

Baseline survey of birds at the proposed Navi Mumbai International Airport (NMIA) site

Final report

(2012–2016)



BOMBAY NATURAL HISTORY SOCIETY

March 2017



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The report has to be used in its totality to achieve its desired goals

Baseline survey of birds at the proposed Navi Mumbai International Airport (NMIA) site

Final Report

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EXECUTIVE SUMMARY

Since 1971, the Navi Mumbai area has been developed as a new urban township of Mumbai by CIDCO (City and Industrial Development Corporation of Maharashtra Ltd), a Government of Maharashtra undertaking. The state government also built one of the largest container terminals in India called Jawaharlal Nehru Port (JNPT) for shipping, ship building and port, which changed the economic condition of Uran falling in the Navi Mumbai area. Due to land filling activities and the development of JNPT at Uran, the habitat in Navi Mumbai has been drastically altered (BUCEROS newsletter special issue 2010; Sarkar 2007).

On the other hand, the need for a second airport in Mumbai region has become inescapable, as the existing airport at Mumbai is fast reaching saturation level, and the scope for further enhancement of passenger and cargo handling facilities, aircraft maintenance and city-side facilities are limited. The Ministry of Civil Aviation, Government of India granted approval to Government of Maharashtra in July 2007 to set up a Greenfield airport through Public-Private Partnership (PPP) at Navi Mumbai. The Government of Maharashtra, in turn appointed CIDCO, as a “Nodal Agency” for the implementation of Navi Mumbai International Airport (NMIA) project. The total area that has been earmarked for the airport development is 1,775 ha, with 1,160 ha allocated for airport area and the remaining for off-site infrastructure such as two parallel runways for independent operation, recourse channel, approach road, railways, interchanges and utility lines.

The Navi Mumbai International Airport is located between the existing National Highway No. 4B (east side) and Aamra Marg (west side) at the centre of Navi Mumbai (18°59'46.06"N, 73°4'36.23"E) in Panvel and Uran Taluka, Raigad District, Maharashtra, at a distance of approximately 35 kms from the existing Santa Cruz airport, as the crow flies.

The Ministry of Environment, Forest and Climate Change (MoEFCC) gave clearance to this project on the basis of some conditions. One condition (condition no. xxxi provided under specific conditions) was that an avifaunal study should be carried out in consultation with the Bombay Natural History Society (BNHS). CIDCO approached BNHS in April 2011 to conduct a study on the baseline information of birds at the proposed NMIA airport with the following objectives.

1. To study the current status and distribution of avian fauna in and around the proposed airport area of Navi Mumbai.
2. To understand how birds use this habitat with special reference to their roosting and feeding behaviour.
3. To study the site preference of birds within a 10-km radius of the proposed airport area.
4. To formulate a management plan for the airport in order to avoid bird hazard problems.

Since, Navi Mumbai is a comparatively new city, we had considered Mumbai region for the literature review. The Mumbai region has always been rich in migratory birds because of the coastal habitat as well its continuity into the Western Ghats. The avifauna of Mumbai has been documented since the late 1800s (Barnes 1882–91, Butler 1880, Keswal 1886). Pioneering work in this field was carried out by Humayun Abdulali and Dr. Sálím Ali, two stalwarts of BNHS, from 1924 to 1935 during which time they recorded 430 species in Mumbai area (Ali and

Abdulali 1937, Abdulali 1973). Ali and Abdulali (1941) provided detailed account of each bird species with note on their migration status such as winter migrant, passage migrant and resident.

Even, typical grassland birds such as the Lesser Frigatebird *Sypheotides indicus* were seen at Mahalaxmi, Churchgate and Panvel (Symons 1889). A flock of 12 Greater Flamingo *Phoenicopterus roseus* was recorded in May 1930 in Alibag and another flock of 8 individuals was seen at Bhayandar on 20 August 1939; there is also a record of three Greater Flamingos being shot at Dharamtar Creek on 12 November 1939 (Ali and Abdulali 1937). A single record of a female Lesser Flamingo *Phoeniconaias minor* (museum specimen) is available from 2 January 1898 (Ali and Abdulali 1937). But flamingos were first noticed in thousands on the Sewri mudflats by Sowrirajan (1994).

Soon these mudflats became very popular amongst birdwatchers and more species of birds were recorded. Flamingos were recorded continuously visiting Sewri in thousands (Sowrirajan 1994, Woodward 2007, Rahmani 2012). In the year 2004, threatened birds such as Oriental Darter *Anhinga melanogaster*, Lesser Flamingo *Phoeniconaias minor*, Indian White-backed Vulture *Gyps bengalensis*, Greater Spotted Eagle *Clanga clanga*, Eastern Imperial Eagle *Aquila heliaca* and Black-bellied Tern *Sterna acuticauda* were observed during a preliminary survey carried out at Mahul Creek by BNHS (Verma et al. 2004) which resulted in its declaration as an Important Bird Area (Islam & Rahmani 2004).

Bird aircraft collisions have been of great concern since the inception of aviation. Bird strike samples received from 35 airfields in India from 1999–2012 were identified by BNHS; the samples helped to identify the birds usually involved in bird-hits. Bird species posing a hazard to the aviation industry are found varying according to various bio-geographic zones in different parts of the country. As the proposed NMIA site mainly includes seashore and creek area, in this report we have discussed congregatory birds that are considered as species of concern.

Based on prior knowledge of the landscape, BNHS accepted the offer to conduct the five-year study and started its field work related to the project in January 2012. After preliminary surveys in Navi Mumbai, eleven sites were shortlisted based on location, habitat and the avifauna they supported. Intensive studies were undertaken at eight wetlands [wetlands near Training Ship Chanakya (TSC), Non-Residential Indian (NRI) Complex, Delhi Public School (DPS), Kharghar Creek, Kalundre River, Sonari-Belpada, Dastan Phata Jasai and Uran) and three forested areas (Karnala Bird Sanctuary, Chirner and Mosare). An additional 24 sites were also opportunistically surveyed. GPS coordinates of locations have been provided in the report.

Field visits and documentation were carried out in each site on a monthly basis, thus resulting in a large repository of baseline avifauna data for a period of 60 months, from January 2012 to December 2016. Total count method was adopted to count the water birds which were seen moving according to the tide level and water level. Therefore, tide-dependent movements of birds were studied across high tide and low tide. To get estimated count, high tide roosting birds were surveyed on monthly basis with more frequent visits in winter. But the highest count was taken into account for analysing the data. With the help of MS Excel results/distributions have been graphically illustrated in the form of month, site, species, as well as season-wise variations.

A total of 287 bird species belonging to 56 families have been recorded in the study area. Of these, 93 are migratory species and the remaining 194 are residential species. Migratory birds are winter visitors that arrive around November and stay on till March–April, while some among them stay back and are seen along with resident birds throughout the year, as overwintering population. Detailed information has been provided in annex V as a checklist of birds seen in the study area during 2012–2016.

We recorded 6 globally threatened species (see annex I for details), which included 2 Endangered, four Vulnerable and eight Near Threatened species. From these 14 species, the Lesser Flamingo *Phoeniconaias minor*, Black-headed Ibis *Threskiornis melanocephalus*, Painted Stork *Mycteria leucocephala*, Eurasian Curlew *Numenius arquata* and Curlew Sandpiper *Erolia ferruginea* were seen frequently and abundantly. On the other hand, species such as Great Knot *Calidris tenuirostris*, Steppe Eagle *Aquila nipalensis*, Alexandrine Parakeet *Psittacula eupatria* and Pallid Harrier *Circus macrourus* were seen rarely/occasionally. Indian Skimmer *Rynchops albicollis*, Greater Spotted Eagle *Clanga clanga*, Indian Spotted Eagle *Clanga hastata*, Woolly-necked Stork *Ciconia episcopus* were seen a few times but in very limited numbers.

Apart from the list of threatened birds, we have also provided detailed information about additional 15 congregatory water birds (see annex II). Congregatory birds are usually globally known to be involved in bird strikes and considered as species of concern for flight safety. Using available literature, we have provided detailed information such as global distribution, habitat, habits and recent records of the species from Mumbai-Navi Mumbai seascape-landscape. The number of birds in a flock/group usually seen in the study area has been provided for the readers to get an idea about the individual species.

We have also provided information about six other congregating birds which were not observed at high tide roosts (annex IV). These species include Blue Rock Pigeon *Columba livia*, Barn Swallow *Hirundo rustica*, Red-headed Bunting *Emberiza bruniceps* Black-headed Bunting *Emberiza melanocephala*, Rosy Starling *Pastor roseus* and Asian Pied Starling *Gracupica contra* which are known to feed in open areas and roost in high number on power lines, mangroves and other suitable perching structures.

We have also provided site-wise bird count dynamics and used data collected from five wetlands (wetlands near Training Ship Chanakya (TSC), Non-Residential Indian (NRI) Complex, proposed NMIA site, Belpada and Panje-Funde area of Uran) for the analysis. These areas receive a large number of wintering, over wintering and resident birds. The data indicates two peaks in bird count, one in October during the arrival of migratory birds and the second in April during their departure. This suggests that some of the wetlands in the study area serve as stopover sites for many birds before they arrive or depart during their migration period.

There are very few breeding records of birds available from Navi Mumbai area and therefore we have tried to collect relevant data through field study to address this gap. Breeding data of 27 species collected opportunistically has been provided along with details of ten species (annex III). We believe this data will be helpful in the future for a comparative study of birds breeding in a human-dominated landscape and their response to the continuously changing habitat.

Observations on communally roosting birds in the study area have been provided. Some birds such as egrets, cormorants, mynas, parakeets, crows, etc. which were found roosting in large numbers at selected sites have been identified and documented. It is important to note that these birds forage in the wetland areas during the day and return to their roosts during dusk. Flight pattern movement during morning and evening between roosting and foraging areas can be correlated with flight paths to avoid bird–aircraft strikes.

Considering that NMIA too will face the bird hazard issue, we have tried to track the movement of congregatory birds and found there is an association with their movement and availability of water in the wetland and tide level. During low tide when the mudflats are exposed, all the shorebirds were found foraging on the shore. During high tide, the mudflats were submerged and birds moved towards shallow areas of the inland wetlands. To understand this pattern in detail, we studied two Near Threatened congregatory species, Lesser Flamingo *Phoeniconaias minor* and Eurasian Curlew *Numenius arquata* in detail. During high tide, the movement of these birds was seen from seashore to three inland wetlands: one near Panje–Funde villages of Uran and the other two behind Training Ship Chanakya (TSC) and Non–Residential Indian (NRI) complex of Palm Beach Road, Navi Mumbai (see figure 3). During low tide, they were seen moving from these wetlands to the seashore area.

Similar pattern of tide dependent movement was seen in other waders also. Therefore, we propose these sites be monitored and protected in the future as they are the only areas left for birds to roost during high tide outside the airport zone (figure 2 showing landing and take-off area of the proposed airport site). In the absence of such measures, there is a high risk of birds congregating on open runways and spaces of the proposed airport area, which may result in bird hazard problems.

Our study in the area over the 5 years revealed that Navi Mumbai harbours a very high bird diversity and number, which is being threatened by fast-paced development (see figure 1). However, high bird diversity and population would mean an increased risk of bird strikes for any airport. Though there is no single solution to check bird hazard, using the baseline data of this study, we believe it will be possible to adopt site-specific mitigative measures. Furthermore, this data will also be helpful to understand the impact of the airport on the birds during the construction and operational phase of the airport.

Our study indicates that there is a high probability of bird movement between the study sites and it appears that the tidal height and water depth in temporary water pools created by local fishermen govern this movement. The movement of tidal birds is very high during high tide and they congregate at these sites to feed and rest. During 2012 to 2016, on average we used to count 40,000 to 50,000 birds in a single day and the maximum number of birds counted were about 1,00,000 in a single day. Therefore looking at this large number of birds and their local movement, we advise NMIA authority to be cautious during high tide and in the winter season, especially during October and April-May when bird congregation can be found at peak, so as to avoid bird hit calamities.

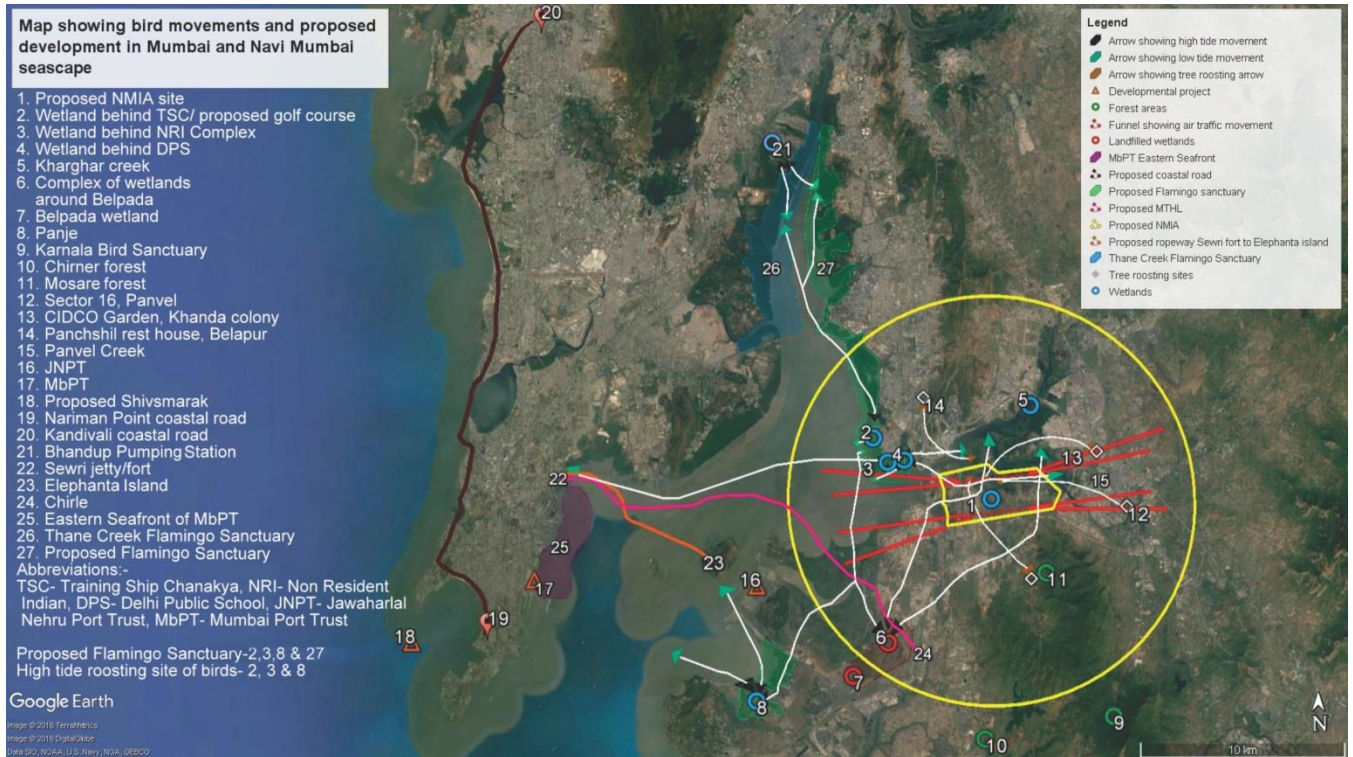


Figure 1 - Map showing on-going and proposed developmental plan in Mumbai-Navi Mumbai seascape along with locations of existing airport in Mumbai and proposed airport in Navi Mumbai

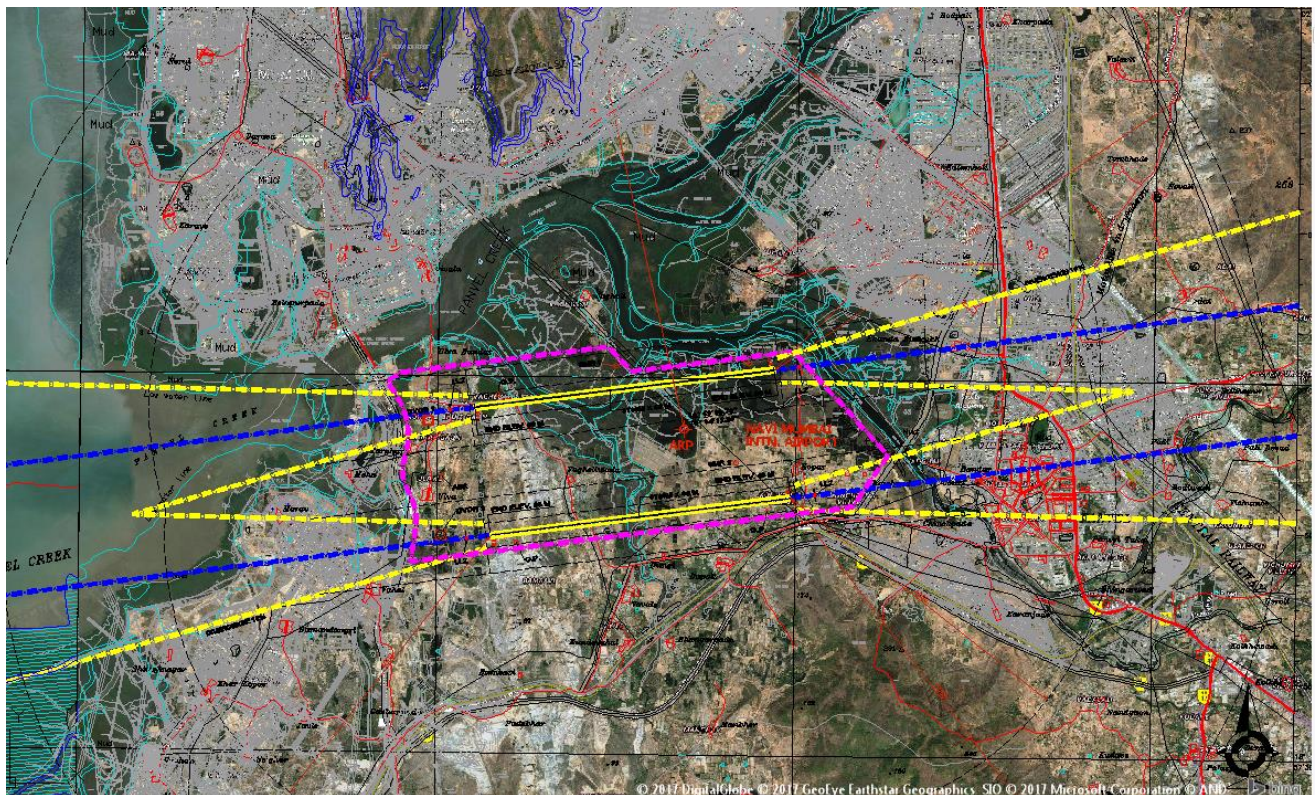


Figure 2 - Funnel map showing flight routes at the proposed NMIA site

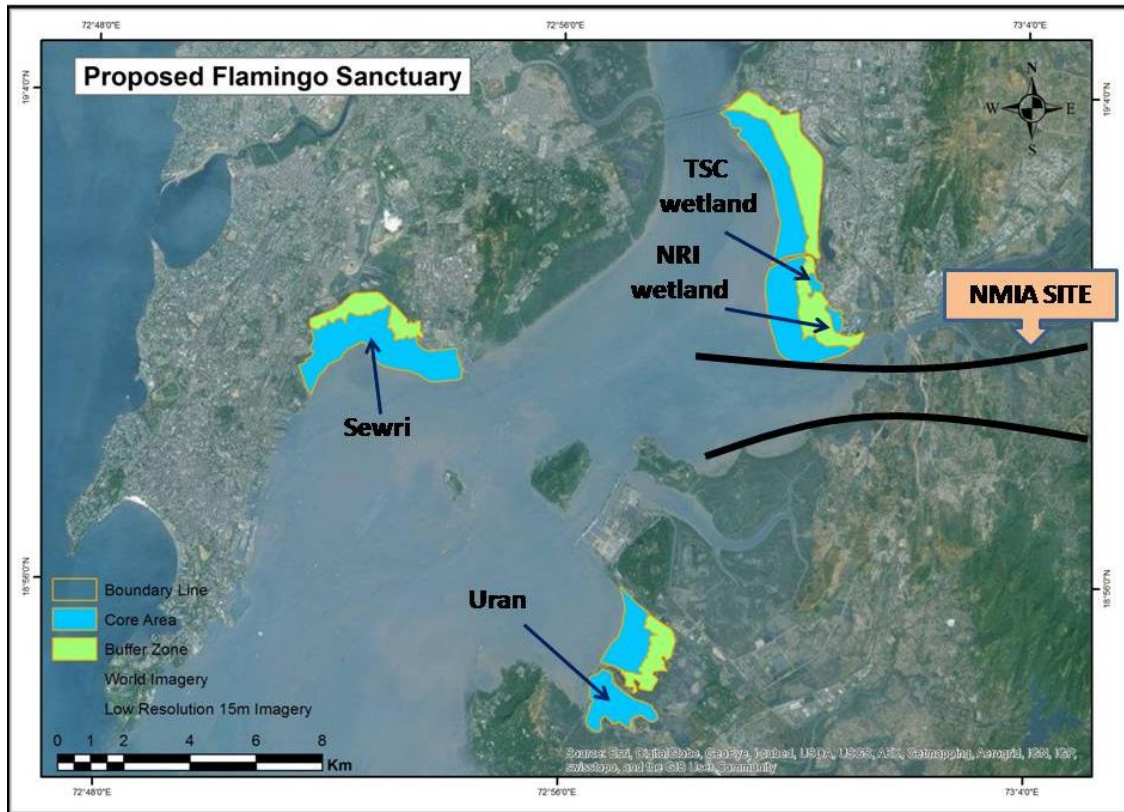


Figure 3 - Map showing Flamingo and wader congregation sites and funnel of the flight movement at the proposed NMIA site. Pale green colour shows mangrove areas and dark blue represents seashore as well as inland wetlands)

I) INTRODUCTION

1.1) Brief description of the proposed airport project

The need for a second airport in Mumbai region has become inescapable and imperative as the existing airport at Mumbai is fast reaching saturation level. The scope for further enhancement of passenger and cargo handling facilities, aircraft maintenance, and city side facilities in the current airport are limited. Therefore, Government of Maharashtra proposed to set up a new international airport at Navi Mumbai, Maharashtra. The Ministry of Civil Aviation, Government of India granted approval to the Government of Maharashtra in 2010 to set up a Greenfield airport through Public–Private Partnership (PPP) at Navi Mumbai. The Government of Maharashtra, in turn, appointed City & Industrial Development Corporation Ltd. (CIDCO as a “Nodal Agency” for the implementation of Navi Mumbai International Airport (NMIA) project.

