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THE DISTRIBUTION AND ABUNDANCE OF PALEARCTIC AND AUSTRALASIAN WADERS *(Charadrii)* IN COASTAL VICTORIA

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A survey of the distribution and numbers of waders in coastal Victoria was carried out in December, 1979. Of the 88 246 waders recorded, 97 per cent were of Palearctic origin and 3 per cent Australasian. The survey concentrated on bays, mudflats and estuaries where most Palearctic migrants are found. Relatively few Australasian waders were encountered as most were dispersed for breeding at this time. Three species of calidridine wader made up 85 per cent of the total number. The most numerous species was the Red-necked Stint which comprised 52 per cent of the total. The majority of the Palearctic (84%) and Australasian (70%) waders were found in Port Phillip Bay, Corner Inlet and Western Port. Generally the areas with the highest numbers also had higher species diversity. The total abundance of Palearctic waders was positively correlated with the estimated area of intertidal and shallow freshwater wetland in each region if one highly-eutrophic area (Werribee Sewerage Farm, Western side of Port Phillip Bay) was excluded from the data. The numbers of only one species, the Eastern Curlew, were correlated with wetland area.

INTRODUCTION

Although the Victorian Coast comprises only 3 per cent of the coastline of Australia, it contains wader habitat of national and international significance (Lane. 1987). Increasing industrial and recreational uses of coastal areas are causing the modification and destruction of these habitats. Large-scale surveys of waders are necessary to establish the relative importance of each area so that priorities for their reservation and appropriate management policies can be established. Regular counts of waders have been carried out in a number of areas in coastal Victoria (Wheeler 1955; Lovn 1975; Corrick and Norman 1980; Corrick 1981; Jones 1984; Lane 1987). Although these surveys provide much information about wader populations at particular sites, it is not possible to assess the relative importance of each area in Victoria without complete surveys of wader habitats along the coast.

In this paper, the results are presented of the first survey of the distribution and numbers of waders along the coast of Victoria conducted in December 1979. Subsequent surveys of the same regions have been conducted as part of the RAOU Wader Studies Program (Martindale 1981; Lane 1987) but the results of this first count have not been published in full.

METHODS

Most of the areas were visited on the weekend of 1–2 December, 1979. As the weather conditions were unsuitable for travelling in small boats on 2 December, the waders at several sites had to be counted up to three weeks later. The ninety observers assisting in the count were competent in the identification of wader species and many had experience of estimating the number of waders at high-tide roosts in Western Port.

The birds were counted at roosting sites when concentrated there at high tide. Preliminary surveys in Corner Inlet (including Shoal Inlet), Gippsland Lakes and Shallow Inlet were made to determine the locations of the roosting sites as most were unknown. All the roosts in Corner Inlet and Anderson's Inlet were counted from boats. The inclement weather during the count period resulted in a poor coverage of Shallow Inlet and few waders were seen there. However, a flock of one thousand unidentified waders was recorded and those birds were included in the totals. Small areas were counted by small groups of observers during the same high-tide.

