

examine how compositional evolution of single volcanoes can be used to constrain plume models.

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## NATURALIST GUIDES ASSIST IN MONITORING FLAMINGOS

**By: Christine Breuker and Hernán Vargas**

#### INTRODUCTION

The population of the Caribbean flamingo (*Phoenicopterus ruber ruber*) in the Galápagos Islands is a small one and has been for at least 30 years. The total number of adult birds is almost certainly less than 500. Given this small size, it is necessary to evaluate the status of the population, so the Charles Darwin Research Station (CDRS) and the Galápagos National Park Service (GNPS) monitor the flamingos by three methods:

- The annual census, conducted since 1967, usually in January, of the birds in most of the lagoons in the Archipelago where flamingos occur.
- The monthly census of the flamingo populations found in lagoons in southern Isabela Island, where the main breeding sites for these birds are located.
- The counts conducted by naturalist guides for the lagoons located near the visitor sites Punta Cormorant (Floreana), Cerro Dragón and Bachas (Santa Cruz), Punta Moreno (Isabela), Rábida, as well as "sail-by" counts of the lagoon on one of the Bainbridge Rocks.

The purpose of this paper is to analyze and summarize the flamingo data submitted to the CDRS by naturalist guides, primarily from the lagoon at Punta Cormorant on Floreana, but also from other lagoons near visitor sites.

The lagoon at Punta Cormorant is a place of great interest for both tourists and biologists. Located at the northern tip of Floreana, the brackish, shallow water is home to a number of wading birds and surrounded by interesting dry-zone vegetation. The water level varies seasonally and yearly. Both a greenish beach (of olivine crystal origin) and a white beach (of coral origin) are nearby. The area is a popular site and is visited by a more or less steady flow of tourists, accompanied by their naturalist guides. The prospect of seeing flamingos on the lagoon is an attraction. The trail taken by tourists overlooks the large lagoon from its northern and eastern shorelines. However, a review of the carrying capacity of the site in 1995-96 showed heavy overuse and resulted in recommendations for reducing use by tourists (Amador *et al.* 1996, Cayot *et al.* 1996).

## METHODS

Naturalist guides were given a report form on which to record information about flamingos. Although for many years guides have submitted their observations, including information on flamingos, this new report form was designed by René Godard, who came to the Station in 1993 as a visiting scientist and recognized that naturalist guides would be an excellent source of data about flamingo numbers and activity at the visitor sites. In addition to recording the date, hour, number of birds, number of chicks, and distance of the flock from the observer, the guides were asked to record information about the kinds of behaviors the birds were exhibiting. They collected the data as they visited the lagoons with their tourist groups, except for the lagoon on Bainbridge Rock, for which flamingos were counted as the boat passed by. These reports from guides have been submitted steadily to the CDRS since November of 1994.

## RESULTS

Approximately 300 reports have been submitted to the CDRS from naturalist guides since counting birds at the lagoons near visitor sites began in November of 1994. Of these reports, 73.4% were for the lagoon at Punta Cormorant, 11.3% from Cerro Dragón (Santa Cruz), 5.5% from Rábida, 4.1% from Las Bachas (Santa Cruz), 2.3% from Punta Moreno (Isabela), 1.7% from Bainbridge Rock, and 1.7% from Playa Espumilla (Santiago) (Table 1). The number of reports submitted per month varied from 1 to 15. The majority of the reports indicate that the birds were seen 20-200 m from the observer between 0700 and 1500.

Most of the flamingos were found at the lagoon on Punta Cormorant, where the average was 21.7 (n=215, range 0-172), and the fewest were found on Rábida, where the average was 1.9 (n=16, range 0-9). Based on only 5 reports, the lagoon on Bainbridge Rock had the second highest average (Table 1).

**Table 1.** Results of flamingo counts at visitor sites near flamingo lagoons carried out by naturalist guides from November 1994 to March 1997.

Site	Number of reports	Average number of birds	Min. number	Max. number
Punta Cormorant	215	21.7	0	172
Bainbridge Rock	5	9.6	4	15
Punta Moreno	7	4.7	1	7
Playa Espumilla	5	4.2	1	11
Las Bachas	12	2.5	0	5
Cerro Dragón	33	2.5	0	8
Rábida	16	1.9	0	9

At Punta Cormorant, the average number of birds per sighting varied from a high of 109.3 in February of 1995 to a low of 0.7 in September of 1996 (Table 2). The average number of birds per sighting was higher in the first four months of the report period (November 1994-February 1995) than it has been at any time since. The averages were 84.0, 81.2, 104.0, and 109.3 birds for each of the four months, respectively, all of which are more than double the sighting average in any month since that time.

**Table 2.** Results of flamingo counts at the Punta Cormorant lagoon carried out by naturalist guides from November 1994 to March 1997.

