tide roosts. Three species that moved further away from Western Port to breed, namely Double-banded Plover, Pacific Gull and Crested Tern, also showed a similar pattern. These latter species showed significant changes in seasonal pattern between years, possibly owing to small variations in the dates of the counts in relation to the timing of breeding and migration. One species (Fairy Tern) appeared to move into Western Port to breed at Rams Island, where high numbers were recorded in spring and summer only. This species was uncommon in the Bay at other times, and it is not known where the birds spent the winter.

The seasonal pattern for Palearctic species was a consistent one of low autumn and winter counts and high spring and summer counts (Figure 4, Table 2). The pattern was similar to that derived from 450 counts at Stockyard Point by Jones (1984a) during the same period.

Table 2

Seasonal mean counts of waders, gulls and terns in Western Port, 1973-83 (mean of 9 or 10 annual counts, covering 18 sites around the Bay).

	Season				
Species	*February*	*Autumn*	*Winter*	*Spring*	*December*
Pied Oystercatcher	105	126	119	70	50
Pacific Golden Plover	68	0	0	7	41
Red-capped Plover	74	113	130	88	80
Double-banded Plover	19	520	485	4	0
Masked Lapwing	520	385	207	79	188
Ruddy Turnstone	64	29	19	49	81
Eastern Curlew	991	139	198	848	823
Whimbrel	14	6	6	9	7
Grey-tailed Tattler	39	17	3	11	30
Common Greenshank	171	29	9	60	139
Bar-tailed Godwit	260	43	35	104	257
Red Knot	7	11	11	4	38
Sharp-tailed Sandpiper	231	5	1	66	271
Red-necked Stint	4402	929	633	3116	4862
Curlew Sandpiper	3332	465	80	2038	3795
Silver Gull	4543	3207	1437	1250	3126
Pacific Gull	209	250	409	189	101
Caspian Tern	15	9	10	21	22
Fairy Tern	10	4	2	22	30
Crested Tern	275	129	108	123	96

Correlations with wetland indices, tide height and number of counts

Many of the waterbirds considered previously (Loyn et al. 1994) were uncommon in Western Port when water was available further inland, but this did not apply to the 20 waders, gulls and terns considered here. Of the nine species that use inland habitats as well as the coast, only two negative correlations were found between Murray riverflows and counts on individual dates, for Masked Lapwing and Silver Gull (both species, $r = -0.37$, $P < 0.05$).

For Red-capped Plover, counts on individual dates and annual mean counts were both positively correlated with Murray riverflows in the current year ($r = 0.50$, $P < 0.001$; $r = 0.92$, $P < 0.001$). Annual mean counts were also correlated with Murray riverflows in the previous year ($r = 0.90$, $P < 0.001$).

The seasonal patterns of the 20 species considered here, especially the migratory waders, were so consistent that few indices explained much variation in individual counts. Correlations were found between the local swamp index and counts on individual dates of Curlew Sandpiper ($r = 0.27$, $P < 0.05$) and negatively for Masked Lapwing ($r = -0.33$, $P < 0.05$). Curlew Sandpipers used local swamps to continue feeding during high tide on some occasions when the swamps contained water, but did not disperse away from the Bay as they depended on mudflats at low tide. Masked Lapwings could have dispersed to wet pasture outside the survey area, and so were more concentrated in the survey area when the local swamps were dry.

Numbers of sites counted were correlated positively with counts of few species, confirming that the most important sites were covered consistently. The only exceptions were counts on individual dates for Ruddy Turnstone ($r = 0.27$, $P < 0.05$) and Pacific Gull ($r = 0.35$, $P < 0.05$).

Second-year Pacific Gull *Larus pacificus*

Plate 66 Photo: M.J. Carter

Annual mean counts of Red-necked Stint and Curlew Sandpiper correlated positively with all the rainfall indices from the previous year only (i. e. lagged by one year), most strongly with the index from southern Australia ($r = 0.93$, $P < 0.001$ for Red-necked Stint; $r = 0.83$, $P < 0.01$ for Curlew Sandpiper). This could suggest better survival of young birds over winter in inland habitats in years when many ephemeral swamps contained water.

