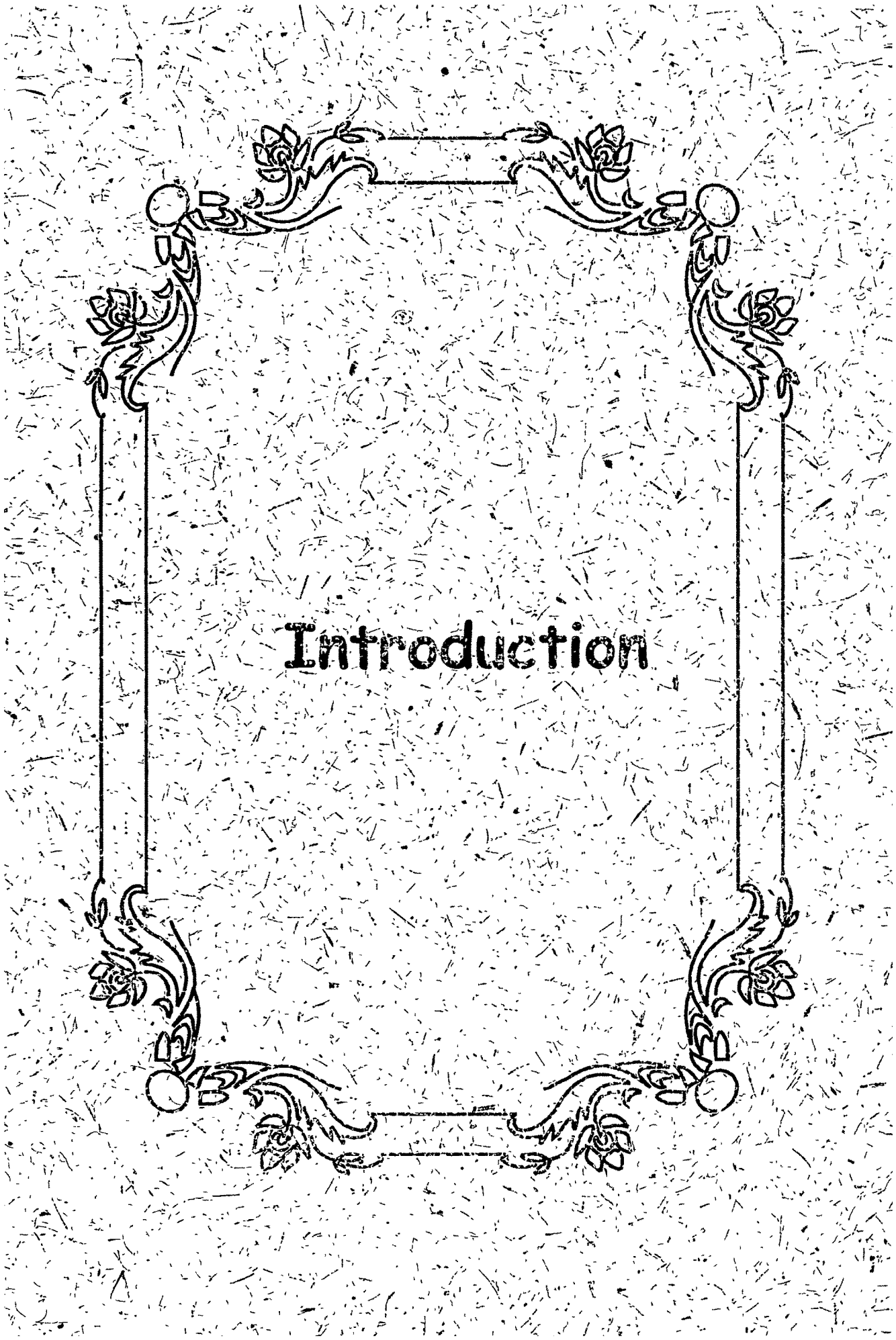

Introduction

INTRODUCTION

Flamingos are one of the most beautiful waterbirds belonging to the order 'Phoenicopteriformes" and to the family 'Phoenicopteridae'. They are one of the oldest bird groups alive today. Long legs and a long, curved neck are the characteristics of all flamingo species. Flamingos have a short tail, large wings, a pink or maroonish color and webbed feet. Their beak is curved down and lamellated, finely adapted for their feeding habits.

There are six species of flamingos in the world, of which two species occur in India *viz* -Greater Flamingo *(Phoenicopterus roseus)* and the Lesser Flamingo *(Phoenicopterus minor)* (Ali and Ripley, 1983; Grimmett *et al., 1998,* Kazmierzack, 2000; Manakadan and Pittie, 2002) The other species are Caribbean Flamingo (*Phoenicopterus ruber)*, the Chilean Flamingo (*Phoenicopterus chilensis)*, the James Flamingo (*Phoenicoparrus jamesi*), and the Andean Flamingo (*Phoenicoparrus andinus*), distributed in various parts of the world like Africa, Chile, Peru, South America, Argentina, Bolivia, and West Indies, *etc* (Ogilvie and Ogilvie, 1986). Earlier, Greater Flamingo and Caribbean Flamingo were considered as two subspecies of the "*Phoenicopterus ruber*" but recently they are categorized as two separate monotype species (Knox *et al*, 2002). In India, the two species of flamingos are mainly found in Gujarat, Rajasthan, Andhra Pradesh, Orissa, Maharastra, Karnataka and Kerala.

The flamingos are "The State Birds of Gujarat" and are recognized by their local names such as *"Hanj", "Dev hanse" and "Bala"* in different parts of Gujarat They are well known as *"Lakha na Janaiya"* or *"Thakorji na Janaiya"* in Kachchh and Saurashtra, as their plumage resembles the white dresses of *Janaiya* (*i e.* members of the groom's marriage party) sprinkled with *gulal* (*i.e.* a red colored powder dye used to sprinkle on the bodies to express joy) during marriages or any good occasions.

Greater Flamingos are about 135-140 cm in height. They are rosy white with bright scarlet and black wings. They have a large pink bill with black tip and pink legs (Plate 1A). Lesser Flamingos are comparatively smaller, about 90-105 cm in height with deeper rosy

pink plumage. They have a darker maroon bill with black tip followed by red; and reddish legs (Plate 1B).

Flamingos are gregarious birds and generally found in groups, ranging from few to thousands or lakhs. Their group is called 'Pat'. Flamingo's most characteristic habitats are large alkaline or saline lake (may be far inland or near the sea) or estuarine lagoons, , mangrove swamps, tidal flats, or sandy islands in the inter-tidal zone.

Flamingos fly with their head and neck stretched out in front, and their legs trailing behind (Plate 1C). To take off they run several steps, begin flapping wings and lift their body in the air While landing the procedure is reversed, the birds come down touch the ground and run several paces.

Flamingos are filter feeders. Greater Flamingos feed largely upon zooplanktons, mollusks, crustaceans (e.g. *Artemia*), sedge seeds, higher plant remains and to some extent on phytoplankton. Lesser Flamingos are particularly herbivorous and feed exclusively on phytoplankton, algae (*Spirulina*), diatoms, and to some extent on seeds of aquatic plants (*Ruppia, Scirpus, etc.*).

Greater Flamingos are known to breed regularly, only in Gujarat state in the Indian subcontinent. Rann of Kachchh (Greater Rann of Kachchh) is a well-known breeding site of flamingos in India. "Flamingo City" in Great Rann of Kachchh is one of the largest breeding colony in the world and a single regular breeding site in entire Asia (Ogilvie and Ogilvie, 1986).

Flamingos mature at 5-6 years after hatching. They are colonial nesters and make mounds of mud. They nest only when inundation of the area occurs. Even after establishing a colony, when the condition does not remain favourable, they desert the colony. If they do not nest successfully for several years, their number decreases. Because of their irregular breeding attempts and restricted distribution, Lesser Flamingos are listed as "Near

Plate 1 : Flamingos of India

A. Greater Flamingos *(Phoenicopterus roseus)*

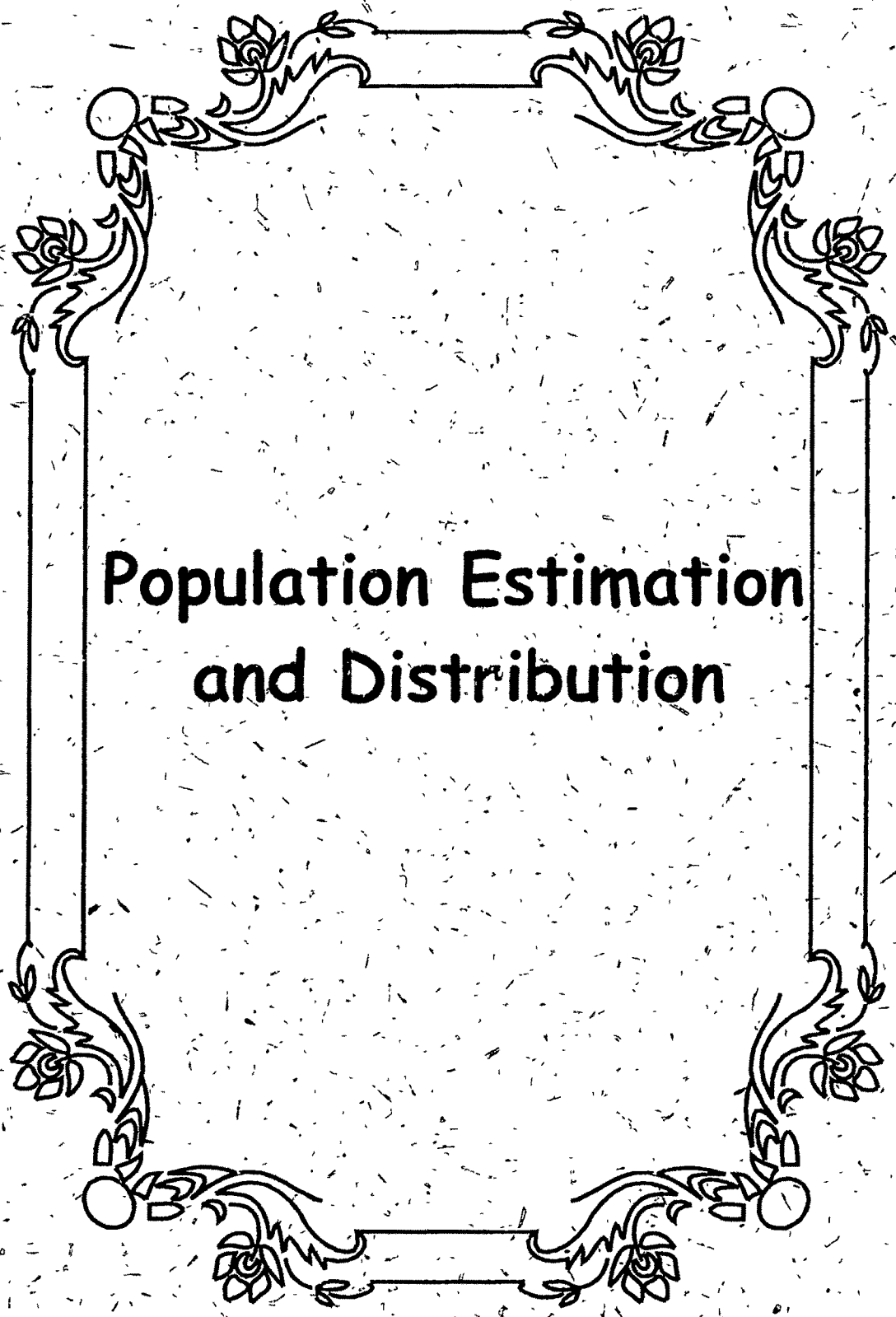
B. Lesser Flamingos *(Phoenicopterus minor)*

C. Flamingos in Flight

Threatened Species" (Collar *et al*, 2001) in Asia. Hence conservation of flamingos is of utmost importance.