Year	Month	Number of reports	Average number of birds	Min. no. of birds	Max. no. of birds
1994	November	1	84	84	84
	December	9	81.2	30	172
1995	January	12	104	60	153
	February	4	109.3	80	131
	March	5	40.4	27	56
	April	6	19.8	14	33
	May	4	4.8	4	5
	June	3	5	4	7
	July	13	7.1	1	18
	August	12	8.9	4	11
	September	15	12.2	0	23
	October	8	12.5	0	18
	November	9	9.3	4	18
	December	3	3.3	0	6
1996	January	14	10.7	0	32
	February	11	15	1	29
	March	12	34.1	18	65
	April	7	10.3	0	24
	May	11	4.3	0	11
	June	12	5	1	9
	July	15	1.9	0	4
	August	2	9	8	10
	September	6	0.7	0	3
	October	3	4.3	2	7
	November	3	2.7	0	5
	December	4	10	2	19
1997	January	6	8.7	4	13
	February	2	15	2	25
	March	3	42	22	60

There was a tendency for the number of flamingos to change in abundance monthly. The range in the average number of birds per report went from a low of 4.3 birds in July to a high of 48.8 birds in December (Table 3). The average number of birds per sighting was lowest in the dry, cool months of May, June, and July, with sighting averages of 4.4, 5.0, 4.3 birds, respectively, and highest in the wet, hot months of December, January, February, and March, with averages of 48.8, 45.3, 37.2 and 36.8 birds, respectively.

During the report period, from November of 1994 to March of 1997, there were three annual censuses of flamingos, conducted in January. The results of the counts from these censuses at Punta Cormorant were as follows: 146 in 1995, 25 in 1996, and 4 in 1997. Naturalist guide report averages for January of these years were as follows: 104 in 1995, 10.7 in 1996, and 8.7 in 1997 (Table 2). No juveniles were reported in the annual census for these years.

### DISCUSSION

Reports from guides have been collected for nearly two and a half years, November of 1994 through March of 1997. The number of reports submitted is understandably related to the vagaries of the tourist business in Galapagos. Nevertheless, a substantial number of reports (nearly 300) has been submitted. There is a published policy with regard to the number of groups allowed daily at the visitor sites (Amador *et al.* 1996, Cayot *et al.* 1996). Cerro Dragón and Rábida have visitor sites in the Intensive category and presumably are able to sustain a large number of visits by tourist groups. The Punta Cormorant site was included in the Intensive category until the carrying capacity study in 1995-96. Average use at that time was 15 groups per day, while the carrying capacity was calculated at 2 groups per day. The decision was made to put Punta Cormorant into the Extensive category and reduce the number of groups per day.

The lagoon at Punta Cormorant, which has had an average of 21.7 birds over the report period, has generated 73.4% of the reports submitted by guides. This visitor site has been heavily used. The lagoon at Cerro Dragón, which has had an average of 2.5 birds per report, is also heavily used, but has generated only 11.3% of the reports. It is possible that guides are less likely to submit reports from visits in which no flamingos have been observed. This may also be the case for sites such as the lagoon on Rábida, which historically has had large numbers of flamingos, but in recent years has not. Oral communication from people recently visiting Rábida indicates a possible return of the flamingos there, although no written reports by guides have been submitted for this site since March of 1996. Recent information about the Bainbridge Rock lagoon is encouraging as well.

Because of the large number of reports, data regarding flamingo flock size at Punta Cormorant on Floreana were

**Table 3.** Monthly average of flamingos per report at the Punta Cormorant lagoon, based on two or three years of data, as available.

Month	Number of reports	Average number of birds per report	Min. no. of birds	Max. no. of birds
January	32	45.3	0	153
February	17	37.2	1	131
March	20	36.9	18	65
April	13	14.7	0	33
May	15	4.4	0	11
June	15	5	1	9
July	28	4.3	0	18
August	14	8.9	4	11
September	22	9.6	0	25
October	11	10.3	0	18
November	13	13.5	0	84
December	16	48.8	0	172

analyzed more thoroughly. At the point of maximum population size in the report period (January and February of 1995), there were individual guide sightings of up to 142 birds at Punta Cormorant. Reports of fewer birds are far more common, however. Of particular interest is the fact that the counts of birds in the early reports of the guides (late 1994 and early 1995) have never been equaled or even approached since that time. It may be of significance that there has been no individual report of a sighting of more than 100 birds at any point since February of 1995. The official census done in January of 1995 supports the findings of the guides, with a count of 146 birds, the highest January count at Punta Cormorant of any year in which the annual census has been done.

