

PRESENT STATUS OF THE FLIGHTLESS CORMORANT, GALAPAGOS PENGUIN AND GREATER FLAMINGO POPULATIONS IN THE GALAPAGOS ISLANDS, ECUADOR, AFTER THE 1982-83 EL NIÑO

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Abstract. The 1982-83 El Niño/Southern Oscillation was the most severe recorded in the tropical Pacific Ocean. It was a period of low ocean productivity. Many seabirds in the Galapagos Islands, including the Galapagos Penguin (*Spheniscus mendiculus*) and the Flightless Cormorant (*Nannopterum harrisi*), did not breed. The cormorant and penguin populations were reduced by 49 and 77%, respectively. The Greater Flamingo (*Phoenicopterus ruber*) population size remained unchanged. Between July 1983 and September 1984, the cormorant population recovered whereas the penguin population had not recovered.

Key words: Galapagos; El Niño; Southern Oscillation; ENSO; Flightless Cormorant; Galapagos Penguin; Greater Flamingo.

INTRODUCTION

The El Niño/Southern Oscillation (ENSO) phenomenon that occurred in 1982-1983 was the most severe ever recorded in the eastern equatorial Pacific Ocean with large changes in fish, marine mammal, and bird populations (Barber and Chavez 1983, Cane 1983, Limberger et al. 1983, Schreiber and Schreiber 1984). The Galapagos Islands, about 950 km west of mainland Ecuador, were surrounded by particularly warm ocean water, there was heavy rainfall (Cruz and Beach 1983, Grant 1984), fish populations declined (Grove 1984), and there were breeding failures of marine iguanas (*Amblyrhynchus cristatus*) (Laurie 1983) and fur seals (*Arctocephalus galapagoensis*) (Limberger et al. 1983). The populations of Flightless Cormorants (*Nannopterum harrisi*) and Galapagos Penguin (*Spheniscus mendiculus*) decreased (Valle 1984). The unusual ENSO conditions lasted from October 1982 to July 1983 when conditions began to return to normal. We censused the populations of Flightless Cormorants, Galapagos Penguins, and Greater Flamingos (*Phoenicopterus ruber*) to record the effects of the 1982-83 ENSO on population sizes and to record any recovery in the populations since the phenomenon. In this paper we summarize the results of previous censuses

and present the results of our own censuses through 1984.

METHODS

Cormorants and penguins were censused along the shores of Fernandina and Isabela Islands 29 August to 8 September 1983, 7 to 15 January 1984, and 4 to 14 September 1984. Individual birds were counted along the coast and in the adjacent waters from an inflatable boat 15 to 50 m from shore. Along 10% of the coastline, we counted birds from a larger boat 50 to 150 m offshore.

Landings were made at 95% of all sites where nesting cormorants or nest traces were seen. We recorded the numbers of adults (blue eyes [Snow 1966]), subadults (brown eyes), juveniles and chicks that were still at the nest, as well as the number of active nests, nest contents, type of nest material, and number of nesting individuals. We were unable to distinguish subadults from adults when they were in the water away from the colony.

Simultaneous counts of flamingos were made at 10:00 on 22 March 1984 at all the 32 locations where flamingos are known to occur.

RESULTS AND DISCUSSION

END OF THE ENSO

The 1982-83 ENSO was a period of warm ocean temperature and heavy rains, during which there

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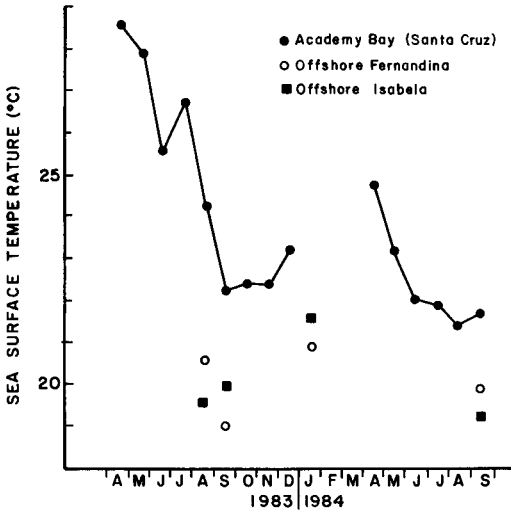


FIGURE 1. Sea temperatures among the Galapagos Islands in 1983 and 1984.

was little breeding activity among seabirds (Merlen 1984; Valle 1985; Coulter, unpubl. data) and heavy mortality among some seabirds. Along the coasts of Isabela and Fernandina, Valle (unpubl. data) counted hundreds of dead Blue-footed Boobies (*Sula nebouxii*) and Brown Pelicans (*Pelecanus occidentalis*). The end of the ENSO in July 1983 was indicated by the lowering of sea temperatures to more normal levels (Fig. 1) and a reduction in rainfall.

