Breeding Ecology

CHAPTER 4
BREEDING ECOLOGY

The flamingos are colonial nesters. Their nests are made of conical mounds of mud. Generally they build nests on exposed mud or salt-flats on small but more or less permanent islands standing above the normal level of the water. The top of the nest mound has a shallow depression in which an egg is laid.

Inundation of the area is a necessary factor for successful breeding of flamingos. Inundation also increases food availability and creates safe nesting site. The flamingos do not breed unless these factors are favourable. Even after establishing a colony, when the conditions do not remain favourable, they desert the colony. If they do not nest successfully for several years, their number decreases, and hence their conservation becomes important. It is necessary therefore, to study breeding ecology of the species so that the key limiting factors are identified and a correct conservative strategy can be formulated.

Greater Flamingos are known to breed regularly only in the Greater Rann of Kachchh in Gujarat state in the Indian subcontinent. The Lesser Flamingos are recorded nesting in the Little Rann of Kachchh very recently. Except for a few visits to the nesting sites by freelance or scientific observers, very little is known about the breeding ecology of both the species of flamingos in India. This chapter deals with the breeding ecology of Greater Flamingos and Lesser Flamingos.

4.1: Nesting History

This section deals with complete account of breeding records of Lesser Flamingos and Greater Flamingos in India.

Materials and Methods:

All past records of nesting of flamingos in Gujarat state as well as in other states of India were referred. This included both successful and unsuccessful nesting attempts.

During the study period, the known nesting sites were visited and nesting attempts were noted. Local inquiries were made near the nest site to know whether the flamingos had nested in the nearby areas which could not be surveyed.

Year wise record of nesting attempts was maintained and on the basis of these, the regular breeding sites were identified.

Results:

4.1A : Lesser Flamingos

Past Records:

Lester (1904) for the first time suspected that the Lesser Flamingos might have bred some where in Kachchh. His presumption was doubted by Ali (1945) as there were no known reports of breeding of Lesser Flamingos within Indian limits (Table 4.1a).

Ali (1954) showed probability of their breeding some where in the Little Rann for the first time in India after observing a huge flock of 1,00,000 Lesser Flamingos including adults and juveniles of 2 to 3 months, on the muddy expanse of the shallow Banas River, near its mouth opposite Dhutari bet ('bet' is a local name which means island), in Little Rann of Kachchh between February 25, 1946 and March 2, 1946.

The full proof for nesting of Lesser Flamingos was provided by Salim Ali, for the first time in India in January 1974 at the Flamingo City. They were found to be nesting along with Greater Flamingos. A total of 25,000-30,000 flamingos were counted on an island of which, the breeding population of Lesser Flamingos was estimated to be 2,000 (Ali)-5,000 (Khachar) (Ali, 1974). In the same report, about 300-400 nests were recorded.

Since then, Lesser Flamingos were not recorded breeding at the Flamingo City, but there have been ample suggestions of their breeding somewhere around. In February 1984, Shri S. D. Jadeja, Shri P. Prunes and C. Briggs sighted non-flying juveniles near Navalakhi port. On December 23, 1984, Taej Mundkur and his team saw 52 juveniles in a flock of 460 Lesser Flamingos at a salt pan northwest of Jalandhar bet in the Little Rann of Kachchh. On December 27, 1985, one non-flying juvenile was observed to the west of Navalakhi port. Based on above evidences, Mundkur *et al.* (1989) suspected that the main Flamingo city was abandoned and Lesser Flamingos had started breeding elsewhere in the Little Rann or the Great Rann.

On January 8, 1985, evidences of Lesser Flamingos breeding in the Little Rann of Kachchh were gathered by Shri Uday Vora for the first time. A colony of 10,000 nests was observed in the salt pans at about 10 km north to Koparani village which was spread in a 1X3.5 km area in the Little Rann of Kachchh. This suggested that Lesser Flamingos had nested there in 1984 during monsoon (July-October). Since Vora could differentiate some old nests from fresh ones, he believed that the Lesser Flamingos had bred there in 1983 and even in earlier years too (Vora, unpublished report).

Lesser Flamingos were reported breeding at a new site in Purabcheria, near Cherwari village in the Little Rann of Kachchh. They were recorded nesting at this site regularly since many years, however the site was only known after 1989, when it was surveyed for three successive years from 1986 to 1988 (Mundkur *et al.*, 1989). However the nesting attempts were not successful due to stealing of egg by the local people.

Lesser Flamingos attempted nesting at Porbandar City in 1991, although, it was an unsuccessful attempt (Khacher, 1994).

On August 24, 1998, Shabbir Malik recorded breeding of Lesser Flamingos in the salt pans on a large scale in the Little Rann. The same colony was visited by the team of GEER Foundation on September 6, 1998. The colony (23^0 19.835' to 23^0 20.125'N; 71^0 27.650' to 71^0 27.696') was located at 9 km to the west of Jalandhar bet and at 7.5 km to south of

Wasraj Solanki bet. It was spread over an area of about 250 acres comprising of 25 salt works of approximately 10 acres each. A total of 25,000 to 30,000 nests, 25,000 chicks and 30, 000 adult Lesser Flamingos were recorded (Singh *et al.*, 1999). The flamingos also made nesting attempts near Zinzuwada in the Little Rann during 1999 and 2000 (Parejia, *Pers. Comm*)

Lesser Flamingos were also recorded breeding along with the Greater Flamingo at Sambhar Lake during 1995 and 1996 (Kumar, 1996). A total of 2,500 Lesser Flamingos along with 7,000 Greater Flamingos and large number of nest mounds and hatchlings were reported at Sambhar Lake in January 1995. In January 1996, nearly 20,000 adults of both the species of flamingos along with 1,500 chicks were again recorded at Sambhar Lake (Kumar, 1996).

Lesser Flamingos were recorded breeding at Purabcheria, near Cherwari, in the Little Rann of Kachchh on August, 24, 1998. A total of 175 nests and 10-15 abandoned eggs were observed. About 2,000 Lesser Flamingos were present along with 350 Greater Flamingos at the nesting site with 100 juveniles (Singh *et al.*, 1999).

Present Study Records:

During the present study, Lesser Flamingos were recorded breeding at Purabcheria and near Zinzuwada in the Little Rann of Kachchh and also in the Great Rann.

(A) Little Rann of Kachchh

(1) Near Zinzuwada:

On November 17, 2002, the site near Zinzuwada was visited and a total 9,259 nests were counted in five different nesting colonies. The nesting was successfully completed and flamingos had left the site at the time of visit. This colony also included old nests which suggested that they might have nested in 2001 also (Table 4.1a).

Flamingos also attempted to nest at the same site in August, 2003. About 1,500 Lesser Flamingos and 3,000 Greater Flamingos had gathered in the salt pans in the month of July 2003. Their number kept on increasing and finally, on August 29, 2003, a total of 30,000 individuals of both species (largely Lesser Flamingos with a few Greater Flamingos) were found nesting in the salt pans and ca. 5,000-6,000 nests were recorded (Parajia 2003, *Pers. Comm.*). However, all the nests were washed out due to flooding of the Rupen River on August 31, 2003. The same site was visited on September 9, 2003 and a total of 8,170 nests were counted in seven different nesting colonies. All the eggs were washed away from the nest top and collected in one corner of the salt pans. The colony was destroyed in its early stage of inhabitation (Table 4.1a).

The flamingos also attempted to nest at Zinzuwada site during September 2004. This site was visited on September 29, 2004 and local inquiries revealed only 150 nests which were abandoned later. They could not breed in mass due to insufficient rainfall and lack of inundation in the area (Table 4.1a).

(2) Purabcheria near Cherwari:

Lesser Flamingos attempted to nest at Purabcheria, near Cherwari every year during the present study. Totally 300 nests were observed in 25 different groups during June, 2003. It was an unsuccessful nesting due to pilferage of eggs by the fishermen of nearby villages.

On July 2, 2004, a total of 3,00,000 adult Lesser Flamingos and 52 Greater Flamingos were recorded at the nest site. About 600 Lesser Flamingos were involved in nest building activities. Totally 296 nests were observed in 15 groups and one egg each was observed on only five nests. On July 20, 2004 the number of nests increased to 964 in 52 different groups. The number of displaying Lesser Flamingos had decreased and only 79,143 flamingos were recorded. They deserted the colony as the eggs were collected by the local fishermen (Table 4.1a).

Table 4.1a: Nesting Events of Lesser Flamingos in India

No.	Year	Reference	Place	Remarks
1	1903	Lester, 1904, Ali, 1954	Kachchh, Gujarat	The LF might be breeding some where in Kachchh.
2	Feb 25, to March 2, 1946	Ali, 1974	muddy expanse of the Banas River opposite Dhutari Bet, LRK, Gujarat	100,000 LF (A + Juv of 2 or 3 months)
3	Jan 24, 1974	Ali, 1974	Flamingo City, GRK, Gujarat	First breeding record of LF. Total 25,000-30,000 Flamingos of which, the LF were 2,000 (Ali) -5,000 (Khachar)
4	Feb, 1984	Mundkur, *et al*, 1989	Navalakhi, LRK, Gujarat	Large No. of non-flying juveniles of LF observed by Jadeja *et al*,
5	Dec 23, 1984	Mundkur, *et al*, 1989	NW to Jalandhar, LRK, Gujarat	460 A + 52 Juv of LF observed
6	Dec 27,1985	Mundkur, *et al*, 1989	West to Navalakhi, LRK, Gujarat	One non-flying juvenile observed
7	1984	Vora, 1985 (Unpublished)	10 km N to Koparani village, Near Zinzuwada, LRK, Gujarat	10,000 nests were observed; Nesting was over; the LF might have nested in 1984 and also in 1983
8	1986	Mundkur *et al*, 1989	Purabcheria, LRK, Gujarat	LF gathered for breeding; No nests; No eggs, LF breed since two generations of fishermen of Cherwari
9	June 19, 1987	"	Purabcheria, LRK, Gujarat	16,000 LF, 83 Nests No eggs
	July 19, 1987	"	Purabcheria, LRK, Gujarat	2,000 LF; 288 Nests, No eggs
10	June 22, 1988	"	Purabcheria, LRK, Gujarat	9,000 LF; 123 Nests: No eggs
	July 9, 1988	"	Purabcheria, LRK, Gujarat	7,000 LF; 183 Nests, Eggs collected by fishermen
11	1991	Khacher, 1994	Porbandar, Gujarat	A few nests; Unsuccessful nesting attempt
12	Jan, 1995	Kumar, 1996	Sambhar Lake, Rajasthan	7,000 GF+2,500 LF; 1,100 Nests
13	Jan, 1996	Kumar, 1996	Sambhar Lake, Rajasthan	1,500 chicks, 20,000 GF+LF
14	Aug 24, 1998	Vihang, 1999	9 km west to Jalandhar, and at 7.5 km south to Wasraj Solanki Bet, LRK, Gujarat	Nesting of Lesser Flamingo recorded by Malik, S and GEER Foundation
15	Sept, 20,1998	Singh *et al.*, 1999	9 km in the west of Jalandhar, and at 7.5 km in the south of Wasraj Solanki Bet, LRK, Gujarat	a colony of 25,000-30,000 nests, 25,000 chicks and 30,000 LF, spread in 250 acres area

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No.	Year	Reference	Place	Remarks
16	Aug 24, 1998	Singh *et al.*, 1999	Purabcheria, near Cherwari, LRK, Gujarat	175 nests; 10-15 abandoned eggs; 2000 LF + 350 GF; 100 Juv
17	1999, 2000	Hirabhai Parejia (*Pers. Comm.*)	west of Jalandhar, 7.5 km south of Wasraj Solanki Bet, LRK, Gujarat	A few nests were made
18	2001	Present Study	west of Jalandhar, 7.5 km south of Wasraj Solanki Bet, LRK, Gujarat	Nests of previous years could be clearly differentiated on November 17, 2002
19	Nov 17, 2002	Present Study	west of Jalandhar, 7.5 km south of Wasraj Solanki Bet, LRK, Gujarat	9,259 nests distributed in five nesting colonies; Successful breeding
20	Aug 29, 2003	Hirabhai Parejia (*Pers Comm.*)	west of Jalandhar, 7.5 km south of Wasraj Solanki Bet, LRK, Gujarat	25,000-30,000 LF + GF; 5,000-6,000 Nests
	Sept 9, 2003	Present Study	west of Jalandhar, 7.5 km south of Wasraj Solanki Bet, LRK, Gujarat	8,170 nests; seven nesting colonies, Nesting failed due to flood
21	June, 2003	Present Study	Purabcheria, near Cherwari, LRK	300 nests in 25 different groups; Eggs collected
22	Oct 19, 2003	Present Study	Rann around Bela, Kuda in GRK	11,220 small chicks; 3,100 A LF, New sites
23	July 2-3, 2004	Present Study	Purabcheria, near Cherwari, LRK	3,00,000LF + 52 GF; nesting continued; 296 Nests; 5 eggs
	July 20, 2004	Present Study	Purabcheria, near Cherwari, LRK	964 nests of LF in 52 different groups; 79,143 flamingos; Unsuccessful nesting due to eggs collection
24	Sept 29, 2004	Present Study	west of Jalandhar, 7.5 km south of Wasraj Solanki Bet, LRK, Gujarat	150 Nest; Unsuccessful nesting due to insufficient rain

LF-Lesser Flamingo; GF-Greater Flamingos; NW-Northwest; N-North; W-West; No.- number; A-adult; Juv.-Juveniles; LRK- Little Rann of Kachchh; GRK-Great Rann of Kachchh; *Pers. Comm.*- Personal Communication

(B) Great Rann of Kachchh:

(3) Rann around Bela and Kuda:

A total of 11, 220 chicks of Lesser Flamingos were observed in the Rann area near Bela on October 19, 2003 along with 3,100 adult Lesser Flamingos. The chicks were of 1-3 week old, blackish grey in plumage, and unable to fly (Table 4.1a).

Lesser Flamingos were not breeding at the Flamingo City. The sighting of large number of small juveniles in the Rann area around Bela, suggested that they might have bred in the nearby area as the chicks were too small to move far.

Conclusions:

Comparison of the past nesting events of Lesser Flamingos showed that they had nested regularly in Gujarat State. They were recorded only twice out side Gujarat State, *i e* in Rajasthan, however their nesting in that state was on a small scale and there are no further records of their breeding in other states of India. Apparently, Gujarat state seems to be the regular breeding site of Lesser Flamingos.

Most of the nesting events of Lesser Flamingos were recorded in the Little Rann They had nested regularly in the Little Rann since 1984 with the gaps of a few years. Hence, during present study it is established that the Little Rann of Kachchh holds the "Regular Breeding Sites" of Lesser Flamingos which was otherwise considered to be an "Alternate Breeding Site".

Inquires from local fishermen of Cherwari revealed that the Lesser Flamingos have been breeding at Purabcheria since two to three generations (Mundkur *et al.*, 1989; Present Study). They bred successively for three years at the same site during the present study. Hence Purabcheria is the "Traditional Breeding Site" of Lesser Flamingos.

Evidences also suggest that the site near Zinzuwada is a "Traditional Breeding Site", as the Lesser Flamingos were recorded nesting there for a consecutive four years 2001-2004.

Earlier record of mass breeding in 1998 (Singh *et al.*, 1999) was also from the same site. The nest site recorded by Uday Vora in 1985 also seems to be the same. Hence, Lesser Flamingos have been breeding near this site at least since 1984 or even earlier. Hence, the Little Rann holds at least two "Traditional Breeding Sites" of Lesser Flamingos.

The Lesser Flamingos were recorded breeding at the Flamingo City only once (Ali, 1974). Thereafter, they were not reported nesting there. He believed that their nesting on Flamingo City in 1974 was due to some hydrological disturbance caused by constructing of the bund across the Little Rann on Banas River outflow for national highway to Kandla in the southern section, forcing the Lesser Flamingos to shift from their suspected breeding ground to the Great Rann of Kachchh (Ali, 1974). Review of nesting history and current study have provided documentary evidences to support Ali's (1974) hypothesis that the Little Rann of Kachchh may be a traditional breeding ground of Lesser Flamingos.