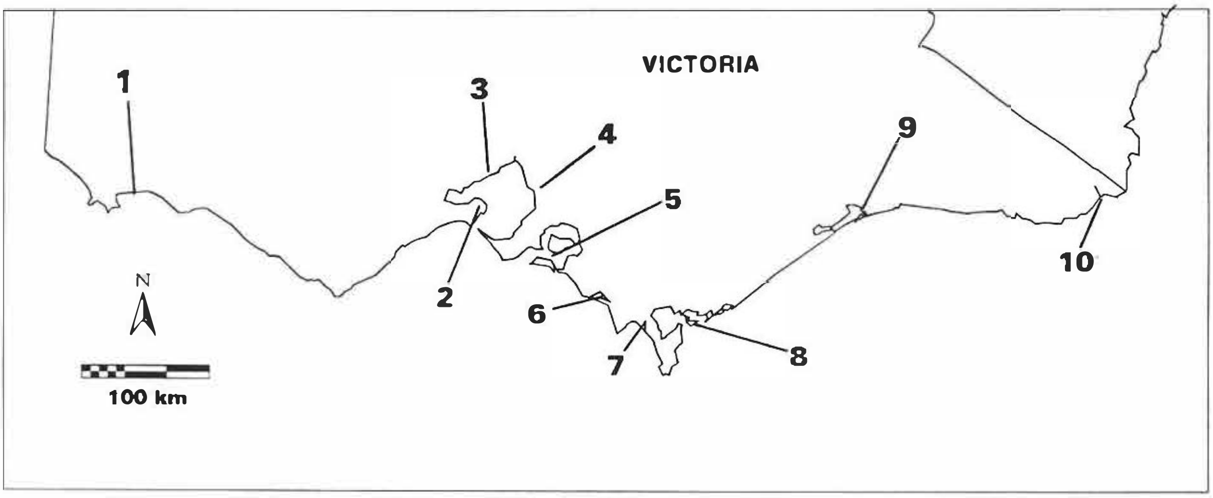

Figure 1. *The locations of the main areas covered in this survey. The numbers represent the following regions:* 1. *South-western Coast,* 2. *Bellarine Peninsula — Port Phillip Bay,* 3. *Western Side — Port Phillip Bay,* 4. *Eastern Side — Port Phillip Bay,* 5. *Western Port,* 6. *Andersons Inlet,* 7. *Shallow Inlet,* 8. *Corner Inlet — including Shoal Inlet,* 9. *Gippsland Lakes,* 10. *East Gippsland. The specific sites counted in each area are given in the text. The estimated areas of wetland available at the time of the survey are given in Table 3.*

Most (at least 90%) of the significant wetlands in coastal Victoria were included in the census. Shallow Inlet was the only significant area not well covered. The major areas surveyed are shown in Figure 1 and contained the following sites:

1. **South-western Coast**. Portland Bay, Little River to Port Fairy (including Griffiths Island, Port Fairy to Tower Hill.

2. **Bellarine Peninsula, Port Phillip Bay**. Point Henry (Geelong Saltworks), Point Richards, St Leonards, Edwards Point to Queenscliff, including Swan Island; Point Lonsdale, Lakes Murtnagurt and Connewarre, Freshwater, Reedy and Victoria Lakes and Mud Islands.

3. **Western Side, Port Phillip Bay**. Avalon Saltworks, Werribee Sewerage Farm and The Spit State Nature Reserve, Laverton Saltworks.

4. **Eastern Side, Port Phillip Bay**. Edithvale, Carrum and Seaford Swamps.

5. **Western Port**. Sandy Point, Yaringa, Tooradin, Yallock Creek, Bunyip River, Settlement Road, Stockyard Point, G.M.H. Drain, Grantville, Reef Island, Rhyll Inlet (Phillip Island), Tortoise Head, Bluegum Point and Rams and Barralliar Islands (French Island).

6. **Andersons Inlet**. Mahers Landing, Townsend Bluff, Masons Road, Pound Creek, Islands at the mouth of the Tarwin River and Point Smythe.

7. **Shallow Inlet**. Sandy Point, Cotters Beach and two unnamed sites along the northern and western shores.

8. **Corner Inlet — including Shoal Inlet**. Mangrove Island, Duck Point, Franklin Island, Toora Beach, Bullock Island, various parts of Snake and Little Snake Islands, Sunday Island, Clonmel Island, Box Bank, Drum Island, Clonmel Banks and St Margaret Island. In addition, 12 unnamed sites were covered.

9. **Gippsland Lakes**. Lake Reeve, Golden Beach, Seaspray, Point Wilson, Lakes Coleman and Guthridge, Lake Tyers Beach, Ewings Marsh, Lakes Entrance, Crescent and Barton Islands.

10. **East Gippsland**. Tamboon, Wingan and Sydenham Inlets, Thurra River, Goodwin Sands, Develings Inlet (Mallacoota Inlet) and Lake Wat Wat.

The diversity of waders at each site was expressed as the Shannon-Weaver Index (H') which is $-\Sigma(p \ln p)$ where p is the proportion of the total population contributed by each species in turn (Shannon and Weaver 1949).