CORMORANTS

Population size. In 1961 Leveque (1963) counted 501 cormorants in approximately 75% of the area where cormorants are found. He estimated a total population of 1,000 individuals. In 1962 Brosset (1963) estimated a population of between 3,000 and 5,000 birds. In 1971, Harris (1974) estimated from numbers of active or recently used nests that there were 406 pairs in the area censused by Leveque, from which he extrapolated a total population of between 700 and 800 pairs. Although there is no available information on the population between 1971 and 1977, there has been no suggestion of any large population decline during this period. Since 1977, the population estimates have remained fairly stable at about 650 to 800 adults, with a sharp decline of about 50% in 1983, which coincided with the ENSO (Table 1). In August and September 1983, after the ENSO had ended, 409

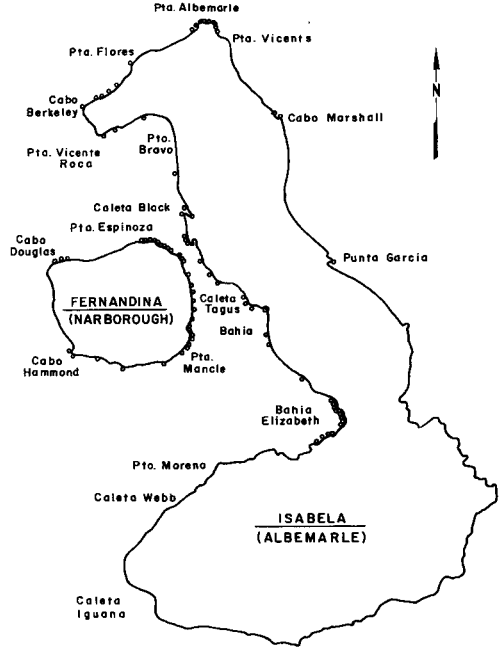


FIGURE 2. Areas censused for Flightless Cormorants and Galapagos Penguins. The small circles indicate cormorant nesting areas.

cormorants were counted and by September 1984, 869 cormorants were counted.

Distribution. The entire range of the Flightless Cormorant is limited to the north and west coasts of Isabela Island and the entire coast of Fernandina Island (Fig. 2). During our visits we censused the entire area. The birds and breeding areas were concentrated along the north coast of Isabela Island (from Punta Vicente to Cabo Berkeley), along the coast of Isabela Island at Bahia Elizabeth, and along the eastern coast of Fernandina Island (Fig. 2).

Reproduction. During the census taken immediately after the ENSO (August/September

TABLE 1. Numbers of cormorants counted along the coasts of Fernandina and Isabela Islands during censuses from 1977 through 1984. Data from Tindle (1977), Harcourt (1980), and this report.

Island	Year				
	1977	1980	1983	1984*	1984**
Fernandina	326	293	169	278	321
Isabela	357	509	240	359	548
Total	683	802	409	637	869

* January.
** August/September.

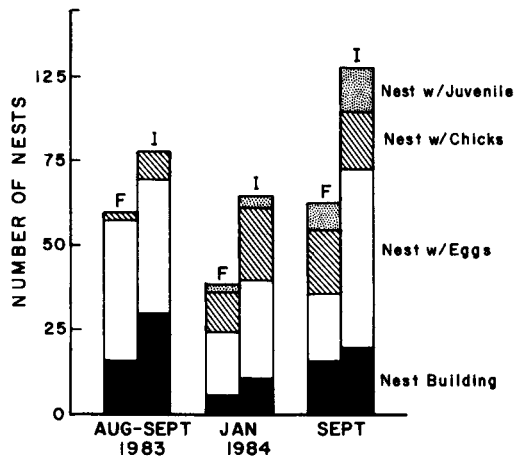


FIGURE 3. Numbers of nests of Flightless Cormorants in different stages of breeding at the times of the 1983 and 1984 censuses on Isabela Island (I) and Fernandina Island (F).