The above knowledge about the flamingos is generalized. However, a specific study on the ecology of Greater and Lesser Flamingos has not been carried out. Except for the records of their breeding events and nesting sites, detailed knowledge about their ecology *i e.* population size, habitat preference, food, behavior, habitat suitability, *etc* is lacking. Keeping this in view, a detailed investigation on the following aspects was taken up:

- Distribution and population estimation
- Habitat preference and habitat suitability analysis through Remote Sensing
- Food and feeding ecology
- Breeding ecology
- Behavior
- Conservation and management



Population Estimation and Distribution

CHAPTER 1

POPULATION ESTIMATION AND DISTRIBUTION OF FLAMINGOS

Information about the relative distribution of the Greater Flamingos and Lesser Flamingos in different states of Asia is available through Asian Waterfowl Census (AWC) (Perennou and Mundkur, 1992, Mundkur and Taylor, 1993, Lopez and Mundkur, 1997). Based on AWC data, Rose and Scott (1997) estimated about 1,50,000 Greater Flamingo and about 1,20,000 Lesser Flamingo in entire Asia. Recently, the estimated number of Greater Flamingo in the eastern Mediterranean, southwest and south Asia was 2,90,000; and Lesser Flamingos in all of South Asia was 1,50,000 (Wetland International, 2002). The Greater Flamingo has a cosmopolitan distribution (Ogilvie and Ogilvie, 1986) and its numbers have remained more or less constant in Asia (Johnson, 2000). The Lesser Flamingo in Asia has restricted distribution with only a few breeding records (Mundkur, 1997). As a result, the Lesser Flamingo is recently categorized as "Near Threatened" species (Collar *et al*, 2001). No systematic attempt has been made to estimate their population size in India

As part of a detailed ecological study of flamingos, numbers of these two species were counted on selected wetlands of Gujarat state during non-breeding, breeding and post-breeding during 2002 to 2004 to (i) estimate population size and seasonal fluctuation, if any, and (ii) determine habitat preference and pattern of distribution and movement with special reference to breeding event.

1.1 Population Estimation and Distribution of Flamingos during Non-breeding Season (January 2003):

Birds having different breeding and feeding sites, gather at their breeding sites as breeding season approaches and leave the site at the end of the breeding season They are distributed at different feeding sites during the non-breeding season. The flamingos are known to gather at the Rann of Kachchh and breed there during their breeding season (Ali

and Ripley, 1983). However, the knowledge about their population dynamics and distribution during the non-breeding season was lacking. Hence, as part of a detailed ecological study, numbers of both the species of flamingos were counted on selected wetlands of Gujarat state during the non-breeding period *i e* January 2003 to study their distribution pattern.

Materials and Methods:

A few selected sites of the Gujarat state were surveyed for the flamingo count from January 11 to 26, 2003. The survey sites were selected on the basis of our earlier experience and available information about the occurrence of flamingos. The sites which could not be surveyed personally, were surveyed by other birdwatchers on personal request and the information regarding the presence and number of flamingos was gathered telephonically or by post. Only those counts were considered which were done between 2^{nd} or 4^{th} week of January for more accuracy.

Flamingos were counted by using a spotting scope (20X80) and binoculars (10X50). "Block Method" was used for counting the number as it is an easy and accurate method for estimating numbers of birds present in large densely packed flocks, either in flight or on the ground (Howes and Bakewell, 1989). This method involves counting or estimating a "block" of birds within a flock. Depending on the overall flock size, a "block" can be 10, 100 or 1000 birds. The "block" is then used as a model to measure the remainder of the flock.

At some coastal sites, the observations were made from the top of buildings or towers. This gave the advantage of height, which helped to cover larger area of the sea coast.

Study Area:

Selected coastal sites as well as inland fresh water wetlands of Gujarat state were visited for flamingo count. The sites covered during this survey are precisely mentioned under study areas and shown in Figures. The study area was broadly categorized as (A) Coastal Sites and (B) Inland Wetlands.

(A) Coastal Sites

The Coastal Sites included the sea coast and Rann areas as well as other wetlands up to 10 km inland from the coast and/or influenced by the sea water. The Coastal Sites were divided into four categories, *viz.*,

a) Rann of Kachchh
b) Gulf of Kachchh
c) Gulf of Khambhat, and
d) Other Coastal Sites

a) Rann of Kachchh

The entire Great Rann and Little Rann of Kachchh were included in this category (Fig. 1). The Rann of Kachchh is known to support large number of flamingos when inundated (Ali, 1954; 1974). However during the January 2003 count, the Rann was dry and no flamingo was recorded.

b) Gulf of Kachchh

The entire coastal area of Okha, Jamnagar, Surajbari, and up to Mandvi of Kachchh district was included in Gulf of Kachchh (Fig. 1).

Southern coast of Gulf of Kachchh, particularly from Okha to Jamnagar was surveyed during January 11-26, 2003. The sea coast and salt pans around Okha, Charakala, Pindhara, Vadinar, Narara and Jamnagar were surveyed. In Okha, the salt pans around Aarambhada, Vadinar and Dalda Bundar were visited. Flamingos were also recorded at Meethapur near railway crossing as well as on the way from Dwarka to Charakala salt pans. At Jamnagar, besides the sea coast and extensive salt pans around Birla, Valsura, Rozi, Rozi Pier and Halar, the area around "Khijadia Bird Sanctuary"; a sewage pond near Jamnagar railway station and Lakhota Lake in the city, were also surveyed (Fig. 1.1).

In Kachchh district, flamingo count was done on Bhadreshwar creek, Rukmavati creek, Ratnal creek dam and Nakti creek, with the help of volunteer birdwatchers. The

remaining coast of Gulf of Kachchh from Jamnagar to Surajbari and northern part of Gulf of Kachchh from Mandvi to Kori Creek could not be surveyed.

c) Gulf of Khambhat

The coastal areas between Gopnath of Bhavnagar district, Dholera of Ahmedabad district, Khambhat of Anand district and Dahej of Bharuch district formed the Gulf of Khambhat (Fig. 1).

Entire coast of Gulf of Khambhat from Gopnath to Bharuch district was surveyed for flamingo count. The southern coast of Gujarat *i e* coastal areas from Bharuch to Navsari district was also surveyed. These areas do not belong to Gulf of Khambhat, but as they are geographically connected and related to Gulf of Khambhat region, they were placed under this category. The counts were taken at different points like Kavi and Sarod of Bharuch district; Khambhat and Dhuwaran of Anand district; Dholera of Ahmedabad district; Bhavnagar, Sartanpur and Gopnath coast of Bhavnagar district (Fig. 1.1).

At Bhavnagar, salt pans of Kumbharwada- Indian Petro Chemical Limited (IPCL), Nirma and New Port were visited. The sewage pond of Kumbharwada adjacent to the salt pans and the Bor Talav (Gaurishankar Lake- a fresh water wetland) were also surveyed. Sea coast at Ghogha, Hathab, Sartanpur and Gopnath was surveyed. At Dholera, sea coast was surveyed from Rah Talav and from Gujarat Heavy Chemicals Limited (GHCL) pump house. The salt pans of GHCL were also surveyed extensively. At Khambhat, the entire sea coast was surveyed from different places like Tarakpur, Vadgam, Tada Talav and Vasna. Coastal area of Dhuwaran was surveyed from the Thermal Power Station. Mahi and Sabarmati River estuaries located in Vadodara and Ahmedabad districts respectively were also surveyed as the sea water of Gulf of Khambhat enters into these rivers. Flamingos were also reported from Onjal and Nani Kakarad, the two wetlands near sea coast in Navsari district (Fig. 1.1). The sea coast beyond Navsari district, *i e* Valsad and Daman, up to Umargam could not be surveyed.