The areas of intertidal and shallow freshwater wetlands in each section of the coast were estimated from topographical maps and aerial photographs, if published estimates were unavailable. Observations by counters of water levels were also used in determining the approximate areas of shallow freshwater wetlands at the time of the survey.

TABLE 1

The numbers of Palearctic and Australasian waders counted in each region of the Victorian Coast during the survey. The numbers of the regions are as follows: 1. South-western Coast, 2. Bellarine Peninsula — Port Phillip Bay, 3. Western Side — Port Phillip Bay, 4. Eastern Side — Port Phillip Bay, 5. Western Port, 6. Andersons Inlet, 7. Shallow Inlet, 8. Corner Inlet — including Shoal Inlet, 9. Gippsland Lakes, 10. East Gippsland.

	1	2	3	4	5	6	7	8	9	10	Total
Palearctic waders	953	12 260	28 855	3 240	9 897	5 394	1 254	20 265	3 070	45	85 233
%	1.1	14.4	33.8	3.8	11.6	6.3	1.5	23.8	3.6	0.1	
Australasian waders	181	680	586	429	461	24	34	381	155	82	3 013
%	6	22.6	19.5	14.2	15.3	0.8	1.1	12.7	5.1	2.7	
Total	1 134	12 940	29 441	3 669	10 358	5 418	1 288	20 646	3 225	127	88 246
%	1.3	14.7	33.4	4.2	11.7	6.1	1.5	23.4	3.7	0.1	

TABLE 2

The numbers of wader species recorded in each region of coastal Victoria during the survey. The numbers of the regions are as follows: 1. South-western Coast, 2. Bellarine Peninsula — Port Phillip Bay, 3. Western Side — Port Phillip Bay, 4. Eastern Side — Port Phillip Bay, 5. Western Port, 6. Andersons Inlet, 7. Shallow Inlet, 8. Corner Inlet — including Shoal Inlet, 9. Gippsland Lakes, 10. East Gippsland.

Species	1	2	3	4	5	6	7	8	9	10	Total
Pied Oystercatcher	24	34	20		69	1	2	311	11	29	501
Sooty Oystercatcher	3	7			2			28			40
Masked Lapwing	26	194	108	170	338	15		11	65	8	935
Grey Plover		111	13					25			149
Lesser Golden Plover	77	12	19		28	50	25	53		3	267
Red-kneed Dotterel		9	51	14					1		75
Hooded Plover	35				4		9		2	12	62
Mongolian Plover		29			1			80			110
Double-banded Plover		4			2					18	24
Large Sand Plover										1	1
Red-capped Plover	84	152	130	35	44	8	23	31	72	11	590
Black-fronted Plover	3	3							4	4	14
Black-winged Stilt	6	196	134	210	2						548
Banded Stilt		1	25								26
Red-necked Avocet		80	118								198
Ruddy Turnstone	196	85	40		72			8	3		404
Eastern Curlew		210	26		652	12	26	1 170		4	2 100
Whimbrel					5			3			8
Wood Sandpiper				2							2
Grey-tailed Tattler	2	38	5		22			21			88
Common Sandpiper	5		2	1							8
Greenshank	3	196	108		180	2		42			531
Marsh Sandpiper			13								13
Terek Sandpiper					1						1
Latham's Snipe	40	14		116					1		171
Black-tailed Godwit		9	2					10			21
Bar-tailed Godwit	1	352	12		229			5 500	5		6 099
Red Knot		124	85		34			1 560	30	1	1 834
Great Knot		18						30			48
Sharp-tailed Sandpiper	140	3 255	6 364	3 000	293	30		111	401		13 594
Red-necked Stint	463	6 808	13 188	106	4 800	5 000	202	10 250	2 620	36	43 473
Curlew Sandpiper	9	999	8 978	15	3 580	300	1	1 102	10		14 994
Sanderling	17							300			317
Unidentified							1 000				1 000
Total	1 134	12 940	29 441	3 669	10 357	5 418	1 288	20 646	3 225	127	88 246

RESULTS

The total number of waders counted in coastal Victoria was 88 246, consisting of 85 233 (96.6%) Palearctic migrants and 3 013 (3.4%) Australasian waders. The numbers and percentages of the two categories of waders in each of the 10 regions of coastal Victoria are given in Table 1. The majority of the Palearctic waders (84%) and Australasian waders (70%) were found in four of the 10 regions surveyed. These were: Bellarine Peninsula, Western Side of Port Phillip Bay, Western Port and Corner Inlet (Table 1).