Sighting of large number of small chicks in the Rann around Bela, suggested that this part of Rann had been used by Lesser Flamingos for breeding at least in 2003. However the exact nesting site in this area is to be located. This is the second report of Lesser Flamingos breeding in the Great Rann, a new location of breeding altogether.

4.1B: Greater Flamingos

The Greater Flamingos are known to breed in India since 1893. This section deals with the complete account of breeding records of Greater Flamingos in India.

Past Records:

The credit for the discovery that the Greater Flamingos breed in Indian subcontinent goes to Late Shri Khengarji of Kachchh, who found them breeding in the Great Rann of Kachchh, in Gujarat for the first time. He received a letter describing the nesting of Greater Flamingo in the Rann from an official of Khadir, on October 23, 1893 along with about 20 eggs, two recently hatched chicks and a few photographs of nesting colony. The flamingos had nested about eight miles to the north-east of the Pachchham bet (later on this place was known as "Hanj bet" or "Flamingo City"). He wrote a letter describing the nesting event of Greater Flamingo to Mr. L. D. Lester, who published a note on breeding of Greater Flamingo in India and suggested that the Maharao Khengarji should be considered to be the first to report the breeding of Greater Flamingos in India (Lester, 1893) (Table 4.1b).

Shri Khengarji made inquiries to know whether the flamingos continued to breed and found that they bred fairly regularly in the Rann, except in years of a scanty rainfall. On November 6, 1903, Shri Khengarji again received a large numbers of eggs and 3 chicks, not fully fledged, along with some photographs of colony. The flamingos had nested again at the same site in the Great Rann (Khengarji, 1904) (Table 4.1b).

Leter the breeding colony was visited by McCann in 1935, and a successful nesting was recorded (McCann, 1939). The nesting was over when he visited the site, however he could see large number of non-flying juveniles of various stages (Ali, 1945).

During October, 1943, Salim Ali visited the City, after he was informed that 7,000-8,000 flamingos had gathered at Flamingo City. However, when he visited the site, the birds had deserted the area as water had started receding fast. By observing the imprints of the feet

of flamingos amongst the nests, fresh scoop in mud and partial re-plastering of old nests mounds, he concluded that flamingos had attempted to nest but deserted the colony as water receded.

After the heavy rain of 1944, a patrol party sent by Maharao Vijayrajji found flamingo concentrated and nesting in great abundance in March, 1945. In April 1945, Maharao sent a shikari to obtain confirmation and graphic record. He returned with excellent photographs showing large number of birds at the nests. Salim Ali, then visited the nesting site with Sir Peter Clutterbuck on April 19, April 21, and April 22 in 1945. He found the nesting colony situated directly north-east to Nir (Nirwandh), 6-7 miles out in the Great Rann. The colony was on a dry island and covered an area of 10,000 square yards with and average of 131 nests per hundred square yards. A total of 1,23,245 nests were counted of which, 1,04, 755 were active. The number of adult birds present in this colony was estimated at 2,09,516 and that of young 69,839 while the total population was including young and non-breeding birds estimated to be about half a million (Ali, 1945; Ali, 1954).

After the good rainfall of 1959, Ali again visited the Flamingo City on March 21, 1960 with Charles Ho and found Greater Flamingos nesting. The number of flamingos (adult and juveniles) estimated by him was 1 million (Ali, 1960). After Salim Ali's visit, the Flamingo City was visited by Shri Shivrajkumar, Dr. R. M. Naik and Shri Lavkumar in the same year on April 21, 1960. They found six separate groups of nests. About 2,000 nests were still occupied (Shivrajkumar, *et al.,* 1960) (Table 4.1b).

In the 1973, Great Rann was deeply inundated by Luni River. Dr. Philip Kahl, who was doing comparative study of all the flamingo species of the world, flew over the breeding ground on November 15, 1973 and took aerial photographs. He estimated about 10,000 nests in two sectors of the City of which 7,132 nests were in occupation. He did not find Lesser Flamingos breeding along with Greater Flamingos. The City was also visited by Salim Ali with Shri Shivrajkumar and Shri Ramsinhji Rathod on January 24, 1974. They recorded 25,000-30,000 flamingos breeding at the site (Ali, 1974) (Table 4.1b).

In 1978, Shri Krupanidhi, a Border Security Force Official, visited the nest site on August 6, and found hundreds of nest mounds with scattered unhatched eggs of last year *i.e.* 1977 (Krupanidhi, 1978). Greater Flamingos were also believed to be nesting at the city, in 1976 (Negi, 1993) (Table 4.1b).

In 1981, flamingos were recorded breeding at a new site, other than the Flamingo City for the first time. About 5,000-6,000 Greater Flamingo and 70-80 nests, in 5-6 different groups on the bank of lake were recorded at Thol Bird Sanctuary, 30 km from Ahmedabad, in Mehsana district on June 21, 1881. Young ones were also noticed. As the flamingos were not recorded breeding in the Great Rann of Kachchh since 1977, it was suspected that they had shifted their breeding site to Thol Lake (Thakker, 1982) (Table 4.1b).

In 1983, Greater Flamingos were recorded nesting again in the Great Rann, but at extreme western end from the previous nesting location. The birds were expected to gather and start nesting activities in December 1982 or January 1983. The young ones were reported suffering from the drying up of the area and ingress of high tidal water and dying because of exhaustion and starvation in May/June 1983 (Himmatsinhji, 1983).

On October 10, 1984, Shri A. A. Vaidya, Conservator of Forests, Kachchh Circle, located two juveniles in a group of 1,500 adult flamingos at Nani Banni, in the Great Rann. On November 29, 1984, he saw a large number of juveniles in different groups of adult flamingos. He counted 21 juveniles in one such group of 400 adult Greater Flamingos (Vaidya, 1986) (Table 4.1b). The presence of large number of juveniles at Nani Banni, in the Great Rann of Kachchh suggested the successful breeding of Greater Flamingos in the Great Rann. Flamingo had not nested in the Great Rann till 1991.

It appeared that flamingos made an unsuccessful attempt to nest at Shahwadi, Ahmedabad in 1990 (D'Souza, 1998) (Table 4.1b).

In 1991, breeding of flamingos was recorded on a large scale again in Flamingo City by Shri Navin Bapat. A total of 25,000 flamingos in compact area of 3000' X 300' were

recorded at the Flamingo City, from January 8, 1991 to January 10, 1991. About 20,000 chicks of 3-10 days were also recorded in this colony. There were three more similar colonies of flamingos, 5-10 km away from the main site which he could not visit. Total flamingos estimated in the area were 5,00,000 including adults and juveniles (Bapat, 1991). Several other people also visited the City during the same period Total nests in a colony were estimated to be about 14,000 (Negi, 1993) (Table 4.1b).

The flamingos again nested at Shahwadi, near Ahmedabad in 1992 (Tatu, 1997). They were observed displaying and building nests from July 3, 1992 to August 2, 1992 (Table 4.1b). However it was also an unsuccessful nesting attempt.

Greater Flamingos were recorded nesting at the Flamingo City, in 1994 ("Kachchh-mitra" Daily Newspaper, 18-03-1999) (Table 4.1b).

Their breeding was suspected, when large number of Greater Flamingos had gathered at the inundated Rann near Khadir Island, in the Great Rann during October 1997 ("Kachchh-mitra" Daily Newspaper, 04-10-1997). Adult Greater Flamingos were recorded along with about 50 juveniles in the inundated area near Khirajuk Dhandh, on Bhuj-Khavda road during January 1998 ("Kachchh-mitra" Daily Newspaper, 22-01-1998). This suggested that Greater Flamingos had bred in the Great Rann during 1997.

A Forest team recorded successful breeding of Greater Flamingos on a large scale at the Flamingo City in late 1998 and early 1999. The team included D.F.O.-Shri S. K. Chaturvedi, Sub D.F.O.-Shri Dahi, Shri Raesinghji Rathod, Shri Ranjitsingh Jadeja and BSF Sub Inspector Shri Gotya. Totally three nesting colonies were observed and 9,000-10,000 eggs on nests were recorded. The colonies were 200 m away from the main Flamingo City ("Kachchh-mitra" Daily Newspaper, 18-03-1999) (Table 4.1b). An assistant commandant of Border Security Force also recorded nesting of Greater Flamingo at the Flamingo City, in the Great Rann during February-March, 1999 (Tiwari, 2003) (Table 4.1b).

Greater Flamingos were also recorded breeding out side the Gujarat state. Both the species of flamingos were recorded breeding at Sambhar Lake for two successive years in 1995 and 1996 (Kumar, 1996). About 7,000 Greater Flamingos along with 2,500 Lesser Flamingos and large number of nest mounds and hatchlings were reported at Sambhar Lake in January 1995. In January 1996, nearly 20,000 adults of both the species of flamingos along with 1,500 chicks were recorded at Sambhar Lake (Kumar, 1996).

There are no records of Greater flamingos breeding in other states of India besides Gujarat and Rajasthan.

Present Study Records:

Greater Flamingos were confirmed (by the presence of larger sized eggs among the eggs of Lesser Flamingos) having nested on a small scale in the Little Rann of Kachchh during 2002 (Table 4.1b). However their number was comparatively very low in both the nesting sites at Little Rann of Kachchh.

In August, 2003, Greater Flamingo were reported nesting in salt pans along with the Lesser Flamingos in the Little Rann of Kachchh. A total of 30,000 adults of both the species were found nesting and 5,000-6,000 nests were recorded on August 29, 2003 (Parejia, 2003, *Pers. Comm.*). However, all the nests were washed out due to flooding water of Rupen river on August 31, 2003. Measurements of several larger sized eggs, amongst the eggs of Lesser Flamingos in November 2002 and September 2003 from the same colony, suggested that the Greater Flamingos also made attempts of nesting there (Present Study).

During October 2003, large numbers of eggs of Greater Flamingos were observed at Nada bet, Suigam, Asara, Mavasari, Gatka bet, Karni, Masali and surrounding areas in the Great Rann of Kachchh The eggs were drawn by flood of August 2003 and accumulated in these areas. The measurements of the eggs confirmed their identification. This suggested that the Greater Flamingos had also attempted to nest some where in the Great Rann away from its traditional nesting site of Flamingo City. However the actual colony could not be discovered.

Table 4.1b: Nesting Events of Greater Flamingos in India

No.	Year	Reference	Place	Remarks
1	1893	Lester, 1893	Flamingo City, GRK, Gujarat	First time breeding recorded by Shri Khengarji.
2	1903	Khengarji, 1904	Flamingo City, GRK, Gujarat	A large number of eggs and 3 chicks received along with photographs of colony
3	1935	McCann, 1939	Flamingo City, GRK, Gujarat	Successful breeding of Greater Flamingo
4	Oct, 1943	Ali, 1945	Flamingo City, GRK, Gujarat	Birds attempted nesting but immediately deserted the colony due to receding water
5	April 19-22, 1945	Ali, 1945; Ali, 1954	Flamingo City, GRK, Gujarat	1,23,245 Nests; 69, 839 young ones; 2,09,516 adult breeding; total half million GF
6	March, 1960	Ali, 1960	Flamingo City, GRK, Gujarat	1 million GF (A+ Juv.)
	April, 1960	Shivrajkumar *et al*, 1960	Flamingo City, GRK, Gujarat	Six nesting colonies; 2000 nests
7	Nov 15, 1973	Ali, 1974	Flamingo City, GRK, Gujarat	Dr. Philip Kahl found 7132 active nests of the total 10,000
	Jan 24, 1974	Ali, 1974	Flamingo City, GRK, Gujarat	25-30,000 Greater and Lesser Flamingo
8	1976	Negi, 1993	Flamingo City, GRK, Gujarat	Flamingos were reported breeding at the city
9	1977	Krupanidhi, 1978	Flamingo City, GRK, Gujarat	Visited the site in August 6, 1978 and reported nests of previous year.
10	June 21, 1981	Thakker, 1982	Thol Lake, Mehsana, Gujarat	5000-6000 GF; 60-80 nests in 5-6 groups; young ones were also noticed
11	Dec, 1982–Jan, 1983	Himmatsinhji, 1983	Flamingo City, GRK, Gujarat	GF breeding in western side of the previous location of nest site.
12	Late 1983-Early 1984	Vaidya, 1986	GRK, Gujarat	Two Juv. in a group of 1500 adult GF at Nani Banni, on October 10, 1984; large number of Juv. in different groups of adult GF seen on November 29, 1984
13	1990	D'Souza, 1998	Shahwadi, Ahmedabad, Gujarat,	Unsuccessful nesting attempt
	January, 1991	Bapat, 1991	Flamingo City, GRK, Gujarat	25,000 flamingos; 20,000 chicks; half million GF (A+ Juv.)
	January, 1991	Hussain, 1991	Flamingo City, GRK, Gujarat	1000-1500 nests, 900-1000 chicks, 10,000 birds
14	January, 1991	Negi, 1993	Flamingo City, GRK, Gujarat	14000 nests of Flamingos
15	July 3-Aug 2, 1992	Tatu, 1997	Shahwadi, Ahmedabad, Gujarat	Unsuccessful nesting

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No.	Year	Reference	Place	Remarks
16	1994	"Kachchh mitra" News Paper of 18-03-99	Flamingo City, GRK, Gujarat	GF bred at Flamingo City
17	1995	Kumar, 1996	Sambhar Lake, Rajasthan	7,000 GF+2,500 LF and 1,100 Nests
18	1996	Kumar, 1996	Sambhar Lake, Rajasthan	1500 chicks, 20,000 GF+LF
19	1997	"Kachchh mitra" News Paper of 22-01-98	Flamingo City, GRK, Gujarat	50 juveniles with adult GF recorded at the inundated area around Khirajuk, on Bhuj-Khavda Road, in GRK
	Late 1998-Early 1999	"Kachchh mitra" News Paper of 18-03-99	Flamingo City, GRK, Gujarat	3 Nesting colonies; 9,000-10,000 eggs
20	Feb-March, 1999	Tiwari, 2003	200m away from the Flamingo City, GRK, Gujarat	A BSF Official recorded breeding of GF from February, 1999 to March, 1999
21	2002	Present Study	Salt Pans near Zinzuwada, in Little Rann, Gujarat	A few Greater Flamingos attempted to nest
22	August, 2003	Present Study (Parejia, 2003; *Pers. Comm.*)	Salt Pans near Zinzuwada, in Little Rann, Gujarat	Total 30,000 adults of both the species were found nesting and 5000-6000 nests were recorded on August 29, 2003. Unsuccessful nesting due to flood.
23	August, 2003	Present Study	Away from Flamingo City, in NE parts of GRK	A large numbers of eggs found on the fringes of GRK, largely drawn along with the flood water
24	October 2003	Present Study	GRK, Gujarat	Eggs drawn by the flood water, observed at Nada, Suigam, Mavasari, Asara, Gatka, Karni, Masali and surrounding areas of Great Rann; Unsuccessful breeding
25	October 2003-April 2004	Present Study	Flamingo City, GRK, Gujarat	7, 000 A + 14, 000 Juv. Recorded in February 2004.
26	July 2-3, 2004	Present Study	Purabcheria, near Cherwari, LRK	52 GF displaying along with 3,00,000 LF; probability of their breeding

GF-Greater Flamingos; LF-Lesser Flamingo; NE-North-East; No.- number; A-adult; Juv.-Juveniles; GRK-Great Rann of Kachchh; *Pers. Comm.*- Personal Communication

(B) Great Rann of Kachchh:

During October 2003, large numbers of eggs of Greater Flamingos were observed at Nada bet, Suigam, Asara, Mavasari, Gatka bet, Karni, Masali and surrounding areas in the Great Rann of Kachchh. The eggs were drawn by flood of August 2003 and accumulated in these areas. The measurements of the eggs confirmed their identification. This suggested that the Greater Flamingos had also attempted to nest some where in the Great Rann away from its traditional nesting site of Flamingo City. However the actual colony could not be discovered.