The total area earmarked for the development of the new airport is 1,775 ha, with 1,160 ha set aside for airport area and the remaining for off–site infrastructure such as two parallel runways for independent operation, recourse channel, approach road, railways, interchanges and utility lines. The Ministry of Environment, Forest, and Climate Change (MoEFCC) has given clearance to this project on the basis of some conditions. One of the conditions (condition no. xxxi provided under specific conditions) is that an avifaunal study should be carried out in consultation with BNHS.

1.2) Project site location

The Navi Mumbai International Airport is located between the existing National Highway No.4B (east side) and Amra Marg (west side) near Panvel, in the geographical centre of Navi Mumbai (73°04'18"E and 18°59'33"N) at a distance of approximately 35 kms from the existing airport at Santa Cruz. The entire area of the airport falls in Panvel and Uran Tehsils of Raigad district covering 10 villages.

1.3) Review of literature on the avifauna of Mumbai and adjoining areas

Mumbai is bound by the Arabian Sea to the west and constituted by the erstwhile seven islands in the South and the suburbs stretching up to Dahisar and Mulund. Owing to its coastal habitat as well as continuity with the Western Ghats region, Mumbai has always seen great diversity of migratory birds. “Birds of the southern portion of the Bombay Presidency” is one of the oldest available publications on the birds of Mumbai (Butler 1880). A document was put together for the first time in the early 20th century about protection of wild birds in the Bombay Presidency (Anon. 1906). Old literature on birds of Mumbai also includes information about Grey Quail *Coturnix communis* seen near the sea (Bethell 1912), notes on two young Great Indian Hornbills *Buceros bicornis* (Prater 1922, Ellison 1923), and crow assemblies (Dalal 1936). An attempt was made in the 1940s to document “The Common Birds of Bombay” (Aitken 1947) through a descriptive account of bird species of Mumbai region, including residents and seasonal migrants .

A series of publications by Humayun Abdulali laid the foundation for a scientific study of birds in Mumbai and adjoining areas. His observations, notes, and sight records enriched the information on the birds of Mumbai. Asian Koel *Eudynamys scolopaceus* brood parasitism

(Abdulali 1931), the sun as a mortality factor among young birds (Abdulali 1939), local movements of Painted Francolin *Francolinus pictus* around Mumbai (Abdulali 1943), extension of breeding range of Black-winged Stilt *Himantopus himantopus* and some notes on its habits and plumages (Abdulali 1951) Cattle Egret fishing (Abdulali 1967), sparrow 'helping' nesting bulbuls (Abdulali 1980), pigeons *Columba livia* nesting on the ground (Abdulali 1983), juvenile plumage of female White-naped Flameback *Chrysocolaptes festivus* and other nesting notes near Mumbai (Abdulali 1985) are some examples of his writings on the birds of the region.

Abdulali, in the series of publications (Abdulali 1934, 1935, 1940, 1941, 1942, 1948; 1950a, 1950b, 1952, 1952b, 1954, 1957, 1958, 1960, 1962, 1963, 1964, 1965, 1965c, 1967a, 1970, 1979), recorded several species to Mumbai region such as White-eared Bulbul *Pycnonotus leucotis*, Grey-fronted Green-pigeon *Treron affinis*, White-bellied Woodpecker *Dryocopus javensis*, Indian Swiftlet *Aerodramus unicolor*, Wilson's Storm-petrel *Oceanites oceanicus*, Blue-tailed Bee-eater *Merops philippinus*, White-winged Tern *Chlidonias leucopterus*, Red Spur-fowl *Galloperdix spadicea*, White-tailed Lapwing *Vanellus leucurus*, Common Cuckoo *Cuculus canorus*, Grey Junglefowl *Gallus sonneratii*, Large Whistling-Teal *Dendrocygna bicolor*, Least Frigate Bird *Fregata ariel*, Small Indian Swallow Plover (presently known as Small Pratincole) *Glareola lactea*, White-rumped Swift (now called as Blyth's Swift) *Apus leuconyx*, Painted Francolin *Francolinus pictus*, Finsch's Starling (now called Common Starling) *Sturnus vulgaris*, Black-headed Munia or Tricoloured Munia *Lonchura malacca*, Black-necked Stork *Ephippiorhynchus asiaticus*, Swinhoe's Snipe *Gallinago megala*, Common Grey Hornbill (now known as Indian Grey Hornbill) *Ocyrceros birostris*, and nesting of Tickell's Blue Flycatcher *Cyornis tickelliae*. Pink-footed or Flesh Footed Shearwater *Ardenna carneipes* (Abdulali & Grubh 1982) and Black-eared Kite *Milvus migrans lineatus* (Abdulali & Sethna 1982) were also recorded for the first time by Humayun Abdulali.

Notes by on Asian Pied Starling *Gracupica contra* and Bank Myna *Acridotheres ginginianus* (Abdulali 1953), and extension of range of Little Bittern *Ixobrychus minutus* (Abdulali & Grubh 1966) are first reported additions to the avifauna of Mumbai area. Apart from these publications, Humayun Abdulali published a comprehensive checklist of the birds of Borivali National Park, at present known as Sanjay Gandhi National Park, with notes on their status (Abdulali 1981a, 1986) and checklist of the birds of Maharashtra with notes on their status around Mumbai (Abdulali & Ali 1940, Abdulali 1981b). Some other publications include literature on pittas and crows (Soman 1963), pugnacious behaviour of breeding White-browed Fantail Flycatcher *Rhipidura aureola* at Cumballa Hills, Mumbai (Tyabji 1964), and the strange feeding habit of Little Bittern *Ixobrychus minutus* (Rao 1965). Some interesting information such as ornithophily – a preliminary study of the reciprocal association between flower birds and bird flowers observed in and around Mumbai (Kannan 1966), unusual mating behaviour of the crow (Chandran 1966), parakeet roosts (Palkhiwalla 1968), Indian Three-toed Kingfisher *Ceyx erythacus* (Creado 1969), Black Drongo *Dicrurus adsimilis* fishing (Serrao 1971), concern for young of other birds by adults of other bird species (Serrao 1973), Jungle Babblers at Pali Hill, Bandra (Ali 1974), sandpipers at a suburban marsh (Akhtar 1977), biometrics and food of some harriers *Circus*

sp. (Satheesan *et al.* 1991) and scavenging by Eastern Cattle Egret *Bubulcus coromandus* (Serrao 1993) is also available.

Flamingos were found frequently visiting Sewri in thousands (Sowrirajan 1994, Ali 2006, Woodward 2007). Threatened birds such as Oriental Darter *Anhinga melanogaster*, Lesser Flamingo *Phoeniconaias minor*, Indian White-backed Vulture *Gyps bengalensis*, Greater Spotted Eagle *Clanga clanga*, Eastern Imperial Eagle *Aquila heliaca* and Black-bellied Tern *Sterna acuticauda* were observed during a preliminary survey carried out at the Mahul Creek by BNHS (Verma *et al.* 2004). This led to the declaration of the area as an Important Bird Area (IBA) (Islam & Rahmani 2004). The Vigors' Sunbird *Aethopyga vigorsii*, an endemic bird of the Northern Western Ghats was observed in Valley Park, Artist Village, and some areas of the Kharghar Hills in Navi Mumbai. Threatened birds such as Greater Spotted Eagle *Clanga clanga* (VU - Vulnerable) and Pallid Harrier *Circus macrourus* (NT-Near threatened) were also reported during a biodiversity survey of Navi Mumbai Nature Park carried out by BNHS for CIDCO, Navi Mumbai.

The proposed project area of the international airport is located about 10 km away from Karnala Bird Sanctuary, which is another major bird area in the region (Pande 2004, Raman 2004). Large numbers of birds were also recorded in Uran and Jasai areas (Monga 2003, Sarkar 2011, BUCEROS special issue 2010) and Navi Mumbai (Vaylure *et al.* 2008). Through literature review, it is clear that the study area is rich in bird diversity and population. Documentation of the avifauna is available from major publications: from 1930 to 1980 by Abdulali (Abdulali 1934, 1979), a preliminary survey carried out at the Mahul Creek by BNHS in 2000-2001 (Verma *et al.* 2004) and review of literature in year 2004 (Prasad 2004). All the publications are based on opportunistic surveys. No documentation is available on the avifauna of the study area. There are some records available on various social media platforms about sighting of birds, but we found many gaps in the knowledge of avifauna in study area except in the above mentioned publications.

1.4) Bird-aircraft strikes – literature review

Throughout history, humans have been intrigued and inspired by the beauty of birds and their ability to fly. Birds first took to the air about 150 million years ago. Humans first began to share their airspace only about 100 years ago. Unfortunately, when aircraft and birds attempt to use the same airspace at the same time, collisions occur (Jayarathna 2011). Bird strikes have been a concern from the early days of powered flight. The first fatality due to a bird strike was in 1912 when a Wright Flyer encountered a flock of gulls while conducting a demonstration flight along a beach. The investigation found that one of the gulls had jammed the rudder control causing the airplane to dive into the surf, breaking the pilot's neck (Maragakis 2009). The highest number of accidents occur during the take-off phase (48%), followed by the approach (30%), and the en-route phase (15%) (including the phases of climb and descent). Compared to other phases of flight, during the take-off phase (acceleration and lift-off), an aircraft is more susceptible to partial or total loss of control if a bird strike does occur. Regarding the type of bird species involved in the accidents, species of concern were known only for 60% of the accidents (Maragakis 2009). Majority of birds involved have been flocks of large birds (45%), followed by strikes from single large birds (31%) such as geese, ducks, cormorants, hawks, etc. (Maragakis 2009).

1.4.1 Bird strikes in the Asia/Pacific region

Bird strike statistics for the Asia and Pacific regions collected from a total of 6,996 bird strikes and reported by eighteen states in the Asia/Pacific region between 1996 and 2006 show that bird strikes occurs throughout the year with two peak periods – April/May and September/October. The months with least reported strikes were February and July (Jayarathna 2011). Bird strikes were reported to be most prevalent during day-light conditions with 61% cases; at night, only 29% cases were reported. Only 10% of the cases were reported during the hours of dawn and dusk. In 88% of all cases, pilots received no prior warning from office of the Air Traffic Control about impending bird strikes. Great majority of aircrafts (88%) collided with one bird; the remaining collided with two to 10 birds. There were two cases where the pilots reported having been struck by flocks consisting of more than 100 birds.

Analysis of data by Jayarathna (2011) shows that of the 6,996 bird strikes, in 3,799 cases (54%), the bird species were not known. Small perching birds struck more frequently with 816 hits (12%), birds of prey came second with 742 collisions (11%), shorebirds accounted for 613 strikes (9%), and other types of birds including parrots, herons, gulls accounted for 14% strikes.

1.4.2 BNHS Studies regarding bird-aircraft issue

Under BNHS initiative from 1980 to 1990 (Ali and Grubh 1989), studies revealed that vultures, kites, rock pigeons, lapwings, doves, myna, stone curlew, egrets, crows, sand grouse, harriers, parakeets and quails were the main bird species found to be involved in bird strike incidents. In the individual species, the maximum number of hits involved the birds closely associated with human habitations such as Black Kite *Milvus migrans migrans/govinda*, mainly due to open garbage dumps which served as an attractive foraging ground for kites. Black Kite was closely followed by the Blue Rock Pigeon and the Red-rumped Swallow *Cecropis daurica* which use manmade structures for nesting and roosting purposes.

During bird strike sample analysis, nesting birds (especially ground nesting) were seen to be most affected by aircrafts as the maximum number of bird strike samples was collected in this category. But more data is required from throughout India to formulate conclusive results. Unfortunately, in India except for few aerodromes of Indian Air Force, there is no mechanism available for long-term monitoring of bird hazard issues. There is need to have a centralized database of all airfields based on pre-construction, construction and post-operation phases to deal with this issue effectively.

Mitigation measures suggested during the past work includes making airfield areas unattractive to birds and developing proper waste disposal systems to avoid accumulation of garbage. Birds of all types use open water wetlands for drinking, bathing, feeding, loafing and roosting, and for safety. Gulls often find safety on or near runways of coastal airports when storms prevent their roosting at sea, on islands or on coastal bays (Godin 1994). Apart from (sewage) ponds, basins and canals, rain pools can be attractive drinking and preening sites. They also support a potential food source when they contain amphibians, fish and insects. Gulls and waterfowl in coastal areas show a strong preference for such locations. They often flock to temporary pools of fresh water at airports after heavy rains.

1.4.3 Coastal airports

Several examples show how coastal airports attract a large number of bird species: Black Kite *Milvus migrans migrans/govinda*, Grey Heron *Ardea cinerea* and Eastern Cattle Egret *Bubulcus coromandus* are usually attracted by grasshoppers that occur in large quantities, according to studies conducted at Kansai International Airport, Japan, which is 5 km from the coast (Inoue 1999). The airport in the North Sea off the Dutch coast is on an island which serves as a feeding station, resting ground and stopover for many migratory birds, especially gulls. The Durban International Airport located along the subtropical east coast of South Africa has a micro habitat of grasslands that supports a wide variety of birds and therefore has a high incidence of bird strikes. The airport is surrounded by reed beds, marshes, forests, shrub land and open patches for commercial cultivation. Birds said to be prone to airstrikes in and around Durban airport are Ibis, Herons, Kites and Geese, to name a few (Froneman & Rooyen 2003). Naval Air Station, Alameda, on the east shore of the San Francisco Bay near Oakland has a large wetland system which serves as an important feeding and resting ground for millions of annually migrating birds (Ellison *et al.* 1992).

NMIA airport is proposed in high bird diversity and density areas which have a mixture of habitats such as creeks, seashore, paddy fields, forest, inland wetlands and mangroves. Even the runways are proposed to be developed parallel to the creeks flowing adjacent to the airport area. The recent developmental activities in Navi Mumbai have resulted in rapid changes in natural habitats with consequences on the movement and distribution of birds. Thus, the knowledge of the movement patterns of species will be extremely important not only for the protection of birds but also for aircraft safety and human life.

1.4.4 Importance of bird hazard management

Collisions between aircraft and avifauna are a concern throughout the world because they threaten passenger's safety (Thrope 1977); result in loss of revenue and costly repairs to aircraft (Milsom & Horton 1990) and also erode public confidence in the air transport industry as a whole (Conover *et al.* 1995). Most wildlife strikes do not result in fatalities but safety hazards exist and the proportion of wildlife strikes that result in damage is substantial. Bird strike is widely regarded with increasing concern, for reasons including the rising counts of certain hazardous species and the replacement of turboprop fleets by jets (Nicholls & Bell 2005). The hazard has become more severe as aircraft speed has increased. This is because though birds are relatively small in comparison to modern aircraft, the impact energy in collisions increases with the square of the relative impact speed (CAA UK – SRG 2002).

Aircraft collisions with wildlife annually cost the civil aviation industry at least US \$ 1.3 billion in direct damage (Jayarathna 2011). Although the economic costs of wildlife strikes are extreme, the cost in human lives lost when aircrafts crash as a result of strikes best illustrates the need for management of the bird strike problem. The presence of wildlife (birds and animals) in and around the aerodrome poses a serious threat to aircraft operational safety (Jayarathna 2011).

1.4.5 Remedial measures used world over to avoid bird hazard (Sourced from Anon, 1988)]

To address bird hazard issue effectively, baseline data on the increase or decrease of the population of migratory or resident birds, and the movement of the birds in a particular area are very important. Measures could be divided into two categories: Ecological and Scaring.

Ecological methods: Includes long-term prevention of the risk. Most of the measures in this category are for general use and could be considered as first step. Scaring methods: This category covers different technical measures. The necessity of ecological background research before applying any of the following two methods should be always kept in mind.

Ecological measures

I. Measures that would be useful are suggested below, with examples from other countries:

- 1) Garbage disposal system should be strictly implemented in and around the airport areas so that birds are not attracted.
- 2) National/local regulations should be enforced preventing the feeding of pigeons in vicinity of airports
- 3) Regulation that prevents the use of land within a certain distance from any runways should be enforced. For example, in Belgium zones of 150 m from the centre line of each runway and 60 m over both ends of each runway cannot be used for agriculture. In case of military airport 30 m from the airport and 50 m from the edge of the taxiways cannot be used for agriculture.
- 4) Rules regarding the existence of trees and bushes in the vicinity of airport India: section 9–A of Indian Aircraft (1934) empowers the Central Government to restrict construction of buildings and growing of trees within 20 km from the aerodrome reference point. However, the government can enforce such a restriction only after issuing a notification in the Official Gazette, which is yet to be done. The International Airports Authority of India (IAAI) actively helps in bird hazard prevention measures.
- 5) Length of the grass along the runways: All over the world, the grass height is generally kept within 15–20 cm to avoid birds using open areas and keep away birds of prey hunting on small birds.

Scaring measures

1. Distress calls/ Emergency calls: These calls are taped carefully and played either via fixed station or established on mobile units.
2. Other techniques:
 - A. In France, noise generators are used along the runways. The sounds are played automatically from sunrise to sunset at high acoustic level (80dB) with silence period of 1 min duration between the emissions (30 seconds duration). This method, tested during 4 years, is effective on lapwings, gulls and pigeons.
 - B. Pyrotechnical devices
 - a. Shell crackers: In India as well as other countries it is widely used on all civil airports
 - b. Gas cannon: In Finland, liquid gas cannon fired automatically at regular intervals has proved cost effective at several airports. In India there is no use of gas cannon.
 - c. Gun shooting: In Denmark visual scaring with shotguns is used at all military and provincial civil airports. In India, it is occasionally used.
3. Use of Birds – methods such as falconry, bird mock up and radio controlled prey of birds can be used to scare the birds roosting in airport areas.
4. Visual Scaring – In Australia, vehicle mounted spotlights are used to shift the birds at night. The method of flashing lights has been found successful in Canada also. In Japan

one company has been testing eyeball painting on an engine spinner. According to their four-year-record, this device showed 20% reduction of bird strike.

Although the issue of bird strikes is as old as aviation, humans are yet to find a suitable solution for the same. In the recent years, very few fatal accidents have been caused by this hazard and most of these appear to involve a particular aircraft type. However, the cost of bird strikes to the civil aviation industry is not negligible.

1.4.6 Indian perspective about bird-aircraft issue

In India, a pioneering study on bird strike was carried out in the 1980s by the BNHS supported by Aeronautics R & D Board, Ministry of Defence, Government of India. This study was carried out at Gwalior, Gorakhpur, Jodhpur, Dundigal, Tezpur, Chabua, Sirsa, Srinagar, Jammu, Kalaikunda, Hyderabad, Trivandrum, Bengaluru, Patna, Nagpur, Kolkata, Chennai, Mumbai, Delhi, Hindan, Agra and Ambala. It was mentioned that about 27 species of mainly terrestrial birds were potential problem birds at Indian Aerodromes (Grubh & Ali 1984).

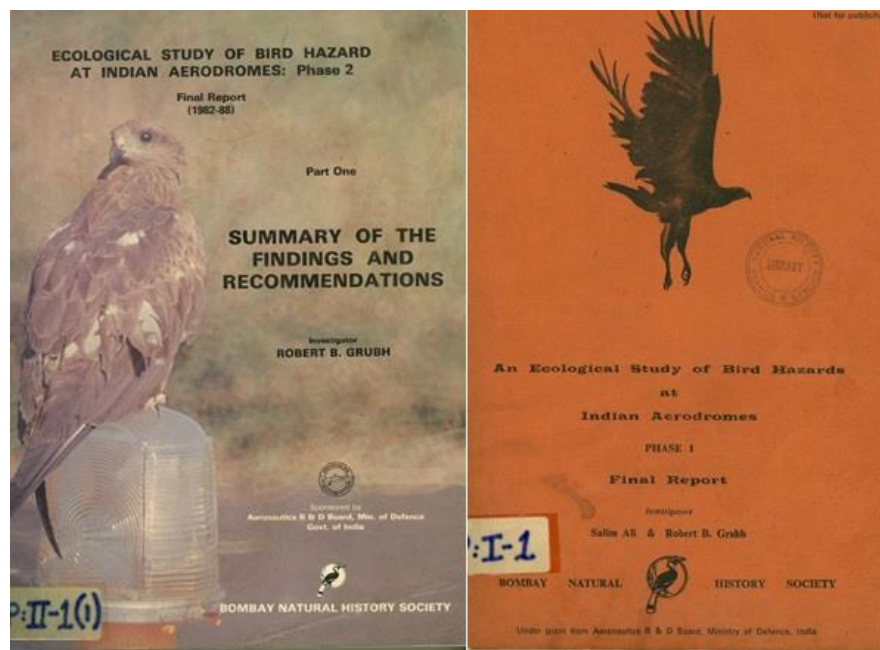


Image 1 - BNHS has done pioneering work in India regarding bird hazard issue since 1980–90

OBJECTIVES OF THE PRESENT STUDY

1. To study the current status and distribution of avian fauna in and around the proposed airport area of Navi Mumbai.
2. To study the habitat use of birds with special reference to their roosting and local movements.
3. To study the site preference of birds at 10 km radius area from proposed airport area.
4. Suggestions for management plan for the airport to avoid bird hazard problems.