Of the 33 species recorded in this survey, 22 were of Palearctic origin and 11 were Australasian. The number of each species of Palearctic and Australasian wader counted in each region is shown in Table 2. The most numerous species observed was the Red-necked Stint *Calidris ruficollis* (52.0% of the Palearctic waders) followed by the Curlew Sandpiper *Calidris ferruginea* (17.6%) and the Sharp-tailed Sandpiper *Calidris acuminata* (15.9%) (Table 2). The three calidridine sandpipers made up 84.5 per cent of the total number of Palearctic waders. Of the Australasian waders, the most numerous was the Masked Lapwing *Vanellus miles* (31.3% of the Australasian waders and 1.1% of the grand total) followed by the Red-capped Plover *Charadrius ruficapillus* (19.7% of the Australasian waders), Black-winged Stilt *Himantopus himantopus* (18.3%) and Pied Oystercatcher *Haematopus longirostris* (16.8%).

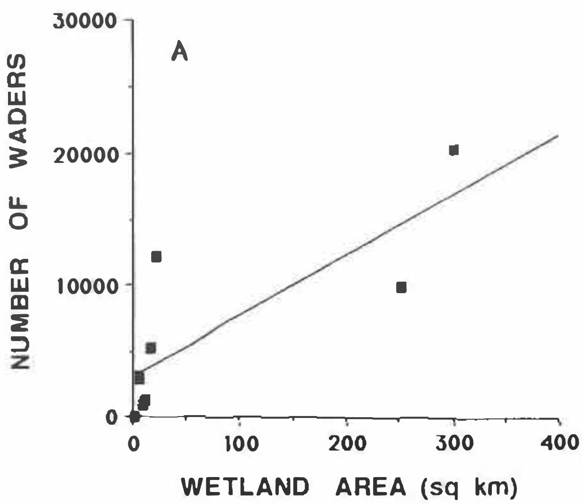

Figure 2. *The relationship between the total numbers of Palearctic waders and the areas of intertidal and adjoining shallow freshwater wetland in each region ($r = 0.81$, d.f. 6, $p < 0.05$). A = western side of Port Phillip Bay which was not included in the regression (see results for explanation).*

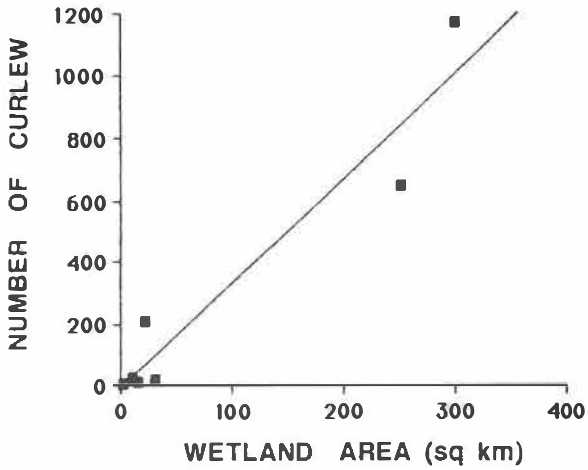

Figure 3. *The relationship between the numbers of Eastern Curlew and the areas of intertidal and adjoining shallow freshwater wetland in each region ($r = 0.96$, d.f. 6, $p < 0.01$).*

There was not a significant correlation between the area of intertidal/shallow freshwater wetland in each section (Table 3) and the number of Palearctic waders counted in that part of the coast (d.f. 9, $r = 0.45$, $p > 0.05$; Fig. 2), if all regions were included. However, when the data from the Western side of Port Phillip Bay (an extreme point) were excluded, the relationship of wetland area to number of waders was significant ($y = 3\,113.7 + 45.7x$); where y was the number of waders and x was the wetland area; $r = 0.81$, d.f. 9, $p < 0.05$; Fig. 3). The reasons why the Western side of Port Phillip Bay could be considered unusual and excluded from the data set are given in the discussion.