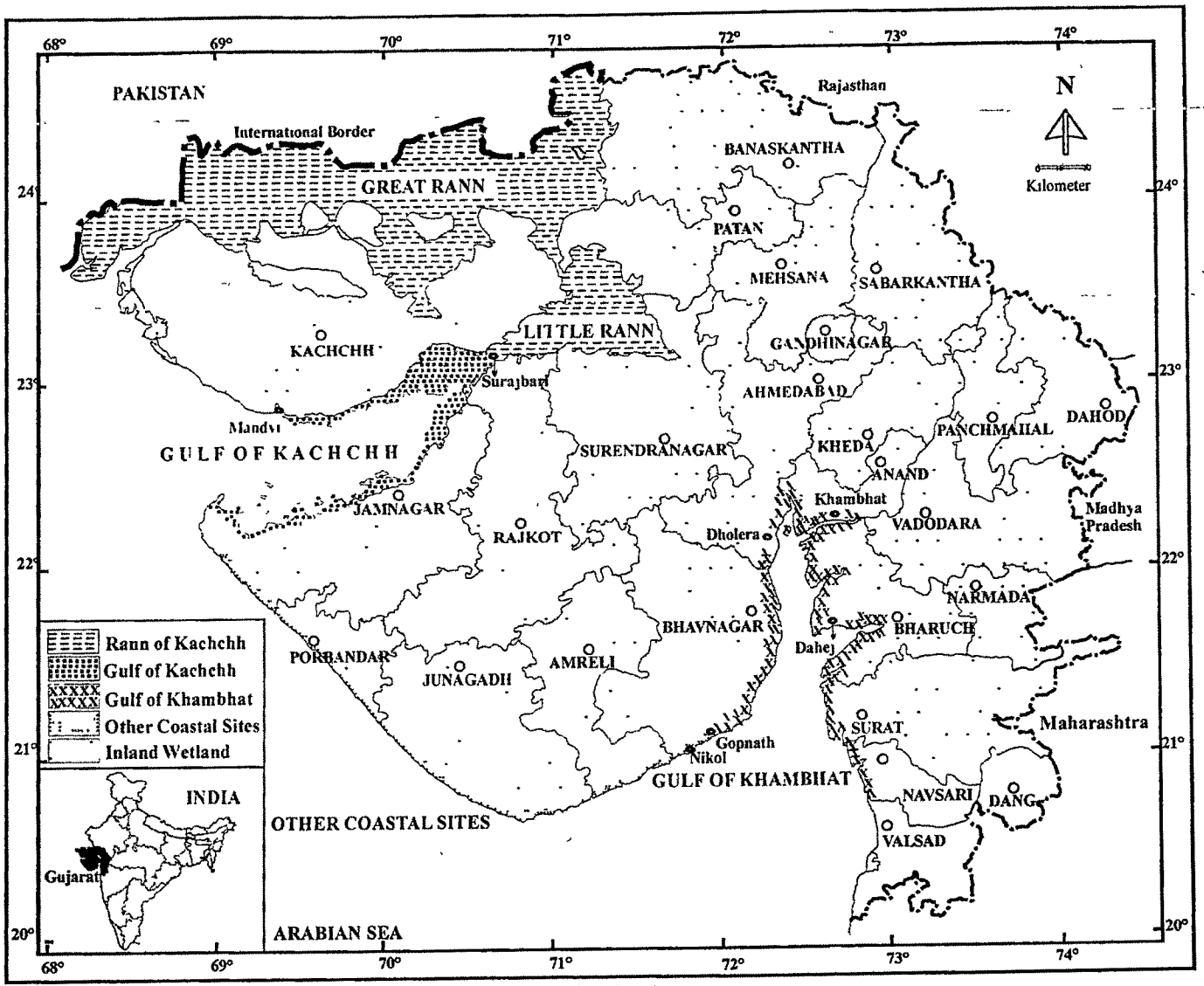


Fig. 1: Study Area

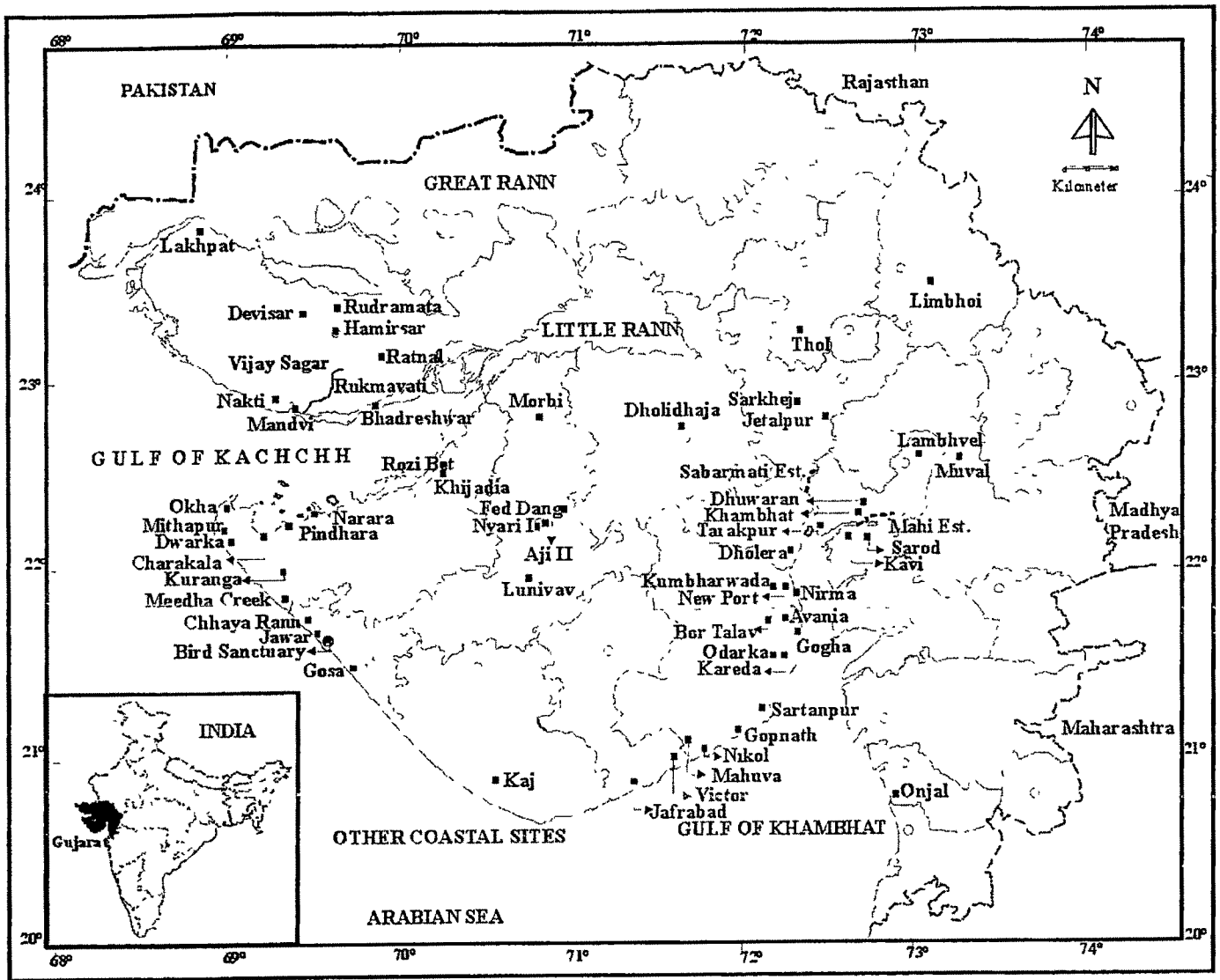


Fig. 1.1: Distribution of Flamingos during Non-breeding Season

d) Other Coastal Sites

Sites in the southern coastal areas of Saurashtra surveyed, included the coastal areas of Porbandar, Junagadh, Amreli and Nikol-Bundhara near Mahuva of Bhavnagar district (Fig. 1). Information regarding the presence of flamingos on wetlands of Junagadh and Amreli districts was gathered from volunteer birdwatchers.

At Porbandar, the salt pan of Jawar, sewage pond area around Chhaya Rann, Porbandar Bird Sanctuary and tidal regulators such as Gosa-Karli, Meedha creek and Karli creek were surveyed. Kuchadi, Barda Sagar and Amipur Wetlands which are regular strongholds of flamingos were totally dry during this season. In Amreli district, the flamingos were recorded from Jafrabad Kharapat and salt pans (Fig. 1.1).

Nikol-Bundhara–a tidal regulator near Mahuva, and the sea coast area were surveyed. At Port Victor, the salt pans and the other surrounding villages *viz.* Pipri and Patvagam were surveyed As these villages were near to the sea coast, they included salt pans as well as fresh water ponds.

(B) Inland Wetlands

The Fresh Water Wetlands which are over 10 km away from the sea coast and/or salt pans were categorized under "Inland Wetlands". This included wetlands of Ahmedabad (Sarkhej sewage pond, Jetalpur village pond); Anand (Lambhvel sewage pond); Bhavnagar (Odarka, Kareda); Gondal (Lunivav irrigation tank); Jamnagar (Kuranga village pond); Kachchh (Vijay Sagar reservoir, Hamirsar tank, Rudramata dam); Mehsana (Thol Bird Sanctuary), Rajkot (Nyari-I, Fed Dang Beti, Aji-II); Sabarkantha (Limbhoi); Surendranagar (Dholidhaja dam, Nayaka dam); and Vadodara (Muval village pond) (Fig. 1.1). The Inland Wetlands, which did not register presence of flamingos, are not listed.

Results:

A total of 32,943 Greater Flamingo and 3,72,778 Lesser Flamingo (Total 4,05,721 flamingos) were counted at different sites in Gujarat during January 2003. Highest concentration of flamingos was recorded at Gulf of Khambhat (75.38%) with substantial

population in Gulf of Kachchh (10.86%) and Other Coastal Sites (13.60%) (Table 1.1). Very few (0 16%) flamingos were recorded at Inland Wetlands.

The number of Lesser Flamingo was many times greater (91.88%) than the Greater Flamingo (8.12%). Both, the Greater Flamingo (98.37%) and Lesser Flamingo (99.97%) were largely restricted to the coastal zone; and very small population of Greater Flamingo (1.63%) and Lesser Flamingo (0.03%) was found in Inland Wetlands (Table 1.1). The proportion of Greater: Lesser Flamingo at three Coastal Sites and Inland Wetlands was significantly different from the expected proportion (x^2=49,825, P<0.001 df =3).

Distribution of Greater Flamingos:

The Greater Flamingo had an almost equal distribution in Gulf of Kachchh (35.24%), Gulf of Khambhat (26.50%) and Other Coastal Sites (36.63%). A small population (1.63%) was observed on Inland Fresh Water Wetlands (Table 1.1).

In Gulf of Kachchh, the sites of major concentration of Greater Flamingo were salt pans of Charakala, Vadinar, and Jamnagar (Table 1.1- a.1; a.2). In Gulf of Khambhat, salt pans of GHCL near Dholera; salt pans of Nirma and New Port at Bhavnagar supported a considerable population (Table 1.1- b.1; b.2). Amongst Other Coastal Sites, salt pans at Porbandar (Jawar) as well as the Meedha and Gosa-Karli tidal regulators were very important. Kaj wetland of Junagadh supported good number of flamingos (Table 1.1- c.1, c.2).

Among Inland Wetlands, the Greater Flamingos were found in almost all types of fresh water wetland *i e* ponds for drinking (Lunivav of Gondal, Rajkot) and irrigation (Nyari-I, Fed Dang Beti and Aji II of Rajkot; Dholidhaja dam and Nayaka dam of Surendranagar; Hamirsar tank, Rudramata dam and Vijay sagar reservoir of Kachchh), village ponds (Kuranga of Jamnagar; Muval of Vadodara, Jetalpur of Ahmedabad; Limbhoi of Sabarkantha; Odarka and Kareda of Bhavnagar district) and sewage ponds (Lambhvel of Anand; Sarkhej of Ahmedabad) (Table 1.1- d.1; d.2).

Distribution of Lesser Flamingos:

The Lesser Flamingos were concentrated largely at the Gulf of Khambhat (79.80%) with, small populations at the Other Coastal Sites (11.46%) and in Gulf of Kachchh (8.71%). A very small fraction of total population was found in Inland Wetlands (0.03%) (Table 1.1).

At the Gulf of Khambhat, about 1,62,000 birds were sighted on the mudflats near GHCL pump house, near Dholera (Table 1.1- b 2) This is the highest number of Lesser Flamingos ever recorded at a single spot from India. Both the Khambhat-Dhuwaran and Gopnath coast supported > 50,000 Lesser Flamingo. Fairly good population was also found at the sea coast, sewage ponds and salt pans of Bhavnagar (14,159) (Table 1.1- b.1; b.2).

At the Gulf of Kachchh, the Lesser Flamingos were found in considerably good number at the salt pans of Charakala and salt pan and coastal areas of Jamnagar (salt pans of Valsura).

Among the Other Coastal Sites, they were found in good numbers at the coastal sites of Porbandar, *viz.,* Gosa-Karli, Chhaya Rann, Meedha tidal regulator and salt pans of Porbandar (Jawar). They were also recorded in good number at Nikol Bundhara.

Very small fraction of total population of Lesser Flamingo (0.03%) was recorded on Inland wetlands at Dholidhaja and Nayaka dam of Surendranagar district. The Lesser Flamingos were totally absent in the rest of the fresh water Inland Wetlands *i.e* drinking, irrigation as well as sewage ponds.

Table 1.1: Distribution of Flamingos at Different Sites of Gujarat during the Non-breeding Season

Sites	Greater Flamingo		Lesser Flamingo		Total	
	No.	%	No.	%	No.	%
(A) Coastal	32,406	98 37	3,72,665	99 97	4,05,071	99 84
Rann of Kachchh	0	00 00	0	00.00	0	00 00
Gulf of Kachchh	11,609	35.24	32,455	08.71	44,064	10 86
Gulf of Khambhat	8,729	26 50	2,97,501	79 80	3,06,230	75 38
Other Coastal Sites	12,068	36.63	42,709	11.46	54,777	13 60
(B) Inland Wetlands	537	01 63	113	00 03	650	00.16
Total	**32,943**	**100**	**3,72,778**	**100**	**4,05,721**	**100**
%	08 12		91 88		100	

Table 1.1(a.1): Distribution of Flamingos at the Gulf of Kachchh during the Non-breeding Season

Site	Greater Flamingo	Lesser Flamingo	Total
1 Jamnagar			
(i) Charakala	5,945	28,610	34,555
(ii) Jamnagar	3,122	2,610	5,732
(iii) Okha	1,689	161	1,850
2 Kachchh	853	1,074	1,927
Total	**11,609**	**32,455**	**44,064**

Table 1.1(a.2): Distribution of Flamingos at the Gulf of Kachchh during the Non-breeding Season

Site	Greater Flamingo	Lesser Flamingo	Total
1. Jamnagar			
(i) Charakala Salt Pans	**5,945**	**28,610**	**34,555**
(ii) Jamnagar			
Birla Salt Pans	305	13	318
Halar Salt Works	94	264	358
Khijadia Salt Works	901	0	901
Rozi Pier Salt Pan	231	25	256
Rozi Salt Pan	26	0	26
Sanctuary Salt Works	1,063	73	1,136
Sewage Pond behind Rly. Station	6	769	775
Valsura Road Salt Pan	496	1,466	1,962
Total	**3,122**	**2,610**	**5,732**
(iii) Okha			
Aarambhada Salt Pan	8	0	8
Dalda Bundar Salt Pan	160	0	160
Dwarka to Charakala Road	8	0	8
Meethapur Fatak	97	0	97
Pindhara	320	0	320
Narara	96	14	110
Vadinar Salt Pan	1,000	147	1,147
Total	**1,689**	**161**	**1,850**
2. Kachchh			
Bhadreshwar Creek	35	74	109
Nakti Creek	800	1,000	1,800
Ratnal Creek Dam	2	0	2
Rukmavati Creek	16	0	16
Total	**853**	**1,074**	**1,927**
Total	**11,609**	**32,455**	**44,064**