II) STUDY AREA

Navi Mumbai, a planned township on the west coast of Maharashtra in India, began to be developed as an urban extension of the densely populated city of Mumbai in 1972. It extends over an area of 344 sq. km and has a coastline stretching roughly across 100 km. Besides the urban cover, this area comprises habitats like mangroves, creeks, mudflats, rocky seashore, forested and agricultural areas. The shore and inland wetlands of Navi Mumbai attract a number of resident/migratory birds throughout the year. After preliminary surveys in Navi Mumbai, eleven sites were shortlisted for monitoring based on location, habitat and the avifauna it supported. Intensive studies were undertaken at eight wetlands – Training Ship Chanakya (TSC), Non-Residential Indian (NRI) complex, Delhi Public School (DPS), Kharghar Creek, Kalundre River, Sonari-Belpada, Dastan Phata Jasai and Panje as congregations of birds were seen at these wetlands. Intensive studies were also carried out in three forested areas – Karnala Bird Sanctuary, Chirner and Mosare – while considering their proximity to the proposed NMIA. The detailed description of the 12 sites under study are as follows (Please refer annexure V for images of study sites).



Figure 4 - Map showing 10 km radius circle around proposed NMIA site

Following 11 selected sites were described in detail as below while glimpses of study sites have been provided in annexure V.

1. Proposed NMIA site

The proposed NMIA site (1,160 hectares) is a mosaic habitat of mangroves, open scrubland, and complex of smaller wetlands created by backwater, paddy fields as well as creeks of Gadhi,

Ulve, Taloje and Panvel rivers. We considered Kopar and Pargaon villages (GPS coordinates of the central point 18°59'20.37" N, 73°03'37.55" E, Figure 5) as centre point of the NMIA site. On the basis of land use pattern observed, the site (Figure 6) was broadly classified into four categories, as listed below:

Sr. No.	Habitat	Area in %	Ha
1	Mangrove patch	20	232
2	Grassland, paddy fields and abandoned salt-pans	50	580
3	Hilly undulating area, used as stone quarries	10	116
4	Area under human settlement	20	232

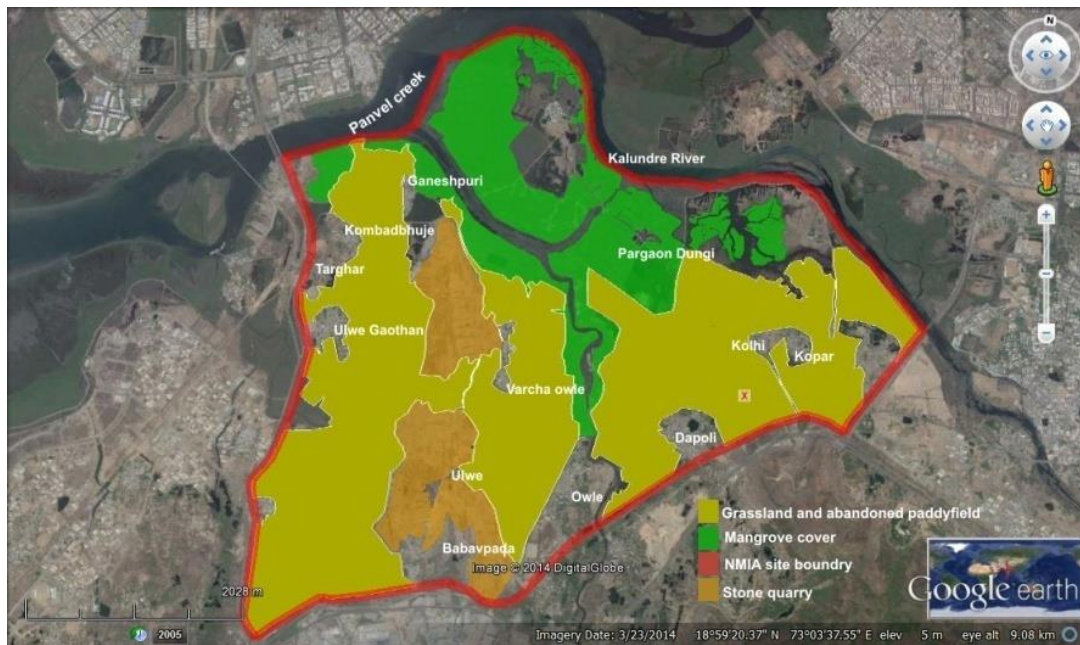


Figure 5 – Land use land cover map of proposed NMIA site showing villages coming under proposed airport



Image 2 - View of the proposed airport site

2. Kalundre River and Panvel creek (proposed NMIA site wetland area)

The Kalundre River joins the Panvel Creek and flows parallel to the proposed NMIA site (19°0'13.44"N, 73°3'51.05"E). Common mangrove species found in the area are *Avicennia marina* and *Acanthus ilicifolius*. Other associated plant species such as Glory Bower *Clerodendrum inerme*, Common Derris *Derris trifoliata*, Sea Purslane *Sesuvium portulacastrum*, Meswak *Salvadora persica*. These are shrubby trees with height of three to seven metres.

3. Wetland behind Training Ship Chanakya (TSC Wetland)

This is a small wetland of about 15 hectares area, located behind the Training Ship Chanakya Maritime Institute, Palm Beach Road, Seawoods (19°0'56.92"N, 73°0'19.33"E and see Fig 6). This site is followed by a stretch of paddy fields, shrub land, mangroves and finally reaches the seashore on western side of the wetland. The water level here was seen controlled by the local fishermen who have been using tidal cycles for effective fishing practices. TSC wetland is one of the important resting grounds for congregating birds found in the coastal area of Navi Mumbai. The population at roosting sites fluctuates according to water level in the wetland. Large congregations were usually observed when the fishermen emptied the wetland through the small check dams and funnel-like water channels. During low tide, the birds were found foraging on mudflats and during high tide they were resting at TSC wetland.



Figure 6 - Map of wetland behind Training Ship Chanakya (TSC Wetland)



Image 3 – Large number of flamingos can be seen in wetland behind TSC in winter

4. Wetland behind Non-Resident Indian (NRI) colony

This site lies in the northwest direction of the proposed NMIA site and located near NRI Colony, Seawoods Estates (19°0'18.02"N, 73°0'43.68"E, Figure 7). This wetland spreads across approximately 20-hectare area and is surrounded by grasslands, shrubs and mangroves. A small bund divides the wetland into two parts. The side towards human settlements is mainly used for fishing activities by the locals.

A part of wetland's interior side of the bund has mangrove cover from two sides and a fence wall of NRI colony on the other. A thin stretch of vegetation on the periphery of the wetland makes it an enclosed and safe habitat for the congregating birds. Accessibility to the wetland has been restricted after a fence was constructed around it in the year 2013, leaving a narrow entry path. Recently, a tree plantation was undertaken along the path and residents in the surrounding societies use this path to jog. Anthropogenic pressure in the form of local fisherman, joggers and bird watchers is increasing day by day here.



Figure 7 - Map of wetland behind NRI Complex

5. Wetland adjacent to Delhi Public School (DPS)

This wetland is adjacent to the Delhi Public School (19°0'21.68"N, 73°1'11.62"E, Figure 8) on Palm Beach Road, Seawoods. The wetland covered about 15 hectares area and is connected to the Kharghar creek by a small canal. It is surrounded by tar roads on three sides and school compound on the remaining other side. The water level of this wetland was also observed fluctuating as per the tidal cycles.

A few bird species were observed foraging in small groups near the shallower part of the wetland, in late winter. A new Sagar Sangam Railway Station connecting Seawoods and Uran area is proposed approximately 500 metres from this wetland and the entire area is under various developmental schemes.



Figure 8 - Map of wetland near Delhi Public School, Palm Beach road

6. Kharghar Creek

This creek is located between Kharghar and Mansarovar railway stations on the Harbour Line ($19^{\circ} 1'48.76''\text{N}$, $73^{\circ} 4'45.46''\text{E}$, Figure 9) and also can be reached via unpaved road from Sino–Panvel highway. The creek is nearly about 2-km long with dense mangroves on the edges. During the low tide, birds were seen foraging on the exposed benthos of open creek.

Birds such as bee-eaters, mynas, starlings, warblers, prinias and bulbuls were seen using mangroves and associated plants for perching and foraging. Incidences of sand mining, illegal release of industrial effluents, and mangrove cuttings for road widening were observed. Because of the undergoing construction of a large flyover on Sion–Panvel highway, access to the particular road is blocked since year 2015.



Figure 9 - Map of Kharghar Creek

7. Wetlands near Jasai and Dastan Phata

Bird species were found congregating on two wetlands covering about 300 hectare area on either side of Panvel-JNPT road, and located between Jasai village and Dastan Phata of Uran tehsil ($18^{\circ}55'33.97''\text{N}$, $73^{\circ} 0'42.20''\text{E}$, Figure 10). These wetlands are connected to the sea via small water channels, the flow of which is being controlled by the local people.

A portion of this wetland adjacent to JNPT toll plaza is a marshy area where birds like storks, ducks and jacanas were seen regularly. In 2013, a bund was built in the wetland on the side of Belpada village which resulted in blocking the usual movement of water. Therefore, water could be seen here only during peak high tides; rest of the period it was found completely dry. Land filling activities were seen in these wetlands in summer.



Figure 10 - Map of wetlands of Jasai and Dastan Phata, Uran

8. Sonari-Belpada Wetland

It is located in the southwest direction of the proposed NMIA site between Sonari-Belpada villages (18°54'41.97"N, 72°59'43.29"E, Figure 11). This site is reachable from Panvel–JNPT road and is about 2–3 km from Jasai village. The size of wetland is about 50 ha and it is located next to JNPT toll plaza. It is surrounded by grassy and shrubby area from three sides and the boundary wall of Speedy Services Ltd on the fourth side. Once part of a coastal mudflat, it is now isolated from the sea and has become an inland wetland that gets completely dry in summer.

In April 2013, the wetland dried up leaving few puddles of water and very few birds were seen here. After monsoon, the wetland was once gain full of water and birds like grebes, coots and ducks were seen here. In September 2014, a drainage outlet was constructed by the adjoining Speedy Company to remove the water from the wetland which was followed by a landfilling activity. This site was land filled in December 2014, losing its status completely.

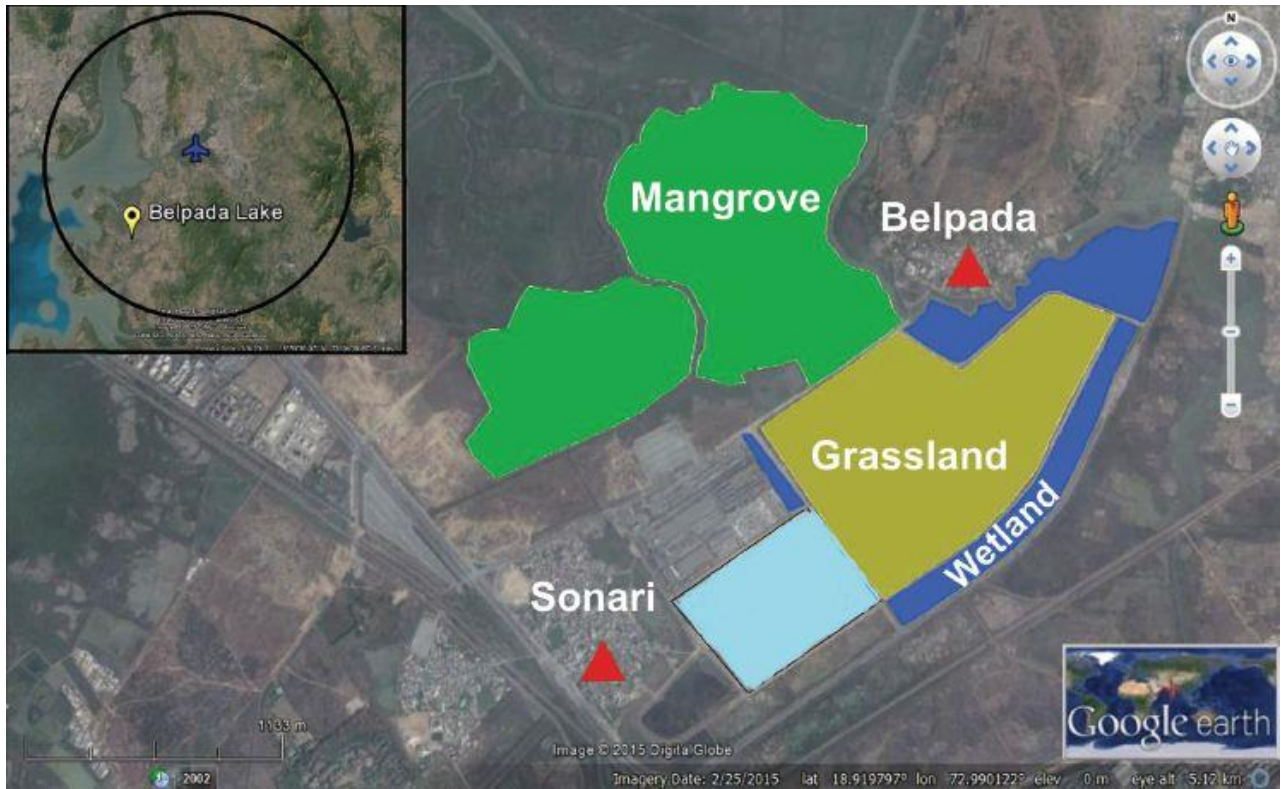


Figure 11 - Map of wetlands of Sonari–Belpada, Uran

9. Wetland near Panje–Funde, Uran

This wetland is sandwiched between villages Dongri, Funde and Panje (18°54'3.04"N, 72°57'1.86"E, Fig. 12). It is used by waders during high tides. The size of this wetland is of 100 hectare and is located within the boundary of the Special Economic Zone (SEZ) of Uran, Navi Mumbai.

This wetland is situated 3 km from Nhava Sheva Police station and is easily accessible via tar road. The site was created as a SEZ in 2009, and a boundary wall was constructed around the wetland separating it from the shore. This wetland has less anthropogenic pressure due to which it has become a safe area for birds to forage and roost.



Figure 12 - Map of Panje-Funde wetland in Uran

10. Karnala Bird Sanctuary and Ransai forest

Karnala Bird Sanctuary is located in Panvel Tehsil of Raigad district, ($18^{\circ}53'39.97''\text{N}$, $73^{\circ}6'57.50''\text{E}$, Fig. 13). The size of the sanctuary is about 14.12 sq. km with the centre point at historic Karnala fort.

Sanctuary is also approachable by road via Mumbai–Goa highway. We also covered Ransai, a recently included area in the sanctuary.

11. Chirner forest

A moist-deciduous forest patch sandwiched between Chirner village and Ransai Dam ($18^{\circ}53'4.43''\text{N}$, $73^{\circ}3'22.50''\text{E}$, Figure 14) was selected for survey. The site was found dominated by trees like Jamun *Syzygium cumuni*, Ber *Zizipus jujuba*, Banyan *Ficus benghalensis*, Teak *Tectona grandis*, Red Silk Cotton *Bombax ceiba* and Anjan *Hardwickia binata*.

This site is a mosaic of different habitats such as forest, grassland, agriculture and plantations of mango, teak and cashew.

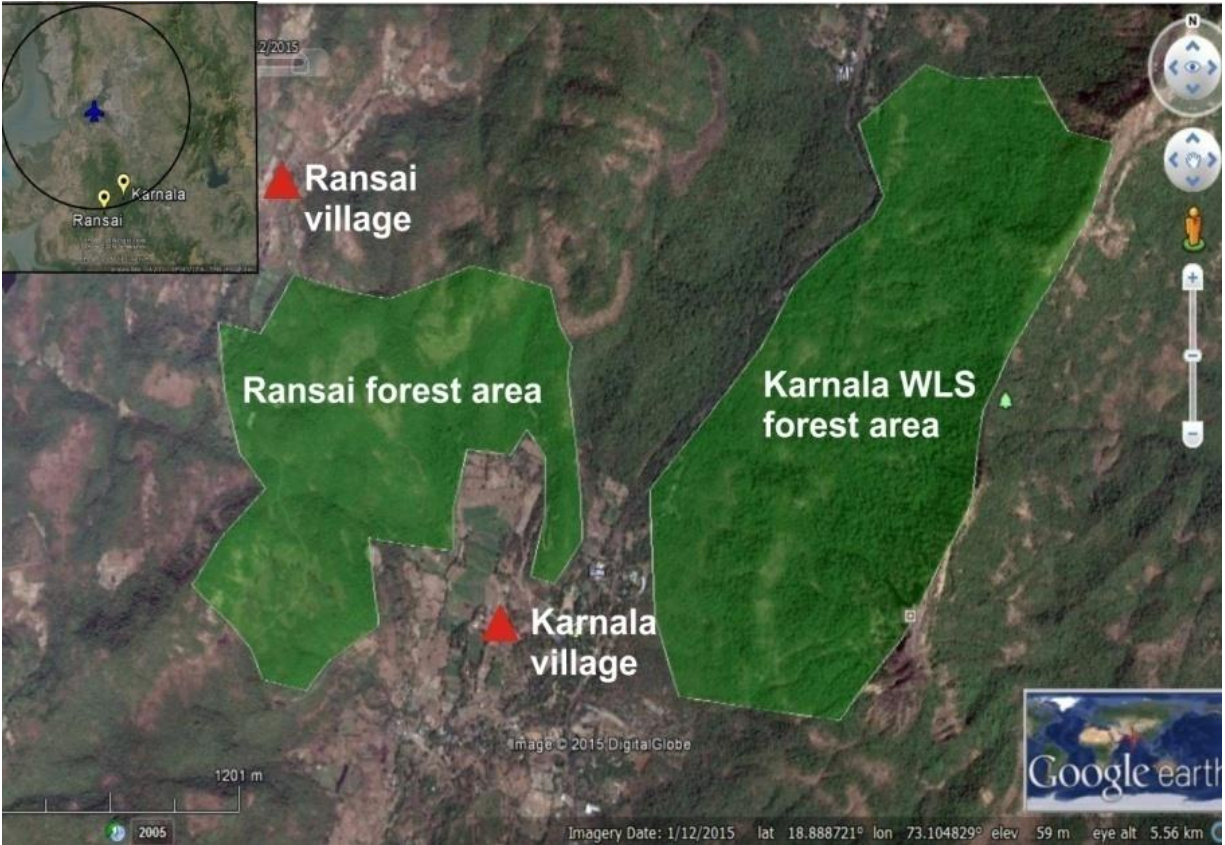


Figure 13 - Map of Karnala Wildlife Sanctuary and Ransai forest

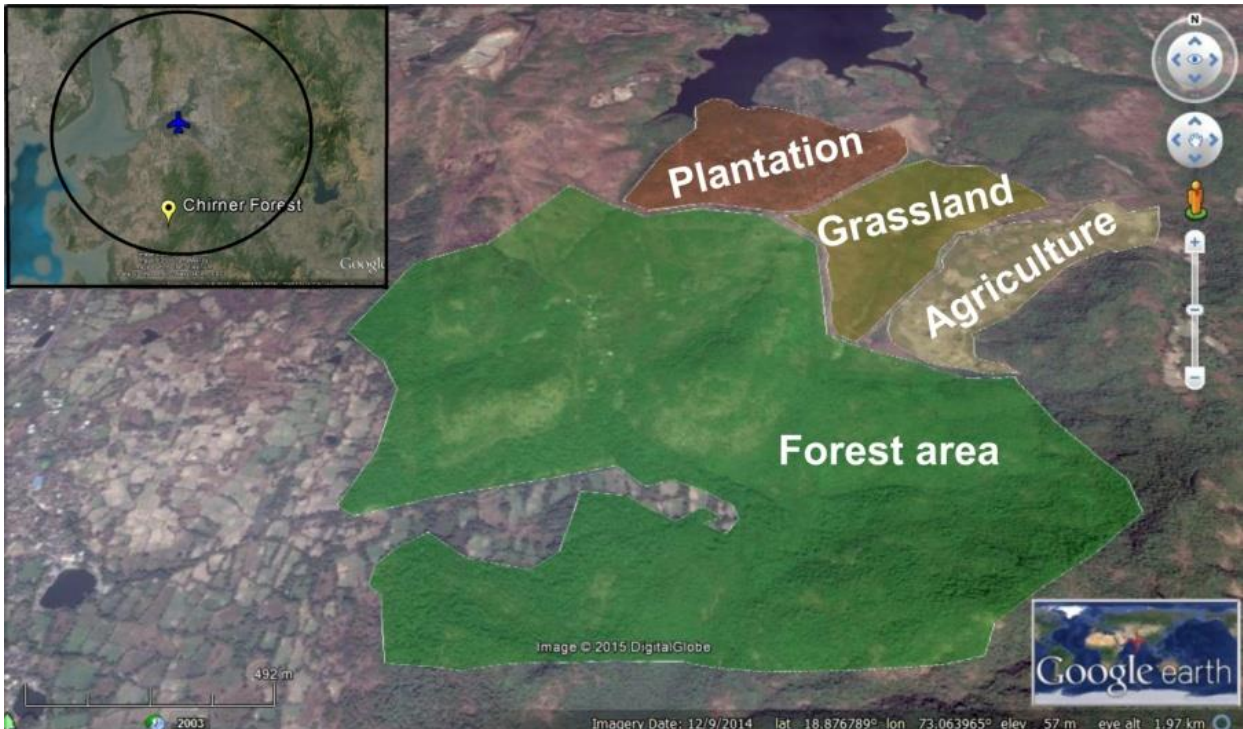


Figure 14 – Map of Chirner forest

12. Mosare–Patnoli reserve forest

A moist-deciduous forest patch of reserved forest located on top of a hillock between the Mosare and Patnoli villages (18°57'23.97"N, 73° 5'8.47"E, Figure 15) was selected to survey forest birds. Agricultural lands cultivated by people from nearby villages surround this hillock.

The forest is of moist-deciduous type and represented by vegetation like Jamun *Syzygium cumuni*, Ber *Zizipus jujuba*, Banyan *Ficus benghalensis*, Teak *Tectona grandis*, Red Silk Cotton *Bombax ceiba*, Karanj *Pongamia pinnata* and Anjan *Hardwickia binata*. A plantation patch near a stream flowing from Mosare village is a communal roosting site for egrets, crows, parakeets, and herons. Each bird species was found roosting on separate trees.