The relationship between the number of each species in a region and the estimated area of wetland in that region was investigated for each Palearctic species, and only one, the Eastern Curlew *Numenius madagascariensis*, showed a significant correlation ($r = 0.96$, d.f. 6, $p < 0.05$; Fig. 3).

The diversity of Palearctic species varied between areas and the four more important areas in terms of numbers of birds also had higher

TABLE 3

The species diversity (Shannon-Weaver index) of Palearctic waders and the estimated area of intertidal and shallow freshwater wetland in each section of the Victorian Coast at the time it was covered by the survey in December 1979.

Region	Species Diversity Index	Wetland Area (sq km)*
South-western Coast	1.69	8
Port Phillip Bay		
— Bellarine Peninsula	1.30	22
— Western side	1.13	30
— Eastern side	0.33	4
Western Port	1.25	251[1]
Anderson's Inlet	0.32	16
Shallow Inlet	0.71	11
Corner Inlet	1.39	300[2]
Gippsland Lakes	0.51	6
East Gippsland	0.74	2

*Sources of estimates: [1]Shapiro (1975); [2]Martindale (1982); others from estimates from maps and aerial photographs.

species diversity (Table 3). The exception was the South-western Coast which had the highest species diversity, despite accounting for only 1.3 per cent of the total number of waders. The diversity of Palearctic waders for each section of the coast was compared to the wetland area of the particular section but there appeared to be no relation between the two parameters ($r = 0.45$, d.f. 9, n.s.).

DISCUSSION

Survey Methods

The timing of this count was determined initially to coincide with the collection of data by two regular counts of smaller areas. However, it became clear during this count that there were some advantages in changing the summer count from December to early February when counting of waders is less likely to be influenced by movement. The commoner Palearctic waders are completing moult or putting on fat in February (Thomas and Dartnall 1971; Paton and Wykes 1978). Also, in February, the amount of temporary habitat for waders is likely to have diminished as shallow wetlands dry up. The waders of inland and coastal regions would be more aggregated, thus allowing better coverage of the populations as fewer wetlands would have to be counted. Subsequent counts have been shifted to February and extended to cover sites in inland Victoria (Martindale 1981; Lane 1987).

It was realized that the data gathered by counts of this kind would be improved by repetition. For example, a mid-winter count on a similar scale would provide data on non-breeding populations of Palearctic waders and population estimates of those Australasian waders which flock along the coast in winter, e.g. oystercatchers. Such counts have been conducted consequently as part of a national study (Martindale 1981; Lane 1987).

Local knowledge of wader sites is of paramount importance and the accuracy and coverage of counts can be enhanced if observers are encouraged to become familiar with particular areas. Subsequent regular counts of Shallow Inlet in 1983–84 (Jones 1984) found between 5 000 and 16 000 waders there in Spring and Summer suggesting that the coverage during this survey was incomplete undoubtedly due to inclement weather and the overlooking of important roosts not known at the time.

Abundance

The total count for coastal Victoria in the following summer, in February 1980, was higher (120 856) than for this survey but the proportions of the totals in each region were similar between the two years (Martindale, 1981). This suggests that the difference was due to a higher productivity and/or survival of waders from the previous breeding season, and perhaps a greater concentration of birds in coastal areas, rather than any difference in coverage of sites. The mean number of waders in coastal Victoria in summer between 1981 and 1985 was 114 349 (the sum of regions 1–8 from Table 7.1 in Lane 1987). Again the proportions remained similar for Palearctic species but disproportionately higher numbers of Australasian species were recorded in some areas, possibly indicating greater concentrations of birds later in the season or reflecting differences in the availability of shallow freshwater wetlands between years.