During the present study, Greater Flamingos were confirmed breeding at the Flamingo City. Their breeding activities started from October 2003 and terminated in April 2004. A total of 21,000 Greater Flamingos (7,000 Adult + 14,000 young ones of various age groups) were counted in the colony in February 2004.

Conclusions:

Comparison of the past nesting events of Greater Flamingos showed that they had nested regularly in Gujarat state. They were recorded breeding twice only out side Gujarat state, *i.e.* at Rajasthan, however their nesting in this state was on a small scale and there are no further records of their breeding either from this state or other states of India. Hence the state of Gujarat stands as the regular breeding site of Greater Flamingos.

Most of the breeding events in Gujarat occurred at the Flamingo City, in the Great Rann of Kachchh. The nesting attempts at other sites were unsuccessful. Hence, the Flamingo City is the "Traditional Breeding Ground" of Greater Flamingos.

The large number of eggs collected in different areas of the Great Rann after the flood suggested their probability of breeding some where away from the Flamingo City in the Great Rann.

Small scale nesting of Greater Flamingos in the Little Rann of Kachchh suggested that they do make nesting attempts regularly. Confirmation of nesting of Greater Flamingos in the Little Rann is new information. As they make regular attempts of nesting in Little Rann, this site can be considered as "Alternate Breeding Sites" of Greater Flamingos.

Their nesting attempts at Thol Lake, in Mehsana district and Shahwadi, in Ahmedabad district, suggested that they also explore other suitable sites and even attempt to breed at such sites, when conditions are not favorable at the Flamingo City.

4.2 Breeding Sites:

In the Indian subcontinent, Greater Flamingo and Lesser Flamingo are known to breed in the state of Gujarat regularly. Great Rann of Kachchh is the well-known breeding site of flamingos where they are recorded breeding successfully. Their regular breeding sites in Rann of Kachchh are:

1. The Flamingo City in Great Rann of Kachchh
2. The Purabcheria, near Cherwari village in Little Rann of Kachchh
3. The salt pans near Zinzuwada village in Little Rann of Kachchh

All these breeding sites are part of protected areas. Flamingo City, of the Great Rann is a part of "Kachchh Desert Wildlife Sanctuary" and the other two breeding sites at the Little Rann are part of "Wild Ass Sanctuary"

Greater Flamingos had made unsuccessful attempts to breed at Thol Lake of Mehsana district and Shahwadi sewage of Ahmedabad district on a small scale. Lesser Flamingos had also made unsuccessful breeding attempts at Porbandar.

Beside their traditional breeding sites, both the species of flamingos were reported breeding successfully, on small scale, at Sambhar Lake in Rajasthan for two successive years of 1995 and 1996 (Kumar, 1996).

Great Rann of Kachchh:

Kachchh Desert Wildlife Sanctuary

"Kachchh Desert Wildlife Sanctuary" is the largest sanctuary of Gujarat state, located in the northwest part of Kachchh district bordering Pakistan and Wild Ass Sanctuary. It has a total of 7,505.22 sq. km area of which, 109.00 sq. km is the forest area, notified under section-4 of the Indian Forest Act, 1927 and 1,313.07 sq. km is the revenue wasteland. The sanctuary was established in February 1986 to preserve the nesting ground of flamingos (Singh, 2001).

There are 42 villages in and around the sanctuary distributed in four talukas. Some of these villages are Kuran, Dhanivandh, Juna, Dedhar Moti, Udai, Jarmariwandh, *etc.* on the western side; Umedpar, Dharmpur, Amrapar, Morgar, *etc.* on the southern side; and Jesada, Narayanpur, Dudanavandh, Sanpur, Desalpar, Navagam *etc.* on the eastern side of the sanctuary. Northern most side of the sanctuary includes international border between India and Pakistan. The nearest towns are Rapar, Bhachau and Bhuj. Four hilly areas of the sanctuary are Pachchham bet (which includes hilly area called Kala Dungar), Khadir and Bela of Kachchh and Chorar of Patan district (Fig. 4.2a).

1. Flamingo City:

Flamingo City (24^0 03.749'N; 70^0 02.671'E) is the known traditional breeding site of Greater Flamingos. It was discovered by Late Shri Maharao Khengarji in 1893. Later, flamingos were frequently recorded breeding at this site, with gaps of a few years in between. As the flamingos are nesting regularly at the same island, this area of the Great Rann is popularly called "Flamingo City" or "Hanj bet" in local language ("Hanj" means Flamingo; "Bet" means island). It is also known as "Anda bet" ("Anda" means "Eggs" in Hindi language); the name given by Border Security Force (BSF) jawans, as they used to find abandoned eggs at this site during their patrolling as soon as the area became approachable.

This nest site is a part of the Kachchh Desert Wildlife Sanctuary and is 25 km northwest to Nirveri and 15 km north to Nirwandh; the two BSF Out Posts located in hilly area of Pachchham bet, called Kala Dungar. It is about 25 km southeast to the Bhedia bet, another BSF Out Post located near international border. The international border between India and Pakistan is just 5-6 km from the Flamingo City. Kala Dungar is a part of long hilly stretch called Pachchham bet. The later is 80 km north from Bhuj, is about 25 km long and 9 km wide and represents highest point (438 m) in the sanctuary (Singh, 2001). The nearest villages are Kuran, Dhrobana, *etc.* located in the Pachchham bet. The nearest town is Khavda, which is about 20 km south to the Kuran (Fig. 4.2a).

The Greater Flamingos were recorded breeding on an island (Present Study) as well as on the plain land, around the bet (Past Records). The island was about 500 X 250 m^2 in

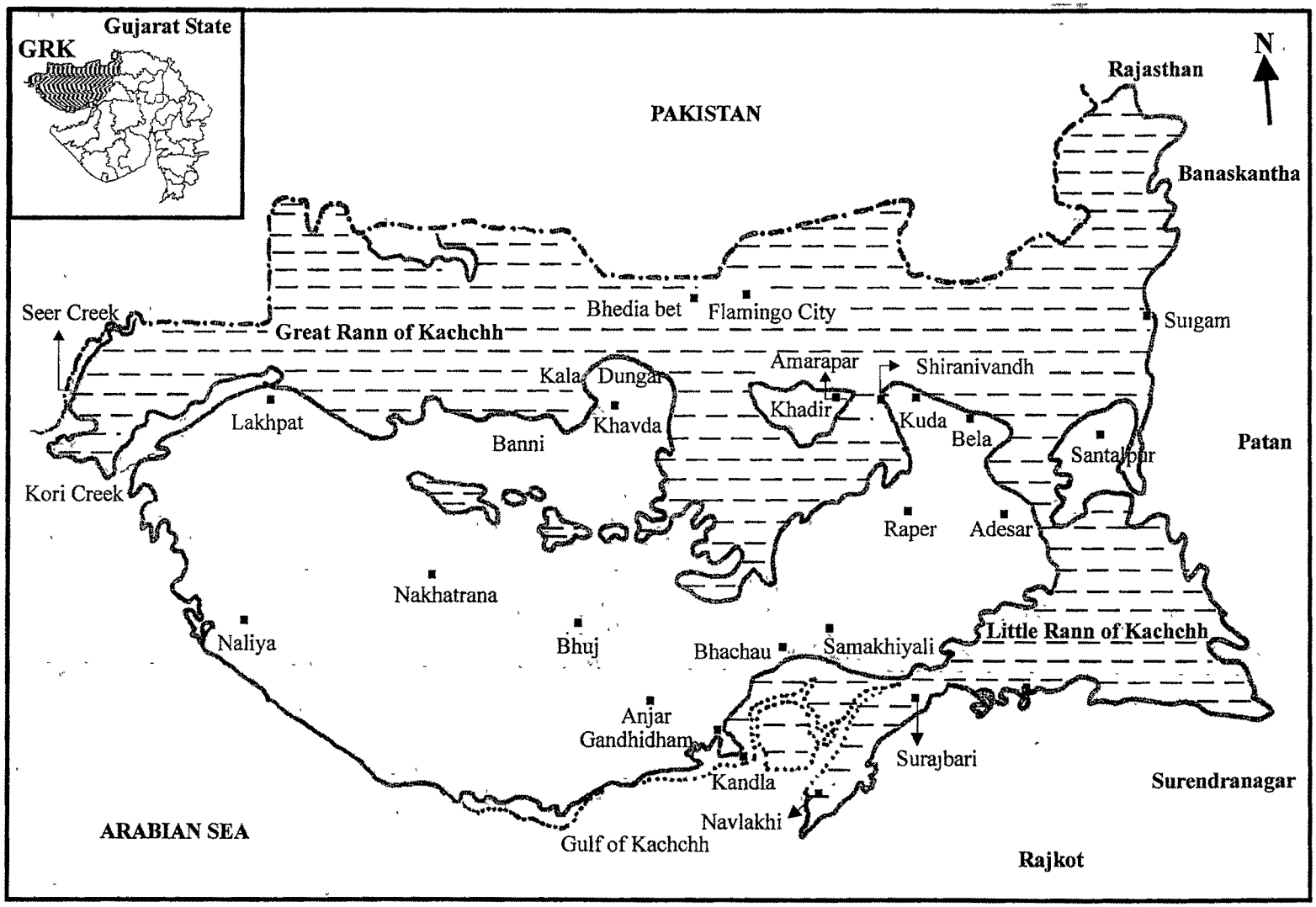


Fig. 4.2a: Traditional Breeding Site of Greater Flamingos

size. It was about 160-180 cm in height at its west and southwest corners, sloping gradually to about 40-60 cm at north and northeast sides. It is a barren, elevated mudflat without trees or shrubs but have some patches of grass, *Sporobolus virginicus.*

This area is a salt-impregnated sun baked undulating mudflats, like the other parts of the Great Rann. It gets inundated by the rain water and also by flood water from the rivers of India and Pakistan. The mixing by fresh water in the salt impregnated area makes it inundated with mixed/brackish water. Kori Creek and Seer Creek join the Rann with the Gulf of Kachchh. Tidal waters come through Kori Creek, flow into the western parts of the Rann and circulate through anastomosing channels into the Rann throughout the year. During pre-monsoon (May-June) and monsoon (July-September), the height of the tidal water increases. Driven by winds, this water spreads further eastwards up to India Bridge. Inflow of rain water into the Rann, mix up with the sea water and turns the Rann into a continuous shallow marsh. As soon as the water starts receding, this continuous water body gets disconnected at several places, retaining water in shallow areas. Salinity of the water increases with the process of evaporation. On total drying, this Rann once again becomes salt encrusted mudflat.

Little Rann of Kachchh:

Wild Ass Sanctuary

The "Wild Ass Sanctuary" is located between 22^0 55'N to 24^0 35' N latitudes and 70^0 30'E to 71^0 45' E longitudes. It is spread over Kachchh, Patan, Surendranagar and Rajkot districts of Gujarat state. The sanctuary covers an area of about 4,953.7 sq. km comprising of the Little Rann and the adjoining wastelands. Of this, 3,569 sq. km comprises fringe areas of Little Rann and the remaining 1,384 sq. km falls in 107 villages of four districts. Tikar, Dhrangadhra, Malwan, Bajana, Kharaghoda, Odu, Zinzuwada of Surendranagar district; Santalpur, Visnagar of Patan district; and Rapar, Adesar and Gagodar of Kachchh district are some notable towns/villages around the Little Rann.

The area is characterized by vast, salt-impregnated, sun-baked mudflats, which are dotted with small islands called "bets". Some of the bets are Dongi bet located towards north, Nanda and Shedwa towards the northwest side, Pung, Khijadia, Dhut, and Mardak located nearly in the middle; Jalandhar bet towards the southeast side; Wasraj Solanki bet and Achewada towards the eastern side and Keshmara, Ratadia towards the southern side of the Little Rann of Kachchh. The mudflats remain submerged for about 4-5 months of a year under fresh water received from a few rivers like Banas and Saraswati, Rupen from northeast side of the Rann and saline water from the Arabian Sea through the Hadakiya Creek and its channels. The rivers like Machchhu, Bambhan, Kankavati and Falku also enter the Little Rann from southern side (Fig. 4.2b).

2. Purabcheria, near Cherwari Village:

This nesting site was discovered by Mundkur and his team. The nesting activity of Lesser Flamingos was recorded since 1986 (Mundkur *et al.*, 1989). This nest site is a part of "Wild Ass Sanctuary" and is located at the western most part of the Little Rann of Kachchh.

A creek called "Hadakiya" enters the Little Rann from the western side and joins it with the Arabian Sea. At the mouth of Little Rann, two bridges are built over which the National Highway 8A (NH 8A) and the railway line from Surendranagar district pass to Kachchh. At the eastern side of these two bridges, a village called Cherwari is located. The two well known towns nearest to Cherwari are (i) Malia of Rajkot district and (ii) Surajbari of Kachchh district (Fig. 4.2b).

Purabcheria (23^0 13.429'N; 70^0 45.583'E) about 5-6 km east to Cherwari village, is a vast, open mudflat area with few patches of mangrove plants, few stunted bushes of *Tamarisk* sp. and *Saccharum* sp. at some places (Fig. 4.2b). Purabcheria is built on slightly elevated area of silt.

The tidal water enters through the Hadakiya creek, flows under the bridges and passes the village to circulate through anastomosing channels extending 3-4 km into the Rann throughout the year. The height of tidal water increases during the pre-monsoon (May-June)

and monsoon (July to September) period. The water is spread further east into the Rann by winds. Addition of rain water, converts the dry salt encrusted mudflat into damp ground and finally into a shallow marsh.

Local inquiries suggested that the flamingos were nesting at this site since three generations of the present fishermen, living in the nearby villages (Mundkur *et al*, 1989; present study), hence it is the "Traditional Breeding Site" of Lesser Flamingo.

3. Salt Pans near Zinzuwada:

This nesting site is located more or less in the central region of the Wild Ass Sanctuary. Large numbers of flamingos are recorded nesting within 5-6 different salt pans separated from each other by a minimum distance of 100 m to more than 5-6 km. The nesting area is about 9 km west from Jalandhar bet and about 7 km south from Wasraj Solanki bet. The nearest villages are Zinzuwada of Surendranagar district, located about 25-30 km east and Kuda about 35 km south to the nesting site.

The saline water from Arabian Sea enters into the Little Rann through Hadakiya creek and spreads through different channels during high tide. It gets fresh water during monsoon and also receives flood water from the rivers Rupen, Banas, Machhu and Saraswati. Hence, the entire area gets inundated by mixed water in the monsoon.

Comparison of the past records of breeding of Lesser Flamingos and the present study revealed that they had nested regularly on large scale at the salt pans near Zinuwada; hence, this site is the "Traditional Breeding Site" of Lesser Flamingos. The Greater Flamingos are also recorded making nesting attempts on a small scale at this site regularly. This site is therefore an "Alternate Breeding Site" of Greater Flamingos.