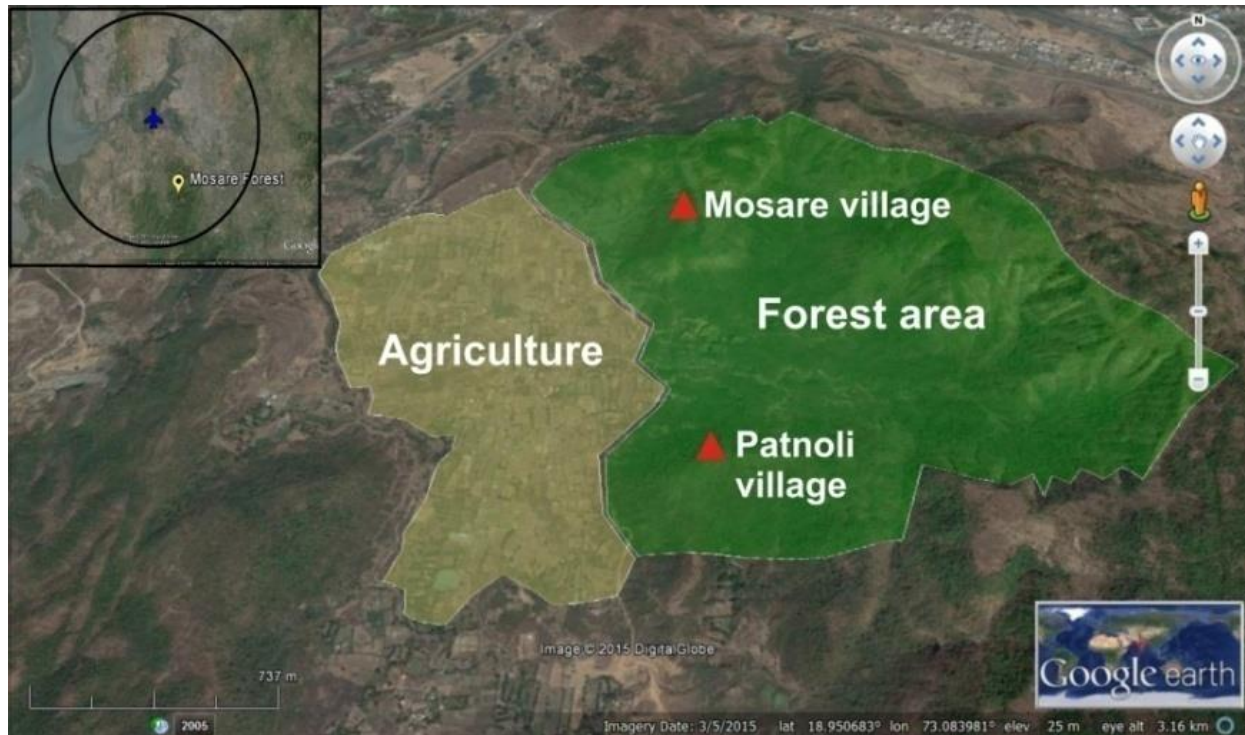


Figure 15 – Map of Mosare forest

Table 1 - Additional sites visited opportunistically

Sr. No	Site	Sr. No	Site
1	Ajivali 19°00'24.3"N 73°09'09.5"E	11	Nere 19°00'52.0"N 73°10'14.9"E
2	Chiple 19°00'23.6"N 73°09'09.7"E	12	Nerul 19°01'05.5"N 73°01'42.5"E
3	Dahirghate 18°52'56.5"N 73°04'28.7"E	13	Nhava 18°57'48.3"N 72°59'06.5"E
4	Dighade 18°54'18.4"N 73°02'41.7"E	14	Palaspe 18°57'31.7"N 73°07'51.1"E
5	Dighati 18°49'43.1"N 73°03'09.7"E	15	Pali 18°59'25.7"N 73°10'53.1"E
6	Diwale 19°00'47.5"N 73°02'16.4"E	16	Pargon 18°58'47.7"N 73°04'03.1"E
7	Dongari 18°53'45.7"N 72°57'28.7"E	17	Ransaidam 18°53'36.5"N 73°04'08.8"E
8	Kopar 18°59'07.1"N 73°04'59.3"E	18	Shedung 18°57'15.1"N 73°10'18.4"E
9	Mansarovar–Kamothe 19°01'07.6"N 73°04'48.2"E	19	Tembhode 19°01'18.5"N 73°07'23.5"E
10	Nanoshi 18°56'20.5"N 73°05'01.6"E	20	Ulve node 18°58'45.9"N 73°01'16.4"E

III) METHODOLOGY

The study sites were surveyed using binoculars and a digital camera. In year 2012, we spent time to understand the landscape and identification of sites (twelve sites mentioned in study area) for long-term monitoring. From 2013, the known roosting and foraging sites of the birds were monitored to study the movement pattern of the birds.

The bird species were recorded on the basis of sighting or call. Birds were identified following Ali & Ripley (1983), Grimmett et al. (2011) and Rasmussen & Anderton (2012). The list of birds was arranged family wise following Rasmussen & Anderton (2012). Total count taken for congregatory birds at high tide roosts and highest count used for comparative analysis of monthly/seasonal variation at various sites (Bibby et al. 2000, Urfi et al. 2005, Driscoll et al. 2012). Site wise variation in bird count across the months and seasons has been graphically presented across for understanding of the pattern.

GPS coordinates of locations were taken and sites were plotted on map. The site wise details of the habitat, area covered, type of count taken, frequency of survey and usage of particular data has been given in the following table.

Table 2 - Summary of methodologies used for site wise data collection and analysis

Sr. No.	Name of site	Habitat	Area in Ha Length in km	Type of Count	Frequency of survey	Data usage
1.	NMIA	Complex of wetland, grassland, paddy fields, mangrove and associated plants	1160	Total count of waterbirds during high tide (2 hours before and 2 hours after high tide)	Monthly. During winter fortnightly	Maximum count of the waterbirds during high tide day/month/season/year for analysis Documentation of other bird species
2.	Kalundre river and Panvel creek	Wetland	50 Ha (Covered trail of 2km distance parallel to Panvel creek(during low tide)	Walk for 1 hour	Monthly. During winter fortnightly	Documentation of bird species, flock size of waterbirds, changes in landscape, see movement of birds from the site
3.	TSC, Palm Beach Road	Wetland	15 Ha	Total count during high tide (2 hours before and 2 hours after high tide)	Monthly. During winter fortnightly	Maximum count of the day/month/season/year for analysis

Sr. No.	Name of site	Habitat	Area in Ha Length in km	Type of Count	Frequency of survey	Data usage
4.	NRI colony, Nerul	Wetland	20 Ha	Total count during high tide (2 hours before and 2 hours after high tide)	Monthly. During winter fortnightly	Maximum count of the day/month/season/year for analysis
5.	DPS, Nerul	Wetland	15 Ha	Total count during high tide (2 hours before and 2 hours after high tide)	Monthly. During winter fortnightly	Maximum count of the day/month/season/year for analysis
6.	Kharghar creek, Navi Mumbai	Wetland	1.5 km trail along creek	Walk for 1 hour	Monthly. During winter fortnightly	Documentation of bird species, flock size of waterbirds, changes in landscape, movement of birds from the site
7.	Jasai and Dastan Phata, Uran	Wetland	300 Ha	Total count during high tide (2 hours before and 2 hours after high tide)	Monthly. During winter fortnightly	Maximum count of the day/month/season/year for analysis
8.	Soanri-Belpada, Uran	Wetland	50 Ha	Total count during high tide (2 hours before and 2 hours after high tide)	Monthly. During winter fortnightly	Maximum count of the day/month/season/year for analysis
9.	Panje-Funde, Uran	Wetland	100 Ha	Total count during high tide (2 hours before and 2 hours after high tide)	Monthly. During winter fortnightly	Maximum count of the day/month/season/year for analysis
10.	Karnala Bird Sanctuary and Ransai	Moist, deciduous forest	2 km trail in each site	Walk for 1 hour	Monthly. During winter fortnightly	Documentation of bird species, count of threatened birds, breeding birds

Sr. No.	Name of site	Habitat	Area in Ha Length in km	Type of Count	Frequency of survey	Data usage
11.	Chirner, Uran	Moist, deciduous forest	2 km trail in each site	Walk for 1 hour	Monthly	Documentation of bird species, count of threatened birds, breeding birds
12.	Mosare-Patnoli	Moist, deciduous forest	3 km trail in each site	Walk for 1.5 hour	Monthly	Documentation of bird species, count of threatened birds; breeding birds; tree roosting birds

Time management for the team – One project scientist and two research fellows were always working on this project with some occasional help from selected volunteers. We visited each site from study area at least once in a month and conducted fortnightly surveys in selected sites where bird congregation was high. One member from the project team used to conduct field surveys in individual site for a day. Remaining time of the month was used by the team for data entry, analysing the available data and compilation of the reports. Submission of tri-monthly reports was a mandate for the project and we were able to submit the report on time except the last comprehensive report which is based on five year data.

Water bird count – Total count method was used to count congregating water birds and waders. A suitable vantage point was located and all individual birds were counted directly using binoculars or spotting scope. Observations were carried out from sufficient distance avoiding disturbance to the birds. Birds were counted with sun behind the observer so that patterns and colors of the different species were seen. For densely packed flock, in flight or at roost, the birds were counted in estimated blocks. The size of the blocks used (10, 100, 1000, etc.) according to the size of the flock (Bibby et al. 2000). Variation in bird count in major five wetlands (TSC, NRI, Panje-Funde (Uran), NMIA, Belpada) given separately.

Count taken at tree roosting sites – Birds were counted in evening while arriving at their roosting sites (mentioned in following table). The birds were seen moving a lot before settling on the roost and it was difficult to count each and every individual. A detail account of the species composition and count was taken in June 2014 and later on total roost count was taken seasonally once and highest count has been provided in the report.

Table 3 - List of sites where tree roosting birds were seen

Sr. No.	Name of site	Sr. No.	Name of site
1.	CIDCO garden, New Panvel	6	Vashi creek
2.	Panchshil Rest House, Belapur	7	Kamothe
3.	Sector 16, Panvel	8	Chowk, NH 4
4.	Panvel Rest House	9	NMIA
5.	Panvel Railway station		

High tide roosting count – During high tide, waders were seen using inland wetlands for roosting and therefore surveys were conducted at these locations. To locate roosts, or suitable habitats such as salt pans, lakes, creeks and beaches, we made visits during rising tide when birds were seen congregating. Counts of waterbirds were carried out during daytime and high tide, when most birds congregate at communal roosts along the shoreline (Koffberg et al. 2003). Tide dependent studies were graphically (bar graph) represented by comparing the fluctuation in bird populations at the shore and inland wetlands at 30 minute intervals. To study the movements of congregatory threatened bird species such as Lesser Flamingo *Phoeniconaias minor* and Eurasian Curlew *Numenius arquata*, we positioned two sets of observers who simultaneously recorded counts at the shore and inland wetland areas. This was done for a period of ~9hours: 4h before high tide and 4 h after high tide for two days followed by taking maximum count at peak tide time (minimum were always zero during low tide). A multivariate line graph was constructed with three variables – tide time, tide level and bird count – to show the variation in number of birds between the two sites during changing tide.

Surveys in low tide areas – The observations carried out in low tide was used to promote a better understanding of how the birds use sites, and are important in informing the conservation management of these important areas (Driscoll et al. 2012, Lewis & Tierney 2014).

Preparation of maps showing mass movement of birds – Movement of birds from their roosting sites towards major foraging sites was tracked using vehicle and multiple observers. For example, during two hours before and after high tide birds were seen flying towards their foraging sites and during low tide towards open mudflats of seashore. Direction of the birds was easily tracked as above mentioned pattern was clearly observed when hundreds and thousands of shore birds seen flying. While, tree roosting birds were seen flying towards their roosts in the evening and from roosts to major foraging sites in the morning.

Bird hazard issue using bird samples from different airfields – To understand type species posing bird hazard issue in various habitats, bird aircraft strike data was compiled by analysing bird strike samples received from 35 airfields all over India (figure 29). A total of 292 samples of bird remnants received during 1998–2012 were identified. Data was graphically represented with the help of Microsoft Excel 2010. Maps were plotted on Google Earth and Tableau Public software. We segregated the samples in eight biogeographic zones of the country such as Himalaya, North–East, North–West Desert and Arid, Western Ghats, Gangetic plains, Deccan Peninsula (Central), Deccan Peninsula (South), Coast. Data was analysed for year wise, month wise, species wise, season wise samples received. Based on data analysed top five regions facing bird hazard issues were plotted on map. Literature review has been done to understand the wildlife/bird hazard management issues and remedial measures to avoid this in all over the world as well as India.

Analysis of data – Graphs were prepared by analysing data with the help of MS Excel. Monthly variation was represented by taking the total highest count of the birds in study area from the particular day or month. Seasonal variation was discerned by categorizing the year into three seasons– summer (March–May), monsoon (June–August) and winter (December–February) October and November is post–monsoon. Proportion of seasonal variation was drawn up by using percentage bar graphs.

Species wise counts – Total 14 Threatened and Near Threatened species of birds are discussed in detail separately. Under seasonal variation we have discussed in detail 15 species of congregating water bird counted during 2012 to 2017 (Calbrade et al. 2010). An account of 27 species of birds breeding in the study area has been given, out of which 10 species which were seen breeding regularly have been discussed in detail.

Discussion – We prepared a comprehensive map showing current and proposed developmental projects coming up in Navi Mumbai area. Movement of birds from roosting to foraging sites and vice versa has been shown on the maps along with proposed airport operations. Recommendations provided for operational site of airport and separately for 10 km radius area. Three sites (wetlands behind TSC, NRI and Panje-Funde) away from landing and take-off have been proposed near seashore for protection of high tide roosting habitat for congregatory birds for long term conservation.

IV) RESULTS AND DISCUSSIONS

4.1) Threatened and near threatened birds found in study area

As per various criteria laid down by IUCN (International Union for Conservation of Nature), each year bird species is included under one of the following categories.

1. Extinct (EX) – A taxon is Extinct when there is no reasonable doubt that the last individual has died.
2. Extinct in the wild (EW) – A taxon is Extinct in the Wild when it is known only to survive in captivity or as a naturalized population (or populations) well outside the past range.
3. Critically Endangered (CR) – A taxon is Critically Endangered when the best available evidence indicates that it meets criteria for Critically Endangered, therefore considered to be facing an extremely high risk of extinction in the wild.
4. Endangered (EN) – A taxon is an Endangered when the best available evidence indicates that the species is facing a very high risk of extinction in the wild.
5. Vulnerable (VU) – A taxon is Vulnerable when the best available evidence indicates the species is facing a high risk of extinction in the wild.
6. Near threatened (NT) – A taxon is Near Threatened when it has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future.
7. Least Concern (LC) – A taxon is Least Concern when it has been evaluated against the criteria and does not qualify for Critically Endangered, Endangered, Vulnerable or Near Threatened. Widespread and abundant taxa are included in this category.
8. Data Deficient (DD) – A taxon is Data Deficient when there is inadequate information to make a direct or indirect assessment of its risk of extinction based on its distribution and/or population status.
9. Not Evaluated (NE) – A taxon is Not Evaluated when it is has not yet been evaluated against any above mentioned criteria.

We recorded 14 Threatened species (2–Endangered, 4–Vulnerable and 8– Near Threatened species) as mentioned below. The Threatened and Near Threatened species have been discussed in detail in annex I.

Table 4: List of threatened bird species found in the study area

Sr. No.	Common Name	Scientific name	IUCN status	Wildlife (Protection) Act, 1972 status
1.	Steppe Eagle	<i>Aquila nipalensis</i>	EN	I
2.	Great Knot	<i>Calidris tenuirostris</i>	EN	IV
3.	Indian Skimmer	<i>Rynchops albicollis</i>	VU	IV
4.	Greater Spotted Eagle	<i>Clanga clanga</i>	VU	I
5.	Indian Spotted Eagle	<i>Clanga hastata</i>	VU	I
6.	Woolly-necked Stork	<i>Ciconia episcopus</i>	VU	IV

Sr. No.	Common Name	Scientific name	IUCN status	Wildlife (Protection) Act, 1972 status
7.	Alexandrine Parakeet	<i>Psittacula eupatria</i>	NT	IV
8.	Pallid Harrier	<i>Circus macrourus</i>	NT	I
9.	Lesser Flamingo	<i>Phoeniconaias minor</i>	NT	I
10.	Black-headed Ibis	<i>Threskiornis melanocephalus</i>	NT	IV
11.	Painted Stork	<i>Mycteria leucocephala</i>	NT	IV
12.	Black-tailed Godwit	<i>Limosa limosa</i>	NT	IV
13.	Eurasian Curlew	<i>Numenius arquata</i>	NT	IV
14.	Curlew Sandpiper	<i>Calidris ferruginea</i>	NT	IV

Bird diversity found in study area

During this study (2012–2017) we had recorded 287 species of birds belonging to 56 families, among which 93 were migratory and 194 were resident species. A comprehensive checklist of birds found in study area was given in annex IV.

Seasonal changes in the count of 15 congregating birds in the study area during the study period had been provided in annex II while a note on the breeding birds in the study area has been given in annex III.



Image 4 - Near Threatened Lesser Flamingo found in study area

4.2) Bird count variation at five major wetlands

A) TSC wetland

A large number of birds were recorded predominantly during late winter and summer (Figure 16, 17) which suggests that the site is a stop-over resting site for birds before they resume their migratory trail.

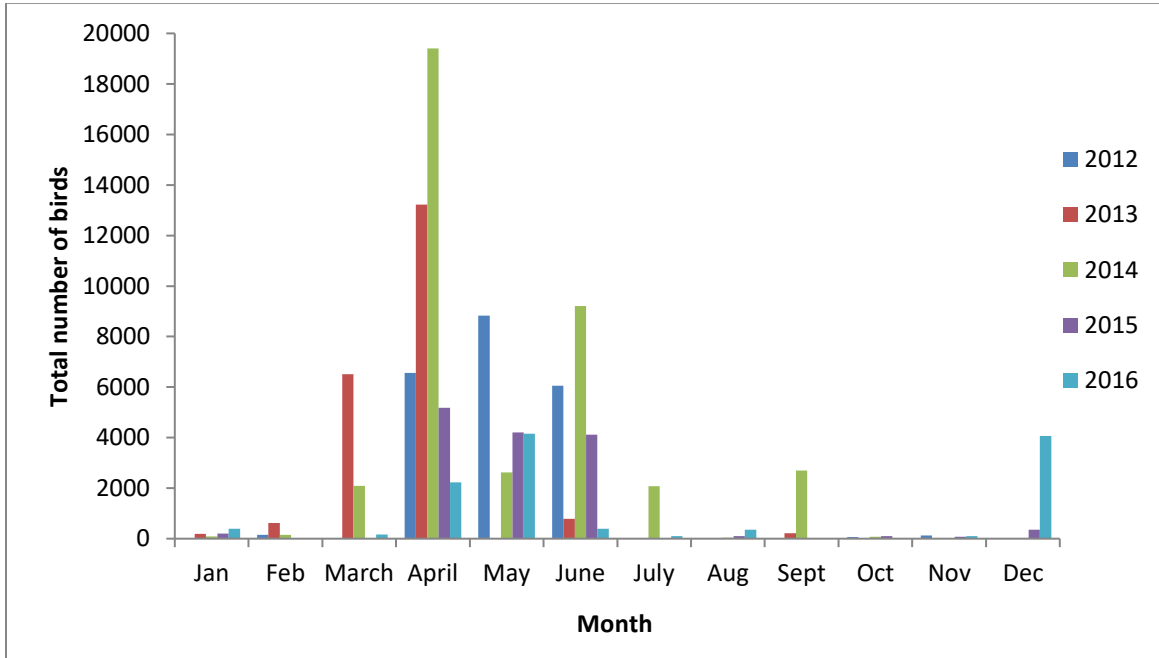


Figure 16 - Monthly variation in bird count at TSC wetland from 2012–2016

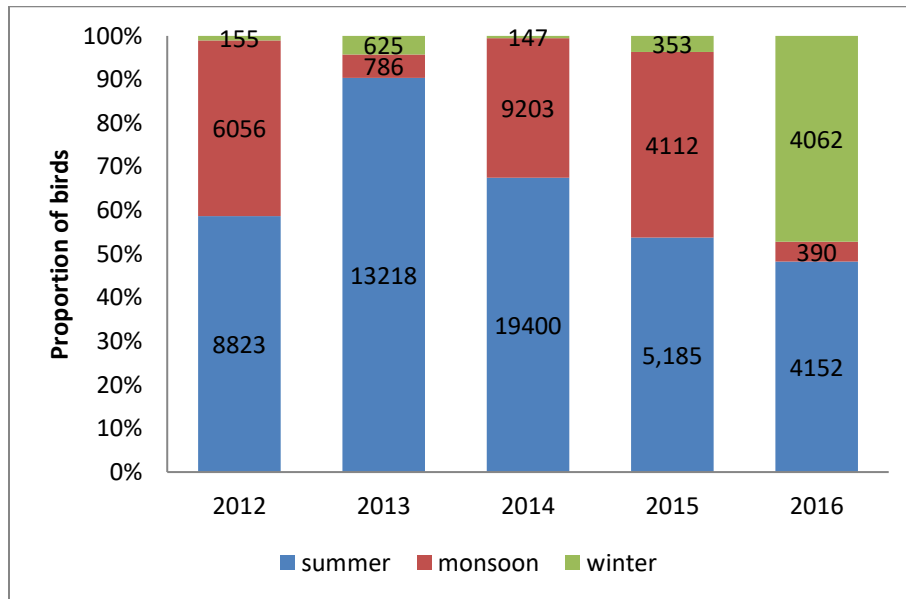


Figure 17 - Proportion of seasonal variation of bird count at TSC wetland from 2012–2016

B) NRI wetland

This wetland is similar to the TSC wetland where there are a large number of over-wintering birds which use this inland wetland as a stop-over site before resuming their migratory trail (See figures 18 and 19).

