Effects of a cyclone on waterbird populations at the Pichavaram mangroves, southern India

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A severe cyclone hit the Coramandal coast of Tamilnadu, southern India on 4 December 1993. The impact of this cyclone on the waterbird populations of Pichavaram mangrove forests was studied. Waterbird numbers and species richness and species diversity in 1994 were compared with census data collected in 1993 and 1995 census i.e. before and after the cyclone event. The waterbird population in the area was 4,883 in January 1993, 3,060 in January 1994 and 5,091 in January 1995. The species richness and species diversity during 1994 was also lower than in the other two years. Although the species richness and species diversity of these mangroves returned to normal after the cyclone, continuous monitoring of the bird populations in this area is needed for a few more years before arriving at a definite conclusion.

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INTRODUCTION

Natural calamities such as floods, forest fires and earthquakes are known to result in bird mortality (Roberts 1932; Alexander 1948; Smith & Webster 1955; Merrill 1961; Stout & Cornwell 1976; Higgins & Johnson 1978; Johnson 1979; Welty 1982; D'Cunha & Akhtar 1987; Rammanohar & Rajasekaran 1989). This paper describes the effects of the cyclone of 4 December 1993 on waterbird populations at the Pichavaram mangroves, southern India.

Location of the Pichavaram mangroves

The Pichavaram mangroves (11°25'N; 74°47'E) are situated about 190 km south of Madras at the mouth of the Vellar, Coleroon and Uppanar rivers on the south east coast, known as the Coramandal coast (Bay of Bengal), of India (Figure 1). They are the only large area of mangroves, covering an area of 11,000 ha, with 51 islets separated by a complex network of creeks and channels (Figure 1). As Figure 1 shows, interspersed in this forest area, there are many types of wetland habitats such as swamps, marshy areas, estuaries, intertidal mudflats and open waters (Wolstencroft *et al.* 1989), offering a wide variety of roosting and nesting places and foraging grounds for several migratory and resident bird species (Nagarajan & Thiyagesan 1996). The adjacent croplands and abandoned fields also act as potential foraging grounds attracting these birds species (Nagarajan & Thiyagesan 1994).

Description of the cyclone

A severe cyclone hit the Coramandal coast of India on 4 December 1993 causing unprecedented devastation. A portion of Coramandal coast suffered the impact of the cyclone that crossed the shore between Nagapattinam (10°46'N; 79°53'E) and Cuddalore (11°43'N; 79°53'E). The cyclone was accompanied by a torrential downpour and winds of up to 70 km/hr, and it continued from 0300 to 1145. Huge storm-waves were generated by the cyclone which caused major structural damage to the Pichavaram mangroves. The brackish waves and 150mm of rain inundated several coastal areas and the nearby agricultural lands and settlements for three days.

Waterbird numbers before and after the cyclone

It was observed and reported by the nearby villagers that many birds at the Pichavaram mangroves died because of the cyclone, as many plants were uprooted and/or their branches and canopy severely damaged. Furthermore, the strong gale created panic and confusion among the birds and they were dashed against the trees and/or adjoining buildings, as they were unable to control their flight. As a result the birds died instantly or were badly injured, fell into the floods and became unable to escape, or were caught by nomadic people and villagers. Some birds were totally emaciated and died because of exhaustion, fatigue and starvation.

In order to assess the impacts of the cyclone on the waterbirds of the Pichavram mangroves, waterbird counts were made a month after the cyclone, in January 1994. They were carried out using 7x50 field binoculars either from a boat or by walking along the edges of the wetlands. The data collected were compared with census data from 1993 and 1995 for the same area, which we collected as part of the Asian Midwinter Waterbird Census. Species richness was measured as the number of waterbird species recorded during the census (Verner 1985). Species diversity was calculated using the Shannon-Wiener index (Shannon & Wiener 1949).

$$H' = -\sum_{i=1}^{s} (p_i)(\log_2 p_i)$$

s = number of species
p_i = proportion of individuals of a given species

The differences in the waterbird population and species composition between the years were analysed by the General Linear Model using the statistical program MINITAB (Ryan *et al.* 1992) and a planned comparison test was done to compare the mean population of the cyclone year with other years.

Table 1 shows the three years' census data grouped by species i.e. herons & egrets; storks; shorebirds; and gulls & terns. The estimated total waterbird population in the area was 4,883 in January 1993, 3,060 in January 1994 and 5,091 in January 1995. The waterbird species richness was 26 in January 1993, 24 in January 1994 and 29 during January 1995. Waterbird species diversity (H') was 2.23, 2.02 and 2.38 during January 1993, 1994 and 1995 respectively (Table 1). There were significant variations in the waterbird population between years (General linear model $F=9.89$, $P<0.001$) and species (General linear model $F=69.91$, $P<0.001$). The mean waterbird population in the year of the cyclone i.e. January 1994 was significantly lower than the other two years ($F=19.60$, $P<0.001$; Planned comparison).