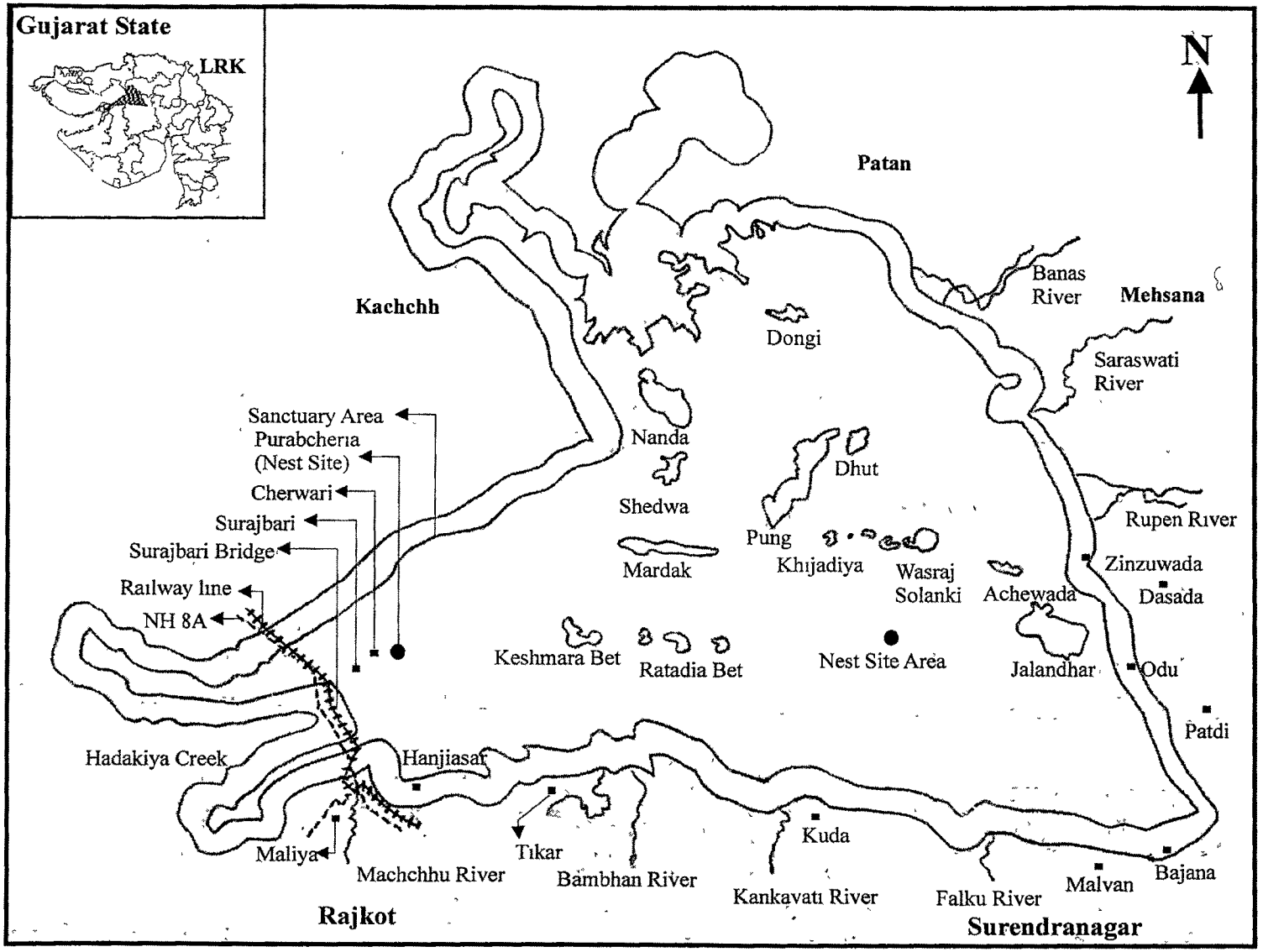


Fig. 4.2b: Traditional Breeding Sites of Lesser Flamingos

4.3: Nesting Season:

Flamingos are known to breed regularly at the Rann of Kachchh. However the information regarding initiation and termination of nesting activity of both the species is lacking. In this section, efforts are made to determine the nesting season of the flamingos at their traditional breeding sites.

Materials and Methods:

The past nesting records of flamingos at their traditional breeding sites at the Great Rann and the Little Rann were referred. The dates of visits by different authors were recorded, and their observations regarding breeding activities and composition of colony were noted. Traditional breeding sites were visited during the study period and observations were assessed to determine the breeding season.

The initiation of breeding activity was extrapolated on the basis of colony composition at the time of visit, and calculating total days required for different stages of breeding cycle with reference to the actual date of visit. For example, (1) Nest building (3-6 days) (2) Egg laying and incubation (28-30 days) (3) Growth period of chick, *i.e.* newly hatched (0 day), 8-10 days old; 30-days old; 90 days old. The young one starts flying at the age of 90-120 days and hence the presence of flying young ones in the colony was also recorded. The culmination of breeding season was arrived at from the actual observations given by different authors as well as from our own observations and inquiries made during the study period.

Results:

4.3A: Lesser Flamingo

Comparing the different breeding events of Lesser Flamingos (Table 4.3a), it seemed that the breeding season of Lesser Flamingo varied at their two traditional breeding sites in the Little Rann.

At Purabcheria, they started nesting activities mostly in June or in early July. They terminated breeding activities in July due to pilferage of eggs from the colony. Certainly, it was never a true termination of breeding activity.

At Zinzuwada, the Lesser Flamingos started breeding slightly later than those breeding at Purabcheria, *i e.* in late July-August and continued their activity till September-October or early November of the same year.

4.3B: Greater Flamingos

Comparisons of past records and present study (Table 4.3b) showed that Greater Flamingos usually started nesting activities during September-October of one year and terminated nesting activities latest by April-May of the next year. There are exceptional records of initiation and termination of breeding. Ali (1945) visited Flamingo City on April 21, 1945 and opined that nesting might have been started in late 1944 or January 1945. As he saw a large part of the colony under incubation, one may presume that the nesting might have continued till June or even beyond which was not confirmed.

Table 4.3a: Nesting Season of Lesser Flamingos

No.	Date of Visit	Reference	Observation	Period of Initiation	Period of Termination
Purabcheria, Little Rann					
1	June 19, 1987	Mundkur *et al*, 1989	16,000 LF; 83 Nests: No eggs	June, 1987	-
	July 19, 1987	"	2000 LF; 288 Nests, No eggs	June, 1987	-
2	June 22, 1988	"	9000 LF; 123 Nests· No eggs	June, 1988	-
	July 9, 1988	"	7000 LF; 183 Nests; Eggs collected by fishermen	June, 1988	July 1988
4	Aug 24, 1998	Singh *et al*, 1999	175 Nests; 2000 LF + 350 GF; 100 Juv; 10-15 abandoned eggs	Late June or early July	Aug, 1998
5	June 2003	Present Study	300 nests in25 different groups	Late June, 2003	June 2003
6	July 2, 2004	"	300,000 LF with 52 GF gathered; 300 Nests; 5 Eggs, Nesting continued	Late June 2004	-
	July 20, 2004	"	964 Nests Eggs stolen	June end 2004	July 2004
Near Zinzuwada, Little Rann					
1	Aug 24, 1998	Vihang, 1999	2000 LF in a colony, three nesting colonies; 39 nests + 4 chicks in one colony	June 1998	Oct 1998
	Sept 20, 1998	Singh *et al*, 1999	a colony of 25,000-30,000 nests, 25,000 chicks and 30,000 LF, spread in 250 acres area	June 1998	-
2	Nov 17, 2002	Present Study	9259 Nests; Nesting was over: Juveniles of 3-4 months observed away from nest site	July 1998	Oct-Nov, 2002
3	Aug 15, 2003	"	25,000 LF and GF nesting	early August 2003	-
	Aug 29, 2003	"	30,000 LF and GF; 5,000-6,000 Nests		August 2003 due to flood
	Sept 9, 2003	"	Colony deserted due to flood	-	-
4	Sept 29, 2004	"	Local Inquiry· 120 nests; nesting continue	August 2004	

LF-Lesser Flamingo; GF-Greater Flamingos; NW-Northwest; N-North; W-West; No.- number

Table 4.3b: Nesting Season of Greater Flamingos

No.	Date of Visit	Reference	Observation	Period of Initiation	Period of Termination
1	1893	Lester, 1893	First time breeding recorded by Shri Khengarji	September 1893	-
2	1903	Khengarji, 1904	A large number of eggs and 3 chicks received along with photographs of colony Flamingo City, GRK, Gujarat	Late September 1903	
2	April 19-22, 1945	Ali,1945	Total 123,245 nests; 104, 755 nests active. 2, 09,516 adult + 69,839 young. Total half million GF	Late 1944 or in January 1945	-
3	March 20, 1960	Ali,1960	Incubation continue Chicks of all age groups, from hatchlings to flying birds present 1 million GF (A+J)	September 1959	April-May 1960
	April 21, 1960	Shivrajkumar, *et al* 1960	Few GF were still nesting	September 1959	April-May 1960
4	Nov 1973	Ali, 1974	7132 nests in occupation observed by Dr. Philip Kahl	October 1973	-
	Jan 24, 1974	Ali, 1974	25-30,000 Greater & Lesser Flamingo nesting	October or November 1973	-
5	Feb-June 1983	Himmatsinhji, 1983	GF recorded in Feb 1983, Nesting activities were believed to be started in Dec 1982 or Jan 1983. Chicks died due to high receding water in May/June 1983	December 1982 or January 1983	May/ June 1983
6	Jan 8-10, 1991	Bapat, 1991	25,000 GF in compact area of 3000'X300' with one chick each. 20,000 chicks of 8-10 days, in the colony. More similar colonies observed. Total half million GF (A+J), recorded.	October or November 1990	–
	Jan, 1991	Hussain, 1991	1000-1500 nests, 900-1000 chicks too small to fly or wade though water, 10,000 birds	October or November 1990	-
	Jan 21, 1991	Negi, 1993	14000 nests of Flamingos	October or November 1990	-
7	Feb-March 1999	Tiwari, 2003	Nesting colony of GF observed by BSF official	February 1999	March 1999
	Late 1998 to Early 1999	"Kachchh-mitra" News paper 18-03-1999	Total three nesting colonies were observed and 9,000-10,000 eggs on nests were recorded	Late 1998 to early 1999	March 1999
8	October 2003	Present Study	Gathering of GF at Flamingo City recorded	October 2003	-
	Feb 28, 2004	"	7,000 adult + 14,000 juveniles of various age groups form hatchlings to flying observed. Total 8678 nests were counted of which, 3750 nests were having fresh eggs	October 2003	-
	April 29, 2004	"	9655 live juveniles + 1102 dead juveniles + 259 adults.	October 2003	April 2004

LF-Lesser Flamingo; GF-Greater Flamingos; NW-Northwest; N-North; W-West; No.- number

4.4: The Nests and Nesting Activity

The flamingos build conical mounds of mud, about 30-40 cm high and 40-50 cm in diameter at the base, which tapers approximately 20 cm across at the top. The top of the mound has a shallow depression in which an egg is laid (Ogilvie and Ogilvie, 1986).

Loose mud is used to make the nest mounds. Building material for the nests is obtained from the area immediately around them, so that the nest itself is surrounded by a depression filled with black slushy mud. Flamingos build nests generally on exposed mud or salt-flats, on small more or less permanent islands standing above the normal level of the water (Ogilvie and Ogilvie, 1986).

Nests are built in colonies. Nest building is done by both the sexes. They build nests by standing astride the nest-site and then leaning down carefully, dragging the tip of its bill through the mud, pulling the mud towards itself and placing it between its legs. The mud is then pressed into place with the bill and feet. As more material is incorporated, the nest begins to take on its familiar cone shape and bird begins to stand on it instead of with a foot on either side. Periodically the nests are repaired also (McCann, 1939; Ogilvie and Ogilvie, 1986).

In this section, the physical characteristics of nests and nesting pattern of both the species of flamingos are dealt with.

Materials and Methods:

Nest Survey:

An intensive nest searching was done at the known regular breeding sites in Great and Little Rann of Kachchh during southwest monsoon, when the area was inundated. Local villagers, the salt pans-owners, the salt pans-workers and officials of Dept. of Forest, Govt. of Gujarat, who regularly visit the interior area of Little Rann were queried regularly about

the arrival of flamingos. Local villagers and Border Security Force officials were also queried about the arrival of flamingos in the Great Rann.

Attempts were made to reach Flamingo City, in the Great Rann from October 2003; however, succeeded only in February 2004. The City was again visited in April 2004. Purabcheria in the Little Rann of Kachchh, was visited in June- July months immediately after the onset of southwest monsoon every year since 2003. The nesting site near Zinzuwada was visited in November 2002, after getting information about the completion of nesting and in September 2003 and 2004, after inundation of the area.

Mode of Travel:

In past, different people visited the Flamingo City by traveling on camel back. During the present study, as the depth of water surrounding the Flamingo City was relatively more, the site was approached by an assault boat provided by the Border Security Force authority.

A hired boat was used during the full moon days to reach to the nest site, at Purabcheria,. However during the low tide days, the nest site was approached by walking about 12-14 km to and fro.

At the Zinzuwada, private tractors were hired from the same village. These tractors were having a carrier called "Supdi" in local language and are specialized for moving in inundated Rann.

Nest Site Selection and Nesting Pattern:

The examination of nesting colonies (*i.e.* location, inundation pattern *etc.*) was done to study the nest site selection. The nesting pattern was identified within the colony.

Nest Measurements:

The parameters such as nest dimensions, nest material *etc.* were worked out. Nests found in different nesting areas, were measured for their dimensions in terms of height,

circumference at the base and top; concavity; and distance from neighbouring nests. The data on various aspects of breeding ecology were recorded in a specifically prepared data sheet.

Nest Material:

The empty nests or part of nest were collected after completion of nesting and brought to the laboratory. The pH of nesting material was recorded. The composition of nesting material was also analyzed.

Nest Building and Repairing activities:

Nest building activities of flamingos were observed at the beginning of breeding season and the nest repairing activities were recorded during the active breeding season.

Results:

4.4A: Lesser Flamingos

Nest Survey:

During the study period, the nests of Lesser Flamingos were observed at Purabcheria and near Zinzuwada, in the Little Rann of Kachchh.

Nest Site Selection and Nesting Pattern:

Lesser Flamingos were observed nesting on the mudflats at Purabcheria and exclusively within the salt pans and its vicinity, at Zinzuwada.

At the Purabcheria, the nests were built in small clusters, distributed over a larger area. The number of nests per cluster varied from 2-90. The distance between the groups varied from 05 to 500 meters. All the nests in a group were of uniform size. Three types of nest groups were identified (Plate 4.4A):

(i) Nests built at the bank of main creek from Hadakiya running interior to Purabcheria, or its branched channels (Plate 4.4A-3)

(ii) Nests away from the creek or channels, in small ditches which held tidal water (Plate 4.4A-4) and

(iii) Nests within the small channels located far interior from the main creek which got surrounded by high tide water during the full moon and no moon day

At the site near Zinzuwada, the nests of flamingos were observed:

(i) On plain land within the salt pans (Plate 4.4A-5)

(ii) On bunds of the salt pans (Plate 4.4A-6)

(iii) On plain land out side the salt pans, but in close vicinity

Nest Measurements:

Nest measurements at Purabcheria and Zinzuwada sites are shown in Table 4.4a. The data shows that values of all the measurements were higher at Zinzuwada than Purabcheria site. At Purabcheria, the nesting site was abandoned within a few days of its establishment whereas at Zinzuwada the nests had remained occupied throughout the nesting season and were repaired regularly.

At Zinzuwada, the height of the nests on bund varied between 5 and 7 cm. The height of bund was 22 cm. Hence the overall height varied between 27 and 29 cm, flamingos obtained the advantage of height of bund. In many nests located on the bunds, the base of one nest merged with the neighboring nest. Such overlapping of the base of the nests was not that prominent in the nests located within the salt pans.

Table 4.4a: Nest Measurements of Lesser Flamingos in Little Rann of Kachchh

Nesting Site	Parameters	n	Min.	Max.	Mean ± SD
Purabcheria	Height	20	06.40	18.00	11.69 ± 3.36
	Circumference at Base	20	105.00	184.00	145.80 ± 21.90
	Circumference at Top	20	57.00	83.00	67.45 ± 06.49
	Inter-Nest Distance	52	48.00	100.00	66.53 ± 12.41
Zinzuwada	Height	39	10.00	29.00	17.89 ± 05.54
	Circumference at Base	39	130.00	227.00	152.8 ± 27.00
	Circumference at Top	39	69.00	97.00	86.0 ± 05.49
	Inter-Nest Distance	134	42.00	98.00	59.0 ± 14.62

The cavity of the nests at both the sites was small and mean depth recorded was less than 1 cm. Looking to the value of circumference at base and top, it is apparent that the nest shape was conical and not cylindrical as found in Greater Flamingos.