Table 1.1(b.1): Distribution of Flamingos at the Gulf of Khambhat during the Non-breeding Season

Site	Greater Flamingo	Lesser Flamingo	Total
Ahmedabad	1,425	1,65,500	1,66,925
Anand	344	62,417	62,761
Bhavnagar	6,590	69,159	75,749
Vadodara	0	400	400
Navsarı	370	25	395
Total	**8,729**	**2,97,501**	**3,06,230**

Table 1.1(b.2): Distribution of Flamingos at the Gulf of Khambhat during the Non-breeding Season

Site	Greater Flamingo	Lesser Flamingo	Total
1. Ahmedabad			
Dholera-GHCL Salt Pan	1,425	500	1,925
Dholera-Rah Talav-Sea Coast	0	3,000	3,000
Dholera GHCL Coast	0	1,62,000	1,62,000
Total	**1,425**	**1,65,500**	**1,66,925**
Anand			
Dhuwaran	0	1,000	1,000
Khambhat-Vasna Pump House	0	40,150	40,150
Tada Talav	0	20,000	20,000
Tarakpur (Sabarmatı Estuary)	144	0	144
Vadgam	200	1,267	1,467
Total	**344**	**62,417**	**62,761**
Bhavnagar			
(ı) Bhavnagar			
Avanıa Salt Pan	61	0	61
Ghogha-Hathab Bunglow	0	110	110
Kumbharwada Sewage Pond	0	4,200	4,200
Kumbharwada IPCL Salt Pan	200	3,000	3,200
New Port Creek	0	1,083	1,083
New Port Salt Pan	3,646	5,570	9,216
Nırma Salt Pans	2,678	196	2,874
On High Way to Nırma	5	0	5
Total	**6,590**	**14,159**	**20,749**
(ii) Shetruanjı Estuary			
Gopnath Sea Coast	0	50,000	50,000
Sartanpur	0	5,000	5,000
Total	**0**	**55,000**	**55,000**
Navsari			
Nanı Kakarad	355	0	355
Onjal	15	25	40
Vadodara			
Mahı-Gambhıra brıdge	**0**	**400**	**400**
Total	**370**	**25**	**395**
Total	**8,729**	**2,97,501**	**3,06,230**

Table 1.1(c.1): Distribution of Flamingos at Other Coastal Sites during the Non-breeding Season

Site	Greater Flamingo	Lesser Flamingo	Total
Amreli	1002	105	1107
Bhavnagar	477	1,200	1,677
Junagadh	2,000	250	2,250
Porbandar	8,589	41,154	49,743
Total	**12,068**	**42,709**	**54,777**

Table 1.1(c.2): Distribution of Flamingos at Other Coastal Sites during the Non- breeding Season

Site	Greater Flamingo	Lesser Flamingo	Total
1. Amreli			
(i) Amreli			
Jafrabad Kharapat	500	50	550
Jafrabad Salt Pan	105	55	160
Total	**605**	**105**	**710**
(ii) Port Victor			
Victor-Salt Pan	318	0	318
Pipri Village Pond	10	0	10
Patvagam Village Pond	12	0	12
Salt Pan near village-Patvagam	57	0	57
Total	**397**	**0**	**397**
2. Bhavnagar			
Nikol Bundhara Tidal Regulator	177	0	177
Nikol Bundhara Sea Coast	300	1,200	1,500
Total	**477**	**1,200**	**1,677**
3. Junagadh			
Kaj Wetland	**2,000**	**250**	**2,250**
4. Porbandar			
Chhaya Rann	10	7,769	7,779
Gosa Karli	2,916	28,515	31,431
Jawar Salt Pan	4,553	2,710	7,263
Karli Bridge	0	250	250
Meedha Creek	1,030	1,910	2,940
Porbandar Bird Sanctuary	80	0	80
Total	**8,589**	**41,154**	**49,743**
Total	**12,068**	**42,709**	**54,777**

Table 1.1(d.1): Distribution of Flamingos in Inland Wetlands during the Non-breeding Season

Site	Greater Flamingo	Lesser Flamingo	Total
Ahmedabad	97	0	97
Anand	96	0	96
Bhavnagar	80	0	80
Jamnagar	14	0	14
Kachchh	75	0	75
Mehsana	13	0	13
Rajkot	86	0	86
Sabarkantha	1	0	1
Surendranagar	70	113	183
Vadodara	5	0	5
Total	**537**	**113**	**650**

Table 1.1(d.2): Distribution of Flamingos in Inland Wetlands during the Non-breeding Season

Site	Greater Flamingo	Lesser Flamingo	Total
1. Ahmedabad			
Jetalpur Village Pond	4	0	4
Sarkhej Sewage Pond	93	0	93
Total	**97**	**0**	**97**
2. Anand			
Lambhvel Sewage Pond	**96**	**0**	**96**
3. Bhavnagar			
Kareda Village Pond	10	0	10
Odarka Village Pond	70	0	70
Total	**80**	**0**	**80**
4. Jamnagar			
Kuranga Village Pond	14	0	14
5. Kachchh			
Hamirsar Lake	1	0	1
Rudramata Irrigation Tank	72	0	72
Vijay Sagar Irrigation Tank	2	0	2
Total	**75**	**0**	**75**
6. Mehsana			
Thol Bird Sanctuary	**13**	**0**	**13**
7. Rajkot			
Aji-II Irrigation Tank	10	0	10
Fed Dang Beti Irrigation Tank	31	0	31
Gondal, Lunivav Irrigation Tank	6	0	6
Nyari-I Irrigation Tank	39	0	39
Total	**86**	**0**	**86**
8. Sabarkantha			
Limbhoi	**1**	**0**	**1**

Cont...

Site	Greater Flamingo	Lesser Flamingo	Total
9. Surendranagar			
Dholidhaja Irrigation Tank	0	13	13
Nayaka Dam Irrigation Tank	70	100	170
Total	**70**	**113**	**183**
10. Vadodara			
Muval Village Pond	**5**	**0**	**5**
Total	**537**	**113**	**650**

Discussion:

Population size

Except for a rough estimate of breeding bird population in the Great Rann of Kachchh (Ali, 1974), an estimate of the population size of the either species has not been attempted in India. The Asian Waterfowl Census has been the only source of information on the population size. Some figures of population estimates were derived through the Asian Waterfowl Census from 1987 onwards, but the estimate has remained very low. Looking to the current figures of Gujarat state, it is suggested that a systematic flamingo count should be done all over Gujarat as well as the entire Indian Subcontinent.

A total 3,72,665 Lesser Flamingos were counted on the selected coastal areas. This is the highest count recorded from any state in India till day. Presence of such a large population could be revealed only because proper sites were surveyed. Huge concentration of Lesser Flamingos has been reported from Dhuwaran (Jadhav and Parasharya 2004), Vadgam-50,000 (Thakker, *Pers Comm*) and New port Bhavnagar-22,500 (Parasharya, *Pers. Comm.*) in the past. Current study has helped to establish that several sites at the Gulf of Khambhat are very important for Lesser Flamingos, as about 2, 97,501 birds were recorded here (Table 1.1, b.2).

Estimated population size of Lesser Flamingo in the entire South Asia is only 1,20,000 birds (Rose and Scott, 1997), while a total of 3,72,778 Lesser Flamingos could be counted in the present study from different sites of Gujarat state alone in January 2003. This is much higher than what was ever estimated during earlier studies. The higher number of flamingos suggests two possibilities, either

1) The flamingo count done in the past, did not include all their preferred coastal and inland sites, and hence the count remained low; or
2) The flamingos might have immigrated to the sites surveyed during January 2003. However it should be confirmed and hence, migration studies using Platform Terminal Transmitter (PTT) is urgently warranted.

Flamingo count reported here is preliminary and incomplete as it represents the count of selected sites only Northern coast of Gulf of Kachchh, southern coast of Gulf of Kachchh between Jamnagar and Surajbari and the southern coast between Navsari and Umargam were not included. Hence, the count given here, should be considered as the minimum. If a systematic survey of the entire state is carried out, an accurate estimate of the actual population size can be worked out.

Distribution

The Greater Flamingos were equally distributed in the Gulf of Kachchh, Gulf of Khambhat and Other Coastal Sites whereas, the Lesser Flamingos were concentrated in the Gulf of Khambhat. Since 79.80% of the Lesser Flamingos were observed in the Gulf of Khambhat, it is presumed that large mudflats exposed during low tide may be the major attraction for them. Remaining 20% population was equally distributed in the Gulf of Kachchh and the Other Coastal Sites which indicate that preferred habitats also occur in these areas.

Several sites supported >20,000 flamingos (and other waterfowls) and > 1% biogeographic population of one or both the species of flamingos and hence qualify as Ramsar sites. However, regular monitoring of such sites is needed.

Conclusions:

1. The highest count of flamingos was recorded during the current study.

2. Both the species of flamingos were largely distributed at the Coastal Wetlands and very small or negligible population was in Inland Wetlands.

3. The Greater Flamingos were equally distributed in the Gulf of Kachchh, Gulf of Khambhat and Other Coastal Sites. The Lesser Flamingos were more concentrated in the Gulf of Khambhat with small populations in the Gulf of Kachchh and Other Coastal Sites.

4. The survey attempted gives an accurate figure of population and distribution of flamingos only at the selected sites of Gujarat State. There may be many other sites supporting both the species. However, these figures can be definitely considered as bottom line when a study is planned in future taking into consideration all possible sites.

5 Special efforts are needed to revise their population size in Asia. This would require (i) coordinated efforts involving a large number of birdwatchers, (ii) systematic survey of all the potential coastal and inland wetland sites, (iii) the survey done in a minimum period to avoid overlap of counts by the local movements of flamingos, (iv) employment of proper survey techniques and (v) funds for the ground as well as aerial survey

6. A huge concentration of Lesser Flamingos in the Gulf of Khambhat suggests the importance of this site for flamingos. The results can be used for taking further measures of conservation.

7. Regulatory monitoring particularly through satellite tracking is urgently required to understand their inter-continental movements and migratory behavior.

1.2: Population Estimation and Distribution of Flamingos during Breeding Season (October 2003):

Birds having different breeding and feeding sites show movement between these two areas regularly. As the breeding season approaches, they migrate to their specific breeding sites, leaving their usual feeding sites. Hence, a total count of Greater Flamingos and Lesser Flamingos was done during their breeding season to estimate the population size and determine their distribution pattern during the breeding season compared to that of non-breeding season.

Materials and Methods:

The flamingos were counted from October 11 to 31, 2003, at different sites of Gujarat state, when the nesting continued in the Great Rann of Kachchh (Chapter 4). The same method was used as in January 2003 for flamingos count. Major sites supporting large number of flamingos in Rann of Kachchh, Gulf of Kachchh, Gulf of Khambhat, Other Coastal sites and Inland Wetlands were surveyed either personally or by other people on personal request and the information was obtained from them (Fig. 1.2).

Results:

The results are compiled in Table 1.2. A total of 1,73,130 Greater Flamingos and 6,65,920 Lesser Flamingos (total 8,39,050 Flamingos) were recorded during October 2003 at different sites of Gujarat. The total number of birds counted in October 2003 was more than double (8,39,050) compared to the count of January 2003 *i e* non-breeding season (4,05,721).

Highest concentration of flamingos was recorded at the Rann of Kachchh (94.09%) with a small concentration at the Gulf of Khambhat (05.64%). Flamingos were negligible on Other Coastal Sites of Gujarat (00.24%) and the Gulf of Kachchh (0.03%), and totally absent at the Inland Wetlands of Gujarat.