Annual mean counts of Sharp-tailed Sandpiper were negatively correlated with rainfall indices from the current year for the Murray/Darling Basin ($r = -0.68$, $P < 0.05$) and from southern Australia ($r = -0.61$, $P < 0.05$), suggesting that more of these sandpipers visit Western Port in dry years than when ephemeral swamps are available inland.

Tide height on count days was negatively correlated with annual mean counts of Bar-tailed Godwit ($r = -0.65$, $P < 0.05$) and Pacific Golden Plover ($r = -0.60$, $P < 0.05$), suggesting that some of these birds moved to uncounted, unknown roosts when tides were particularly high. Tide height was positively correlated with annual mean counts of Silver Gulls ($r = 0.68$, $P < 0.05$), suggesting that these gulls were more concentrated in the survey area when the tides were particularly high.

Discussion

Seasonal changes in distribution

The local distributions of most waders, gulls and terns changed between seasons. Such local movements were presumably linked to changes in the availability of food. A marked seasonal change in abundance in benthic invertebrates has been shown to

occur in Western Port, with densities being significantly lower in summer than in winter (Watson et al. 1980). The reasons proposed for this were the accumulated effects of predation before annual recruitment, which occurs in late summer, or heat stress coincident with low tides during the day in summer. Seasonal changes in diet may occur as a result and cause seasonal shifts in distribution. It is also possible that local prey depletion by waders (Goss-Custard 1980, Zwarts & Drent 1981) may cause changes in feeding areas throughout the year.

Most fish species using intertidal areas in the Bay showed a marked seasonal pattern of abundance and biomass with peaks occurring in spring and autumn (Robertson 1978), which may explain the seasonal pattern of distribution of some piscivores. For example, the increase in numbers and breeding of Fairy Terns in spring and summer coincided with the main period of recruitment of the smaller size classes of fish whereas the disappearance of these terns in winter coincided with minimum fish numbers and biomass (Robertson 1978).

Studies in the United Kingdom have attributed seasonal changes in local distribution of waders to changes in the distribution and availability of food (Ferns 1981) or disturbance (Mitchell et al. 1988). We have observed that disturbance can influence the choice of particular roosts on particular days but have not observed long-term shifts in distribution as a consequence.

Annual changes in numbers

There are many possible causes for the reduced numbers of four Palearctic waders (Eastern Curlew, Grey-tailed Tattler, Red-necked Stint, Curlew Sandpiper), two Australasian waders (Double-banded and Red-capped Plovers) and Pacific Gull found during this study, including unknown processes operating during migration and in the breeding areas. However, there has been a major change in Western Port during this survey which was of a magnitude sufficient to cause large changes in numbers of birds feeding in intertidal areas. Between 1974 and 1984 the area covered by seagrasses in Western Port declined by about 70% (Bulthuis et al. 1984). Most of the secondary productivity of the intertidal system of Western Port is derived from the assimilation of detritus by invertebrates, with seagrass as the major source of primary production (Shapiro 1975). Changes in the amount of energy available to higher consumers would take place in two stages. Firstly there would be an increase in available energy caused by the increase in detrital material as the seagrass died, probably resulting in a period of higher secondary production. The second stage would be one of reduced primary and secondary production as the seagrass areas decrease. The higher numbers of some species at the beginning of the survey may have coincided with this first period of high secondary productivity and the subsequent decrease in numbers with the second period of declining productivity. The seagrass dieback was most severe in the inner northern and eastern parts of the Bay, and this may account for some of the observed changes in distribution of birds over the years. If the seagrass beds recover, population sizes may return to previous levels.

Australasian-breeding species

Increased breeding success or immigration from Port Phillip Bay were possible causes for the increase of Pied Oystercatchers, and movements of banded birds from Port Phillip Bay into Western Port were reported during this survey (P. Dann unpubl. data; C. D. T. Minton pers. comm.). Numbers of the South Island Pied Oystercatcher *Haematopus finschi* have increased enormously on the Manukau Harbour and Firth of Thames in New Zealand between 1940 and 1975 (Sibson 1966, Veitch 1978). The

South Island Pied Oystercatcher also breeds away from the coast and feeds in pasture (Falla et al. 1966); hence it may have been favoured by the agricultural practices of post-European settlement in New Zealand. This does not apply to the birds in Australia, where Pied Oystercatchers rarely feed in pastures or occur away from the coast.