Nest Material:

The nests were made of wet mud at Purabcheria, in the Little Rann of Kachchh. The mud was sticky in nature. Its pH was 8.52. No other material except mud was found incorporated into the nest mounds.

At Zinzuwada, the nest mounds were made up of sandy soil. In a few nests, feathers were also incorporated. However the soil was not sticky.

Nest Building Activities:

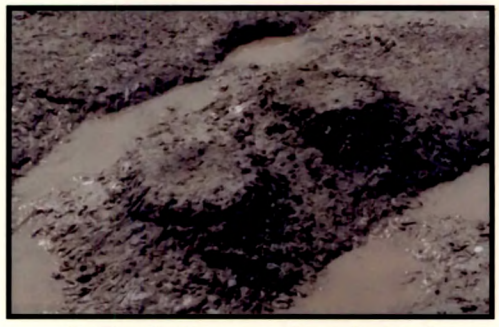
Nest building activities of Lesser Flamingos were observed at Purabcheria, on July 2, 2004. About 600 birds were engaged in nest building activity. They were building nests at the edge of branched channels of main creek running interior into the Rann. The channels were about 1 m wide and having loose mud. Its depth was 15-20 cm. The loose mud from the channel was used to build the nests (Plate 4.4 A-7, 8).

Both the male and the female were involved in nest building. They could be identified by their uneven size. The mud was scooped from the channel by beak and thrown on the edge. Once appropriate amount of mud was collected, the birds gave shape by their feet and bills. They were pressing the top by feet. Once the shape was given, they again started collecting and depositing mud. While one bird was building the nest, another of a pair remained close to it. In some cases, both male and female were simultaneously making nest. One bird was observed standing within the channel and throwing the lumps of mud on the bank.

Once the appropriate size of mound was made, some birds sat on top of the nest, and increased its height by dragging the mud with the help of beak from all sides of the nest towards its top.

Plate 4.4A : Nests of Lesser Flamingos in Little Rann of Kachchh

1. Abandoned Nests at Zinzuwada



2. Fresh Nests at Purabcheria

3. Nests at the Bank of a Channel

4. Nests in a Ditch

5. Nests within the Salt Pan

6. Nests on Bunds

7. Mud from Channel Used for Nest Building

8. Nest Buillding

The nest building activity was not continuous. At some intervals, all birds were rubbing their beak with their tibio-tarsus. Hence, the entire leg was covered by muddy layer. This was a very typical behavior and seemed to have some significant function as all the birds building nests were performing this behavior at some intervals. Probably they were removing the sticky mud adhered to the beak before it dries.

While building the nest, both the partners constantly showed aggressive behavior, raising their scapular feathers constantly and hooking at the neighbor occasionally.

4.4B: Greater Flamingos

Nest Survey:

The nests of Greater Flamingos were recorded at Flamingo City, in the Great Rann of Kachchh during the study period.

Nest Site Selection and Nesting Pattern:

At Flamingo City, a total of 8,678 nests of Greater Flamingos were recorded built on a small island, measuring 250 m wide and 500 m long. The island was 160-180 cm in height at the west and southwest sides and tapering to 40-60 cm to the north and north east side (Plate 4.4B-1).

The nests of Greater Flamingos were uneven in size. Three groups of nests could be identified (Table 4.4b, Plate 4.4B).

I. Low elevated nests. The nests on the west and southwest sides of the island, where the height of the island was 160-180 cm, were comparatively low in height (Plate 4.4B-2).
II. High elevated nests: The nests were very tall at the north, northeast and northwest sides of the island, where the height of the island was 40-60 cm (Plate 4.4B-3).

III. Intermediate type of nests: The nests in the central part of the island were intermediate in height from low elevated to high elevated.

The concavity of the top of the nest was deeper ranging between 1 and 3.5 cm (Plate 4.4B-4).

Nest Measurements of Greater Flamingos:

The nest measurements of three size category (based on placement and height) are given in Table 4.4b. The data showed that there was clear-cut gradient in the size of the nests from northern side to southern side of the island. The values of the measurements of all the parameters were maximum in high elevated nests, minimum in low elevated nests and intermediate in remaining nests. In spite of this, the difference in the values of different parameters of these three nest categories were statistically non significant except for the nest height. Nest height differed significantly in the three categories (F= 51.6, CD at 5% = 4.76, df=15)

In all the three nest size categories, there was not a marked difference in the circumference either at the base or at the top. As a result, the nest appeared like a cylinder rather than a pyramid. This character was prominently different from that of Lesser Flamingos.

Inter-nest distance of Greater Flamingos in all three categories was significantly low (CD = 6.491, df=247, F=65.404) (mean of high elevated nests = 37.00±7.22, CD = 6.491) compared to Lesser Flamingos (mean at Zinzuwada = 59.01± 14.62, CD = 6.491), since, limited space was available for nesting.

Nest Material:

The nests of Greater Flamingos consisted of dry sandy soil. In many nests, feathers were incorporated while in some, the grass, *Sporobolus virginicus* was incorporated. The pH of nest soil was 7.55. In some cases, the eggs were laid down directly on the grassy vegetation of *Sporobolus virginicus*, after pressing and making a comfortable platform for incubation (Plate 4.4 B-5).

Some of the eggs were laid on the soil, which were also being attended to. This may be because the bird did not have time to build nest and egg was ready for laying. Flamingos nesting directly on grass have not been reported before this.

Nest Building and Repairing Activities:

The nest building activities of Greater Flamingos could not be recorded, as the colony was active, when visited and all the flamingos were incubating or rearing their young ones. While incubating, flamingos were constantly raising their scapulars, thereby threatening the intruder and defending the nests. Flamingos defend very small area around the nest, which comes under "Type C" category, of territories described by Perrins and Birkhead (1983).

Greater Flamingos were observed repairing their nests. The birds were lifting dry soil from the base and dragging it to the top with the help of the bill. Fresh marking of bill on many nests was clearly visible indicating the nest repairing activities (Plate 4.4B-6).

Table 4.4b: Nest Measurements of Greater Flamingos at Flamingo City

Nest Pattern	Parameters	n	Min.	Max.	Mean ± SD
Low Elevated	Height	6	8	17	11.33 ± 03.32
	Circumference at Base	6	44	60	51.00 ± 07.21
	Circumference at Top	6	30	45	37.00 ± 04.62
	Inter-Nest Distance	19	20	38	28.31 ± 06.48
High Elevated	Height	5	30	35	33.20 ± 01.92
	Circumference at Base	5	64	83	72.60 ± 06.91
	Circumference at Top	5	46	50	48.40 ± 01.82
	Inter-Nest Distance	20	23	49	37.00 ± 07.22
Intermediate	Height	5	14	25	19.83 ± 05.02
	Circumference at Base	5	60	89	71.16 ± 09.94
	Circumference at Top	5	44	51	55.6 ± 02.91
	Inter-Nest Distance	23	19	44	31.52 ± 06.15

Plate 4.4B: Nests of Greater Flamingos at Flamingo City

1. Nesting Site

2. Low Elevated Nests

3. High Elevated Nests

4. Nest with Deep Cavity

5. Greater Flamingo Nesting on Grass

6. Nest Repairing

Discussion:

Nesting of Greater Flamingos on the island.

The Greater Flamingos were recorded nesting on plain land or on the lower end of the island in inundated Rann during the year 1983, 1991, and 1998 (Himmatsinhji, 1983; Bapat, 1991; "Kachchh mitra" Daily Newspaper, 1999). However nesting on the highest elevated area of the island is not a common phenomenon. It seems that during the year 2003, water depth in the entire Rann was much higher than the earlier years and the flamingos nested on the highest elevated land of the island which was exposed when nesting started in October 2003.

Difference in height of nests on the island:

It seemed that when this area was inundated, the island at its north and northeast side might have been covered totally because of its low height. To keep the top of the nest above the level of water, the flamingos, therefore, built high elevated nests in this part of the island. At the west, southwest side, on other hand, the island stands 160-180 cm high and the flamingos did not have to exert much to keep the top of the nest out of water.

Another possibility of the difference in height of nests is that, after the water receded from the island, the northern part of the island might have been colonized first. The nests were used repeatedly, but as the loose mud was not available, their height was not increased by deposition of fresh mud and they faced wear and tear. On the other side, the southern part of island became available for nesting at later stages. Hence, it was still in contact with water and available loose mud was used to make the nests and repair them. Therefore the nests on this side remained elevated. Since these nests came into existence at a later stage, they were not repeatedly used by several pairs. As a result they had less wear and tear.

Conclusions:

Difference in the nests of two species of flamingos:

The average height of low elevated nests of Greater Flamingos was similar to the height of nests of Lesser Flamingos at Purabcheria. The average height of intermediate nests of Greater Flamingos was similar to the height of the nests of Greater Flamingos at Zinzuwada.

However, there was a marked difference in the maximum height of nests of Greater Flamingo (35.0 cm) and Lesser Flamingo (29.0 cm.)

The circumference of the nest of Lesser Flamingo at the base was more (105-184.0 cm at Purabcheria and 130-227.0 cm at Zinzuwada) than the nest of the Greater Flamingo (44.0-60.0 cm in low elevated and 64-83.0 cm in high elevated nests, at Flamingo City). The circumference of the nest of Lesser Flamingo at the top was also more (57-83 cm at Purabcheria and 69-97 cm at Zinzuwada) than the nest of Greater Flamingo (30-40 low elevated and 46-50 cm high elevated). The concavity of the top of the nests of Greater Flamingo was deeper (1 to 3.5 cm) than the nests of Lesser Flamingos (less than 1 cm).

The comparative measurements of the nests of both the species suggest that the nests of Lesser Flamingos are more conical while those of Greater Flamingos are more cylindrical in shape.

Results:

4.5A: Lesser Flamingo

The eggs of Lesser Flamingos were elongated oval in shape and chalky white in color. One egg was found in most of the nests however, in some, two eggs were occasionally present.

Measurements of a single, freshly laid egg were done at Purabcheria. It was 8.04 X 3.798 cm in size and weighed 110 gm with ESI value of 47.24. Volume of the egg was 59.13 cm^3 (Table 4.5a).

Measurements of eggs were recorded twice, during 2002 and 2003 at the nesting colony, near Zinzuwada. The length of the eggs varied between 7.09 cm and 8.57 cm during 2002, with a mean length of 8.00± 0.35 cm (n=29). The width of the eggs varied between 4.45 cm and 5.19 cm with a mean width value of 4.86± 0.19 cm (n=29). The ESI value during the year 2002 varied from 53.20 to 66.96 with a mean value of 60.79 ± 3.66. The volume of the eggs varied between 76.51 cm^3 and 110.19 cm^3 with the mean value of 96.48 ± 8.46 cm^3 (Table 4.5a).

In 2003, similar values of the measurements of the egg were obtained from the same site (n=23). The length of eggs varied between 7.39 cm and 8.50 cm with a mean length of 7.98 ± 0.30 and the width varied between 4.59 cm and 5.31 cm with a mean width of 4.95 ± 0.15 cm. The mean ESI value of eggs, varied between 57.29 and 67.23, during the year 2003 with a mean value of 64.75 ± 3.56. The volume of eggs varied between 79.4 cm^3 and 111.04 cm^3 with a mean value of 99.88 cm^3 ± 7.87 cm^3 (Table 4.5a)

Table 4.5a: Measurements of Eggs of Lesser Flamingos

Parameter	Length (cm)	Width (cm)	ESI	Volume (cm^3)
Zinzuwada 2002				
n	29	29	29	29
Minimum	07.09	04.45	53.20	76.51
Maximum	08.57	05.19	66.96	110.19
Mean	08.00	04.86	60.75	96.48
SD	± 00.35	± 00.19	± 03.66	± 08.46
Zinzuwada 2003				
n	23	23	23	23
Minimum	07.39	04.59	57.29	79.40
Maximum	08.50	05.31	67.23	111.04
Mean	07.98	04.95	64.75	99.88
SD	± 00.30	± 00.15	± 03.56	± 07.87
Purabcheria 2004				
n=1	08.04	03.79	47.20	59 13

Discussion:

Average size and weight of eggs of Lesser Flamingos, suggested by Ogilvie and Ogilvie (1986) was 7.8 X 4.9 cm and 115 gm respectively. At Purabcheria, the average of 3 eggs of Lesser Flamingo was 7.87 X 4.97 cm (Mundkur *et al.*, 1989). At Zinzuwada, the average length of eggs of Lesser Flamingo was 7.9 cm (Singh *et al.*, 1999). Average size of 20 eggs of Lesser Flamingos at Lake Natron, Tanzania, was 7.85 X 4.93 cm (Brown and Root, 1971).

Conclusions:

The morphometry of the eggs recorded at Purabcheria, during the present study period was very close to the average values recorded in past by Mundkur *et al* (1989).

The average length of eggs of Lesser Flamingo at the site, near Zinzuwada was similar to the ones recorded in past at the same site and very close to the measurements recorded at Lake Natron, Tanzania.

4.5B: Greater Flamingo

Flamingo City was visited during the active nesting season in February, 2004 and the morphometrics of eggs were taken. Most of the nests contained one egg (Plate 4.5-1) but a few had two (Plate 4.5-2). The freshly laid eggs were chalky white while old and deserted eggs had become light brown due to deposition of mud on their surface (Plate 4.5-3). The egg size of Greater Flamingos varied considerably (Plate 4.5-4).

Minimum and maximum length of eggs of Greater Flamingo recorded were 7.97 cm and 9.97 cm respectively. Mean length was 8.83 ± 0.46 cm (n=43). Width of eggs varied between 5.02 cm and 6.10 cm, with a mean width of 5.57 ± 0.18 cm (n=43). Only one egg was having the width value of 6.10 cm, while the width of the rest of the eggs was between 5.02 cm and 5 78 cm. The ESI value varied from 56.64 to 70.55 with a mean value of 63.33 ± 3.24 (n=29). The volume of eggs varied between 1.026 cm^3 and 1.894 cm^3 with a mean value of 1.41 ± 13.75 cm^3 (n=43) (Table 4.5b). The mean egg length (F=107.84, CD at 5% =0.161, df=94) and width (F=324.97, CD at 5% =0.424, df=94) of Lesser Flamingos are significantly different from those of the Greater Flamingos (Table 4.5c).

The mean weight of eggs was 135.76 ± 15.52 gm (n=37) with minimum and maximum values of 114 gm and 179gm respectively. As the flamingos breed asynchronously, the colony contained eggs of different incubation stages; recently laid or fresh eggs could not be identified and hence, the eggs were weighed randomly. As a result, their weight varied considerably. The egg shell thickness varied between 0.0592 cm and 0.0957 cm with a mean value of 0.0797 ± 0.079 cm (n=29) (Table 4.5b).

Incubation:

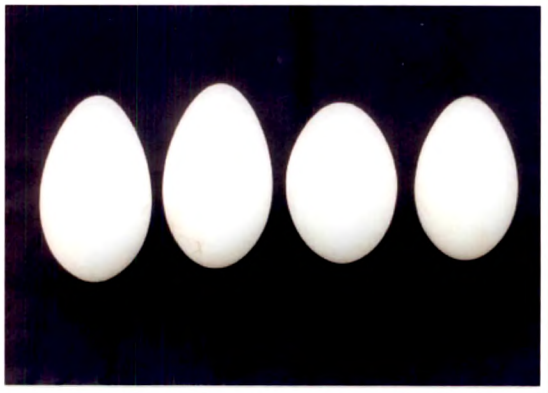
The incubation behavior of Greater Flamingos was observed at Flamingo City, in February 2004. The bird sits on its nest by folding its legs under its body while incubating (Plate 4.5-5). Both male and female were participating in incubation.