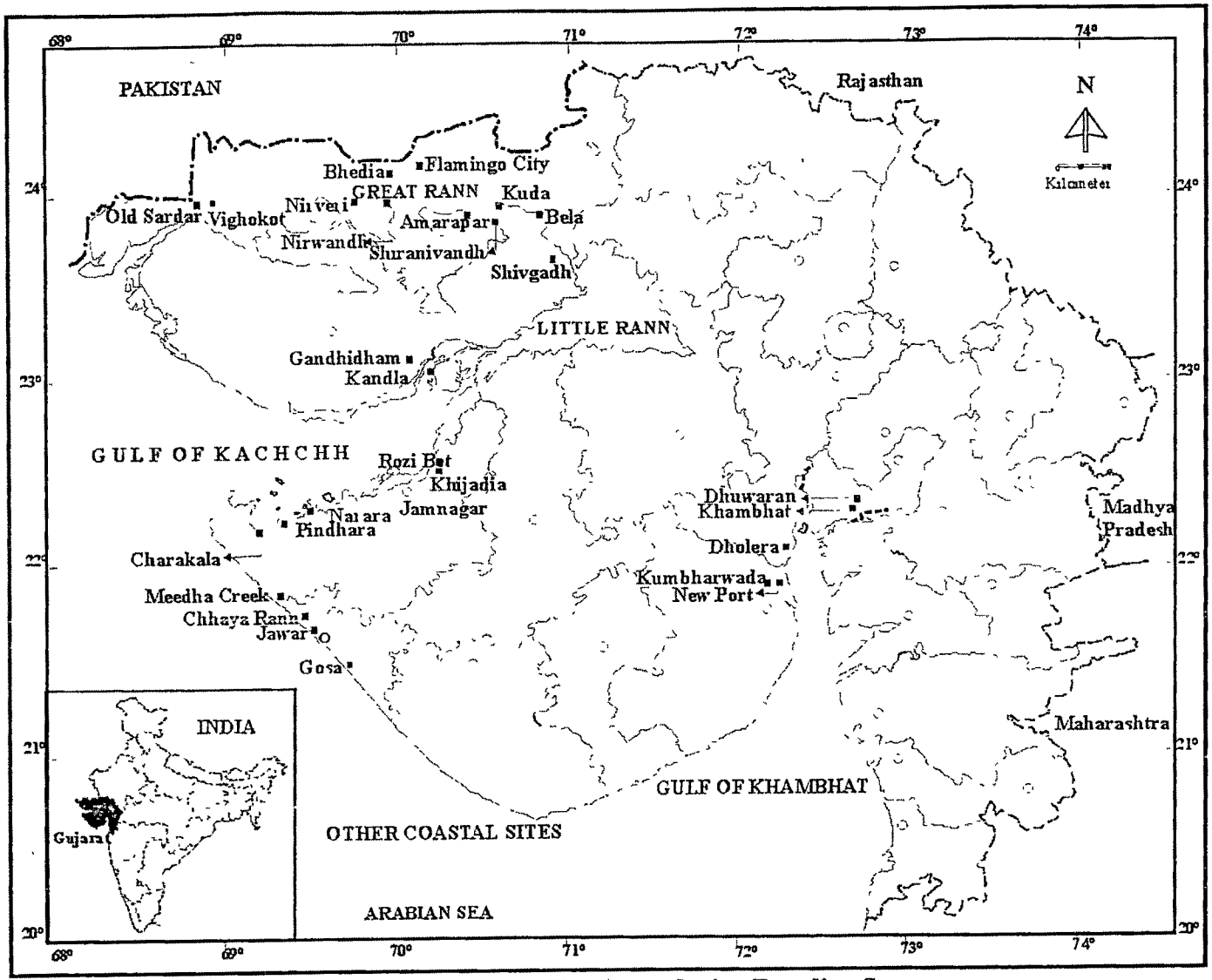


Fig. 1.2: Distribution of Flamingos during Breeding Season

Distribution of Greater Flamingos:

A total of 1,73,130 Greater Flamingos were recorded, of which major population was in the Rann of Kachchh (99.42%) while only a fraction was recorded from the Gulf of Khambhat (00.58%). The Greater Flamingos were absent in the Gulf of Kachchh, Other Coastal Sites and Inland Wetlands of Gujarat (Table-1.2).

In the Great Rann, the major population of Greater Flamingo (1,00,000) was concentrated at the Flamingo City. They were also recorded in considerable number between Shiranivandh and Amarapar (20,000) and Shivgadh (50,000). All these sites were around their nesting colonies (Table 1.2a).

In the Gulf of Kachchh, the areas like salt pans of Jamnagar and Charakala, sea coast of Gandhidham and entire coast up to Mandvi were surveyed. However, the Greater Flamingos were absent in all these areas of salt pans (Table 1.2 b).

In the Gulf of Khambhat, the Greater Flamingos were absent at the coast of Khambhat and Dhuwaran and recorded from Dholera and Bhavnagar only (Table 1.2c).

Compared to January 2003 count (Non-breeding Season), their number had increased enormously in October 2003 (Breeding Season), from 32,943 to 1,73,130 birds.

Distribution of Lesser Flamingos:

Major population was recorded in the Rann of Kachchh (92.70%) and a very small population was recorded in the Gulf of Khambhat (6.95%) of the total 6,65,920 Lesser Flamingos. Negligible numbers were recorded on Other Coastal Sites of Gujarat (0.30%) and the Gulf of Kachchh (0.05%). Lesser Flamingos were absent in Inland Wetlands (Table 1.2).

A total of 6,00,000 adult Lesser Flamingos were sighted at Shiranivandh, about 50 km south east to the Flamingo City in the Great Rann of Kachchh (Table 1.2a). The Lesser Flamingos were recorded in such a big number at just one site, for the first time in India. A

total of 11,200 young ones along with 3,100 adult Lesser Flamingos were recorded from Bela.

In the Gulf of Kachchh, they were recorded only from Charakala salt pans and were absent from rest of the sites (Table 1.2b). In the Gulf of Khambhat, Lesser Flamingos were recorded from the coastal mudflats near GHCL, Dholera (38,000) and coastal areas around Bhavnagar (8,300). The count in the Gulf of Khambhat was much lower than that in January 2003 (Table 1.2c). At Other Coastal Sites, the Lesser Flamingos were recorded only from Chhaya Rann-a sewage pond located in Porbandar City (Table 1.2d).

Table-1.2: Distribution of Flamingos at Different Sites of Gujarat during the Breeding Season

Sites	Greater Flamingo		Lesser Flamingo		Total	
	No.	%	No.	%	No.	%
(A) Coastal	**1,73,130**	**100**	**6,65,920**	**100**	**8,39,050**	**100**
Rann of Kachchh	1,72,130	99 42	6,17,320	92 70	7,89,450	94.09
Gulf of Kachchh	0	00.00	300	00.05	300	00 03
Gulf of Khambhat	1,000	0.58	46,300	06.95	47,300	05 64
Other Coastal Sites	0	00 00	2,000	00 30	2,000	00 24
(B) Inland Wetlands	0	00 00	0	00 00	0	00 00
Total	**1,73,130**	**100**	**6,65,920**	**100**	**8,39,050**	**100**
%	20 63		79.37		100	

Table 1.2a: Distribution of Flamingos in Rann of Kachchh during the Breeding Season

Site	Greater Flamingo			Lesser Flamingo			Total
	Adult	Juv.	Total	Adult	Juv.	Total	
Great Rann							
Amrapar	20,000	0	20,000	0	0	0	20,000
Bela Post	0	0	0	3,100	11,220	14,320	14,320
Bhedia Post	0	0	0	0	0	0	0
Chhapper Bet	303	0	303	0	0	0	303
Flamingo City	1,00,000	0	1,00,000	0	0	0	1,00,000
India Bridge	0	0	0	0	0	0	0
Kanthvandh	1,729	0	1,729	0	0	0	1,729
Nirweri to Nirwandh	98	0	98	0	0	0	98
Old Sardar Post	0	0	0	0	0	0	0
Shiranivandh	0	0		6,00,000	0	6,00,000	6,00,000
Shivgadh	50,000	0	50,000	3,000	0	3,000	53,000
Vighokot Post	0	0	0	0	0	0	0
Total	**1,72,130**	**0**	**1,72,130**	**6,06,100**	**11,220**	**6,17,320**	**7,89,450**

Juv - Juveniles

Table 1.2b: Distribution of Flamingos in Gulf of Kachchh during the Breeding Season

Site	Greater Flamingo			Lesser Flamingo			Total
	Adult	Juv	Total	Adult	Juv.	Total	
1. Gandhidham							
Kandla Port	0	0	0	0	0	0	0
2. Jamnagar							
(i) Jamnagar Salt Pan	0	0	0	0	0	0	0
(ii) Charakala	0	0	0	300	0	300	300
Total	**0**	**0**	**0**	**300**	**0**	**300**	**300**

Juv - Juveniles

Table 1.2c: Distribution of Flamingos in Gulf of Khambhat during the Breeding Season

Site	Greater Flamingo			Lesser Flamingo			Total
	Adult	Juv	Total	Adult	Juv.	Total	
1. Ahmedabad							
Dholera, GHCL (SP)	200	0	200	0	0	0	200
Dholera, GHCL Coast	0	0	0	38,000	0	38,000	38,000
Total	**200**	**0**	**200**	**38,000**	**0**	**38,000**	**38,200**
2. Anand							
Dhuwaran	0	0	0	0	0	0	0
Total	**0**	**0**	**0**	**0**	**0**	**0**	**0**
3. Bhavnagar							
Adhelai Port	0	0	0	6,000		6,000	6,000
Kumbharwada	200	0	200	2,000	0	2,000	2,200
New Port	600	0	600	300		300	900
Total	**800**	**0**	**800**	**8,300**	**0**	**8,300**	**9,100**
Total	**1,000**	**0**	**1,000**	**46,300**	**0**	**46,300**	**47,300**

Juv - Juveniles

Table 1.2d: Distribution of Flamingos on Other Coastal Sites during the Breeding Season

Site	Greater Flamingo			Lesser Flamingo			Total
	Adult	Juv	Total	Adult	Juv	Total	
1. Porbandar							
Chhaya Rann	0	0	0	2,000	0	2,000	2,000
Kuchadi	0	0	0	0	0	0	0
Meedha Creek	0	0	0	0	0	0	0
Total	**0**	**0**	**0**	**2,000**	**0**	**2,000**	**2,000**

Juv.- Juveniles

Discussion:

Greater Flamingos:

In January 2003, the Greater Flamingos were evenly distributed in the Gulf of Kachchh (35.24%), the Gulf of Khambhat (27.37%) and other Coastal Sites (37.76%). In October 2003, the major concentration of Greater Flamingos (99.42%) was observed in the Great Rann of Kachchh, which suggests that they left the sites inhabited during the non-breeding season and the entire population has migrated to the Great Rann (their breeding ground) during breeding season.

Estimated population size of Greater Flamingos in South Asia is 1,50,000 (Rose and Scott, 1997) and in the entire middle East, south and south east Asia, it is estimated to be 2,25,000 (Wetland International, 2002). Concentration of 1,72,130 Greater Flamingo in the Great Rann of Kachchh suggests that probably the entire Asian population had gathered at one place for breeding. Hence, it can be proposed that the Greater Flamingos spread in entire Asia belong to one mega-population. On the other hand, in past, there were evidences of migratory movement of Greater Flamingos between Europe and India (Ali and Ripley, 1983). Hence, now the evidences suggests that Asian and European population may not be different but may be part of one mega-population. If there are evidences of migration between Africa and European population, then Greater Flamingos of all the three subcontinent may be belonging to a single mega-population. Bechet's (2004) theory of one mega-population for Europe is hereby expanded further to three biogeographic zones.

Lesser Flamingos:

Major concentration of Lesser Flamingos in the Rann of Kachchh (92.70%) suggested that like the Greater Flamingo they also migrated from their preferred sites of non-breeding season to areas of Great Rann.

The number of Lesser Flamingos counted in October 2003 (6,65,920), was extremely higher compared to the count in the non-breeding season during January 2003 (3,72,778). The incredible concentration of Lesser Flamingos during the breeding season suggests the immigration of major bulk of population from the entire subcontinent during the breeding

season. However, a detailed study is required to check whether these flamingos had converged from the Indian subcontinent only or from Africa also.