Reasons for the abnormally large flamingo count at Punta Cormorant during the period from November 1994-February 1995 are unclear, since no information is available for the months immediately prior to that time. The annual census done in January of 1994 indicates no unusually large number of flamingos at the site. Breeding success in 1994 would not account for the dramatic increase in the number of adult birds at the site by November. A more likely explanation is the immigration of birds from other lagoons in the archipelago. Though that is a matter of speculation, inter-island migration of the Galapagos flamingo has been documented (Gordillo 1973). Favorable conditions with respect to water level and food supply are likely to be part of the explanation as well (Tindle and Tindle 1978).

It is possible that the best conditions for flamingos at Punta Cormorant occur in March, as shown by an average count of at least 30 birds in each of the three months of March in the report period (Table 2). If this is the case, March would be the month in which tourists could most reliably expect to see flamingos there.

With a range in monthly report averages from 4.3 to 48.8 birds, the flock size at Punta Cormorant is clearly not what would be thought of as large at any time of year. Nevertheless, a seasonal pattern is apparent, with flock size being lowest in the dry, cool months of May, June, and July and highest in the wet, hot months of December, January, February, and March. Though the time of breeding in flamingos is variable and susceptible to interruption, the Galapagos flamingo tends to have a breeding season from June to November (Godard and Stevens 1993). The drop in the water level with the onset of the dry season produces the muddy conditions necessary for nest construction. There is, in fact, evidence of breeding activity at Punta Cormorant, though very little from the naturalist guide reports. This is understandable, considering the large size of the lagoon and distance from any observer on the trail (at the northeast corner) to the likely nesting sites on the western edge and small islets of the lagoon (Vargas 1989). Nevertheless, 7 nests were reported by a guide in April of 1996, and a sighting of 38 old nests (some with abandoned or destroyed eggs) was reported after a field trip by CDRS personnel in May of 1996 (CDRS files).

Guides also reported sighting chicks at various times in early 1995.

The decrease in the flock size at the lagoon on Floreana at the onset of the dry season suggests, however, that other lagoons may be more important breeding locations. The lagoons of southern Isabela are likely candidates. Of these, the flock at the lagoon at Quinta Playa seems to be the largest. Because there is no visitor site at Quinta Playa, no guide reports are available for that location, so it is of some interest to look at the bird counts from the lagoons at Punta Cormorant and Quinta Playa generated by the last three January censuses. At Quinta Playa the flock size increased from 97 (1995) to 226 (1996) to 245 (1997). At Punta Cormorant, the flock size decreased from 146 (1995) to 25 (1996) to 4 (1997). This decline at Punta Cormorant is corroborated by the counts reported by naturalist guides for January of these three years, which go from 104 (1995) to 10.7 (1996) to 8.7 (1997).

While to suggest that flock sizes between these two lagoons alternate in this way is certainly premature, it is also important to keep in mind the possible impact of heavy tourism at the lagoon on Floreana. In a one-week period in April of 1997, for example, 64 tour boats were scheduled to visit the site, and as many as 13 tour boats (both large and small) in one day (GNPS records). Quinta Playa, on the other hand, has no tourist site. Much more information is needed before any meaningful conclusion can be drawn with regard to the impact of tourism on flock size at Punta Cormorant.



Photo by Robert Tindle

## RECOMMENDATIONS

The staff at the CDRS encourages additional naturalist guides to become involved in reporting information about flamingos at any location in the archipelago, in order to obtain as much information as possible.

Because reports of visits in which no flamingos are sighted (negative data) are just as important as the ones from visits in which the birds are observed (positive data), the CDRS staff would encourage the guides to submit both kinds of data to this on-going monitoring of flamingos.

Because little is known about the reproductive behavior of flamingos, information on courtship behavior, nests, chicks, and juveniles is particularly appreciated.

The GNPS should reduce the number of groups per day visiting Punta Cormorant so that it coincides with the numbers established in the study of carrying capacity.

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## INSIDIOUS INVADERS

By: J. P. Lundh

Those involved in the work of conservation in the Galápagos Islands have given first priority to the control of introduced mammals. This is amply justified by the enormous destruction these animals have caused to the flora and fauna of the islands where they have been introduced. But there are other invaders that are far less obvious due to their size, which usually also makes us unaware of their presence until they have become more or less established and thus nearly impossible to eradicate.

Dr. Chantal M. Blanton, Director of the Charles Darwin Research Station (CDRS) from May 1992 to September 1996, has expressed concern about the introduction of these small animals, recommending stricter control. This has

become most urgent, considering the greatly increased traffic between the islands and the mainland in the last two or three decades. The likelihood of introducing such animals has increased enormously compared to previous years. This is not to say that the problem is recent or that its importance has not been realized before.

Fortunately, it is far from easy for accidentally introduced living organisms to become established. A cargo with half a dozen geckos scattered throughout it is not necessarily an opportunity for these to become established on an island. There is the possibility of the animals not going ashore with the cargo or being eaten by a predator upon arrival. A gravid female must arrive, or a female