Plate 4.5: Eggs of Greater Flamingos

1. Nests with Clutch Size of One Egg

2. Nest with Clutch Size of Two

3. Fresh and Abandoned Eggs



4. Variation in Size of Eggs

5. Adult Flamingos Incubating

Table 4.5b: Measurements of Eggs of Greater Flamingos

Parameter	Length (cm)	Width (cm)	ESI	Volume (cm^3)	Weight (gm)	Egg Shell (cm)
n	43	43	29	43	37	29
Minimum	07.97	05.02	56.64	01.02	179.0	0.0592
Maximum	09.97	06.10	70.55	01.84	114.0	0.0957
Mean	08.83	05.57	63.30	01.41	135.76	0.0797
SD	± 00.46	± 00.18	± 03.24	± 13.75	± 15.52	± 00.079

Table 4.5c: Comparison of Egg Size of Lesser and Greater Flamingos

Parameters	Lesser Flamingo		Greater Flamingo
	Year 2002	Year 2003	Year 2003
Sample Size (n)	29	23	43
Length (cm)			
Range	7.09-8.57	7.39-8.50	7.97-9.97
Mean ± SD	8.00 ± 0.35	7.98 ± 0.30	8.83 ± 0.46
Width (cm)			
Range	4.45-5.19	4.49-5.31	5.02-6.10
Mean ±SD	4.86 ± 0.19	4.95 ± 0.15	5.57 ± 0.18

Discussion:

The average size and weight of eggs of Greater Flamingos as suggested by Ogilvie and Ogilvie (1986) was 9.0 X 5.5 cm and 140 gm respectively.

McCann (1939) recorded the average size of 13 eggs of Greater Flamingos at Flamingo City, in the Great Rann as 8 2 X 5.6 cm with a minimum value of 7.5 X 5.5 and 8.8 X 5.3; and maximum value of 10.0 X 5.9 cm. Average of 100 eggs recorded at Flamingo City, was 8.85 X 5.45 cm (McCann, 1939).

Average size of 100 eggs of Greater Flamingos at Flamingo City recorded by Jourdain was 8.88 X 5.45 cm (Ali and Ripley, 1983). The measurements of three eggs of Greater Flamingos collected from the same site were 8.3 X 5.0 cm; 8.3 X 5.3 cm and 9.3 X 5.8 cm (Ali and Ripley, 1983).

The length of eggs of Greater Flamingos varied between 7.9-10.3 cm (mean 8.83) and width varied between 4.89-5.86 cm (mean 5.39) at the Bredasdorp, South Africa (Uys *et al*, 1963).

Conclusions:

Morphometry recorded at the Flamingo City, during the present study period, are similar to the one taken in the past from the same site, and also very close to the one recorded at Bredasdorp, South Africa.

Measurements of length, width and weight showed that the width was the most constant of all the parameters. This was related to the fact that cross-sectional area of the oviduct from where the eggs originated has a limited extensibility (Romanoff and Romanoff, 1963).

Eggs measured 5.57 % of average adult body weight {average body weight of adult Greater Flamingo= 2,481 gm (Ali and Ripley, 1983)}. The observations agree with the

earlier established fact that the larger birds lay proportionally smaller eggs than smaller birds (Pettingill, 1971; O'Connor, 1985; Mukherjee, 1999).

Comparison of the morphometry of eggs of both the species revealed that the maximum length and width of the eggs of Lesser Flamingos are overlapping with the minimum length and width of eggs of Greater Flamingos. Hence, eggs of both the species falling in this range can not be differentiated. However, eggs of Lesser Flamingos and Greater Flamingos can be identified by their minimum and maximum values respectively.

4.6: Factors Regulating Breeding of Flamingos and Habitat Evaluation through Remote Sensing:

Flamingos bred at the Rann of Kachchh after inundation of the nesting ground by southwest monsoon (McCann, 1939; Ali, 1945, 1960, 1974; Himmatsinhji, 1991). Their breeding attempts were reported to fail during the years when Rann was not inundated. Hence inundation of the breeding ground is the known necessary factor for breeding.

In this section, inundation of Rann and other factors, which also play important roles in regulating breeding of flamingos, are identified and discussed. This section deals largely with the breeding of Greater Flamingos at the Great Rann.

Materials and Methods:

Past records, during which the flamingos did not attempt to breed at the Flamingo City were referred and the physical conditions of the ground were compared with the Remote Sensing images of that duration. The Landsat, IRS P6 and OCM data were used to understand the inundation pattern and inundation period. Similar comparison was done for the years, during which the flamingos bred successfully.

Total precipitation (rainfall in mm) of different years at Bela and Khavda was taken. A record of breeding attempt made by Greater Flamingos at the City was correlated with the precipitation and inundation.

During present study, the Flamingo City and its nearby areas were visited during different periods: (i) initiation of breeding, in October, 2003 (ii) during active breeding, in February 2004 and (iii) at the end of breeding seasons, in April 2004. Habitat evaluation of Flamingo City and surrounding areas was done by Remote Sensing and verified through ground truth studies. The inundation pattern was studied and the food abundance was estimated throughout the breeding season.

Results:

The comparison of breeding events and habitat analysis revealed following factors influencing the breeding of flamingos.

1. Inundation:

(A) Inundation Pattern:

Insufficient inundation:

Greater Flamingos did not attempt to nest during the years, when there was no or insufficient inundation around Flamingo City. They bred successfully in the years with good precipitation *i e* 1959, 1982, 1990 *etc* (Table 4.6). They did not make any breeding attempt in the years of low precipitation. During some years, flamingos started nesting with initial good precipitation *i. e.* 1978, but deserted the colony as the water receded fast (Table 4.6).

Landsat Images of October-November, 1972 showed that the area around flamingo city was completely dry (Plate 4.6-1). The OCM data of October 10, 1999 showed wet soil in some parts of Great Rann; however the area around Flamingo City was totally dry (Plate 4.6-3).

Heavy Inundation of Nesting Grounds:

In November, 1979, Salim Ali visited the Flamingo City. The area was deeply inundated after the southwest monsoon (Table 4.6) and water was up to the stomach of the camel. The water was so deep, that he could not land from the camel back. During this period, flamingos did not breed at Flamingo City (Himmatsinhji, 1991). The Landsat image of January 1980 (Plate 4.6-2) shows deep black color within the Great Rann, suggesting inundation by deep water.

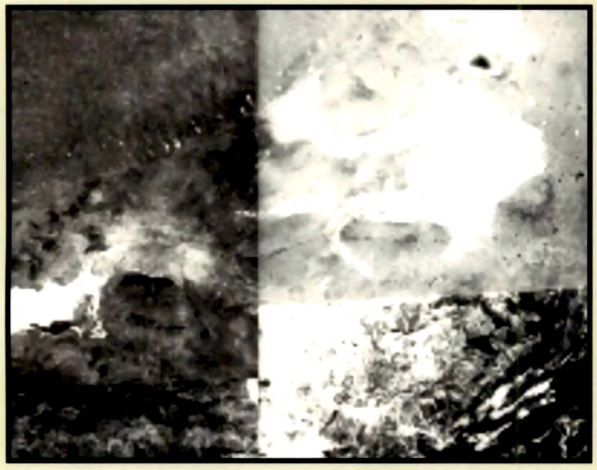
During the present study, flamingos started nesting in October, 2003, though the area was inundated in September 2003. The OCM image of September 29, 2003 (Plate 3.4B-1) showed inundation of the area around Flamingo City by deep water and the island was not visible. The flamingos had not started breeding at the Flamingo City during this period (Present Study).

Table 4.6: Total Precipitation at the Nearest Sites of Flamingo City

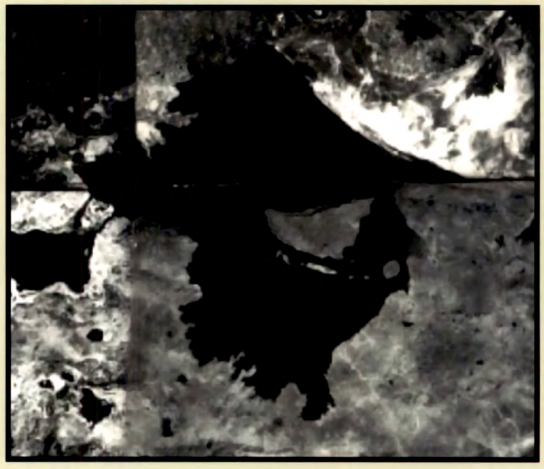
Site	Year	Rainy Days	Total Rain Fall (mm)	Breeding Attempt by GF			
				NI	Successful	Unsuccessful	No attempt
Bela	1976	21	514.0	-	-	√	-
	1977	18	563.0	-	-	√	-
	1978	21	376.5	-	-	√	-
	1979	15	949.5	-	-	-	√
	1980	12	380.5	√	-	-	-
	1982	9	365.9	-	√	-	-
	1983	22	514.0	√	-	-	-
	1985	9	103.0	-	-	-	√
	1988	12	384.2	√	-	-	-
	1989	9	301.0	√	-	-	-
	1990	12	480.0	-	√	-	-
Khavda	1959	27	755.9	-	√	-	-
	1960	4	334.0	-	-	-	√
	1961	32	1042.8	√	-	-	-
	1962	11	171.0	√	-	-	-
	1963	10	145.0	√	-	-	-
	1977	6	296.4	-	-	√	-

GF-Greater Flamingo; mm-milimeter; NI- No information

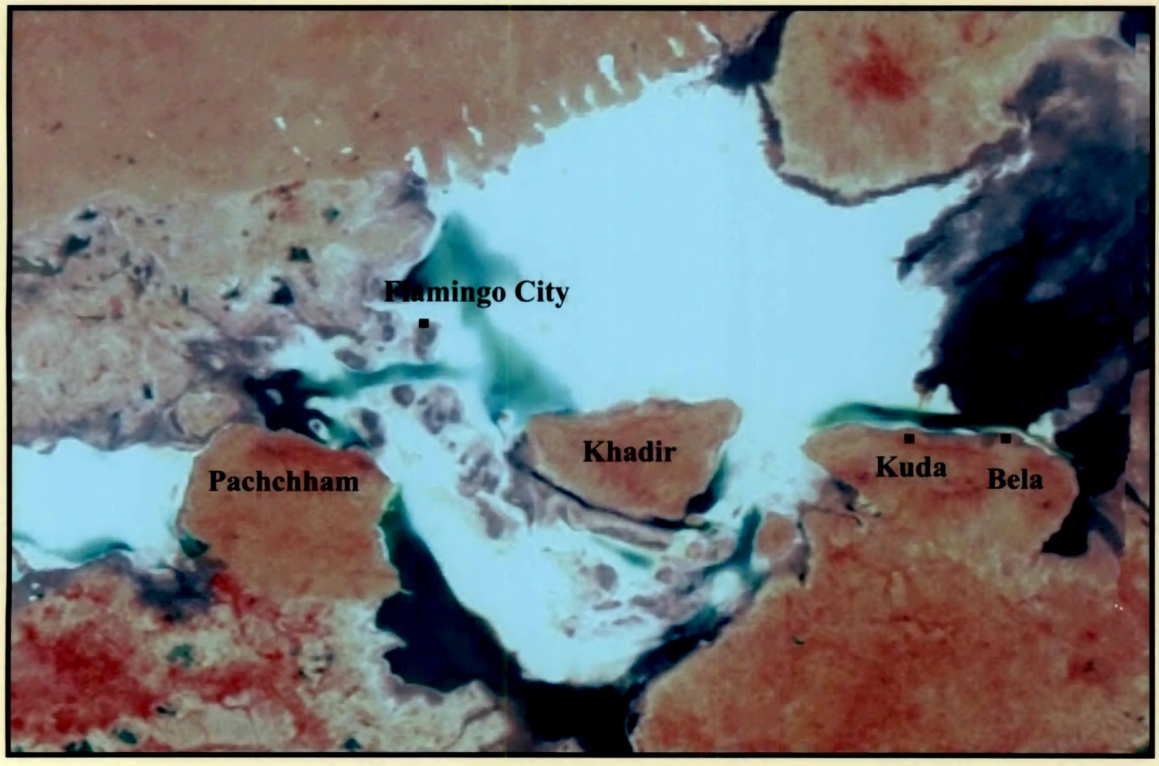
Plate 4.6 : Remote Sensing Images of Great Rann



1. Landsat-1972



2. Landsat- Jan 1980



3. OCM-Oct 10, 1999

Inundation by shallow water:

The depth of water varied considerably from 46 cm to 180 cm around the island during October 2003, when the breeding had just initiated at the Flamingo City. The water was about 10 m away from the nesting site, and the depth of water varied between 40 to 64 cm.

The OCM data of October 15, 2003 and January, 2004 showed inundation of area around the Flamingo City, and very small area of the island was exposed out of water. During three months, there was very little increase in the exposed area of the island.

(B) Inundation by Brackish Water:

Inundation in the Great Rann:

The area of Great Rann is a salt-impregnated sun baked undulating mudflats. The sea water enters through the Kori Creek which spreads into the Rann due to high wind velocity. Rann gets inundated by the rain water and also by flood water from the rivers of India and Pakistan. Addition of fresh water in the salt impregnated area makes it inundated with mixed/brackish water.

Greater Flamingos were recorded breeding at the Flamingo City in the Great Rann, after the area was inundated by the mixed water by addition of rain or flood water to salt impregnated area (Past Records; Present Study).

Inundation in Little Rann:

The tidal water from Arabian Sea enters through Hadakiya creek at the mouth of Little Rann, flows under the bridges and passes Cherwari to circulate through anastomosing channels extending 3-4 km into the Rann throughout the year. The height of tidal water increases during pre-monsoon (May-June) and monsoon (July to September). The water is spread further east into the Rann by winds. The addition of rain water converts the dry salt encrusted mudflat into damp ground and finally into a shallow marsh (Mundkur *et al.*, 1989). The nesting site near Zinzuwada, also receives flood water from the rivers Rupen, Banas,

Machhu and Saraswati, which ultimately flow into Gulf of Kachchh through Hadakiya creek. Hence, the entire area gets inundated by mixed water the in monsoon season.

Lesser Flamingos are recorded breeding during June-July at Purabcheria with the onset of monsoon and during July-August onwards in the salt pans near Zinzuwada after the inundation of area by mixed water. The nest building activities of Lesser Flamingos were observed during July 2004 after the rains in the area. After inundation, the loose mud available in the channels was used for nest building. The site at Purabcheria is under continuous influence of tidal water of Gulf of Kachchh but the Lesser Flamingos breed only during the monsoon. Hence, existence of brackish water around the nest site may be a pre-requisite for nesting.

Apparently, inundation of nesting site by brackish water is important for the flamingos to start breeding activity.

(C) Inundation Period:

About 7,000-8,000 flamingos were reported gathered at Flamingo City in September, 1943 and nesting. However when the site was visited during October, 1943, the flamingos had deserted the area, as the water receded from the nest site area (Ali, 1945).

Large numbers of flamingos were reported to have arrived at Flamingo City on July 1, 1978. The rain started early in July, during this year. However no rain occurred there-after. Hence, when the site was visited on August 6, 1978, the birds had deserted the area (Krupanidhi, 1978).

Comparison of OCM and IRS P6 data of different months revealed that the area of Great Rann was inundated by deep water during September 2003. OCM data of September 29, 2003 showed blackish green color around Pachchham bet, the Khadir island was totally surrounded by deep water and the Flamingo City was not exposed (Plate 3.4B-1). In October, the depth decreased slightly exposing little area of Flamingo City (Plate 3.4B-2). With progressing season, the water depth decreased but major area around Flamingo City

remained inundated. OCM data of April 9, 2004 showed some white areas in green background suggesting dry salt impregnated areas exposed out of water. The blue green color in OCM data, at the eastern side of Khadir island suggested that the water has receded but the area was still wet. Flamingo City was exposed out of water and seen clearly (Plate 3.4B-5). The Greater Flamingos had started breeding at Flamingo City in October 2003 and completed it in April, 2004 (Present Study).