In Africa, a coordinated census efforts in January 2002 showed that 2.6 million Lesser Flamingos were missing from the expected figures (Simmons 2002, *Pers. Comm*). Though there are no evidences of inter-continental migration, Jadhav and Parasharya (2004) suggested that migratory movement of the Lesser Flamingo should be monitored to confirm possible movement between African countries and India. Current population estimates further strengthens the suspicion about the inter-continental movement of Lesser Flamingos. Hence, to prove the hypothesis of migration, studies using satellite tracking are urgently needed. On the other hand, there is an urgent need to set up a network of volunteers to monitor population size and migratory movement of the flamingos within the respective countries.

Presence of 46,300 Lesser Flamingos in the Gulf of Khambhat and 2000 Lesser Flamingo at Porbandar suggest two possibilities; either (i) small population had not gone to the breeding ground or (ii) the population which could not breed successfully had returned back to the feeding ground. In the Little Rann, breeding attempt of Lesser Flamingos had failed in the last week of August 2003 (Chapter 4). The birds which lost their nests might have gone back to the feeding ground. In September 2003, when Little Rann was surveyed, there were only few Lesser Flamingos around the deserted colony (Chapter 4).

During breeding season, the flamingos were seen in compact groups in specific areas and hence we found 1,00,000 Greater Flamingos at Flamingo City and 6,00,000 Lesser Flamingos at Shiranivandh. The unusual concentration of flamingo in the Great Rann suggests the potentiality of these sites for breeding.

Conclusions:

1. Flamingos left different sites inhabited during non-breeding season and concentrated at their breeding site in the Great Rann of Kachchh during breeding season. Large congregation of flamingos at Flamingo City, Shiranivandh, Bela, and Shivgadh

suggest that during breeding season, they concentrated around the nesting colony only.

2. The tremendous increase in number of both the species of flamingos, during October 2003, suggests their immigration from the entire subcontinent to the Great Rann (Breeding area). However, to prove the hypothesis of migration, studies using satellite tracking are urgently needed.

3. The presence of considerably good number of flamingos at Gulf of Khambhat, during breeding season, suggests its importance as a preferred site of flamingos.

1.3: Population Estimation and Distribution of Flamingos during Post-Breeding Season (May-June 2003):

In the breeding season, the flamingos were found to migrate from all different sites of Gujarat to the Flamingo City and other sites in the Great Rann of Kachchh (Breeding site). Hence it was equally important to investigate their distribution pattern at the end of breeding.

Materials and Methods:

A count was done from May 04 to June 12, 2004, when nesting of Greater Flamingo was over (Chapter 4). The same method was employed as for January 03. Major sites supporting flamingos in the Rann of Kachchh, Gulf of Kachchh, Gulf of Khambhat, Other Coastal Sites and Inland Wetlands of Gujarat were surveyed (Fig. 1.3). Flamingo count was done personally on the wetlands around Khambhat, Ahmedabad, Dholera, Anand and Vadodara. Remaining sites were surveyed by different birdwatchers and the information was collected thereafter.

Results:

A total of 71,667 Greater Flamingos and 1,50,907 Lesser Flamingos, making a grand total of 2,22,574 flamingos were counted at different sites of Gujarat during the post-breeding season. Compared to October 2003, this count was less as, all the sites surveyed during the breeding season could not be surveyed in post breeding season.

Highest concentration of flamingos was recorded in the Gulf of Khambhat (68.29%), followed by Inland Wetland (12.27%) and Other Coastal Sites (10.39%). Comparatively low population was recorded in the Rann of Kachchh (04.58%) and in the Gulf of Kachchh (04.47%) (Table 1.3).

Distribution of Greater Flamingos:

A total of 71,667 Greater Flamingos, including 59,161 (82.55%) adults and 12,506 (17.45%) immatures, were counted from different sites of Gujarat. Greater Flamingos had

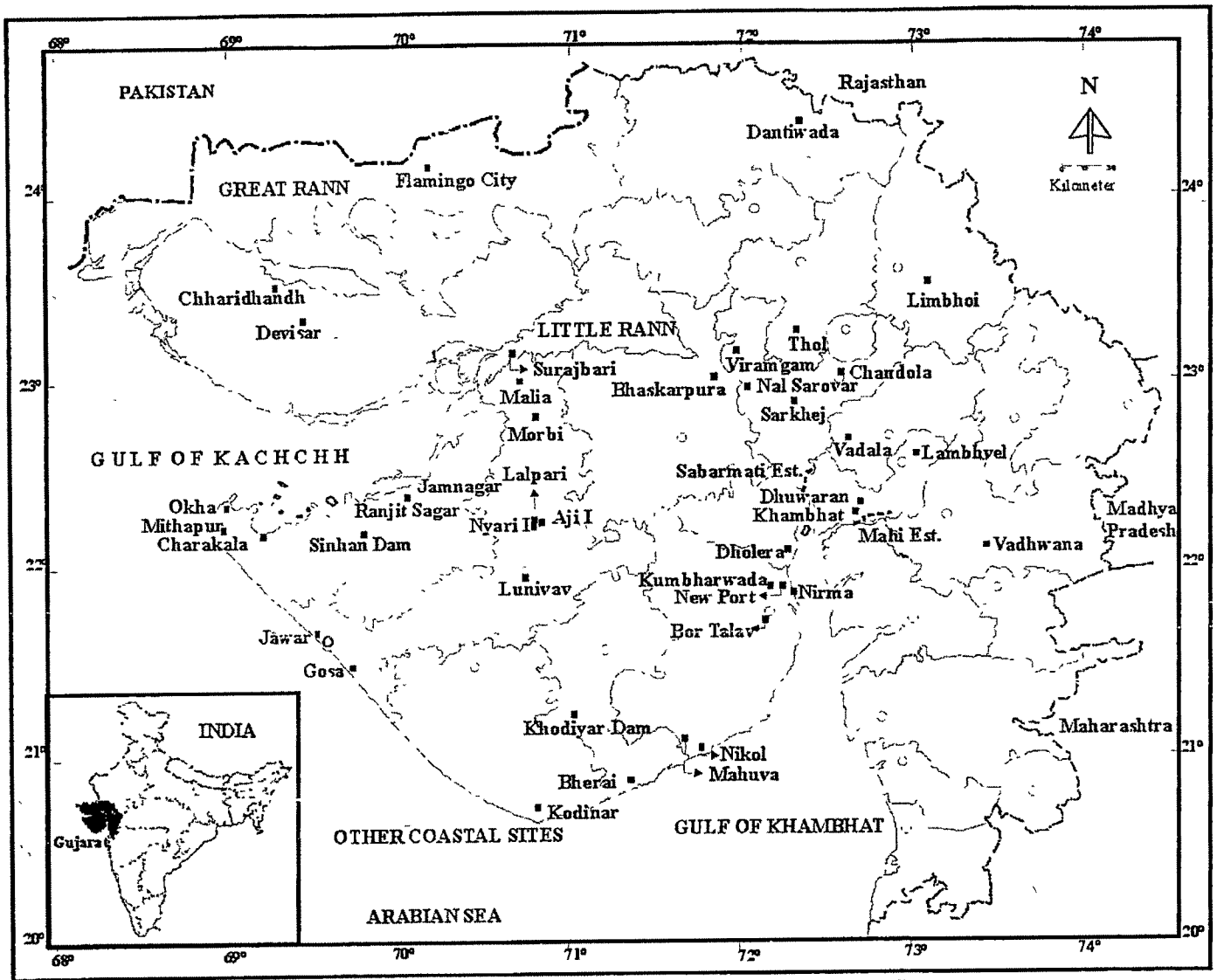


Fig. 1.3: Distribution of Flamingos during Post-breeding Season

almost equal distribution in the Rann of Kachchh (14.20%) and Inland Wetland (18.98%). Highest concentration of Greater Flamingos was found in Gulf of Khambhat (51.64%). Comparatively low number was found in Gulf of Kachchh (06.45%) and Other Coastal Sites (08.73%).

Greater Flamingos were recorded only in Flamingo City, at Rann of Kachchh, where 259 adults were present along with 9,655 immatures (Table 1.3a). In the Gulf of Kachchh, Greater Flamingos were present at salt pans of Charakala, Okha, Malia and Jamnagar (Table 1 3b). In the Gulf of Khambhat, they were recorded from salt pans and sea coast of Bhavnagar, Dholera, and Khambhat (Table 1.3c). In Other Coastal Sites, Greater Flamingos were recorded from sea coast, mudflats, salt pans of Porbandar, Junagadh, Amreli and Mahuva of Bhavnagar district (Table 1.3d). Comparatively good number of Greater Flamingos was recorded from Inland Wetlands of at least 12 districts (Table 1.3e). Their abundance and distribution in Inland Wetlands was much wider than during the non-breeding season (January 2003).

Distribution of Lesser Flamingos:

A total of 1,50,907 Lesser Flamingo, including 1,45,240 (96.24%) adult birds and 5,667 (03.76%) immatures, were counted at different sites of Gujarat. Highest concentration of Lesser Flamingos was recorded in the Gulf of Khambhat (76.19%). They were distributed equally on Other Coastal Sites (11.17%) and Inland Wetlands (09.09%). Very low number was recorded in the Gulf of Kachchh (03.54%). Only 23 birds were recorded from India Bridge in the Great Rann (0.01%) and they were absent from rest of the areas of Rann of Kachchh (Table 1.3).

At the Gulf of Kachchh, they were recorded from the salt pans of Charakala, Jamnagar and Malia (Table 1.3b). At the Gulf of Khambhat, they were recorded from the salt pans and sea coast of Bhavnagar, Dholera and Khambhat (Table 1.3c). At Other Coastal Sites, they were recorded from Porbandar, Junagadh, Amreli and Mahuva (Table 1.3d). In Inland Wetlands, the Lesser Flamingos were present only at Nal Sarovar, Chharidhandh and Sarkhej and were absent at other fresh water Inland Wetlands (Table 1.3e).

Table 1.3: Distribution of Flamingos at Different Sites of Gujarat during the Post-breeding Season

Site	Greater Flamingo				Lesser Flamingo				Total	
	Adult	Imm.	Total	%	Adult	Imm.	Total	%	Total	%
(A) Coastal	**46,152**	**11,914**	**58,066**	**81.02**	**1,31,709**	**5,483**	**1,37,192**	**90.91**	**1,95,258**	**87.73**
Rann of Kachchh	474	9,706	10,180	14 20	21	2	23	0 01	10,203	04 58
Gulf of Kachchh	4,086	534	4,620	6 45	5,000	339	5,339	3 54	9,959	04 47
Gulf of Khambhat	36,888	118	37,006	51 64	1,11,831	3,145	1,14,976	76 19	1,51,982	68 29
Other Coastal Sites	4,704	1,556	6,260	8 73	14,857	1,997	16,854	11 17	23,114	10 39
(B) Inland Wetland	**13,009**	**592**	**13,601**	**18 98**	**13,531**	**184**	**13,715**	**9.09**	**27,316**	**12.27**
Total	**59,161**	**12,506**	**71,667**	**100**	**1,45,240**	**5,667**	**1,50,907**	**100**	**2,22,574**	**100**
%	82 55	17 45	100		96 24	3 76	100			

Imm - Immatures of flamingos

Table 1.3a: Distribution of Flamingos in Rann of Kachchh during the Post-breeding Season

Site	Greater Flamingo				Lesser Flamingo				Total
	Adult	SA	Juv.	Total	Adult	SA	Juv.	Total	
Great Rann									
Flamingo City	259	0	9,655	9,914	0	0	0	0	9,914
India Bridge	215	32	19	266	21	0	2	23	289
Total	**474**	**32**	**9,674**	**10,180**	**21**	**0**	**2**	**23**	**10,203**

SA- Sub adult; Juv - Juveniles

Table 1.3b: Distribution of Flamingos in Gulf of Kachchh during the Post-breeding Season