Waders from the Palearctic comprised the main element of the summer count in 1979 in both species composition (67%) and numbers (97%). The abundance of the three species of calidridine wader in the survey indicates that coastal Victoria is an important non-breeding habitat for these species but this cannot be quantified fully until the sizes of their world populations are known. The numbers recorded for some of the less common species, which may have relatively small world populations (e.g. Eastern Curlew), suggest that Victoria may be a non-breeding area of importance. Even a substantial part of the total population of these less numerous species would not contribute significantly to the figures for the overall abundance of waders in Victoria. The relative abundance of the three calidridine waders and the concentration of 84 per cent of the Palearctic waders in four main regions within the State (Table 1) indicate priorities for future research on these commoner species and the declaration of wildlife reserves in these areas.

There were significant correlations between the estimated size of wetlands and the number of Palearctic waders only if the area where the densest concentration occurred (Western side of Port Phillip Bay) was removed from the data. Most of the wader feeding areas of the western side of Port Phillip Bay are on or adjacent to the Werribee Sewage Farm. The treated effluent from the farm results in increased microalgal productivity and very high densities of benthic macrofauna (Axelrad *et al.* 1979; Dorsey 1982). Consequently the densities of feeding waders are many times greater in intertidal areas at Werribee than in Western Port (Dann, unpubl. data). Due to the eutrophication of the Werribee area, it appears valid to treat the Western side of Port Phillip Bay separately; and its removal from the data set provides a significant relationship between wetland area and total number of waders.

The relationship between the total number of Palearctic waders and the size of the wetland suggests that the available food supply in each region was roughly proportional to the size of intertidal/shallow freshwater wetlands. However, with the exception of Eastern Curlews, the numbers of individual species did not occur in direct proportion to the estimated wetland area in each region. By contrast, a similar comparison of counts from 23 estuaries in eastern England showed highly significant positive correlations with estuary size for all species except Black-tailed Godwit (Prater 1981). Densities of waders on their non-breeding grounds have been related to prey densities in different areas (Goss-Custard, Kay and Blindell 1977; Wolff 1969). However Evans and Dugan (1984) caution against the extrapolation of such relationships to larger scales, due to geographic differences in the influences of tide and weather on the availability of prey.

In addition to tide and weather variations, a relatively high degree of habitat specificity or a great diversity of intertidal habitats in each area may be responsible also for the lack of significant correlations between numbers of each species and size of the wetlands. In each case the relationship between numbers and area could be hidden by the geographical scale of the survey and would require greater resolution through the measurement of the size of actual feeding areas, for significant correlations to be realized. There appears to be no information in support of greater habitat specificity of waders in Victoria. The greater diversity of intertidal habitats in the Victorian survey areas, as a cause of the lack of correlation, has some credence through the wider range of intertidal habitats and much greater diversity of intertidal invertebrates found there than in the English estuaries, where significant correlations have been found (pers. obs.). Whereas most of the English surveys involved estuaries (Prater 1981), this survey included bays, inlets, estuaries and shallow freshwater marshes. The larger bays and inlets in Victoria in this study may not have proportionally greater amounts of the feeding areas for particular species. In comparisons of total numbers, the effect of areas having proportionally less of a particular habitat and hence less of a particular species is compensated by another species being more abundant due to the same area having proportionally more of another habitat. The result is a significant positive correlation between total number of waders and the area of wetland. The implication of this explanation for the correlation of the numbers of Eastern Curlews with the area of wetland available is that their feeding areas are distributed (and used by the birds) in direct proportion to the size of the wetland. It was not possible to examine this further in the study.

Species Diversity

The diversity of wader species in Victoria was generally higher in those areas where most waders were found. Since some wader species have different habitat requirements in the non-breeding period, it appears likely that higher diversity is a reflection of greater diversity of habitats, although measurement of this was not attempted. This would seem to be so in the South-western Coast region where the greatest species diversity was recorded. In this region most of the coastal habitats found in Victoria are represented (pers. obs.). Any considerations of the future conservation of waders in Victoria should give high priority to those areas with greater diversity in addition to those areas with greater abundance of waders.

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