At Laguna Salad, Spain, in 1967, flamingos display copulation activity and initial interest in nests ceased during three months of cloudy, dark and dry weather. However, when it rained, several groups of 15-50 flamingos immediately came to the breeding island, visited old nests and began nesting activities. However, the rain was extremely meager and short-lasting and hence all the nesting interest decreased rapidly (Studer-Thiersch, 2000).

2. Food in Surrounding Water:

In October 2003 and February 2004, 4 food items *viz.* very small sized fishes *Cyprinodon disper,* cysts of *Artemia salina,* and pupae of *Chironomous sp* were recorded from the inundated water and *Chironomous* larvae from the substrate. The adult of *Artemia salina* were absent during the breeding season. The food was abundant in the surrounding water at the beginning and during the active breeding season (Chapter 3.4A). The Greater Flamingos started breeding during October 2003 and continued till February 2004.

There was a 50% decrease in total food abundance in April 2004 compared to February 2004, as the salinity of water increased (Chapter 3.4A). The *Chironomous* larvae and pupae were absent and the *Cyprinodon* fishes died. The number of *Artemia* cyst decreased by 44.49%. At the end of the breeding season, the adults of *Artemia salina* were found, however, most of the adults were dead and floating in the inundated water.

Salinity was affecting the food abundance in the surrounding water (Chapter 3.4A). As the salinity increased, the food depleted and the flamingos terminated breeding in April 2004.

3. Salinity:

Salinity of water at the time of initiation of breeding and during active breeding at the Flamingo City was 51.2 ppt and 66.5 ppt respectively. However the salinity increased tremendously at the end of breeding and was recorded at 80.6 ppt. Salinity played an important role in regulating the breeding of flamingo by influencing the abundance and quality of food in water.

4. Predation:

No Ground predator was observed at the nesting site, at Flaming City during the active breeding period. The inundation of vast area prevents the ground predators to reach the nesting site. Moreover, the entire area gets submerged during heavy inundation and so there are least possibilities for the survival of ground predators. "Predation Free" condition of Flamingo City seems to be the major factor attracting the flamingos to this site.

The inundation makes the nesting ground totally isolated from the mainland. Location of the traditional nesting ground in the remote and sanctuary areas makes them free from human disturbance.

Discussion:

The flamingos did not attempt to breed in the years when the Rann was not inundated. The inundation of nesting ground is an ultimate factor to initiate the breeding activities (Perrins, 1985). Length of the nesting activity depended upon the extent of inundation. This suggested that the duration of inundation should be for the sufficiently long period, *i e.* the period within which the chicks can hatch out and reach the flying stage, which is about 100-120 days.

The heavy inundation during 1979 and failure of nesting attempt by flamingos (as the island was not yet exposed) suggested that the inundation by shallow water is important. The nests should remain out of water, forming an island.

Availability of food in the surrounding environment is an ultimate factor determining the schedule of breeding in birds. The inundation by brackish water generates food preferred by flamingos. During October 2003 the food was abundant (Chapter 3.4), after the area was inundated by mixed water. As soon as the food in the surrounding water depleted, Greater Flamingos terminated breeding activities in April, 2004 and left the nest site, though the water was still available about 500 m away from the nesting site and in larger areas of Rann.

In the Great Rann, the salinity of water was found to be an important factor for the availability of food in the water. As the salinity increased, the food depleted and flamingos terminated breeding. Hence, the salinity also regulates the breeding schedule of flamingos (Chapter 3.4).

Conclusions:

Factors regulating breeding of flamingos:

1. Shallow Inundation of nesting ground by brackish water is an important factor for nesting of flamingos.

- Nest building activities in areas with shallow water suggested that the inundation is important for the nest building activities. Inundation ensures availability of loose mud for making nests.
- Inundation of area by brackish water is important for availability of food around nest site.
- Inundation of area protects the colony from the ground predators.
- The nesting attempts are successful when the inundation by shallow brackish water around the breeding site is for sufficient period, *i.e.* the period during which the young fledgling and grow to flying stage.

2. Food is an ultimate factor for breeding of flamingos. They start breeding when the food is abundant and terminate breeding and desert the colony when the food in surrounding water depletes, even though the area is still inundated.

3. Salinity is an important factor controlling food in the nesting area and thereby regulating the breeding of flamingo.

4.7: Colony Composition of Greater Flamingos:

The flamingos are colonial nesters. The nesting colony is composed of adult birds, eggs and chicks of various age groups. However at different stages of breeding cycle, the composition varies.

Materials and Methods:

The active nesting colony of Greater Flamingos, at Flamingo City, in the Great Rann of Kachchh was visited on February 28, 2004, and the composition of colony was studied.

The numbers of adults, eggs and nests were counted. The numbers of chicks were counted and were categorized according to their age group. The descriptions on the chicks of different age groups given by Uys *et al.* (1963) and Shanon (2000) were referred to identify their age groups. Bill and tarsus measurements as well as the body weight of small and approachable chicks were recorded.

Results:

1. Adult Flamingos

A total of 7,000 adult Greater Flamingos were recorded at Flamingo City. Most of them were on the island and engaged in nesting activity *i e* incubating the eggs (Plate 4.7-1) or raring the chicks and a few were in the nearby water, away from the colony, along with large number of juveniles. The adults were in bright pink breeding plumage, giving pink appearance on the bet from a distance. About 150-200 birds were displaying in water, 500 m away from the island.

2. Eggs

A total of 3,750 eggs were counted at the nesting colony. Most of the nests contained only one egg, while few nests had two eggs. The freshly laid eggs were chalky white and old

and deserted eggs had become light brown due to deposition of mud on their surface. The eggs are described in section 4.5 in more details.

3. Chicks

A total of 14,000 chicks of various age groups were seen at the nesting site. The age of chicks could be identified by their size, plumage color and also from their behavior. The following were the different age groups of chicks observed in the colony.

(1) Newly Hatched Chicks:

About 100 newly hatched chicks were observed at the nesting site. The chicks were precocial, *i.e.* their bodies were covered with grey or whitish grey down and eyes were open. Their beak was straight and bright pink in color with yellowish white egg tooth on the tip of upper mandible. The egg tooth is used to break the egg shell and to come out from the egg. Their legs were comparatively thick and bright red in color with black or grayish black claws. The legs and neck were not disproportionately long.

Few chicks about to hatch, remained inside the eggs and make chipping noise. Some had also made a hole on the egg shell (Plate 4.7-2).

The newly hatched chicks were identified by their wet downy plumage and presence of egg shall within the nest. They were not able to balance their body and were not very active (Plate 4.7-3).

(2) 1-2 Days Old Chicks:

They looked similar to the newly hatched chicks. Their bodies were covered by smooth downy feathers. They were comparatively more active, able to move their body by wings and dragged on abdomen; however not able to stand on feet and remained in the nest only (Plate 4.7-4). The bill and tarsus length of a chick was 2.50 cm and was 3.65 cm respectively. It weighed up to 73 gm.

Some chicks were seen out side the nests. They might have fallen out of nests and remained there only as they could not climb the nests. Totally 900 chicks of 1-2 days old were observed at the colony.

(3) 10 Days Old Chicks:

They were able to stand on their feet and walk slowly. Most of them remained in groups with the adults and did not try to isolate themselves from the group, while some were moving amongst the nests. Progressive darkening of bill and legs could be seen. Bill was straight (Plate 4.7-5). The bill and tarsus length of a chick were 2.75 cm and 4.5 cm respectively. It weighed up to 107 gm.

(4) 15 Days Old Chicks:

The bill and legs were blackish grey. The legs were thick and neck was disproportionately longer than the legs. Slight curvature of bill was observed. Body plumage was dark grey or black. They were slightly larger than 10 days old chicks, and formed groups with 10 days old chicks and adults birds (Plate 4.7-5). They could run fast. A total of 4,000 chicks varying from 10 to 15 days were observed at the nest site.

(5) 30-60 Days Old Young Ones:

The size of the chicks was nearly half the size of adult flamingos. Bill was dark black at the tip and greyish black at the base, and finely curved. The legs were dark black. Their body was covered with blackish downy plumage. Most of them were in water though a few were on the island. They started crèche (group) formation in water and were able to swim (Plate 4.7-6). About 5,000 young ones of 1-2 months were observed.

(6) 90-120 Days Old Young Ones:

They were in water and capable of taking short distance flight. A total of 3000 such birds were observed in water near the nest site (Plate 4.7-7).

Plate 4.7 : Colony Composition of Greater Flamingos

1. Adults Incubating

2. A Chick Hatching Out of Egg

3. A Chick Just Hatched

4. 1-2 Days Old Chick

5. 10-15 Days Old Chicks with Adults

6. 30-60 Days Old Juveniles in Water

7. 90-120 Days Old Juveniles

8. >120 Days Old Young Ones

(7) >120 Days Old Young Ones:

They were nearly the size of adult flamingos, with whitish plumage. Their bill was black at the tip and dull white at the base. The legs were blackish pink (Plate 4.7-8). They were able to fly. A total of 1,000 young ones of this age group was observed in water away from the nesting site.

Conclusions:

The Flamingos bred asynchronously as chicks of all age groups were found in the same colony. The presence of flying young ones in the colony indicated that the nesting activity started somewhere in October 2003.

4.8: Chick Mortality and Habitat Evaluation through Remote Sensing:

During the present study, heavy chick mortality of both the species of flamingos was noted. The factors causing chick mortality were identified and described.

Study Area:

Rann area, within the range of 40-50 km from the Bela and Kuda villages, in Great Rann of Kachchh was surveyed during the study period and heavy mortality of chicks of Lesser Flamingos' was observed.

The Flamingo City in Great Rann was frequently visited during the breeding season and mortality of Greater Flamingos was recorded.

Materials and Methods:

Ground Truth Studies:

Rann area around Bela and Kuda was surveyed on October 19, 2003 to study the population and distribution of flamingos. Total number of adult flamingos and their juveniles were counted. The same sites were visited on December 15, 2003 and December 23, 2003. Habitat evaluation of the sites was done, the water spread area, depth and salinity were recorded.

The Flamingo City and surrounding areas were surveyed during active breeding, on February 28, 2004. Total number of adults and juveniles were noted. The same site was visited on April 29, 2004. Total numbers of dead chicks were counted. Close observation of chicks was done to find out the possible reasons of mortality.

Food abundance in the surrounding environment was assessed during these two periods. Total water spread area, water depth, salinity, pH, ambient and water temperatures were all measured.

Habitat Evaluation through Remote Sensing Images:

Habitat evaluation of this area was done through remote sensing by using OCM and IRS P6 data of different periods to understand the water spread area and inundation pattern. MODIS data and Chlorophyll Map of October 2003 of the Great Rann were utilized to analyze the primary food present in water surrounding the study site. The water depth and spread out area was worked out.

Habitat evaluation of this area was done through Remote Sensing using OCM and IRS P6 data of different periods. Total water spread area, water depth and dry and salt encrusted areas were identified.

Results:

4.8A: Lesser Flamingos

Following two factors were observed causing heavy mortality of chicks of Lesser Flamingos during the study period.

(1) Rapid Receding of Water:

October 2003:

During October 2003, the area of Rann around Bela and Kuda was inundated by shallow water. The depth of water varied from 15 cm to 30 cm. The soil was covered with soft mud. The salinity of water was 55.2 ppt (Table 4.8a). A total of 11,220 chicks of Lesser Flamingos was observed along with 3,100 adults in the Rann around Bela. The chicks were of 10-20 days old with blackish grey plumage and were unable to fly.

OCM data of October 15, 2003 showed blue green colored area at the edge of Bela and Kuda, indicating that the area was inundated with shallow water (Plate 3.4.B-2). The MODIS data of October 2003 (Plate 3.4C-2) showed presence of primary food in the water. From the Chlorophyll map (Plate 3.4C-1), the amount of chlorophyll present in water was estimated to be between 3 to 9 mg /m^3.

December 2003:

The area of Rann around Bela and Kuda had become totally dry in December 2003. Water was absent in most of the areas and available only in a few very small ditches with 10 to 15 cm depth. Salinity of the remaining water was very high (about 85.6 ppt) (Table 4.8a). The soil was covered with thick layers of salt.

Flamingos migrated westwards and were recorded in the Rann around Kuda (23^0 56.809'N; 70^0 38.494'E) on December 19, 2003. A total of 5,600 live chicks and 180 adult Lesser Flamingos were observed in the Rann. The chicks were of various age groups. Most of them were non-flying and only few were free flying.

Heavy chick mortality was observed during December 2003. Totally 2,700 dead bodies of chicks were observed bogged in salt at many places in the Rann (Plate 4.8A-2,5). About 300 chicks were observed lying motionless on the ground or water (Plate 4.8A-3). Most of them did not make any attempt to escape when approached by us for close examination. Careful observation of such chicks revealed deposition of salt layers on feathers of wing, neck, breast and abdomen (Plate 4.8A-4). The salt was also deposited on the legs. The salt was badly stacked in feathers. It could not be removed just by pulling out smoothly (Plate 4.8A-6). These chicks were very weak and about to die. They were unable to walk or stand on their feet, and were standing on their tibiotarsus instead of their feet.

The IRS P6 data of November 22, 2003 showed complete drying of the areas of Rann around Bela and Kuda (Plate 3.4B-3). However, very small points of blue color indicated presence of small patches of water. The white color in the image indicated thick layers of salt in Rann areas around Bela and Kuda. The water was still present around Khadir island, as indicated by dark and light blue colors (Plate 3.4B-3). The comparison of OCM data of October 2003 and IRS P6 data of November 2003 showed that the water had receded very fast from the east sides of Great Rann towards the west sides, rapidly drying the areas around Bela and Kuda.

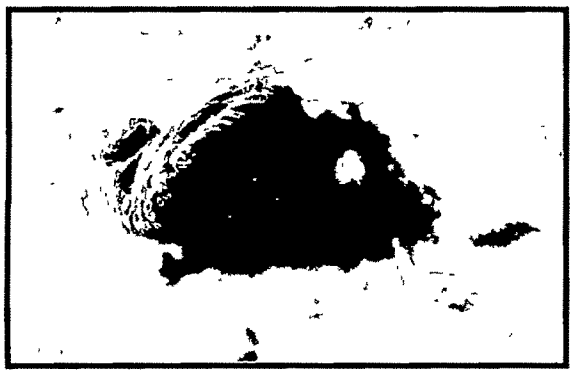
Plate 4.8A : Chick Mortality of Lesser Flamingo

1. Chicks of Lesser Flamingos in Dry Rann

2. Dead Chicks in Highly Saline Water

3. Motionless Chick in Highly Saline Water

4. Observation of a Chick



5. Dead Chick Bogged in Salt Layers

6. Deposition of Salts on Wing

Table 4.8a: Habitat Condition at Rann around Bela and Kuda, in Great Rann of Kachchh and Chick Mortality of Lesser Flamingo

No.	Parameter	Oct, 2003	Dec, 2003
1	Water Depth	15-30 cm	0 cm
2	Salinity	55.20 ppt	85.6 ppt
3	Primary Food	3-9 mg/m^3	0 mg/m^3
4	Live Flamingo Adults	3,100	0
5	Live Flamingo Chicks	11,220	5,600 live; 300 about to die
6	Dead Chicks due to starvation	0	2,700
7	Dead Chicks due to Predation	0	1,650

Discussion:

The rapid drying of area and tremendous increase in salinity of remaining water resulted in depletion of food. Most of the adult Lesser Flamingos and the young ones which were able to fly left the area during November, 2003. Only a few adult birds remained guarding the large number of chicks unable to fly.

The chicks gradually became weak due to lack of food in the surrounding environment. Salt deposition started on their body, as they walked through the water. Gradual and continuous deposition of salt made their bodies heavier, further making them unable to walk to a long distance. The weaker and starved chicks with heavily loaded salt became unable to move to any safer site, and were lying helpless on the ground. This resulted in the heavy chick mortality of Lesser Flamingos.