Site	Greater Flamingo				Lesser Flamingo				Total
	Adult	SA	Juv.	Total	Adult	SA	Juv.	Total	
1. Jamnagar									
(i) Charakala	**3,736**	**0**	**483**	**4,219**	**1,979**	**0**	**317**	**2,296**	**6,515**
(ii) Jamnagar									
Valsura	**18**	**0**	**0**	**18**	**3,000**	**0**	**20**	**3,020**	**3,038**
(iii) Okha									
Aarambhada	100	0	0	100	0	0	0	0	100
Meethapur	17	0	0	17	0	0	0	0	17
Total	**117**	**0**	**0**	**117**	**0**	**0**	**0**	**0**	**117**
2. Kachchh									
Malia	**215**	**32**	**19**	**266**	**21**	**0**	**2**	**23**	**289**
Total	**4,086**	**32**	**502**	**4,620**	**5,000**	**0**	**339**	**5,339**	**9,959**

SA- Sub adult; Juv - Juveniles

Table 1.3c: Distribution of Flamingos in Gulf of Khambhat during the Post-breeding Season

Site	Greater Flamingo				Lesser Flamingo				Total
	Adult	SA	Juv.	Total	Adult	SA	Juv.	Total	
1. Ahmedabad									
Dholera, GHCL (SP)	1,501	62	5	1,568	5,532	544	67	6,143	7,711
Dholera, GHCL Coast	0	0	0	0	15,000	0	0	15,000	15,000
Rah Talav Coast	0	0	0	0	0	0	0	0	0
Total	**1,501**	**62**	**5**	**1,568**	**20,532**	**544**	**67**	**21,143**	**22,711**
2. Anand									
Khambhat-Vadgam	0	0	0		5,985	0	34	6,019	6,019
Near Navi Akhol	0	1	0	1	0	0	0	0	1
Vasana Pump House	2,650	0	50	2,700	11,300	0	0	11,300	14,000
Vasana	0	0	0	0	3,000	0	0	3,000	3,000
Total	**2,650**	**1**	**50**	**2,701**	**20,285**	**0**	**34**	**20,319**	**23,020**
3. Bhavnagar									
Kumbharwada	700	0	0	700	13,400	2,500	0	15,900	16,600
New Port	16,062	0	0	16,062	45,775	0	0	45,775	61,837
Nirma	15,975	0	0	15,975	11,839	0	0	11,839	27,814
Total	**32,737**	**0**	**0**	**32,737**	**71,014**	**2,500**	**0**	**73,514**	**1,06,251**
Total	**36,888**	**63**	**55**	**37,006**	**1,11,831**	**3044**	**101**	**1,14,976**	**1,51,982**

SA- Sub adult; Juv - Juveniles

Table 1.3d: Distribution of Flamingos on Other Coastal Sites during the Post-breeding Season

Site	Greater Flamingo				Lesser Flamingo				Total
	Adult	SA	Juv.	Total	Adult	SA	Juv.	Total	
1. Amreli									
GHCL Bherai	462	0	198	660	120	0	84	204	864
Khera, Kathivadar	212	0	83	295	4	0	1	5	300
Victor	1,430	0	745	2,175	8	0	2	10	2,185
Chikhali	400	0	0	400	1,500	0	0	1,500	1,900
Total	**2,504**	**0**	**1,026**	**3,530**	**1,632**	**0**	**87**	**1,719**	**5,249**
2. Bhavnagar									
Mahuva, Pingleshwar	**0**	**0**	**0**	**0**	**125**	**0**	**10**	**135**	**135**
3. Junagadh									
Kodmar	**0**	**0**	**0**	**0**	**800**	**0**	**0**	**800**	**800**
4. Porbandar									
Birla Creek	200	30	0	230	5,000	600	0	5,600	**5,830**
Gosa Karli	0	0	0	0	300	0	0	300	300
Jawar Salt Pan	2,000	500	0	2,500	7,000	1,300	0	8,300	10,800
Total	**2,200**	**530**	**0**	**2,730**	**12,300**	**1,900**	**0**	**14,200**	**16,930**
Total	**4,704**	**530**	**1,026**	**6,260**	**14,857**	**1,900**	**97**	**16,854**	**23,114**

SA- Sub adult, Juv.- Juveniles

Table 1.3e: Distribution of Flamingos on Inland Wetlands during the Post-breeding Season

Site	Greater Flamingo				Lesser Flamingo				Total
	Adult	SA	Juv.	Total	Adult	SA	Juv.	Total	
1. Ahmedabad									
Chandola Talav	30	0	0	30	0	0	0	0	30
Nal Sarovar	5,000	0	100	5,100	11,000	0	130	11,130	16,230
Sarkhej	190	0	27	217	8	0	2	10	227
Total	**5,220**	**0**	**127**	**5,347**	**11,008**	**0**	**132**	**11,140**	**16,487**
2. Amreli									
Khodiyar Dam,	**89**	**0**	**22**	**111**	**0**	**0**	**0**	**0**	**111**
3. Anand									
Lambhvel	**246**	**0**	**146**	**392**	**0**	**0**	**0**	**0**	**392**
4. Banaskantha									
Dantiwada	**7**	**0**	**0**	**7**	**0**	**0**	**0**	**0**	**7**
5. Bhavnagar									
Bor Talav	**150**	**0**	**0**	**150**	**0**	**0**	**0**	**0**	**150**
6. Jamnagar									
Sinhan Dam	10	0	0	10	0	0	0	0	10
Ranjit Sagar Dam	30	0	0	30	0	0	0	0	30
Total	**40**	**0**	**0**	**40**	**0**	**0**	**0**	**0**	**40**
7. Kachchh									
Chharidhandh	5,815	0	90	5,905	2,523	0	52	2,575	8,480
Devisar	18	0	2	20	0	0	0	0	20
Dhonsa	25	0	0	25	0	0	0	0	25
Total	**5,858**	**0**	**92**	**5,950**	**2,523**	**0**	**52**	**2,575**	**8,525**
8. Kheda									
Vadala	**100**	**0**	**0**	**100**	**0**	**0**	**0**	**0**	**100**
9. Mehsana									
Thol	**450**	**0**	**50**	**500**	**0**	**0**	**0**	**0**	**500**
10. Rajkot									
Aji-I	10	0	0	10	0	0	0	0	10
Lalpari	248	65	0	313	0	0	0	0	313
Machhu-Morbi	40	0	0	40	0	0	0	0	40
Nyari-I	0	0	0	0	0	0	0	0	0
Total	**298**	**65**	**0**	**363**	**0**	**0**	**0**	**0**	**363**
11. Surendranagar									
Bhaskarpura	**510**	**0**	**90**	**600**	**0**	**0**	**0**	**0**	**600**
Viramgam	40	0	0	40	0	0	0	0	40
Total	550	0	90	640	0	0	0	0	640
12. Vadodara									
Vadhawana	**1**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**1**
Total	**13,009**	**65**	**527**	**13,601**	**13,531**	**0**	**184**	**13,715**	**27,316**

SA- Sub adult; Juv - Juveniles

Discussion:

There were 17.45% immature birds in a total of 71,667 Greater Flamingos and 3.76 % immature ones in a total of 1,50,907 Lesser Flamingos. This suggests the successful breeding of both the species of flamingos during the preceding season.

In October 2003, *i.e.* breeding season, the flamingos were found concentrated at/around their breeding sites in the Rann of Kachchh and had almost disappeared from all wintering sites of Gujarat. During post-breeding count, the flamingos were found distributed again at different sites of Gujarat. Very low number of flamingos was recorded at the Gulf and the Rann of Kachchh. Comparative count of breeding and post breeding seasons suggested that as soon as the breeding was over, the birds returned back to their feeding sites inhabited during the non-breeding season and started foraging in different habitats.

The sighting of juveniles of Lesser Flamingos at Bela, suggested that they had completed nesting in October 2003, while the Greater Flamingos were still engaged in nesting activities. The Lesser Flamingos had left the breeding ground and only 23 Lesser Flamingos could be recorded from the Rann of Kachchh during the post-breeding season.

Greater Flamingos occupied a large number of Inland Wetlands all over Gujarat state. It appeared that Greater Flamingos occupied wider range of habitats and distributed themselves in smaller flock size. The strategy might be useful in increasing survival of their young ones, as such pattern might help them to reduce competition for food (as against compact flocking in an area) and reduction in predation risk.

Lesser Flamingos did not occupy Inland Wetlands except Nal Sarovar and Chharidhandh. These welands supported a large number of flamingos. They were shallow due to drying of water and hence, the water became salty (alkaline).

Highest Concentration of both the species of flamingos was recorded at the Gulf of Khambhat, which shows the potentiality of the area for the flamingos during the post-breeding season also.

Conclusions:

1. Flamingos started radiating to different sites of Gujarat from their breeding site (Rann of Kachchh), once the breeding season was over.

2. Highest concentration of flamingos at the Gulf of Khambhat suggests the importance of this site for the flamingos.

3. The proportion of immatures in the total counted flamingos gives clues regarding their successful breeding

1.4: Seasonal Variation in Distribution of Flamingos at Different Sites of Gujarat:

Materials and Methods:

A comparison of flamingo count of different seasons was carried out to understand the seasonal variation in their distribution. Counts of non-breeding season (January 2003), breeding season (October 2003) and post-breeding season (May-June 2004) were considered.

Results:

Both the species of flamingos were absent at the Rann during the non-breeding season as it was dry. Greater Flamingos were equally distributed in Gulf of Kachchh, Gulf of Khambhat and Other Coastal Sites. The major concentration of Lesser Flamingo was recorded from the Gulf of Khambhat both, during non-breeding and post breeding seasons (Table 1.4).

Highest numbers of both the species were recorded from the Rann of Kachchh, during breeding season and were absent or negligible at the Other Coastal Sites and Inland Wetlands of Gujarat.

In the post-breeding season, the highest number of both the species was recorded from the Gulf of Khambhat. Considerable population was also recorded from other sites. The distribution pattern of Lesser Flamingo did not differ much during non-breeding and post-breeding seasons but the Greater Flamingos showed a different pattern.

The number of flamingos at the Inland Wetland during the non-breeding and post-breeding season was relatively low compared to the coastal sites. The flamingos were totally absent from the Inland Wetland during the breeding season.