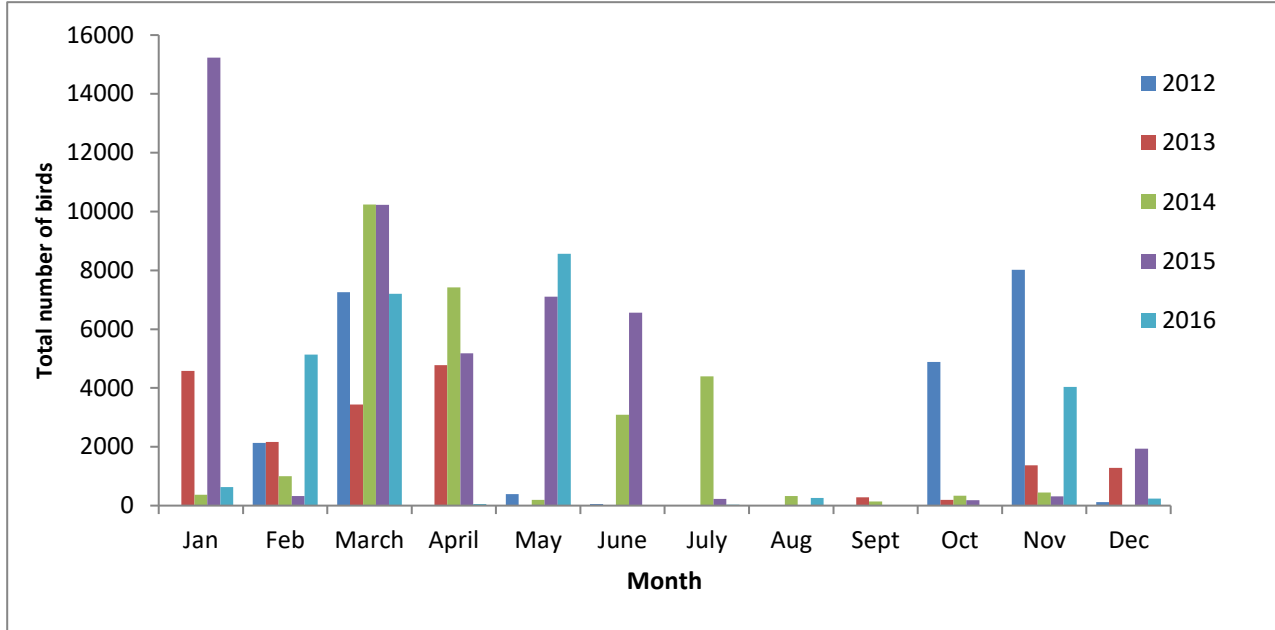


Figure 18 - Monthly variation in bird count at NRI wetland from 2012–2016

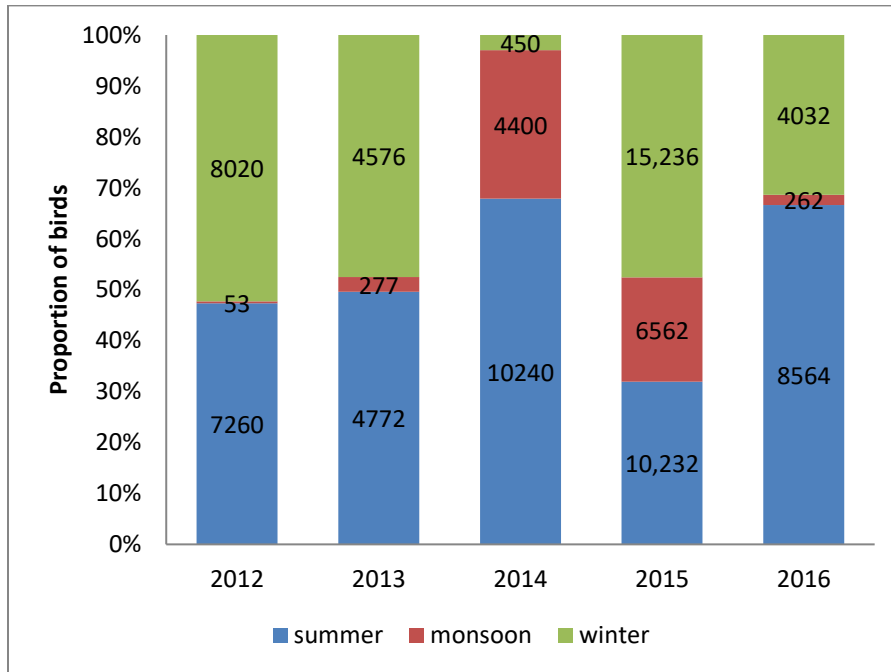


Figure 19 - Proportion of seasonal variation of birds at NRI wetland from 2012–2016

C) Navi Mumbai International Airport – proposed site

Data collected over the past 5 years here clearly show that the area is an important wetland for wintering and over-wintering birds. In 2016, we recorded total 1200 congregatory birds at this site (See Figures 20 and 21).

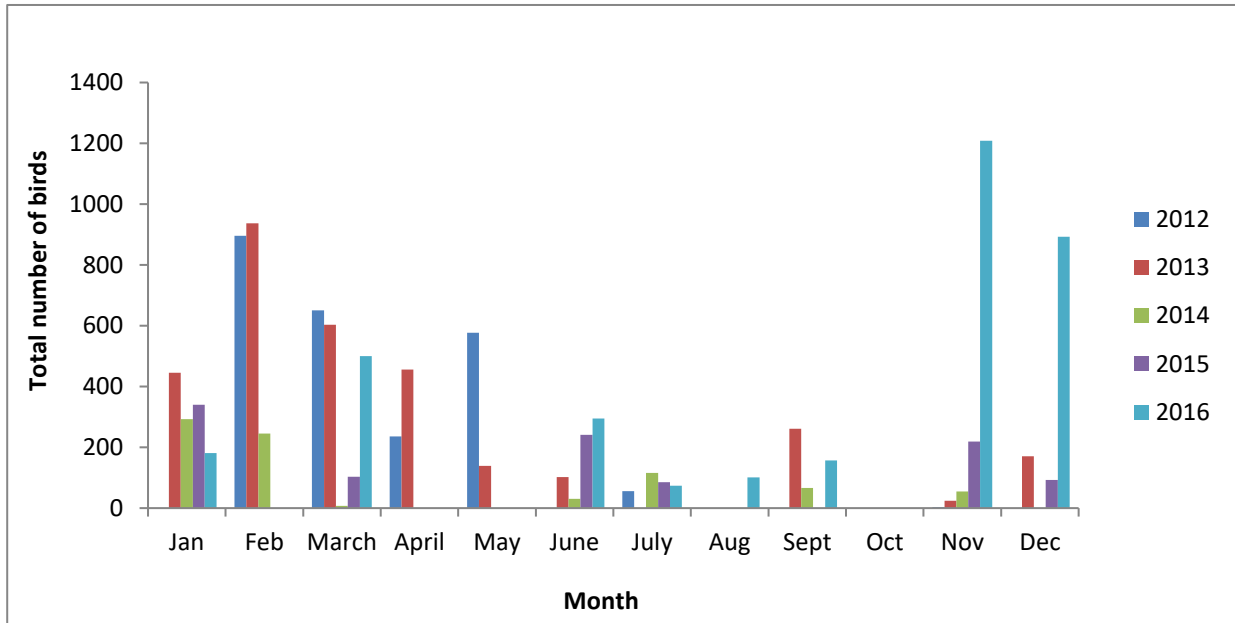


Figure 20 - Monthly variation in bird count at NMIA proposed site wetland from 2012–2016

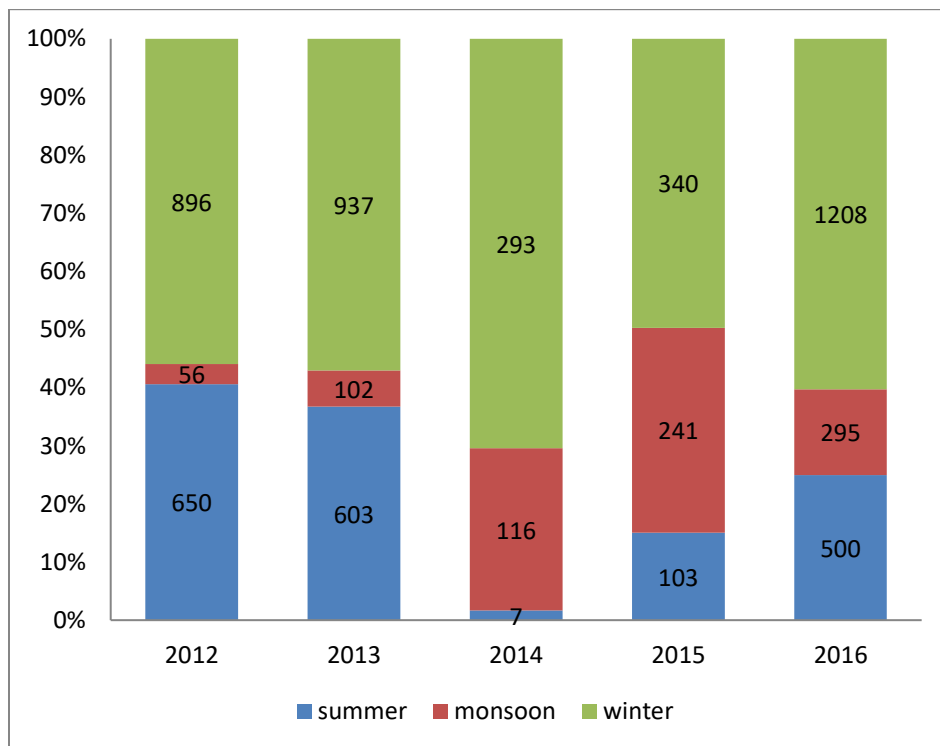


Figure 21 - Proportion of seasonal variation of birds at NMIA proposed site from 2012–2016

D) Belpada wetland

This wetland had number of wintering birds in between 2012–2014. It was an important breeding ground for many birds. In 2014 land filling activities were underway and by 2015 the site lost its status of wetland. There were very few birds recorded during 2015–2016. Temporary water bodies formed in Belpada (site where wetland existed) during the monsoon resulted in pools and were visited by few birds during this period from 2015–2016 (for details please see Figures 22 and 23).

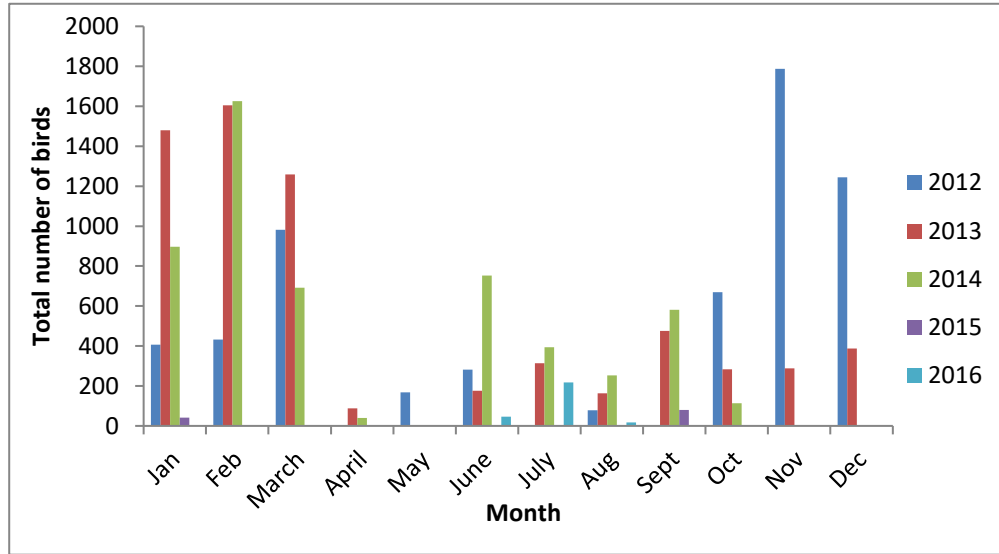


Figure 22 - Monthly variation in bird count at Belpada wetland from 2012–2016

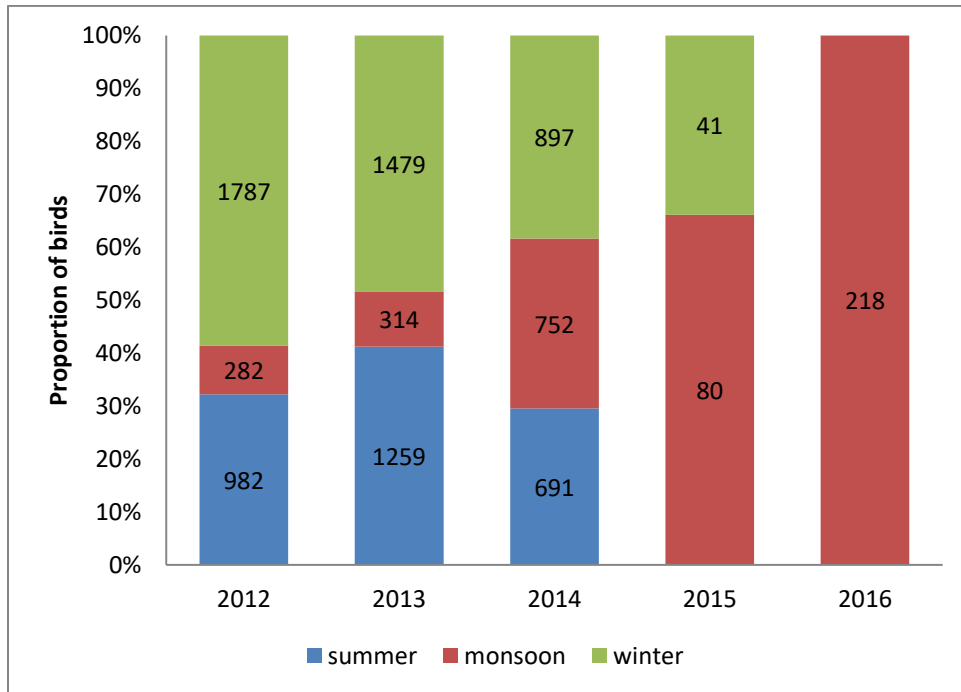


Figure 23 - Proportion of seasonal variation of birds at Belpada wetland from 2012–2016

E) Panje-Funde wetland, Uran

It is the largest of all surveyed wetlands. It comprises the Panje and Funde areas and receives many congregatory birds in thousands and sometimes around 1, 00,000 birds, especially during the winter months. For seasonal variation please see Figures 24 and 25.

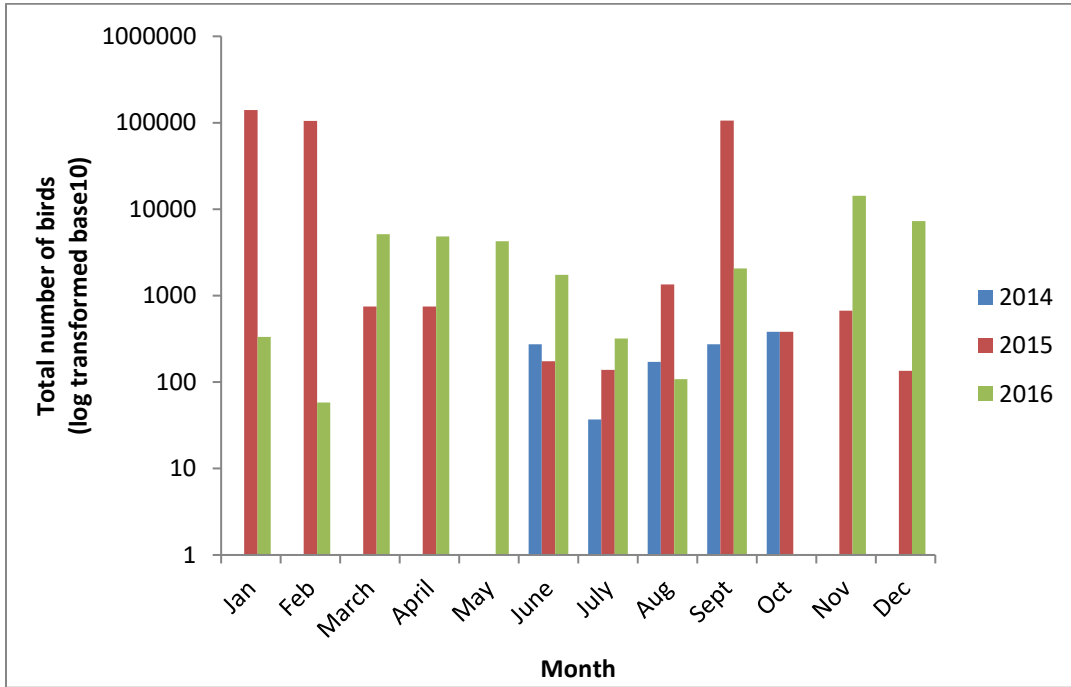


Figure 24 - Monthly variation in bird count at Uran wetland from 2014–2016

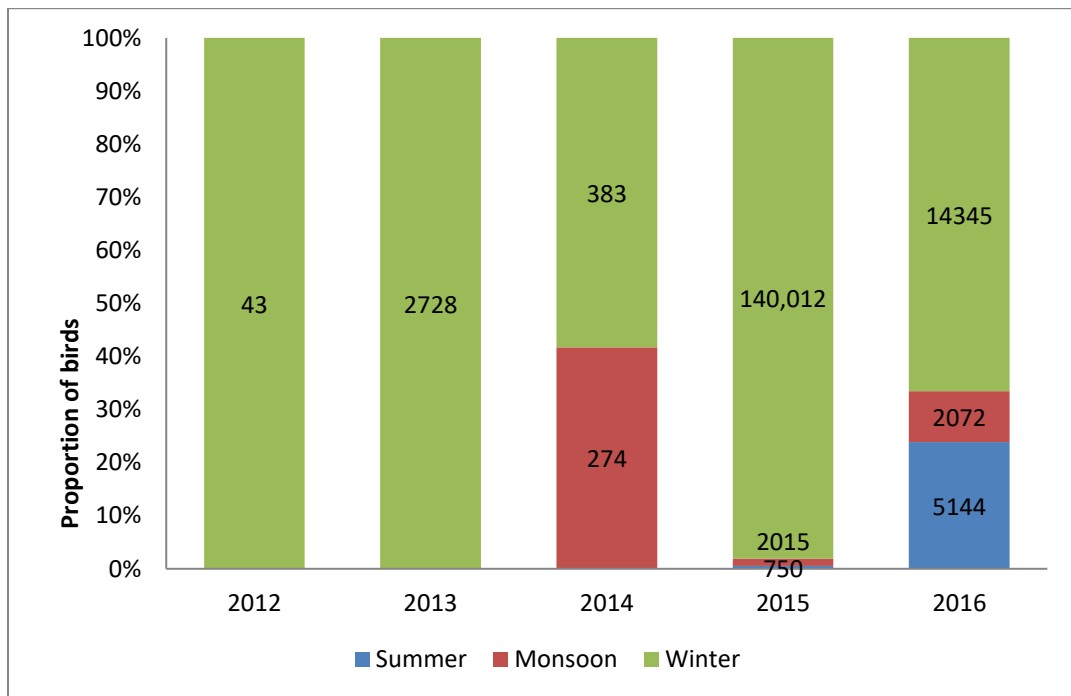


Figure 25- Proportion of seasonal variation of birds at Uran wetland from 2012–2016

4.3) Communal roosting birds

4.3.1) communally roosting sites of birds were recorded at the following locations

1. Mosare Forest

A detailed account of the species composition and count was taken in June 2014, followed by seasonal counts while mean count has been considered in the table. The Indian Jungle Crow *Corvus [macrorhynchos] culminatus* was the first one to enter the roost at about 6:00 pm followed by the Rose-ringed Parakeets *Psittacula krameri* and the Egrets were seen coming even after 7:00 p.m. The birds were seen flying from the west to east while entering the roost. Rose-ringed Parakeet *Psittacula krameri*, Indian Jungle Crow *Corvus [macrorhynchos] culminatus*, House Crow *Corvus splendens*, Black-crowned Night-heron *Nycticorax nycticorax*, Laughing Dove *Spilopelia senegalensis* and a mixed group of Egrets were seen roosting in large numbers here. About 500 Eastern Cattle Egrets *Bubulcus coromandus*, Intermediate Egret *Egretta intermedia*, about 50 Great Egrets *Egretta alba* and over 50 Black-crowned Night-herons *Nycticorax nycticorax* were seen in a communal roost. About 20 individuals of Laughing Dove *Streptopelia senegalensis* were seen in low height bushes next to the ground level. House Crows *Corvus splendens* typically gathered on the power transmission wires and then entered the roost on top. Egrets were seen coming in from approximately 6:15 p.m. until 7:45 p.m. and later. The birds were seen approaching from west to east while entering the roost. In morning these birds were seen flying in all directions, especially towards mangrove areas.

2. CIDCO Garden

About 1,000 House Crows *Corvus splendens*, 45 Indian Jungle Crows *Corvus [macrorhynchos] culminatus*, approximately 1,000 Common Mynas *Acridotheres tristis*, 100 Asian Pied Starling *Gracupica contra*, 30 Indian Pond-herons *Ardeola grayii*, 100 Indian Shags *Phalacrocorax fuscicollis* and 100 Eastern Cattle Egrets *Bubulcus coromandus* were seen roosting on the trees in CIDCO Garden at Sector 9, Khanda Colony, Navi Mumbai. Indian Shag *Phalacrocorax fuscicollis* was seen arriving between 5:00 p.m. and 6:00 p.m. followed by Common Myna *Acridotheres tristis*. Eastern Cattle Egret *Bubulcus coromandus* and Indian Pond-heron *Ardeola grayii* were seen arriving 6:00 p.m. onwards until dark. Crows were seen moving in all directions in the mornings for foraging on food wastes, garbage dumps, seashore, forest areas.