1983) adults, chicks, most of which were less than a month old, and a few juveniles still dependent on their parents were observed; there were no subadults (Fig. 3). We counted 143 breeding pairs, representing 70% of the total number of birds counted (Table 2). The nests observed during this census were constructed of dead Blue-footed Boobies, Brown Pelicans, and marine iguanas as well as mangrove twigs and leaves, and black coral (*Anthipathes* sp.). Nests are usually made of marine algae (*Sargassum* sp., *Laminaria* sp., and *Ulva* sp.), which had all but disappeared during the ENSO.

In January and September of 1984, we counted 104 and 166 nesting pairs, respectively. This was a lower proportion of the population than observed in 1983 and probably reflected the addition to the population of juveniles and subadults which did not breed. In all three censuses we counted a total of 413 breeding attempts which indicates that the majority of the adults bred during the post-ENSO period and that many bred more than once. Flightless Cormorants are op-

TABLE 2. Number of nesting pairs of cormorants and proportion of the population during the post-ENSO censuses.

Island	Number of nesting pairs (percent) of the population in		
	August/September 1983	January 1984	September 1984
Fernandina	62 (73%)	39 (28%)	63 (39%)
Isabela	81 (68%)	65 (36%)	103 (38%)
Total	143 (70%)	104 (33%)	166 (38%)

portunistic breeders, and females which leave their mates to finish raising the young may breed successfully twice during a year (Tindle 1984).

Between September 1983 and September 1984, the population increased by 112%, or 2.3 young introduced into the population per pair in a 12-month period. The production estimated for this study period is higher than that suggested by Harris (1977) for a previous non-ENSO year. He calculated a reproductive rate of 0.76 young per nesting attempt in 1970 and 1971, and juvenile survival rate of 92% in 1970. Assuming two breeding attempts per year, the production would be 1.5 fledglings of which 1.4 would be recruited into the population, less than the 2.3 calculated for 1983/1984.

PENGUINS

Population. Early estimates of the Galapagos Penguin population were vague. In 1962 Brosset (1963) estimated the population to be between 3,000 and 5,000 individuals. Leveque (1963) estimated 500 breeding pairs, but later revised the total estimate to 1,500 individuals (Leveque 1964). Harris (1977) later suggested a population size similar to that put forward by Brosset, 3,000 to 5,000. Boersma (1977) censused the entire breeding range in 1970 and again in 1971 (Table 3). She estimated a total population of between 6,000 and 15,000 birds.

Subsequent censuses have indicated a relatively stable population. In 1980 there was a de-

TABLE 3. Counts of Galapagos Penguins around the coasts of Fernandina and Isabela Islands in censuses made since 1970. Data from Boersma (1977), Harcourt (1980), and this report. See Figure 2 for areas.

	Year					
	1970	1971	1980	1983	1984*	1984**
Number of penguins	1,584	1,931	1,716	398	463	435

* January.

** August/September.

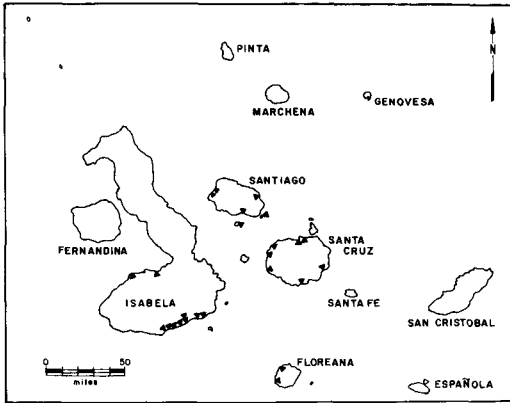


FIGURE 4. Locations of areas where Greater Flamingos have been observed among the Galapagos Islands.

cline in numbers in areas seven and eight (Fig. 2). Harcourt (1980) has suggested that this may have been related to predation by feral dogs and the eruption of Volcan Chico (Cerro Azul) on Isabela Island in November 1979. During this eruption the lava reached the sea, raising the water temperature and modifying the coastline around Bahia Elizabeth. Nevertheless, in 1982–1983 there was a 77% reduction associated with the ENSO. The population has not recovered. Few juveniles have been observed during the last three censuses, suggesting poor reproduction and recruitment.