Table 1.4: Seasonal Variation in Distribution of Flamingos at Different Sites of Gujarat

Sites	Non-breeding		Breeding		Post Breeding	
	GF (%)	LF (%)	GF (%)	LF (%)	GF (%)	LF (%)
(A) Coastal Sites	**98.37**	**99.97**	**100**	**100**	**81.02**	**90.91**
Rann of Kachchh	00 00	00 00	99 42	92 70	14 20	0.01
Gulf of Kachchh	35 24	08 71	00 00	00.05	6 45	3 54
Gulf of Khambhat	26 50	79 80	0 58	06 95	51 64	76 19
Other Coastal Sites	36 63	11 46	00 00	00 30	8 73	11 17
(B) Inland Wetlands	**01.63**	**00.03**	**00.00**	**00.00**	**18.98**	**9.09**
Total Flamingos	**32,943**	**3,72,778**	**1,73,130**	**6,65,920**	**71,667**	**1,50,907**

GF- Greater Flamingo, LF-Lesser Flamingo

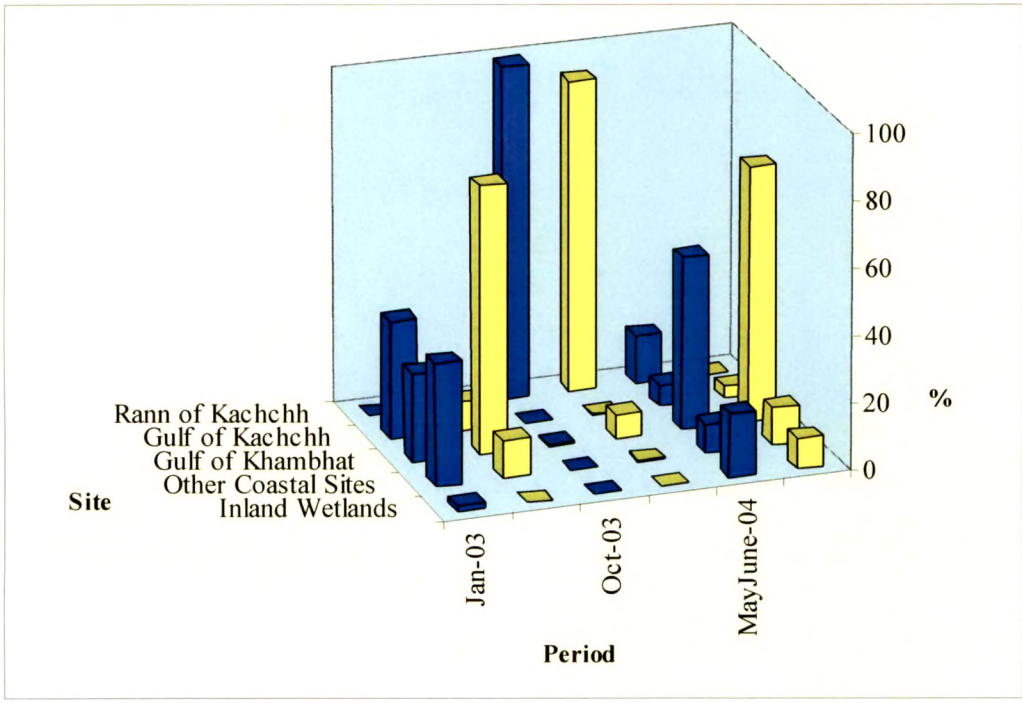


Fig. 1.4: Seasonal Variation in Distribution of Flamingos in Different Sites of Gujarat

GF- Greater Flamingos; LF-Lesser Flamingos

Conclusions:

During breeding season, most of the flamingos left all the sites inhabited during non-breeding season and concentrated at their breeding site at the Rann of Kachchh (Fig. 1.4). In the post-breeding season, the flamingos started radiating to different sites of Gujarat from their breeding site (Great Rann of Kachchh), once the breeding season was over.

The highest concentration of both the species of flamingos at the Gulf of Khambhat during the non-breeding and post-breeding seasons, suggests that this site is very important and probably the most preferred

1.5: Distribution of Flamingos at the Gulf of Khambhat

As part of a regular monitoring of flamingo population, all the important sites of Gulf of Khambhat were surveyed during August 2002, November 2002, January 2003, October 2003 and May-June 2004 with the following objectives:

1. Estimate population size of both the species.
2 Work out variations in the seasonal abundance, if any.
3. Determine the pattern of distribution within the gulf so that important sites can be identified precisely, and conservation priorities can be worked out.

Materials and Methods:

A detailed survey of Gulf of Khambhat was carried out and flamingos were counted from fringe areas on the entire gulf between August 13 and 27, 2002; November 06 and 23, 2002; January 11 and 26, 2003; October 11 to 31, 2003 and May 04 to June 12, 2004.

The coastal fringe of Gulf of Khambhat was divided into three zones (Fig. 1.5)

(i) Western Fringe of Gulf of Khambhat. entire coastal areas of Bhavnagar district

(ii) Northern Fringe of Gulf of Khambhat: sea coast around Dholera of Ahmedabad district; Khambhat-Dhuwaran of Anand district and Dabka and surrounding sea coast of Vadodara district

(iii) Eastern Fringe of Gulf of Khambhat: sea coast of entire Bharuch district

Results:

August 2002:

A total of 35,647 flamingos were counted at different sites of Gulf of Khambhat, of which, 91.90 % flamingos were recorded in the western fringe of gulf, 07.99% flamingos were recorded from northern fringe, and only 0.11% flamingos were recorded from the eastern fringe (Table 1.5).

A total of 9,294 Greater Flamingos and 26,353 Lesser Flamingos were recorded at the gulf. 87.5 % Greater Flamingos were recorded from the western fringe and 12.07 % were from the northern fringe. Only 0.43 % Greater Flamingos were recorded from the eastern fringe. Major population of Lesser Flamingos (93.45 %) was concentrated at the eastern fringe and only 6.55 % was from the northern fringe. The Lesser Flamingos were totally absent at the eastern fringe (Table 1.5a).

November 2002:

A total of 79,737 flamingos were counted at different sites of Gulf of Khambhat, of which, 52 22% flamingos were recorded in the western fringe of gulf, 47.71% flamingos were recorded from northern fringe, and only 0.07% flamingos were recorded from the eastern fringe of Gulf of Khambhat (Table 1.5).

A total of 6,888 Greater Flamingos and 72,849 Lesser Flamingos were recorded at different sites of gulf. 66.99 % Greater Flamingos were recorded from the western fringe and 32.20 % were from the northern fringe. Only 0.81 % Greater Flamingos were recorded from the eastern fringe. Equal numbers of Lesser Flamingos were recorded from the western fringe 50.82 % and northern fringe 49.18 %. The Lesser Flamingos were totally absent at the eastern fringe (Table 1.5b).

January 2003:

A total of 3,06,230 flamingos were counted at different sites of Gulf of Khambhat, of which, 24.74% flamingos were recorded in the western fringe of gulf, 75.14% flamingos were recorded from northern fringe and 0.12% flamingos were recorded from the eastern fringe of Gulf of Khambhat (Table 1.5).

A total of 8,729 Greater Flamingos and 2,97,501 Lesser Flamingos were recorded at gulf. 75.50% Greater Flamingos were recorded from the western fringe; 20.26% from the northern fringe and 4.24% from the eastern fringe. Major population of Lesser Flamingos (76.74%) was concentrated at the northern fringe with considerable population (23.25%) in

the western fringe. Only 0.01% Lesser Flamingos was recorded at the eastern fringe (Table 1.5c)

October 2003:

A total of 47,300 flamingos were counted at different sites of Gulf of Khambhat, of which, 19.24% flamingos were recorded in the western fringe of gulf and 80.76% flamingos were recorded from northern fringe. Both the species were absent at the eastern fringe (Table 1.5).

A total of 1,000 Greater Flamingos and 46,300 Lesser Flamingos were recorded at the gulf. 80.00% Greater Flamingos was recorded from the western fringe and 20.00% was from the northern fringe. Major population of Lesser Flamingos (82.07%) was concentrated at the northern fringe with considerable population of 17.93% in the western fringe.

May 2004:

A total of 1,51,982 flamingos were counted at different sites of Gulf of Khambhat, of which, 69.91% flamingos were recorded in the western fringe of gulf and 30.09% flamingos were recorded from northern fringe. Both the species were absent at the eastern fringe (Table 1.5).

A total of 37,006 Greater Flamingos and 1,14,976 Lesser Flamingos were recorded at the gulf. 88.00% Greater Flamingos was recorded from the western fringe and 12.00% was from the northern fringe Major population of Lesser Flamingos (63.94%) was concentrated at the western fringe with a considerable population of 36.06% in the northern fringe.

Table 1.5: Distribution of Flamingo in Gulf of Khambhat during different periods

Site	Aug 02		Nov 02		Jan 03		Oct 03		May 04	
	No.	%	No.	%	No.	%	No.	%	No.	%
Western Fringe	32,760	91 90	41,636	52 22	74,749	24 74	9,100	19 24	1,06,401	62 95
Northern Fringe	2,847	07 99	38,045	47 71	2,30,086	75 13	38,200	80 76	62,611	37 05
Eastern Fringe	40	0 11	56	0 07	395	0 13	0	00 00	0	00.00
Total	35,647	100	79,737	100	3,06,230	100	47,300	100	1,69,012	

Table 1.5a: Distribution of Flamingos in Gulf of Khambhat during August 2002

Site	GF	%	LF	%	Total	%
Western Fringe						
Bhavnagar	**8,132**	87.50	**24,628**	93.45	**32,760**	91.90
Northern Fringe						
Ahmedabad (Dholera)	1,020		1,300		2,320	
Anand	102		425		527	
Vadodara	0		0		0	
Total	**1,122**	12.07	**1,725**	06.55	**2,847**	07.99
Eastern Fringe						
Bharuch	**40**	00.43	**0**	00.00	**40**	00.11
Total	**9,294**	100	**26,353**	100	**35,647**	100

GF-Greater Flamingo; LF-Lesser Flamingo

Table 1.5b: Distribution of Flamingos in Gulf of Khambhat during November 2002

Site	GF	%	LF	%	TOTAL	%
Western Fringe						
Bhavnagar	**4,614**	66.99	**37,022**	50.82	**41,636**	52.22
Northern Fringe						
Ahmedabad (Dholera)	2,203		25,727		27,930	
Khambhat	15		10,100		10,115	
Total	**2,218**	32.20	**35,827**	49.18	**38,045**	47.71
Eastern Fringe						
Bharuch	**56**	00.81	**0**	0	**56**	00.07
TOTAL	**6,888**	100	**72,849**	100	**79,737**	100

Table 1.5c: Distribution of Flamingos in Gulf of Khambhat during January 2003

Site	GF	%	LF	%	TOTAL	%
Western Fringe						
Bhavnagar	6,590		14,159		20,749	
Shetruanji est.	0		55,000		55,000	
Total	**6,590**	75.50	**69,159**	23.25	**75,749**	24.74
Northern Fringe						
Ahmedabad (Dholera)	1,425		1,65,500		1,66,925	
Khambhat-Dhuwaran	344		62,417		62,761	
Vadodara	0		400		400	
Total	**1,769**	20.26	**2,28,317**	76.74	**2,30,086**	75.14
Eastern Fringe						
Bharuch	0		0		0	
Navsari	370		25		395	
Total	**370**	04.24	**25**	00.01	**395**	00.12
Total	**8,729**	100	**2,97,501**	100	**3,06,230**	100

Table 1.5d: Distribution of Flamingos in Gulf of Khambhat during October 2003

Site	GF	%	LF	%	Total	%
Western Fringe						
Bhavnagar	**800**	80.00	**8,300**	17.93	**9,100**	19.24
Northern Fringe						
Ahmedabad (Dholera)	**200**	20.00	**38,000**	82.07	**38,200**	80.76
Eastern Fringe						
Bharuch	0		0		0	
Navsari	0		0		0	
Total	**0**	00.00	**0**	00.00	**0**	00.00
Total	**1,000**		**46,300**		**47,300**	

Table 1.5e: Distribution of Flamingos in Gulf of Khambhat during May-June 2004

	GF	%	LF	%	Total	%
Western Fringe						
Bhavnagar	**32,737**	88.00	**73,514**	63.94	**1,06,251**	69.91
Northern Fringe						
Ahmedabad	1,568		21,143		22,711	
Khambhat	2,701		20,319		23,020	
Total	**4,269**	12.00	**41,462**	36.06	**45,731**	30.09
Eastern Fringe						
Bharuch	**0**	00.00	**0**	00.00	**0**	00.00
Total	**37,006**	100	**1,14,976**	100	**1,51,982**	100

Conclusions:

Comparison of the seasonal count at the Gulf of Khambhat showed variations in numbers of both the species. The number of birds of both the species was comparatively less in August 2002 and October 2003 *i e* during breeding season of flamingos, which then increased considerably in November 2002 and May 2004 *i.e* post breeding season. The number of flamingos was highest in January 2003 *i e* during the Non-breeding season (Table 1 5). This suggested that the Gulf of Khambhat is a preferred site of flamingos during non-breeding and post-breeding seasons

However, the flamingos were not distributed evenly in the entire Gulf of Khambhat. Highest concentration of flamingos around Bhavnagar showed that the western fringe of Gulf of Khambhat was very important for both the species of flamingos Highest concentration of Lesser Flamingos around the mudflats of Dholera and Khambhat-Dhuwaran, suggested that the northern fringe of Gulf of Khambhat was an important site for the Lesser Flamingos. Negligible number of flamingos on the sea coast around Bharuch and Navsari district suggested that the eastern fringe was not preferred by either of the species of flamingos.