3. Panchshil Rest House, Belapur

About 1,000 to 1,200 House Crows *Corvus splendens* were seen roosting all over the Parsik Hill area of Belapur regularly. Crows can be seen roosting on trees as well as on rooftops of buildings. Flocks of 30–40 individuals were seen travelling from west to east. About 700 Indian Shags *Phalacrocorax fuscicollis*, 50 Indian Pond-herons *Ardeola grayii*, 30 Eastern Cattle Egret *Bubulcus coromandus* were seen on a Gulmohar tree *Delonix regia* at Panchshil Rest House, Belapur (Navi Mumbai). Indian Shags were seen in the groups of 10–50 individuals, flying from the mangroves at the proposed site of NMIA and moving towards Kamothe, Kharghar and the Panchshil Rest House site. In the morning, the shags were seen flying back to the mangroves towards the seashore on the west of the proposed site of NMIA.

4. Panvel Railway Station area

Total 180 Indian Shag *Phalacrocorax fuscicollis*, and Eastern Cattle Egret *Bubulcus coromandus* roosting and nesting, scattered over a large area in Sector 16, New Panvel near Panvel Railway Station.

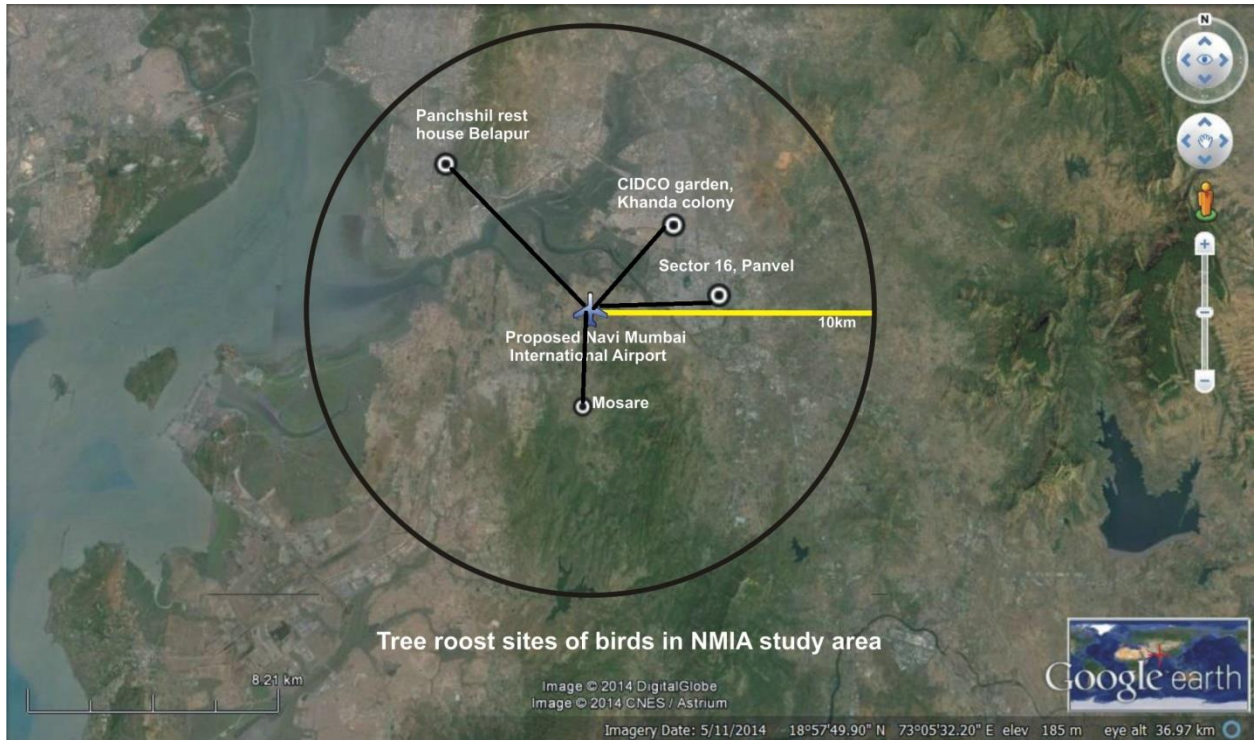


Figure 26 - Movement pattern of birds from tree roosting areas to foraging areas (black lines)

5. Panvel Rest House

Total 50 Indian Shag *Phalacrocorax fuscicollis*, Eastern Cattle Egret *Bubulcus coromandus* roosting and nesting on large trees opposite to Panvel Rest house.

6. Vashi Creek area

Bird species like Asian Pied Starling *Gracupica contra*, Common Myna *Acridotheres tristis*, and House Crow *Corvus splendens* were seen roosting in mangroves spread across Vashi station to creek where we could not get the bird count because of inaccessibility. About 150 Black Kites *Milvus migrans migrans/govinda* were seen roosting in the evening on power lines running parallel to Vashi Bridge.

7. Kamothe area

About 1500 House Sparrow *Passer domesticus* were seen roosting in groups of 300–400 individuals in various areas in Kamothe node during winter season. Sparrows were seen shifting their roosting trees within Kamothe area.

8. Chowk village near Morbe dam

Though this site was outside the 10 km radius area of NMIA, it has been included here since bird species such as 30 Eastern Cattle Egret *Bubulcus coromandus*, 50 Indian Shag *Phalacrocorax fuscicollis*, 15 Little Cormorant *Phalacrocorax niger*, 15 Indian Black Ibis *Pseudibis papillosa*

and 70 House Crow *Corvus splendens* were seen roosting at the site in the evening and moving to the proposed NMIA in the morning.

9. NMIA site

We observed 500 Black-headed Bunting *Emberiza melanocephala* and 700 'Indian' Baya Weaver *Ploceus philippinus* were observed roosting in mangrove at this site in winter season. Around 300 Rosy Starling *Pastor roseus* were seen roosting occasionally during October (early winter) and late winter (February) period. Sometimes around 100 House Crow *Corvus splendens* were also seen roosting along with otherspecies. Thirty to forty Grey Heron *Ardea cinerea* were seen roosting on power line tower near Khandeshwar railway station.

Table 5 - Roosting sites of birds in study area

Sr. No.	Species	Site	Number of birds	Season
1.	Rose-ringed Parakeet <i>Psittacula krameri</i>	Mosare	150	Regularly
2.	Indian Jungle Crow <i>Corvus[macrorhynchos] culminates</i>	Mosare	150	– All the seasons
3.	Eastern Cattle Egret <i>Bubulcus coromandus</i>	Mosare	500	Regularly
		Panchshil Rest House	50	Regularly
		CDICO garden (Khanda Colony)	65	Regularly
		Chowk, near Panvel	30	Regularly
4.	Black-crowned Night–heron <i>Nycticorax nycticorax</i>	Mosare	30	Regularly
5.	Common Myna <i>Acridotheres tristis</i>	CDICO garden (Khanda Colony)	1000	Regularly
6.	Asian Pied Starling <i>Gracupica contra</i>	CDICO garden (Khanda Colony)	100	Regularly
7.	Indian Shag <i>Phalacrocorax fuscicollis</i>	Panchshil Rest house, Belapur	700	Monsoon
		Sector 16 near Panvel station	180	Monsoon
		Panvel Rest House	50	Monsoon
		Chowk (outside 10km radius)	50	Monsoon
8.	Indian Black Ibis <i>Pseudibis papillosa</i>	Chowk (outside 10 km radius)	15	Monsoon
9.	Little Cormorant <i>Phalacrocorax niger</i>	Panchshil Rest house, Belapur	35	Monsoon
		Chowk, near Panvel	15	Monsoon
10.	Rosy Starling <i>Pastor roseus</i>	Mangroves at Kharghar creek, Panvel Creek, Nhava Sheva	300 at each place	Winter
11.	Black-headed Bunting <i>Emberiza melanocephalus</i>	Pargao (the proposed NMIA site)	500	Winter
12.	Baya Weaver <i>Ploceus philippinus</i>	Pargao (the proposed NMIA site)	700	Winter
13.	Red-wattled Lapwing <i>Vanellus indicus</i>	Belpada	40	Regularly
14.	Black Kite <i>Milvus migrans migrans/govinda</i>	Belpada day roost	200	Summer
		Vashi creek evening roost	150	Regular

4.3.2) High tide roosts of ground roosting birds

During the study period, the birds were observed using different sites in different seasons. Tidal cycles of the sea and water levels in the wetlands were found to influence the seasonal variations in species abundance at the roosting and foraging sites. Roosting sites such as wetlands near NRI, the proposed NMIA site, Sonari-Belpada and TSC wetland and adjoining mangroves hold considerable count of birds in the study area. These roosting sites are located near the major foraging sites such as seashores and creeks (maps showing movement of birds). Thousands of waders and water birds were seen moving in flocks across the sites, and towards open creeks and mudflats on the seashore to forage (Please see Figure 27 for movement of birds).

Bird species like Lesser Flamingo *Phoeniconaias minor*, Lesser Sand Plover *Charadrius mongolus*, Greater Sand Plover *Charadrius leschenaultia*, Grey Plover *Pluvialis squatarola*, Eurasian Curlew *Numenius arquata*, Common Redshank *Tringa totanus*, Little stint *Ereunetes minutus* were seen roosting during high tide and waiting until the mudflat at the seashore got exposed. It was observed that bird congregation occurs usually in shallow water, and the count of the congregating birds in different roosting areas changes annually. For example, due to low rainfall in monsoon 2012, wader count was seen very less in year 2013 as compared to 2012 and 2014. In 2014 we have seen sudden increase in count of Lesser Flamingo, especially juveniles, which indicated that there has been a good season at its breeding sites. The month of April usually attracts a high congregation of waders.



Figure 27- Map showing representative flight path of birds using at high-tide (left) and low-tide (right)

Table 6: Conditions influencing the sighting of birds at inland wetlands

Season	Tide Level	Water level	Congregatory birds	
			NRI and TSC	Panje
Early Winter (October– December)	High	High	Terns, Gulls	Terns, Gulls, Flamingo
		Moderate	Terns, Gulls, Flamingo	Terns, Gulls, Flamingo
		Low	All Birds including waders	All Birds including waders
	Low	High	Cormorants, Egrets, Herons	Cormorants, Egrets, Herons
		Moderate	No birds	No birds
		Low	No birds	No birds
Late Winter (January– March)	High	High	Terns, Gulls	Terns, Gulls, Flamingo
		Moderate	Terns, Gulls, Flamingo	Terns, Gulls, Flamingo
		Low	All Birds including waders	All Birds including waders
	Low	High	Cormorants, Egrets, Herons	Cormorants, Egrets, Herons
		Moderate	No birds	No birds
		Low	No birds	No birds
Summer	High	High	Terns, Gulls	No birds
		Moderate	Terns, Gulls, Flamingo	No birds
		Low	All Birds including waders	Small Waders
	Low	High	Cormorants, Egrets, Herons	No birds
		Moderate	No birds	No birds
		Low	No birds	No birds
Monsoon	High	High	Flamingo	No birds
		Moderate	Flamingo	No birds
		Low	Flamingo	No birds
	Low	High	Cormorants, Egrets, Herons	No birds
		Moderate	No birds	No birds
		Low	No birds	No birds

Note regarding water levels

High– >12”, Moderate: 6–12”, Low 2–6”

4.4) Shorebirds and tide dependent movements

A total 66 bird species were reported during the study period in the study area. We observed the communal roosting of birds such as Lesser Flamingo *Phoeniconaias minor*, Lesser Sand Plover *Charadrius mongolus*, Greater Sand Plover *Charadrius leschenaultia*, Grey Plover *Pluvialis squatarola*, Eurasian Curlew *Numenius arquata*, Common Redshank *Tringa totanus*, and Little Stint *Ereunetes minutus* at the high tide roosting sites.

Birds were seen moving in flocks from these roosting sites to open creeks and mudflats of the seashore in order to forage during low tide and roost mainly during high tide (see tide dependent variation in high tide roost count in Figure 28).

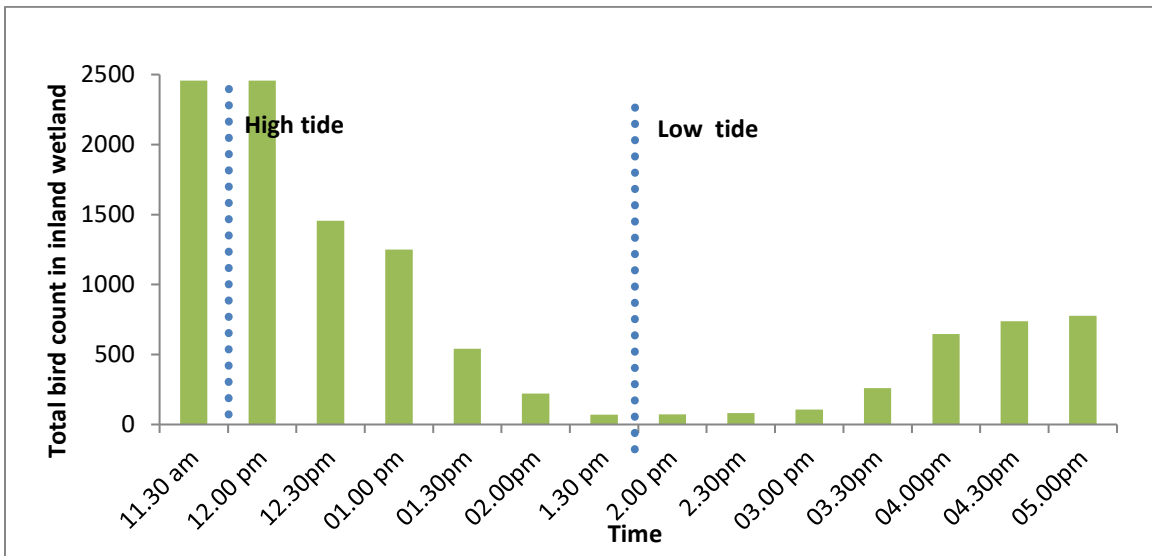


Figure 28 - Total count of shorebirds in TSC and NRI wetlands in a day

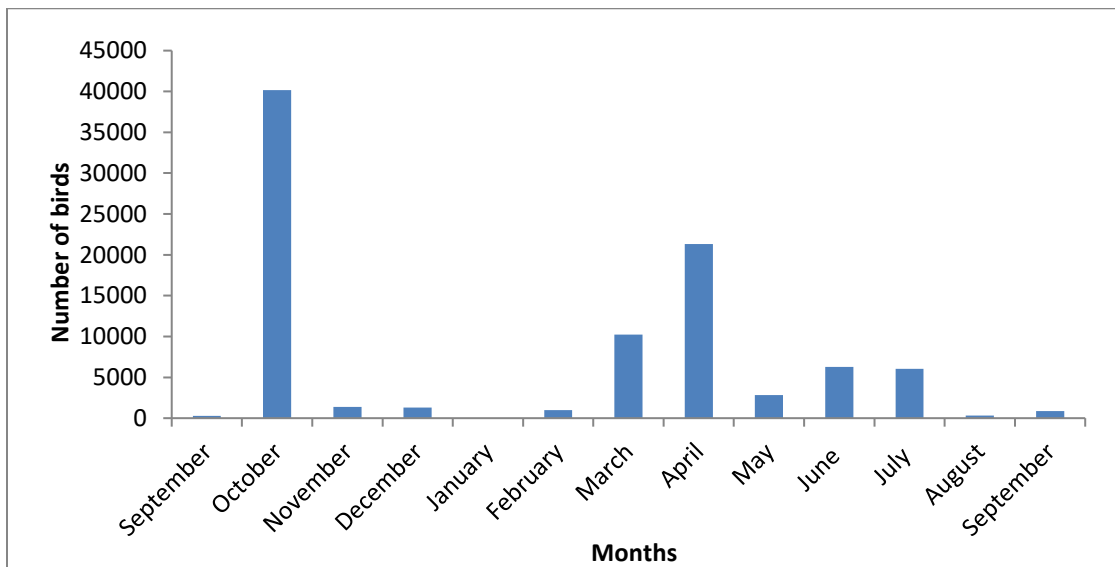


Figure 29 - The monthly variation in total bird count in NRI and TSC wetlands, 2013 to 2014

During 2013 and 2014, in the course of annual monitoring, two peaks were observed in the monthly count of birds. One was in October 2013 when the count reached 40,000 birds and another in April 2014 when the count was 20,000 birds (Figure 29). This correlates with the previous observations of the study where a sudden increase in counts of birds was recorded during the arrival of migratory birds in October as well as during their departure in April. This indicates that some of the birds use this site as stopover purpose. Bird congregations were usually observed in shallow water, and the count of the congregating birds in different roosting areas fluctuated annually. In 2014, a sudden increase was recorded in count of Lesser Flamingo *Phoeniconaias minor*, especially juveniles indicating a possible successful breeding season.

We saw decreasing count of birds at high tide roosting sites with receding tide as the birds started flying to the open sea shore for foraging. Conversely there was an increase in the count of birds at inland wetlands during high tide; birds were seen arriving at roosting sites from foraging areas. This movement can be clearly seen while monitoring the movements of the Lesser Flamingo and Eurasian Curlew *Numenius arquata* simultaneously at the shore and inland wetland areas (Figure 30 and 31).

We observed Lesser Flamingo *Phoeniconaias minor* in large flocks of about 6,000–7,000 individuals foraging on the seashore alongside the NRI and TSC wetland mainly during the latewinter and the summer of 2013. Eurasian curlew were seen in groups of 2 to 15 individuals foraging on the seashore during the low tide and roosting in the flocks of 100–150 individuals at wetland behind NRI complex during high tide.

In summary, we can say that in the study area, huge fluctuations in bird count can be seen from more than 1,00,000 birds to few individuals across the sites, seasons and years. It indicates complex pattern of bird movement within the seascape-landscape (Please see Figure 32 for further details).