The numbers of Red-capped and Double-banded Plovers declined during the survey. Red-capped Plovers disperse widely through inland areas (Lane 1987) and may also breed there in numbers (Hobbs 1972). The high numbers were recorded during the early wet years, when many inland waters would have been full, with little shoreline exposed. Red-capped Plovers inhabit broad flat lake shores including saltpans (Emison et al. 1987), and may have suffered a greater loss of inland habitat than other species during those years. Declining productivity in Western Port or favourable conditions inland could have resulted in a nett loss of birds in the Bay. Similar factors may have affected Double-banded Plovers, which sometimes feed in non-tidal areas around Western Port (Dann 1991). Although in general they do not feed far from the coast in south-eastern Australia, large numbers do use inland lakes in western Victoria (Appleby 1992). However, this species has a highly variable breeding success, largely caused by unpredictable climatic events in the breeding areas (R. Pierce pers. comm.). There have been no reports of corresponding increases in numbers in other parts of southern Australia, and the decrease in Western Port may be related to a series of relatively poor breeding seasons in New Zealand.

The annual means of Pacific Gulls decreased significantly with time, despite an increasing availability of food from human activity. This trend may reflect their dependance on intertidal feeding areas (in contrast with the more versatile Silver Gulls), and the corresponding effects of seagrass loss.

Palearctic-breeding species

The numbers of Grey-tailed Tattlers and Eastern Curlews fell sharply between 1978 and 1980. Declines in the number of Eastern Curlews in Western Port coincide with similar trends in Tasmania and South Australia (Close & Newman 1984). In a review of historical and recent information, these authors reported a drastic decline in South Australia and a gradual one in Tasmania. The two proposed causes of the decline were an alteration of the non-breeding range or a fall in total population. They believed the former proposal more probable and suggested human disturbance as a likely cause. Decreasing numbers in Western Port could be related to either of these factors or to the large reduction in seagrass there.

Red Knots *Calidris canutus* were uncommon (Table 1) and occurred erratically during the survey but, in contrast, Bar-tailed Godwits and Whimbrels showed remarkable consistency with no significant changes in mean counts or distribution between years. The numbers of Turnstone and Red Knot varied greatly between years and this may be a result of their dependence on breeding habitats in the northern strip of the Arctic coast where the greatest annual variations in climatic conditions occur for breeding Palearctic species. Consequently, an irregular pattern with large annual differences in adult survival and breeding success could be caused by highly variable weather on the breeding grounds. Alternatively, Western Port may be a marginal habitat for some of these species and numbers there reflect whether or not there is a surplus elsewhere.

Relationship with inland wetlands

The abundance of most of the waders, terns and gulls in Western Port appeared

unaffected by the condition of inland wetlands, unlike many of the waterfowl and larger waterbirds considered previously (Loyn et al. 1994). It is unlikely that the Bay serves as a major drought refuge for waders, and more likely that their movements are predominantly between coastal areas.

Acknowledgements

We express our thanks to the large number of dedicated and skillful observers who have contributed so much to this survey throughout the ten-year period and beyond. The Bird Observers Club of Australia has supported the project through the voluntary efforts of its members as counters and convenors and financially, for the processing of data (through the Australian Bird Environment Fund) and the hiring of boats.

The study was started as a project of the Ministry for Conservation, Victoria (now Department of Conservation & Natural Resources) as part of the Westernport Bay Environmental Study. We particularly thank Alan Chandler and family and the Department of Conservation, Forests & Lands (now Conservation & Natural Resources) for transport on French Island, and the Zoology Department, University of Melbourne, for the use of boats at various times. We also thank various landholders for access and co-operation.

Expert help in computing was generously provided by Graham Hepworth and Simon Bennett (CNR). The laborious job of data preparation and entry was carried out by Alison Livermore, Mollie Perkes and staff of the Victorian Government Computing Centre. Ian Norman (CNR), Valerie Curtis, Ren Millsom, Mike Carter, Kate Creed, Gerry Quinn and anonymous referees provided valuable comments on a draft.