DISCUSSION

Compared to 1993 and 1995 the populations of all bird species and groups were lower during January 1994 i.e. after the cyclone (Table 1). This may be due to large scale mortality of birds (Nagarajan & Thiyagesan 1995) caused by the cyclone and/or by movement of birds to other areas to escape from the cyclone. Avian mortality and other effects of extreme weather conditions have been widely reported and are summarised in Table 2.

Since high flood waters commonly result in the loss of eggs and young of waterbirds (Welty 1982) and the cyclone and its associated flooding occurred during the breeding season of Black-crowned Night Heron *Nycticorax nycticorax*, Pond Heron *Ardea grayii*, Grey Heron *Ardea cinerea*, Little Egret *Egretta garzetta*, Cattle Egret *Bubulcus ibis*, Painted Stork *Mycteria leucocephala*, Asian Open-billed Stork *Anastomus oscitans* and Black-headed Ibis *Threskiomis melanocephalus*, it might also have caused severe damage to their nests, eggs and young.

The Pichavaram mangroves are an important wintering area for many migratory birds whose annual peak occurrence is usually during November to January (Sampath & Krishinamurthy, 1990, 1992; Nagarajan & Thiyagesan 1994, 1996). Thus, it was feared that since the cyclone occurred during that period it might also have had significant effects on the avian migration patterns on this peninsula (Nagarajan & Thiyagesan 1995).

However, the birds seemed to have recovered from this event, as the species richness and species diversity as well as the number of waterbirds visiting these mangrove returned to normal or even higher values during 1995. However, continuous monitoring of the bird populations in this area is needed for a few more years, before arriving at a definite conclusion.

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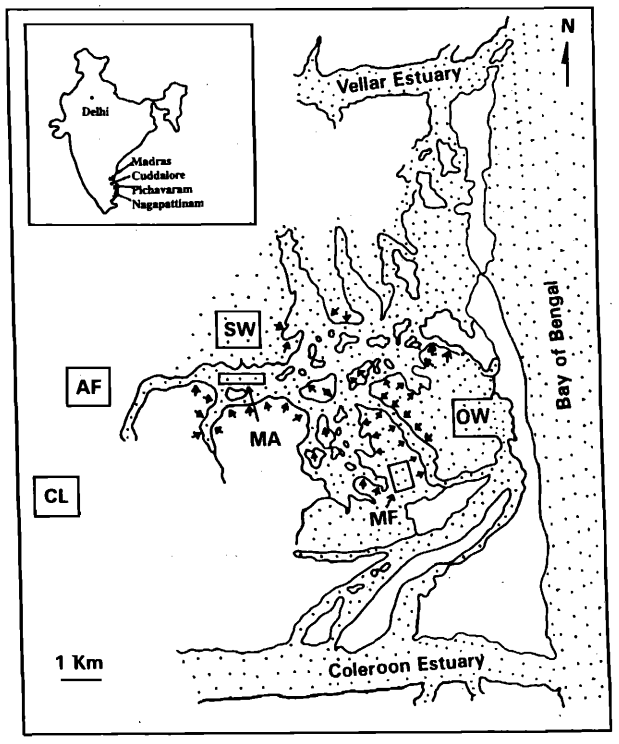

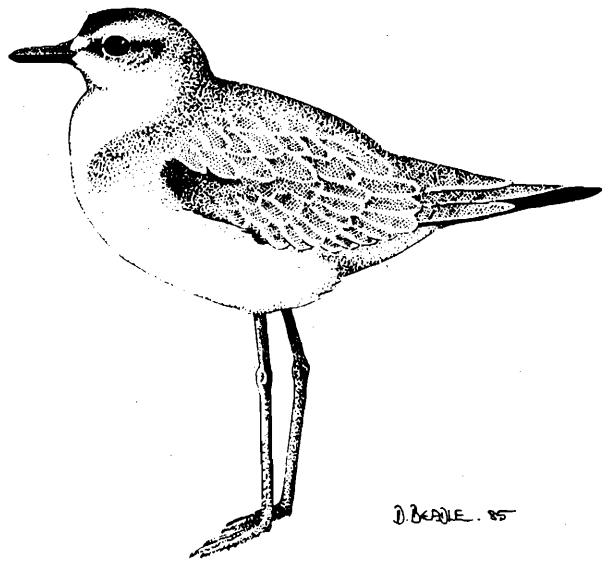

Figure 1 Map of the study area, Pichavaram Mangroves, Southern India showing different types of wetlands (CL=croplands; AF=Abandoned fields; MF=mudflats; SW=Swamps; MA=Marshy areas; OW=Open water; ⊡ = water bodies; ↑ = mangrove vegetation

Table 1 Comparison of waterbird population parameters (total counts, species richness and species diversity) of Pichavaram mangrove forests during January 1993, 1994 and 1995.