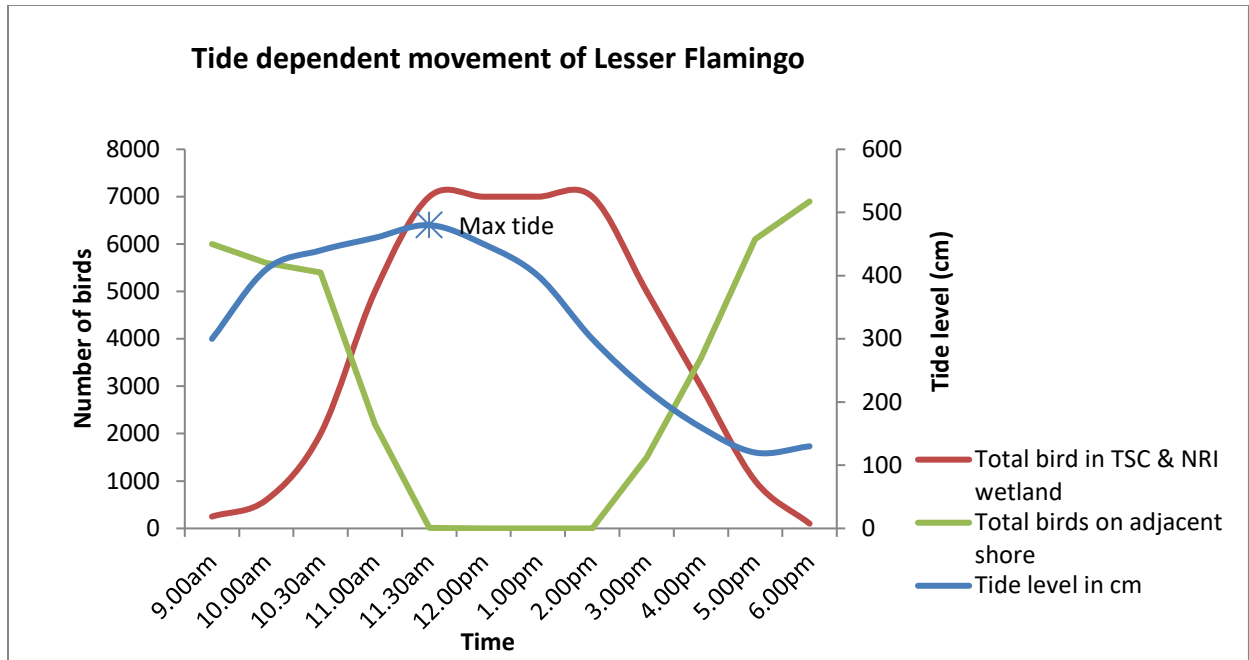


Figure 30 - The tide dependent movement of Lesser Flamingo in May 2012

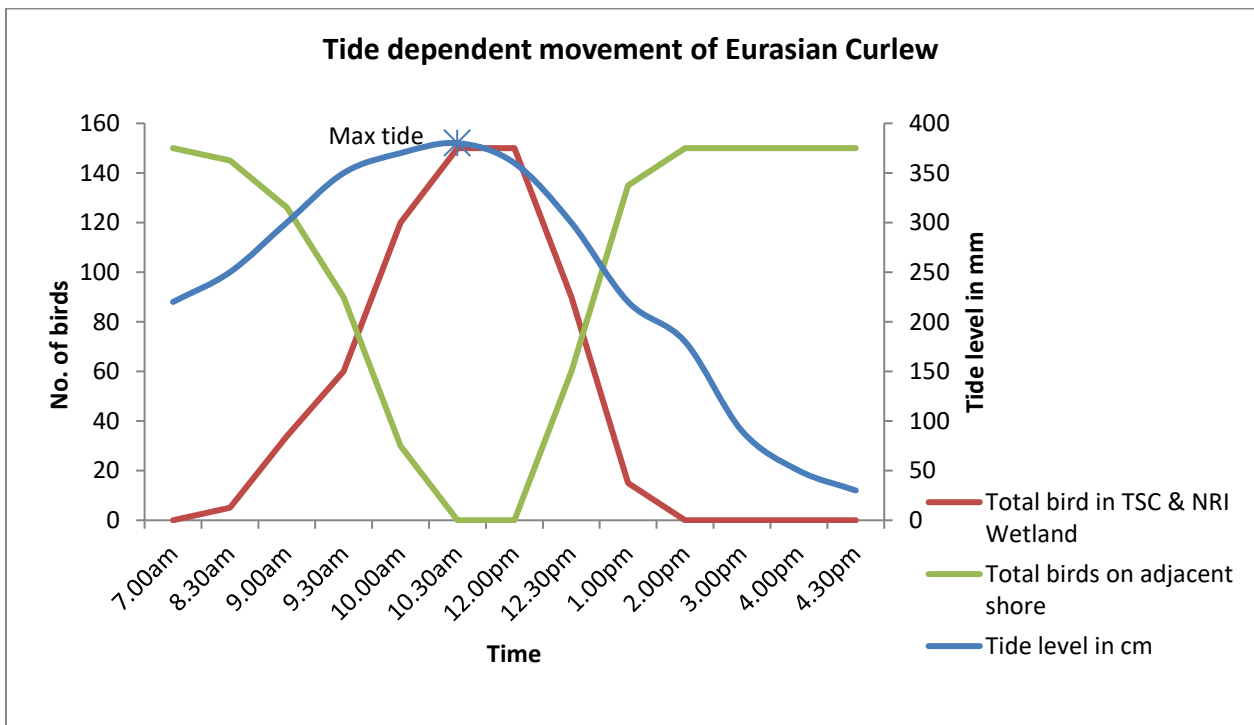


Figure 31 - Tide dependent movements of Eurasian curlew in January 2013

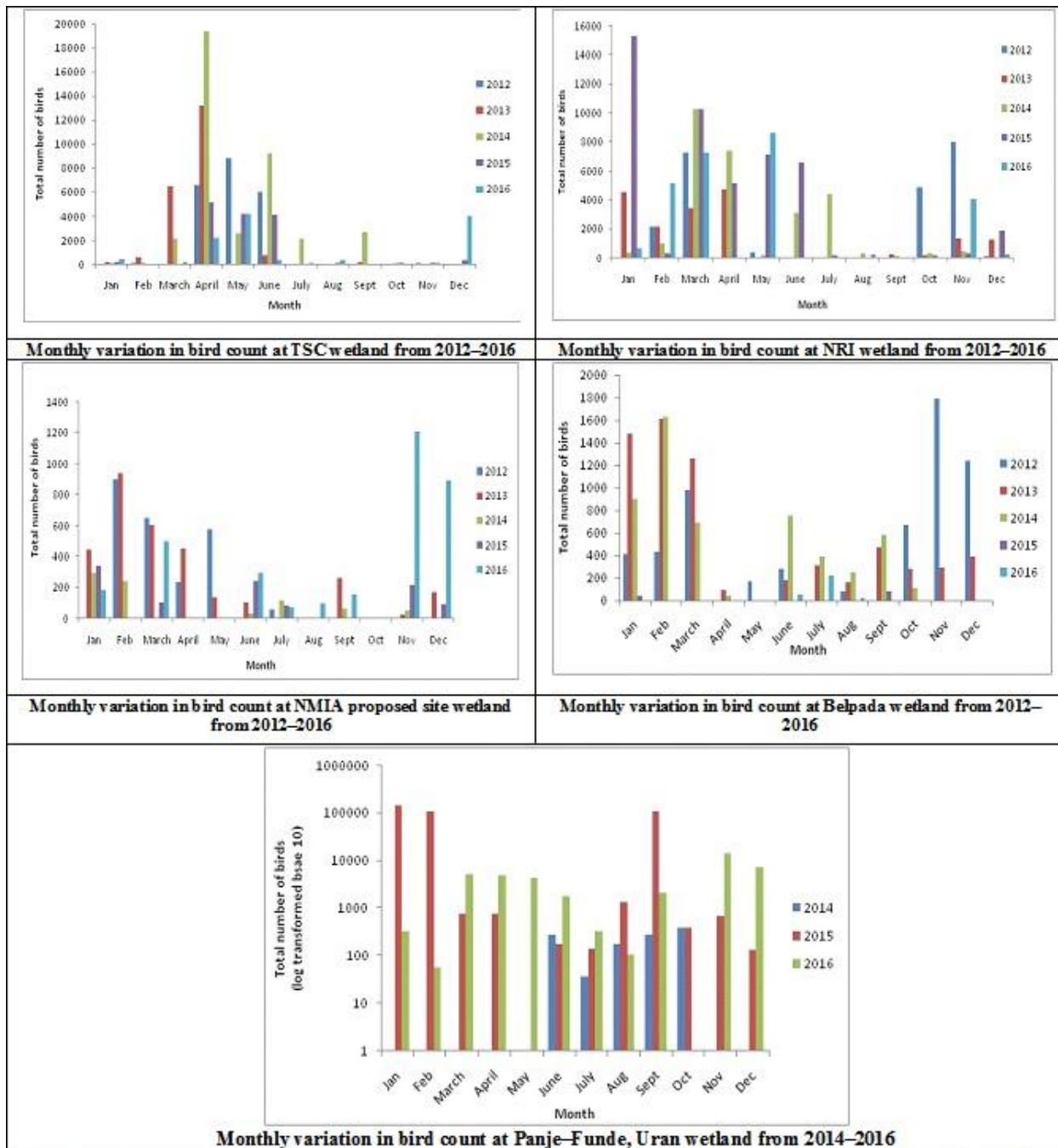


Figure 32 – Graph showing summary of monthly and yearly fluctuations in bird count across the selected five wetlands in study area

4.5) Bird-aircraft strike data analysis

Enclosed in this report are earlier studies by BNHS on 35 airfields. Military as well as civil airfields situated all over India have been considered in this analysis. Samples of bird collisions were received from 35 airfields with a majority from Gwalior, Bidar, Nagpur, Hyderabad, Secunderabad, Hasimara, Jalpaiguri, Tezpur, Barmer, Jaisalmer, Jalandhar, Jamnagar, Jodhpur, Naliya, Suratgarh, Dabolim, Mumbai, Nashik, Pune, Agra, Ambala, Bareilly, Bhatinda, Delhi, Gorakhpur, Halwara, Hindon, Lucknow, Patna, Srinagar, Bengaluru, Bhubaneshwar, Coimbatore and Tambaram (Figure 33).

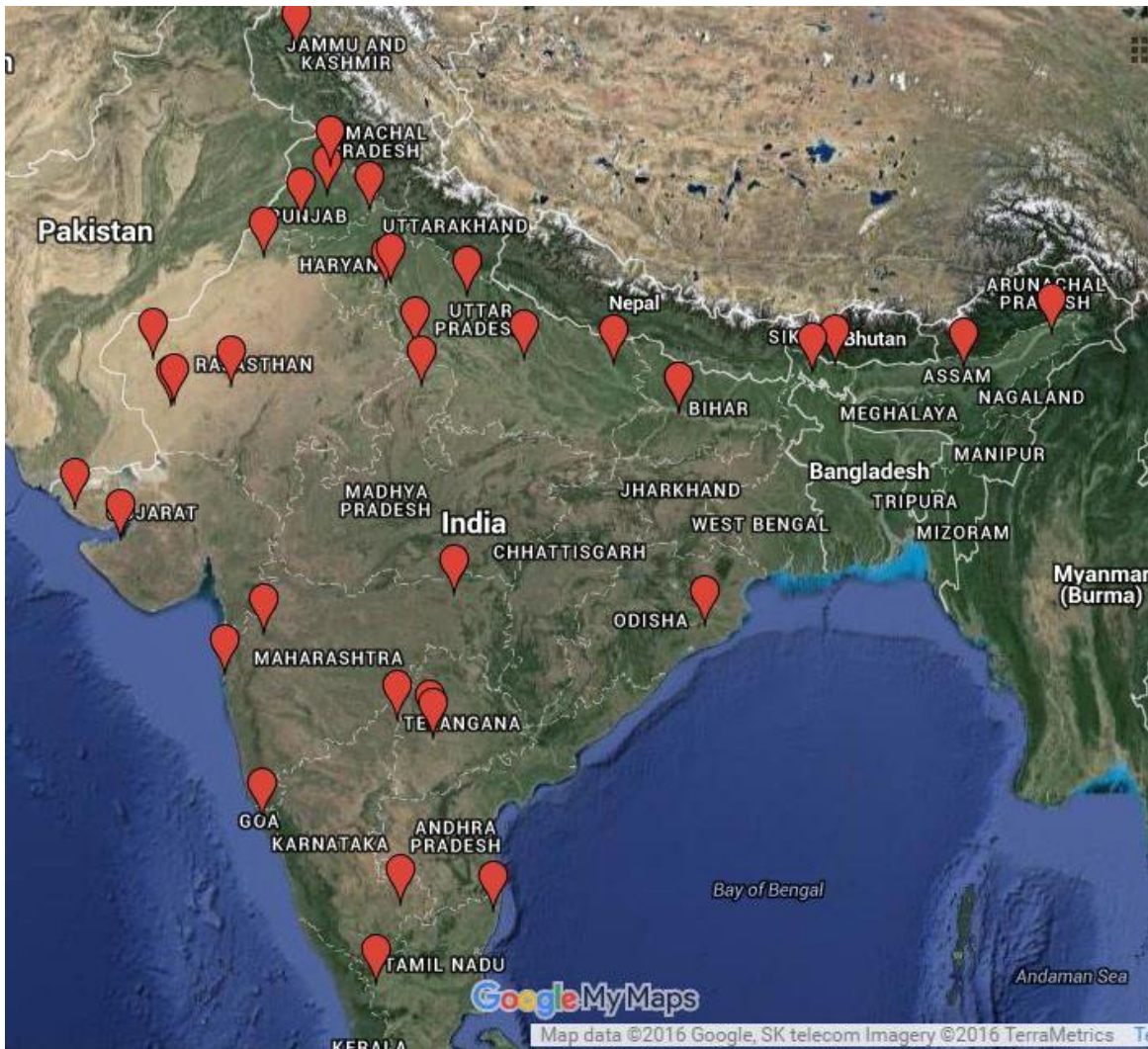


Figure 33– Pan-India locations of airfields from where bird strike samples received

Data of bird strikes sent to BNHS by various airfields in India during 1997–2000 was published (Mathews et al. 2003) in an International Bird Strike Committee, Warsaw (IBSC26). Records of bird samples sent for identification from the year 2000 onwards to the BNHS Collections department were compiled in an excel sheet.

Samples of bird remnants received were identified using BNHS bird strike database. Initially, samples were cleaned with hydrogen peroxide and water to remove any unwanted particles.

Samples were then examined with the naked eye and general patterns/observations were noted. Visual markers considered in feathers were size, pattern and colour. After preliminary examination, feathers were viewed under the microscope to observe finer distinct patterns. Observations were compared with specimen catalogues and ultimately identified up to the species level. The 292 samples received between 1998 and 2012 were accurately identified to be from 53 bird species and two bat species.

Data analysis

Samples were analysed and graphically represented with the help of Microsoft Excel 2010. Maps were plotted on Google Earth and Tableau Public software. Data was categorized and graphically represented into years and months of samples received, seasons (summer:March to May; monsoon:June to September; winter:October to February), species, habitat and geographic zones (for details see table number 5 as given below).

Table 7 - Biogeographic zones considered for data analysis

Sr. No.	ZONE	PLACES
1	Himalaya	Srinagar
2	Northeast	Chabua, Hasimara, Jalpaiguri, Tezpur
3	Northwest Desert and arid	Barmer, Bhatinda, Jaisalmer, Jalandhar, Jodhpur, Suratgarh, Halwara,
4	Western Ghats	Dabolim, Nashik, Pune
5	GangeticPlains	Agra, Ambala, Bareilly, Delhi, Gorakhpur, Hindon, Lucknow, Patna,
6	Deccan Peninsula (Central)	Gwalior, Bidar, Nagpur, Hyderabad, Secunderabad
7	Deccan Peninsula (South)	Bengaluru, Coimbatore,
8	Coast	Tambaram, Bhubaneshwar, Mumbai, Jamnagar, Naliya

Year-wise variations in bird strike samples received

Variation in the number of bird strikes samples received over 14 years indicates that bird hazard issue is dependent on many factors and there is no clear pattern in it (Figure 34). We received 43 samples in 1998 and only three in 2012 since almost all aerodromes have assigned special human resource/officers for conducting their own bird studies as per the guidelines of Airport Authority of India (AAI).

Owing to the availability of good cameras and deployment of special monitoring teams, most of the remnants received were identified at the airfields itself by the airfield authorities. Majority of the bird strike samples were received from five sites namely Bidar, Jodhpur, Bengaluru, Mumbai and Jamnagar (Figure 35).

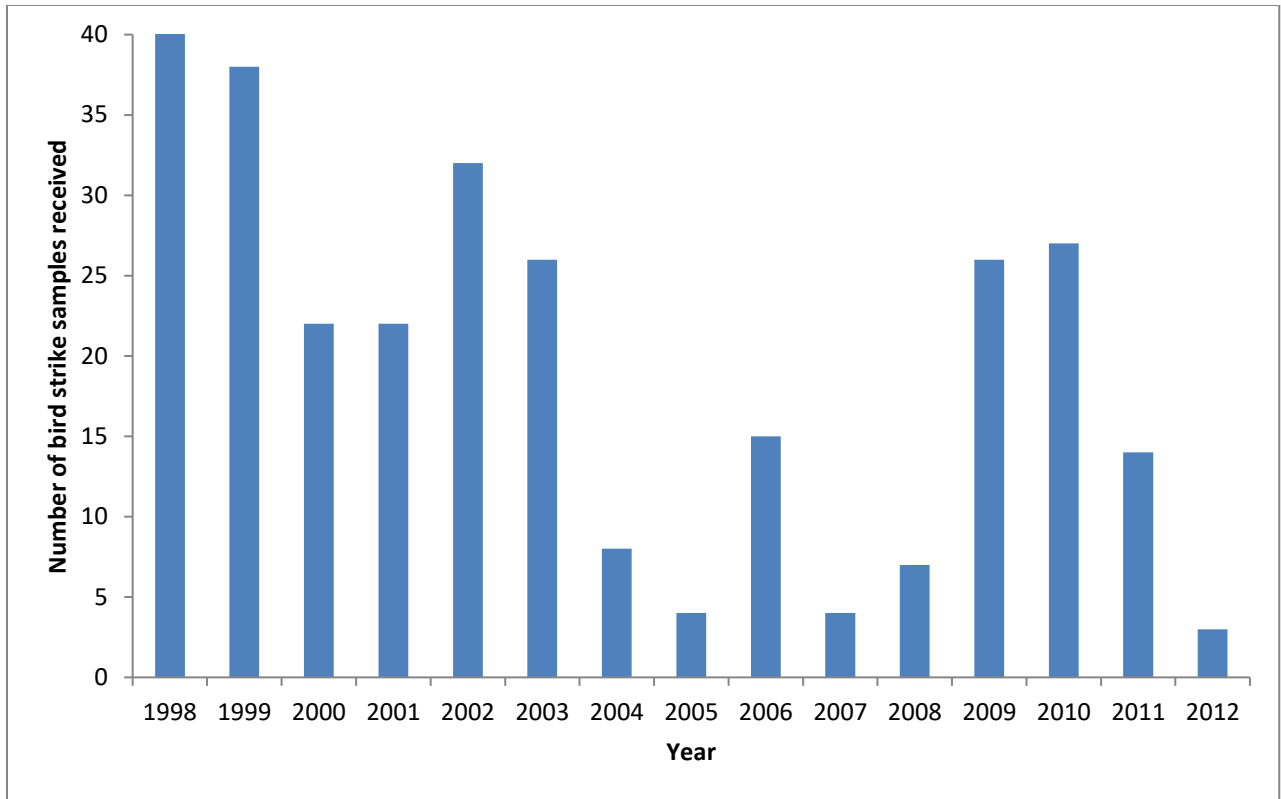


Figure 34 – Number of bird strikes reported yearly from 1998–2012

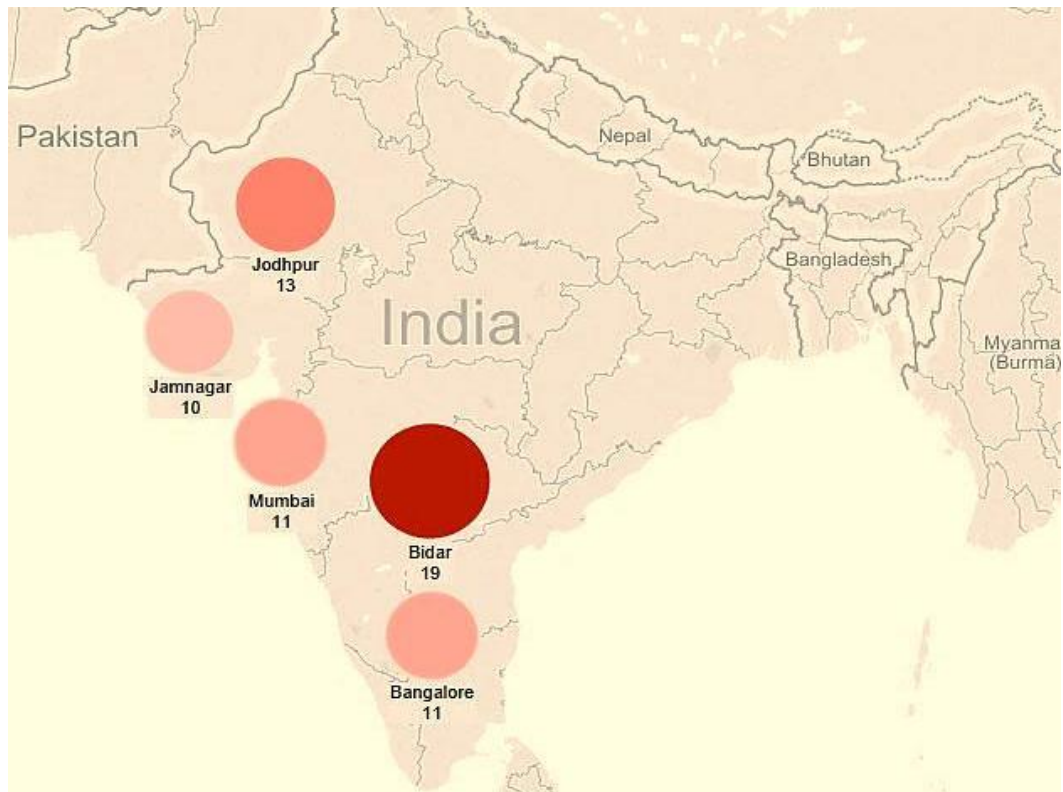


Figure 35– Based on sample data top 5 airstrike regions in India (Bangalore is known as Bengaluru now)

Month-wise variations in bird strike samples received

Most of the bird hits were recorded during July and August followed by October, November and January (Figure 36). The monsoon season (Figure 37) clearly shows more number of avian strikes. This could be probably due to the breeding season of birds and ideal conditions available to them in the form of open fields near runways.

Species-wise variations in bird strike samples received

Total of 292 samples were received and we could identify they belonged to 53 species of birds. Out of them, 11 species were seen commonly involved in bird strikes (Figure 38). The Black Kite *Milvus migrans migrans/govinda* topped the list followed by the Blue Rock Pigeon *Columba livia* and the Red-rumped Swallow *Cecropis daurica*.