The enthusiastic contributions of all these people and organisations are gratefully acknowledged.

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Received 10 May 1994

Appendix 1

Species which were recorded infrequently or in low numbers at the survey sites in Western Port between 1973 and 1983. Some of these species were relatively common in the vicinity but were usually found outside the area surveyed.

Sooty Oystercatcher *Haematopus fuliginosus*

One or two birds were seen at Tortoise Head on most counts with three there occasionally and five in September 1983. One or two were seen less regularly at Observation Point, Rams Island (or up to three on Bird Rock offshore from Rams Island), Long Island and Newhaven. Singles were seen occasionally at Stockyard and Bluegum Points and once each at Yallock Creek and Settlement Road. There were three at Sandy Point in December 1982 and at Reef Island there were five from July 1982 to April 1983 and two still there in September 1983. The largest total count was 11 in December 1982; more occur on the exposed southern and western shores of Phillip Island.

Black-winged Stilt *Himantopus himantopus*

Black-winged Stilts were encountered on five occasions between August and February; between one and eight birds were seen at five sites (Tortoise Head saltmarsh, Bunyip River saltmarsh, Bullock Swamp, Bluegum Point and near the San Remo Bridge). Stilts often bred in nearby freshwater marshes not covered by the count (e.g. Swan Lake).

Red-necked Avocet *Recurvirostra novaehollandiae*

One was seen at Yallock Creek in September 1974 and at Stockyard Point there were 28 in January 1979 and two in January 1983.

American Golden Plover *Pluvialis dominica*

One individual seen on 28 February 1976 at Barralliar Island was identified as being of the 'American race' of the Pacific Golden Plover (Doughty & Carter 1977). This race has been elevated to specific status (see Connors 1983) but this record has not yet been appraised for inclusion on the Australian list.

Grey Plover *Pluvialis squatarola*

Three counts of eight birds were made in the 1975-76 season (December to May) and no more than four were seen in other years, with most records coming in early summer (in contrast with the congeneric Pacific Golden Plover). Only four birds are known to have overwintered in the ten-year period (two in 1976, one in 1977 and one in 1979). The sightings of Grey Plover were usually at Tortoise Head, Barralliar Island, Bunyip/Yallock Creek or Stockyard Point.

Mongolian Plover *Charadrius mongolus*

Flocks were consistently at Tortoise Head (up to 18) and Rams Island (up to 20) in spring and summer, with fewer remaining into April or early May, and one was observed in winter (Rams Island, July 1981). Elsewhere a few were seen at Sandy Point/Hanns Inlet, Barralliar Island, Bunyip/Yallock Creeks and Stockyard Point, and singles at Observation and Bluegum Points.

Large Sand Plover *Charadrius leschenaultii*

Between one and four individuals were seen in the spring and summer counts of most years at Tortoise Head or Bunyip/Yallock Creeks. Birds were also seen occasionally at Rams Island and once at Bluegum Point (April 1982).

Black-fronted Plover *Elseyornis melanops*

Most Black-fronted Plovers (up to 30) were observed at Decoy and Bullock Swamps, two freshwater swamps in the north-west of French Island. Peak numbers occurred in autumn and winter and lowest numbers in late summer. Small numbers were seen at other freshwater swamps (e.g. Dwyers Road Swamp) and occasionally at rainwater pools in saltmarsh or behind mangroves.

Hooded Plover *Thinornis rubricollis*

Apart from one record of eight birds at Sandy Point in December 1975, Hooded Plovers were found usually in single pairs or with young at Sandy Point and Observation Point. More birds were encountered in spring and summer than in autumn or winter, and nesting was noted near Observation Point in most years. Sandy ocean beaches are the preferred habitat for this species and little suitable habitat exists elsewhere in the survey area; more Hooded Plovers occur on exposed southern and western coasts of Phillip Island.

Red-kneed Dotterel *Erythrogonys cinctus*

One was seen at Heifer Swamp in February 1978 and between one and four at Decoy/Bullock Swamps in the autumns of 1975 and 1978. One was seen at a freshwater pool in saltmarsh on the north of French Island, August 1979.