In Kenya and other African countries, the salt deposition forms a thick ring on the legs of chicks, due to which they are unable to walk (Ogilvie and Ogilvie, 1986). However, the heavy ring formation around the ankle did not occur and the salt deposition was found mainly on wings and legs and also on head, neck, breast and abdomen (Plate 5.8A-6) in present study.

(2) Predation:

On December 15, 2003, a total of 50 adult Steppe Eagles (*Aquila nipalensis*) were observed preying on a 4-7 days old chicks of Lesser Flamingos in the Rann around Kuda (23^0 55.470' N; 70^0 49.737' E). There was no adult Lesser Flamingo with this group of chicks.

A total of 1,500 live chicks were in a compact group and cordoned of by the eagles. Each eagle had one chick and was preying upon it. After feeding one, the eagles were striking on the compact group, trying to separate out some of the birds from the compact flock. As soon as a chick got separated from the group, it was caught by the eagle and preyed upon. About 100 carcasses of chicks preyed upon by eagles were observed (Plate 6-2,3,4).

On December 23, 2003 the same site was re-visited. No live chick was observed but there were total of 1,650 carcasses of chicks preyed upon by the eagles.

Discussion:

Predation of juveniles of Lesser Flamingo by the Steppe Eagles is recorded for the first time from Indian Sub-continent. No other predator was recorded during the study period.

Several birds of prey are known to prey upon the juveniles of Lesser Flamingos in Africa. The Egyptian Vulture is a major avian predator of eggs and small chicks at Lake Magadi and Natron colonies in Kenya (Brown and Root, 1971).

Maribou Storks have been found to be a major predator of chicks of Greater Flamingos in East-Africa. Vultures and eagles are known to prey upon the chicks and eggs of flamingos in South Africa. Herring Gull is a major predator in Camargue (Ogilvie and Ogilvie, 1986).

Conclusions:

Starvation due to rapid receding water and predation were the two major factors causing heavy chick mortality during the study period.

4.8B: Greater Flamingos

Chick mortality was recorded at Flamingo City during April 2004.

February 28, 2004:

During February 2004, the Greater Flamingos were nesting on an island. The water was just 10 m away from the nesting site and the depth was 46 cm (Plate 4.8B-1). The depth of water was 64 cm at 50 m from the nest site. The salinity of water was 66.5 ppt and pH was 7 5 during the breeding season (Table 4 8b). The food was abundant (Chapter-3.4).

A total of 21,000 Greater Flamingos (7,000 Adults + 14,000 Juveniles) were counted in February 2004. Most of the adult Greater Flamingos were engaged in nesting. A large number of chicks observed at the nesting site were of various age groups (section 4.7).

The OCM data of January 2004 showed inundation of Rann by deep water around Flamingo City. Several white, salt encrusted, high elevated areas were exposed in the eastern and northeastern parts of Great Rann. The deep blue color indicated high water level and large water spread area during the active nesting period.

April 29, 2004:

The water had receded to ca. 500 m away from the nest site (Plate 4.8B-3). The salinity and pH of the water were 80.6 ppt and 7.33 respectively (Table 4.8b). The water level and water spread area of the Rann had decreased drastically. There was a 50% decrease in total food abundance (Chapter-3.4).

At the end of the breeding season, only 259 adult Greater Flamingos were present along with 9,655 live juveniles in water. Of the total live juveniles, 2,897 were flying young ones and remaining 6,758 were non-flying chicks.

A total of 1,102 chicks were dead and embedded in the soil of Rann, at the edge of nest site, where the water had receded completely (Plate 4.8B-4). Large numbers of chicks

Plate 4.8B : Chick Mortality of Greater Flamingo

February 2004:

1. Water 10 m from Nesting Site

2. Juveniles Swimming

April 2004:

3. Water Receding from the Nesting Site

4. Juveniles Bogged in Salt Layers

were observed lying motionless on the ground or walking very slowly. A close observation these chicks revealed deposition of thick layers of salt on different parts of their bodies.

OCM data of April 15, 2004 indicated light blue color of wet soil between the Khadir and Pachchham islands. White color indicated exposed, dry salt encrusted areas. Flamingo City was exposed out and clearly seen as a dot. Large numbers of salt encrusted high elevated areas were seen in the water around Khadir island. Light blue color with white shading around the Flamingo City suggested that the depth of water had drastically decreased (Plate 3.4B-5).

Table 4.8b: Habitat Conditions at the Flamingo City in Great Rann of Kachchh and Chick Mortality of Greater Flamingo

No.	Parameter	Feb, 2004	April, 2004
1	Distance of water from nest site	10 m	500 m
2	Water Depth near nest site	46 cm	10-15 cm
3	Salinity	66.5	80.6
4	Food in water	Abundant	50 % Decrease
5	Live Flamingo Adults	7,000	259
6	Live Flamingo Chicks	14,000	9,655
7	Dead Flamingo Chicks	0	1,102

Discussion:

As the water receded from the nesting site, and total water spread area decreased, the salinity of remaining water increased tremendously. This resulted in depletion of food in the surrounding environment. Hence, most of the adult Greater Flamingos and the young ones able to fly left the area in April 2004 and only a few adults remained with the large number of chicks.

The deposition of salt on body and chick mortality occurred by the same phenomenon as for the Lesser Flamingos.

Incidences of chick mortality of flamingos were also reported earlier at the same site, in May-June 1983, when about a thousand chicks of Greater Flamingo were reported dying due to rapid drying of area and ingress of high tidal waters with brine content. The chicks got bogged down in mud or, reached the hard baked surface and salt encrusted areas where they died of exhaustion and starvation (Himmatsinhji, 1983).

Conclusions:

Starvation due to rapid receding water at the nest site was the major factor causing mortality of chicks of Greater Flamingos at Great Rann. No other factors, such as predation, were found causing mortality of chicks of Greater Flamingos during the study period.

4.9: Breeding Success:

This section deals with the breeding success Lesser Flamingos and Greater Flamingos at their traditional breeding sites during the study period.

Materials and Methods:

The breeding sites of the flamingos and surrounding areas were visited either during the active breeding season or after the completion of breeding during the study period.

The number of eggs hatched out of total number of eggs laid, was considered as hatching success and expressed in percentage. The percentage of juveniles reaching to free flying stage of total chicks hatched was considered as fledging success. Number of young birds fledging from total number of eggs laid, gave an estimate of breeding success and it was expressed in percentage.

Results:

4.9A: Lesser Flamingos

(A) Breeding Success at Purabcheria, in the Little Rann of Kachchh:

Lesser Flamingos were recorded nesting during 2003 and 2004, however their attempts of nesting failed as the eggs were pilfered by the fishermen from the Cherwari village, compelling them to desert the colony (Table 4.9a).

(B) Breeding Success Near Zinzuwada, in Little Rann of Kachchh:

On November 17, 2002, the Lesser Flamingos had left the colony. Hence, the total number of juveniles could not be observed. A total of 9,259 nests were counted and 2,700 unhatched eggs were observed. As the flamingos generally lay one egg per nest, a total of 9,259 eggs were considered to have been laid in the colony. The hatching success was calculated to be 70.83%. Notable numbers of young ones in brown plumage was observed

during the January 2003 counts at different sites of Gujarat state. As no chick mortality was observed at the nest site, the fledging success was estimated to be almost cent percent during the year 2002. As no chick mortality was observed, and notable number of young ones were counted, the breeding success was estimated to be 70.83% (Table 4.9a).

During 2003 and 2004, Lesser Flamingos attempted to nest at this site however, their nesting attempt failed at nest building and incubation stage due to flood and insufficient inundation in the respective years (Table 4.9a). Hence, the hatching, fledging and breeding success was zero per cent.

(C) Breeding Success in Rann around Bela and Kuda in Great Rann of Kachchh:

Totally 11,220 juveniles of 10-20 days were observed along with 3,100 adult Lesser Flamingos in the Rann area of Bela on October 19, 2003. Their nesting colony could not be approached, and so actual number of eggs laid could not be counted. However their nesting colony was suspected in the near by area around Bela, as the chicks were too small to move far away. Looking to the large number of juveniles, it seemed that most of the eggs might have been hatched; hence, hatching success was considered to be 90-100 % (Table 4.9a).

On December 15, 2003 about 50 Steppe Eagles (*Aquila nipalensis*) were observed preying upon the juvenile flock, in the Rann around Kuda. There were no adults around and the compact herd of the chicks was cordoned by the eagles. Each eagle was having one chick and preying upon it. After feeding on one, they were attacking on the flock to have another. A total of 100 remains of chicks were observed. On December 23, 2003 no live chick was observed at the same sites, but there were a total of 1,650 remains of chicks preyed upon by the eagles (Table 4.9a).

Table 4.9a: Breeding Success of Lesser Flamingos during the Study Period

No.	Date of visit	Observation	Hatching Success (%)	Fledging Success (%)	Breeding Success (%)	Remarks
Purabcheria, Little Rann of Kachchh						
1	27-06-03	300 nests; no flamingo	0	0	0	Eggs collected
2 a	02-07-04	3 lakhs LF+52 GF; 296 nests; 5 eggs; nest building continued				
2 b	20-07-04	964 nests abandoned; 79,143 flamingos; no eggs	0	0	0	Eggs collected
Near Zinzuwada, Little Rann of Kachchh						
1	17-11-02	9,259 nests; 2,700 abandoned eggs; no flamingos; no chick mortality; notable No. of juveniles observed at different sites of Gujarat during January 2003 count	(9,259-2,700 = 6,559) 70.83	no chick mortality 100	(9,259-2,700 = 6,559) 70.83	One egg per nest hence 9,259 eggs were considered as total number laid
2 a	29-08-03	25,000-30,000 LF and GF; 5,000-6,000 nests; nesting continued				
2 b	31-08-03	Nests washed out; abandoned eggs; colony deserted	0	0	0	Sudden flood
3	29-09-04	150 nests; colony deserted	0	0	0	Insufficient inundation
Area of Bela and Kuda in Great Rann of Kachchh						
1	19-10-03	11,220 chicks of one week old; 3,100 adult Lesser Flamingo	{Number of juveniles was considered as 90 % (12,466)-100% (11,220)}	(11,220 -1,650 -2,700 -300 -5,600 -200 770)	(Total eggs 11,220-12,466 Total fledged 770) (=970x100/11,220 or 12,466)	Total 11,220 considered as 90-100 %
2 a	15-12-03	1,500 live chicks + 150 dead preyed upon by Steppe Eagle				
2 b	23-12-03	No live chicks + 18-20 Steppe Eagles; total 1,650 dead chicks				
3 a	12-12-03	5,600 live non-flying juveniles + 180 adult + 2,700 dead due to starvation resulting from high receding water + 300 about to die +				
3b	23-12-03	200 dead due to starvation near Amarapar, Shiranivandh	90-100	6.86	6.17-6.86	

GF-Greater Flamingo; LF-Lesser Flamingo; No.- Number

On December 12, 2003, a total of 2,700 chicks were found dead due to high rates of receding water at the Rann of Kuda, in the Great Rann and 300 non-flying chicks were about to die. The remaining 5,600 live chicks were too small to fly or move to the safe area, hence their probability of survival was nil. Hence, total numbers of dying chicks due to high rates of the receding water were estimated to be 8,600. Moreover, about 200 chicks of Lesser Flamingos were found dead due to starvation in receding water of Rann area around the bridge joining Shiranivandh and Amarapar (Table 4.9a).

Thus a total of 10,450 chicks (1,650 + 8,600 +200) died out of 11,220 and only 770 chicks could survive. Hence the fledging success of Lesser Flamingo in the Great Rann was 6.86 % only. Considering 11,220 chicks representing 90% hatching success, it is extrapolated that, Lesser Flamingos might have laid 12,466 eggs. Hence, estimated breeding success was 6.17 to 6.89 % (Table 4.9a). Estimated total numbers of eggs laid were 90-100 % (*i.e* 11,220-12,466), hence, the estimated breeding success was 6.17-6.86 % (Table 4.9a).

Conclusions:

The breeding success of Lesser Flamingos varied at different nesting sites during the study period. The nesting attempts by Lesser Flamingos failed in all years, at Purabcheria in the Little Rann due to egg stealing. The nesting attempt during 2002 near Zinzuwada in the Little Rann was successful, however during following years the attempts failed due to flood (2003) and insufficient inundation (2004).

The hatching of Lesser Flamingos in the Great Rann around the Bela and Kuda was successful, as large number of juveniles was observed. However most of the chicks could not survive due to starvation resulting from high rate of receding water and to some extent by predation.

4.9B: Greater Flamingos

(I) Breeding success of Greater Flamingos at Flamingo city, Great Rann:

During February 2004, a total of 7000 adult Greater Flamingos and 14,000 chicks of various age groups were observed at the nesting colony. Totally 8,678 nests were counted of which, 3,750 nests had fresh eggs. Incubation was continuing. Hence, total numbers of eggs laid were 17,750 (14,000 + 3,750) (Table 4.9b).

In April 2004, a total of 9,655 live chicks of different age groups were observed along with 259 adults adjacent to the nesting site in water. Totally 1,102 juveniles were observed dead due to rapid receding of water at the nesting site. Of the total live juveniles, 2,897 were flying young ones and the remaining 6,758 non-flying chicks. The nesting was over and about 50 abandoned eggs were observed at the nesting sites.

Total eggs hatched were estimated to be 17,700 (14,000 + 3,750 – 50 abandoned eggs), at the end of the breeding season. Hence the hatching success was 99.72 % (Table 4.9b).

As the chance of non-flying juveniles to survive was nil as they were too small to move to safer areas, total dead chicks were estimated to be 7,860 (1,102 + 6,758) and total chicks survived and fledged were estimated to be 9,840 (17,700-7,860). Hence the fledging success of Greater Flamingos at Flamingo City, during 2003-2004 was 55.59 %. Of the total 17,750 eggs laid, only about 9,840 young ones could reach the free flying stage, hence the breeding success was 55.43% (Table 4.9b).

(II) Breeding success of Greater Flamingos at un-discovered breeding site in Great Rann:

Large numbers of eggs were drawn along the flood water and reported in different parts of Great Rann, such as Nada bet, near Suigam, Asara, Mavasari, Gatka bet, Karni, Masali *etc.* during August 2003. The nesting colony could not be located due to heavy flood, which might have washed out the nests. However the eggs were identified to be of

Table 4.9b: Breeding Success of Greater Flamingos during Study Period

No.	Date of visit	Observation	Hatching Success (%)	Fledging Success (%)	Breeding Success (%)	Remarks
1a	28-02-04	7,000 adult GF; 14,000 juveniles of various age groups; 8,678 nests; 3,750 eggs; incubation continued.	Total eggs hatched (14000 + 3750 – 50 abandoned eggs) = 17,700	(9,840 x 100/17,700)	(9,840 x 100/17,750)	Total eggs laid =14,000+3,750 =17,750
1 b	29-04-04	Nesting over; flamingos had left the colony; 259 adult; 9,955 juveniles of which 6,758 were non-flying and 2897 were flying young ones. 1,102 dead juveniles due to starvation after high receding water; 50 abandoned eggs,	99.72	55.59	55.43	As 6,758 juveniles were of too young, their survival chance was nil, hence total dead chicks estimated 7,860 (1,102 + 6,758) Total chicks survived and fledged = 9,840
2	October 2003	Eggs of flamingos were drawn along the flood water and reported in nada bet, Suigam; Asara; Mavasari; Gatka bet; Karni; Masali and surrounding areas of great Rann	0	0	0	Colony destroyed due to flood during august 2003

GF-Greater Flamingo; LF-Lesser Flamingo

Greater Flamingos by their measurements. As the colony was destroyed after flood, the hatching, fledging and breeding success was zero.

Conclusions:

At the Flamingo City, the hatching success of Greater Flamingo during the year 2003-2004 was nearly cent percent; however the breeding success was reduced to 55.43 % due to starvation of chicks resulting from sudden decline in food availability due to increased salinity.

Their nesting attempt at an unknown site, besides Flamingo city, in the Great Rann failed due to heavy flood.