Bird groups & bird species	January 1993	January 1994	January 1995
HERONS & EGRETS			
Black-crowned Night Heron (*Nycticorax nycticorax*	262	102	186
Pond Heron *(Ardeola grayii)*	1600	1100	1428
Little-green Heron (*Ardeola striatus)*	62	48	56
Grey Heron (*Ardea cinerea)*	12	2	18
Purple Heron (*Ardea purpurea)*	4	0	8
Reef Heron (*Egretta gularis)*	0	2	0
Little Egret (*Egretta garzetta*)	1250	898	1300
Great Egret (*Ardea alba)*	182	58	162
Cattle Egret (*Bubulcus ibis*)	150	128	210
Great Bittern (*Botaurus stellaris*)	0	0	12
Sub total	**3522**	**2338**	**3380**
STORKS			
Painted Stork (*Mycteria leucocephala*)	10	4	62
Asian Open-billed Stork (*Anastomus oscitans*)	68	52	182
Sub total	**78**	**56**	**244**
IBISES & SPOONBILLS			
Black-headed Ibis (*Threskiornis melanocephalaus*)	0	0	14
Sub total	**0**	**0**	**14**
SHOREBIRDS			
Black-winged Stilt (*Himantopus himantopus*)	280	32	168
Redwattled Lapwing (*Vanellus indicus*)	128	102	212
Little Ringed Plover (*Charadrius dubius*)	220	180	316
Kentish Plover (*Charadrius alexandrinus)*	112	72	128
Greater Sand Plover (*Charadrius leschenaultii)*	12	0	18
Little Stint (*Calidris minutus*)	124	87	186
Common Sandpiper (*Tringa hypoleucos*)	72	26	88
Marsh Sandpiper (*Tringa stagnatilis)*	25	16	18
Green Sandpiper (*Tringa ochropupus)*	64	48	58
Wood Sandpiper (*Tringa glareola*)	16	8	10
Redshank *(Tringa totanus)*	58	0	14
Common Snipe (*Gallinago gallinago*)	26	11	32
Stone Curlew (*Burhinus oedicnemus*)	0	4	0
Asiatic Dowitcher (*Limnodromus semipalmatus*)	0	0	2
Sub total	**1137**	**586**	**1250**
GULLS & TERNS			
Whiskered Tern (*Chlidonias hybrida*)	28	13	22
Caspian Tern (*Hydroprogne caspia*)	42	18	47
Little Tern (*Sterna albifrons*)	68	49	122
Gull-billed Tern (*Gelochelidon nilotica*)	8	0	12
Sub total	**146**	**80**	**203**
Grand total	**4883**	**3060**	**5091**
Species Richness	**26**	**24**	**29**
Diversity (H')	**2.2299**	**2.0231**	**2.3768**

Table 2. Literature review of the impact of extreme weather conditions on birds.

Country/Place	Weather condition	Species	Effect	Source
Western Iowa & Minnesota	Heavy snow storm	Lapland longspurs *Calcarius lapponicus*	Killed	Roberts 1932
Britain	Severe winter	Grey herons *Ardea cinerea*	Population reduced	Alexender 1948
Southwestern Oklahoma	Hail storm & high winds	Several species of Birds	Killed	Jones 1952
Northern California	High winds	Waterfowls	Killed	Wooten 1954
Minnesota	Torrential rain & hail storm	Whistling Swans *Olor columbianus* Canada Geeses *Branta canadensis* and Ducks	Killed	Hochbaum 1955
Saskatchewan	Hail storm	Waterfowls	Killed	Fyfe 1957
America	High winds	Redheads	Killed	Rate 1957
Alberta	Hail storm	Waterfowls	Killed	Smith & Webster 1955; Smith 1960
New Mexico	Hail storm	Several species of birds	Killed	Merrill 1961
Minnesota	Severe hail storm	Ducks	Population declined	Ordal 1964
Aleutian Island	Storm	Murres *Uria aalge*	Killed	Bailey & Devenport 1972
North America	Hail storm	Waterfowls	Weather caused deaths	Stout & Cornwell 1976
America	High wind & hail storm	Several species of birds	Killed	Higgins & Johnson 1978
America	Summer storm	Several species of birds	Population declined	Johnson 1979
India	Hail storm	Several species of birds	Killed	D'Cunha & Akhtar 1987; Rammanohar & Rajasekaran 1989
India	Cyclone	Barn Owl *Tyto alba*	Nests damaged	Nagarajan *et. al.*, 1994
India	Cyclone	Several species of birds	Killed	Nagarajan & Thiyagesan 1995