Banded Lapwing *Vanellus tricolor*

Six were seen at a dam near the mouth of the Bunyip River in December 1974. Sometimes seen in low numbers in pasture outside the survey area, mainly on Phillip Island.

Common Sandpiper *Tringa hypoleucos*

Common Sandpipers were regular visitors from spring to autumn in numbers not exceeding 11. They fed along land-backed muddy channel banks and roosted at inconspicuous sites away from major wader roosts. Hence many were overlooked. They often roosted on jetties, marinas or seawalls, or on posts or tree stumps surrounded by water. The only winter record was of one at Hastings in July 1974; singles at Warneet in August 1979 and 1981 were probably early migrants.

Terek Sandpiper *Tringa terek*

Terek Sandpipers were regularly seen in small numbers (up to ten in summer and autumn, and up to four staying over winter into spring). Most were in the northern part of the Bay, with up to eight at Barralliar Island (mainly 1974-78), up to ten at Bunyip/Yallock Creeks (some in most years) and up to six at Settlement Road (1974-76 only). Records from these three sites constituted 87% of the 158 bird-days (n birds X n days) recorded. Other records came from Rams Island (up to four on four occasions 1976-82), Stockyard Point (one or two on four counts 1977-82), Bluegum Point (one or two on three counts 1980-82) and Long Island (one on three counts 1978-80). Additional records were made during frequent observations at Stockyard Point (Jones 1984a).

Latham's Snipe *Gallinago hardwickii*

This species was most commonly seen from August to November, with fewer recorded during summer. Small numbers of Snipe frequented vegetated marshes and heaths and were found incidentally to the main survey, mainly at Tortoise Head saltmarsh, Heifer Swamp and a freshwater marsh near Long Island. More surprisingly, two were flushed from the floor of scrubby forest at Corinella on 20 November 1977.

Black-tailed Godwit *Limosa limosa*

This species was recorded ten times, mostly as single birds with the Bar-tailed Godwits at Observation Point (February 1974, March 1974 — two birds, March 1975, July 1976, January 1977, May 1978 and January 1983—two birds). Also singles at Rams Island in January 1974, with the same flock of Bar-tailed Godwits, Barralliar Island in February 1974 and Tortoise Head in December 1976.

Great Knot *Calidris tenuirostris*

Single birds were seen at Barralliar Island (January 1974), Observation Point (September 1974), Long Reef north of Barralliar Island (October 1976) and Tortoise Head (September 1983). Three were seen at Rams Island in October 1974 and two at Bunyip/Yallock Creeks in November 1974.

Sanderling *Calidris alba*

One was seen at Stockyard Point in September 1974 and two at Reef Island in May 1976. During October 1976, four were seen at Observation Point and one three weeks later at Stockyard Point.

Oriental Pratincole *Glareola maldivarum*

One was seen at Yallock Creek on 19 January 1974 (Loyn 1978).

Kelp Gull *Larus dominicanus*

Single birds were seen at Observation Point (March 1975) and Churchill Island (April 1976 and June 1977). A few pairs breed at Seal Rocks (at the western entrance of the Bay) and the species is often seen nearby, e.g. at Swan Lake.

Whiskered Tern *Chlidonias hybrida*

Five birds were recorded at Stockyard Point in December 1978 and singles were seen at Dwyers Road Swamp (October 1975) and Yallock Creek (April 1974 and October 1982, the latter in saltmarsh).

White-winged Tern *Chlidonias leucoptera*

One individual was seen at Barralliar Island in December 1974.

Gull-billed Tern *Sterna nilotica*

Singles were seen at Stockyard Point (November 1975, October 1977 and February 1981) and Red Bluff Creek (October 1982). Four were at Yallock Creek in October 1976 and five were there in March 1975.

White-fronted Tern *Sterna striata*

Between one and four birds were seen on four occasions in winter 1974 in the vicinity of Tortoise Head and Sandy Point. This species is regularly seen at sea near the Bay's western entrance.

Little Tern *Sterna albifrons*

One was seen at Barralliar Island in May 1975 and one at Long Reef (north of Barralliar Island) in October 1976. Nine small terns possibly of this species were seen flying from Rams Island and past Reef Island in July 1975.

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