Reproduction. During the three censuses since the ENSO, many pairs have been observed courting. Yet only 29 juveniles were counted during the two 1984 censuses. This indicates a lack of actual reproduction or low reproductive success.

GREATER FLAMINGOS

Population and distribution. Leveque (1963) estimated a population size of less than 150 flamingos. However, based on complete censuses since 1967, it is estimated that the population is closer to 400 individuals (due to the discovery of additional feeding sites between censuses). At present there are 32 areas where flamingos have been observed (Fig. 4). Furthermore, the population seems to have remained relatively stable. In January 1984, 394 birds were observed, only 12% less than the 418 counted in January 1982 (Table 4). Apparently the population was not greatly affected by the ENSO.

Reproduction. Flamingos have been observed

TABLE 4. Numbers of Greater Flamingos counted in censuses since 1967. Data from de Vries (unpubl. observ.), Harcourt (1981, 1982), and this report.

	Year					
	1967	1968	1976	1981	1982	1984
Numbers of individuals	317	512	442	371	418	394

nesting at only six small brackish lagoons: El Sarten and the Salt Mine on Santiago Island, Bainbridge Rocks, Poza del Cementerio and Quinta Playa on Isabela Island, and at Punta Cormorant on Floreana Island. The Greater Flamingo is the only flamingo species that breeds in groups as small as 50 or fewer pairs (Tindle 1978). These flamingos can reside in the Galapagos Islands, perhaps, because they are able to breed successfully in small colonies. During the 1984 census no nesting was observed, although six pairs were observed nesting at Quinta Playa in April 1984 (Tupiza, pers. comm.). During the census 15% of the flamingos were juveniles compared with 9% recorded in 1982. This indicates that there was a significant amount of breeding after the ENSO.

CONCLUSION

The 1982–83 ENSO phenomenon was a period of low ocean productivity and heavy rains. Many animals that depended on marine resources suffered heavy mortality. Among seabirds there was little reproductive activity and many birds may have left the Galapagos. Both the Galapagos Penguin and the Flightless Cormorant are endemic to the archipelago and severe declines in their numbers or inability to recover from a decline may have important consequences for the species. The Greater Flamingo that breeds in the Galapagos also breeds in the Caribbean but it is doubtful that the Galapagos population has contact with other populations. After the ENSO the Flightless Cormorant population was 51% as large as it had been during censuses before the ENSO. There is no evidence that cormorants bred during the 1982–1983 event and there was probably heavy mortality. This contrasts with the 1972 ENSO when Harris (1979) recorded some, albeit low, reproductive effort and high juvenile mortality. The Galapagos Penguin population was reduced to 23% of its previous levels. In contrast to these species, the flamingo population did not decrease significantly during the ENSO.

During the year after the ENSO event, the cormorant population increased to above its previous levels. This was due to nearly all of the adults in the population breeding (and many breeding more than once), and to low mortality rates and high recruitment of juveniles into the population. Such high reproductive effort is possible because successfully breeding females can reproduce twice a year; and males that breed successfully, while reproducing at somewhat longer intervals than females, probably breed at intervals of less than a year.

The Galapagos Penguins, in contrast, have not recovered. The 1984 census indicated that the population had only increased 9% since the ending of the ENSO. The low number of juveniles observed suggests that penguins have reproduced very little in 1983 and 1984. Penguins probably have much stronger pair bonds than the cormorants and usually breed with the same mate from year to year. Pair bonds may have been disrupted during the ENSO, through mortality or through separation of members of pairs when food was scarce. The many courting pairs that we observed during all the censuses after the ENSO suggests that it may take a long time for pair bonds to become established and for the birds to begin laying eggs. It may, then, take many years for the penguin population to recover.

The numbers of Greater Flamingos were apparently little affected by the climatic changes during the ENSO. They do not feed on marine animals and were not affected by changes in the oceans. One might have expected that the increase in rain may have decreased the salinity in the brackish lagoons, and so affected the reproduction and density of their prey. If this did occur, the changes were not sufficient to affect the flamingo population size.

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