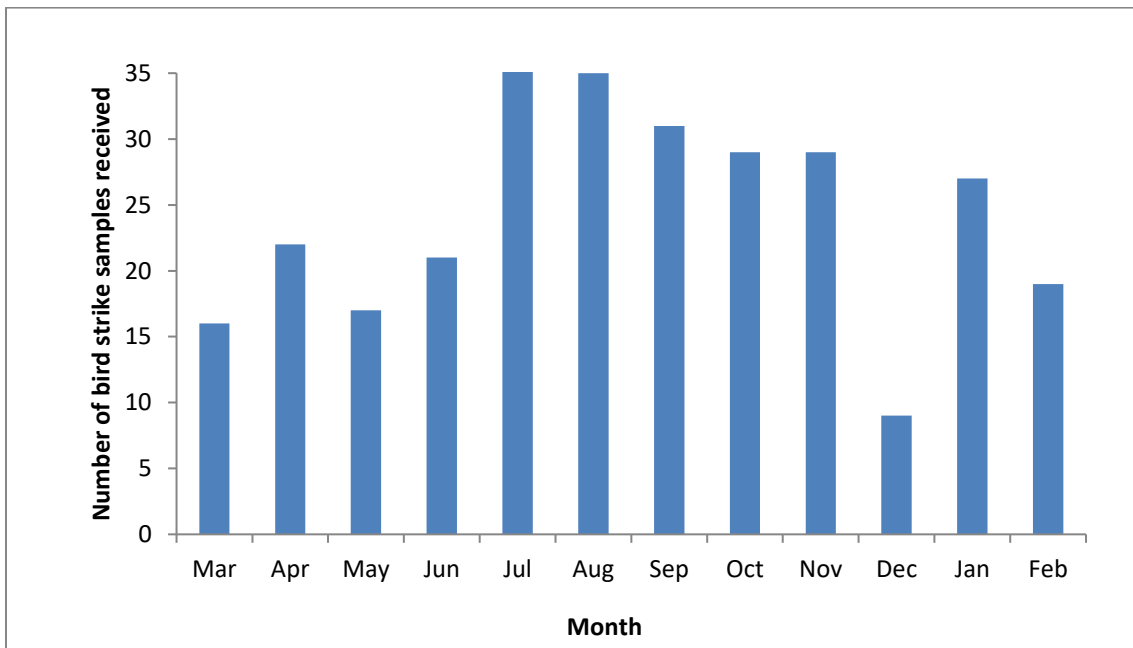


Figure 36 – Month-wise number of bird strike samples received from 1998–2012

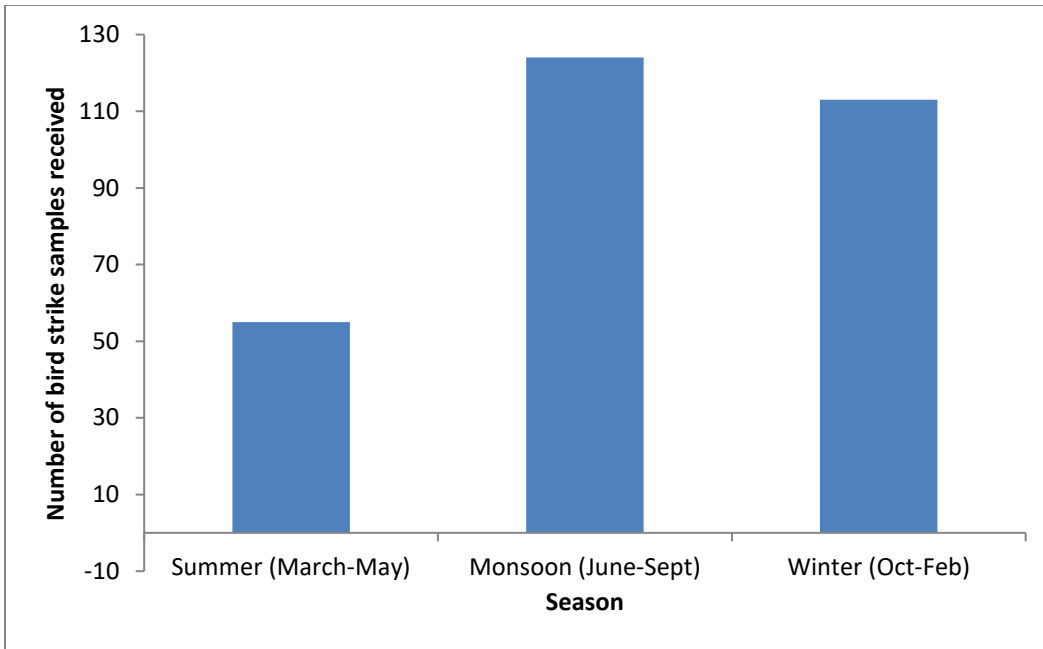


Figure 37 – Seasonal variations in bird strike samples received

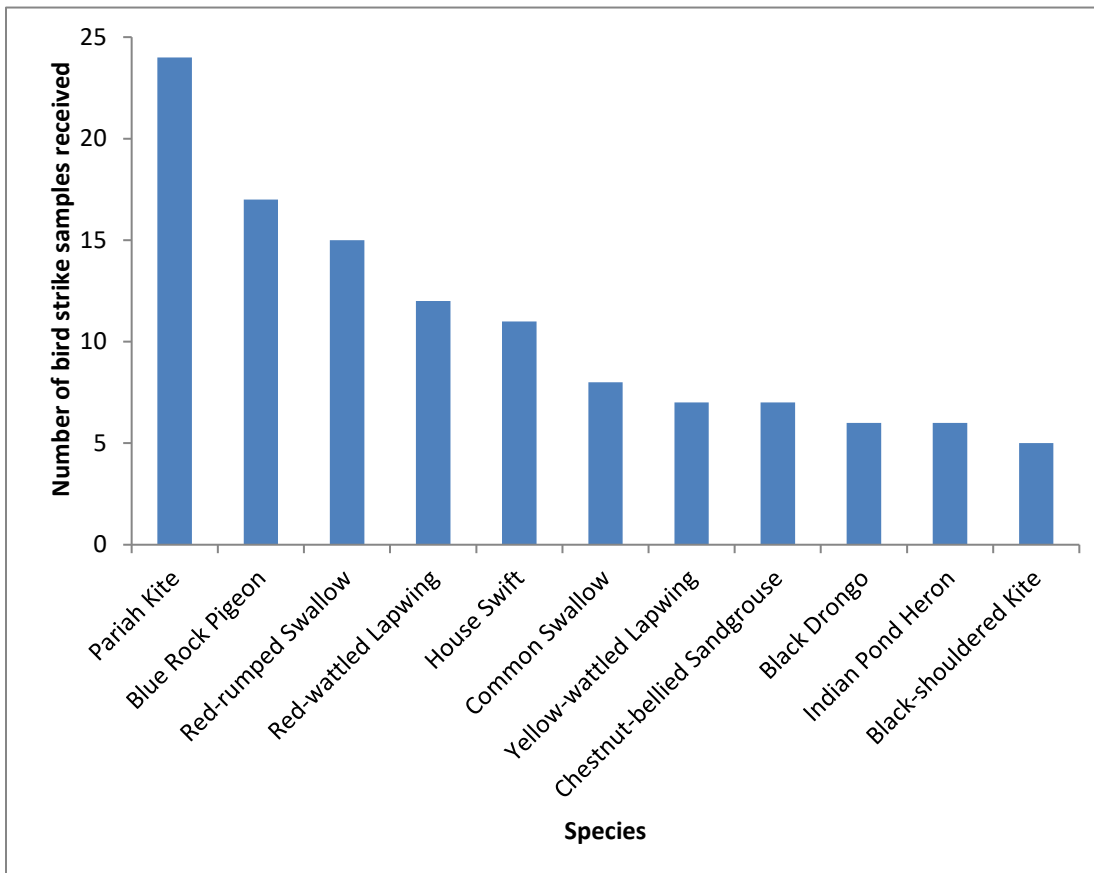


Figure 38 – Top 11 bird species samples received

Biogeographic zone-wise variations in bird strike samples received

The 35 airfields were divided into 8 biogeographic zones in which the North-West Desert and Arid regions showed the maximum number of samples received (37), followed by the coastal region with 32 samples and closely followed by the central Deccan Peninsula region with 31 samples (Figure 39). A high number of bird samples under species-wise category received from the top three zones are shown in Figures 40, 41 and 42.

Variations in bird strike samples received from various groups

Figure 43 shows that threats are from almost all types of birds such as ground-nesting and tree-nesting birds, birds using human habitation and soaring birds.

From these examples, it is clear that airports located near coastal areas have potential threats from many bird species that congregate on the coastal beaches, mudflats, wetlands and mangrove for foraging, resting and roosting. Therefore, development of the Navi Mumbai International Airport near the coast certainly poses a high risk of bird strikes. It is of utmost importance to consider and manage the issue by taking into account all possible preventive measures from the beginning of the construction.

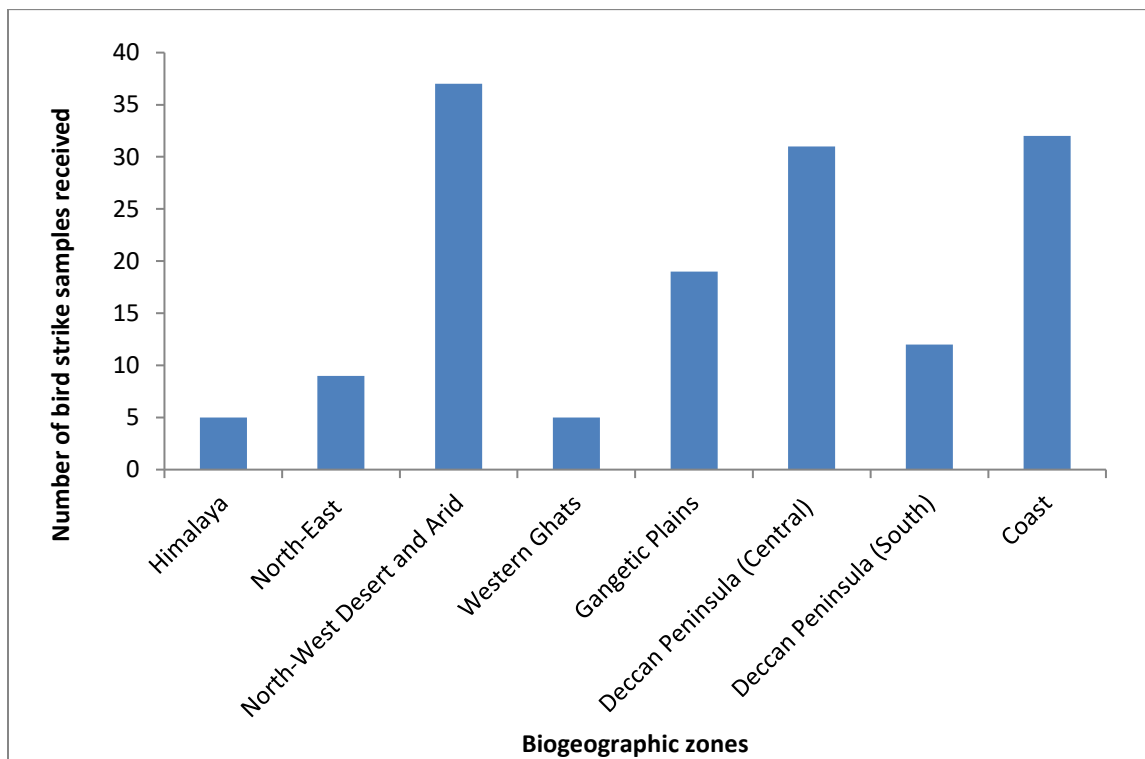


Figure 39 – Biogeographic zone variations in number of samples received from all airfields

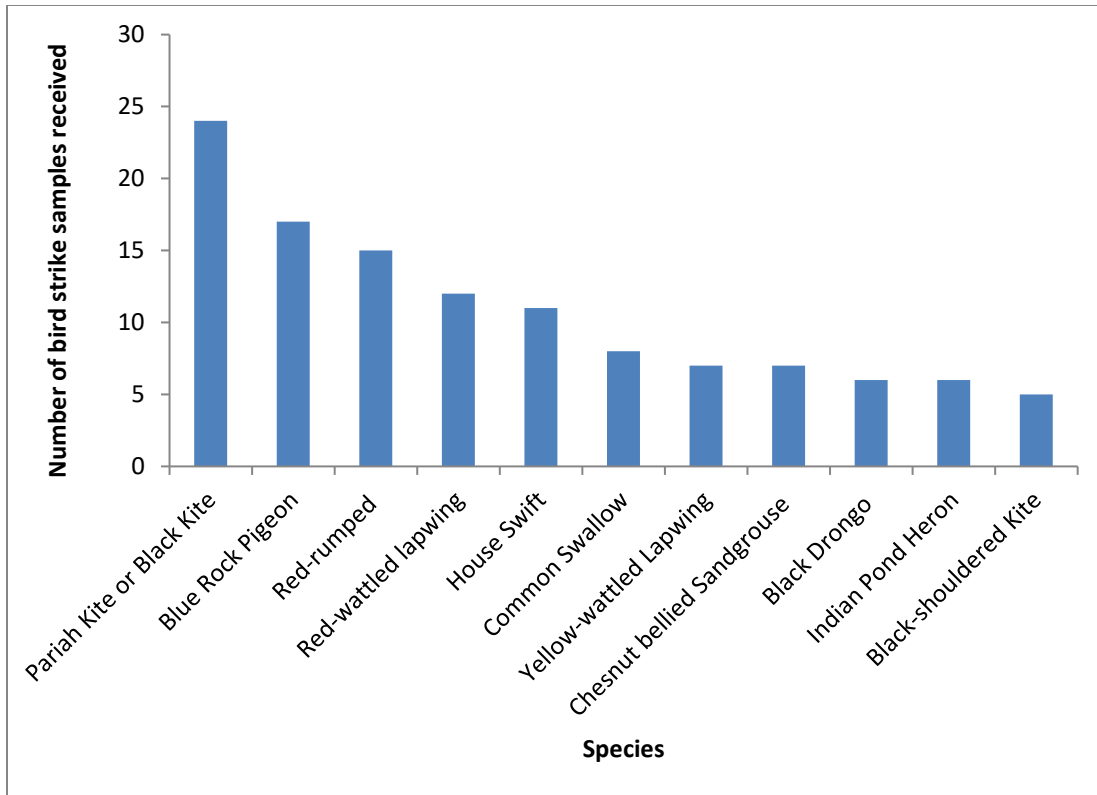


Figure 40– Samples of the species received from the North-West Desert and Semi-Arid zone

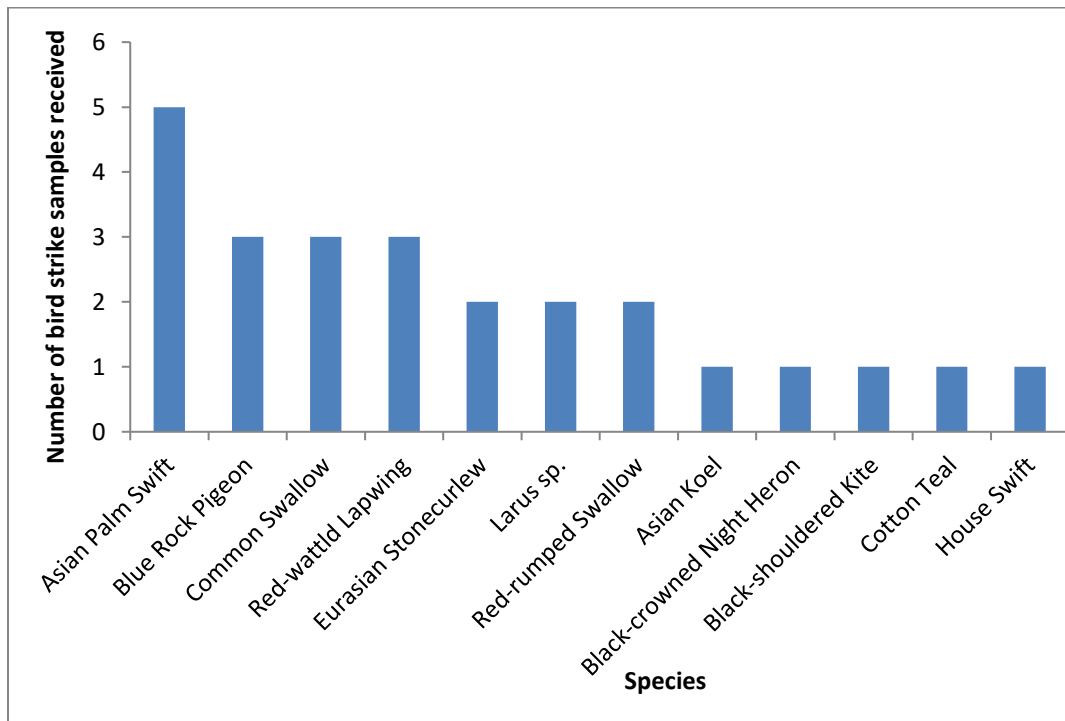


Figure 41 – Samples of the species received from the Coastal zone

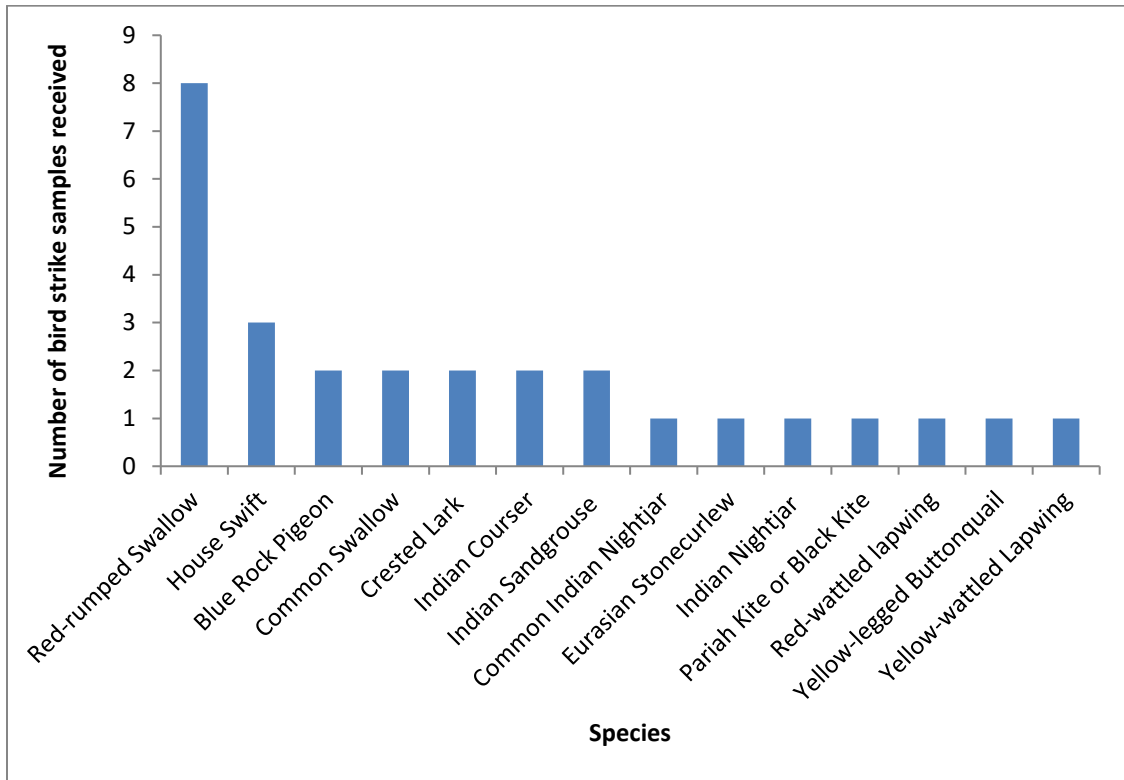


Figure 42 – Samples of the species received from the Central Deccan Peninsula

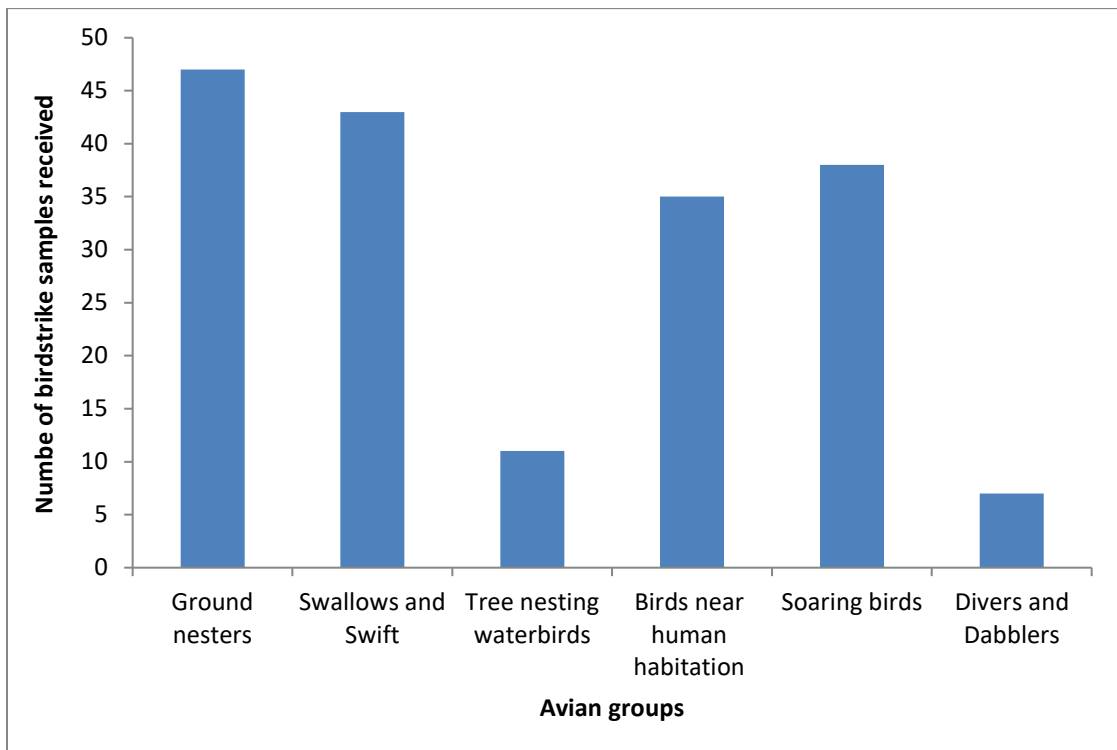


Figure 43 – Group-wise birds commonly involved in bird strike incidences

V) RECOMMENDATIONS

After reviewing the available literature and using bird strike sample analysis, we found that there can be no single method to address the bird hazard issue at airports and there is a need to design site-specific multiple bird strike prevention methods at NMIA. Therefore, even while drawing from the earlier lessons of bird strike, we would have to come up with site-specific solutions for NMIA, which calls for further surveys and research in the proposed airport area. The current study has been conducted during pre-construction phase of the proposed airport and associated developmental activities. There is a need to conduct such a study during the construction as well as operational phases.

1) Runway and adjoining areas

A crucial need is to make NMIA, its runway and the adjoining areas unsuitable for congregatory birds. At the same time, additional areas away from flight landing and take-off zones need to be developed as bird-friendly areas. Since a majority of migratory birds have strong site fidelity, they will continue to come to the areas proposed for airport only to find no suitable habitat is left and that, in fact, will enhance bird strike risk. Thus development and protection of other suitable sites (mudflats) and first 5 years of rigorous monitoring (of the airport, once it is operational, and also of the areas being developed as alternate habitats) will help us understand occupancy pattern of the newly developed sites and how the migratory birds are responding to the altered or changing seascape/landscape habitats of the airport.

2) Cautions to be taken during high tide timing

Our study indicates that there is significant bird movement between the study sites and it appears that tidal height and water depth in temporary water pools created by local fishermen govern this movement. The movement of tidal birds is very high during high tide and they congregate at these sites to feed and rest. On an average we counted around 40,000–50,000 birds in a single day during winter season. One particular day, the maximum numbers of birds counted were about 1,00,000; therefore considering the large numbers of birds and their local movement, we advise the NMIA authority to exercise caution during high tides, particularly in the months of October-November and March-April.

3) Measures to be taken to avoid movement of birds in the proposed airport area

To address the bird hazard issue effectively, a knowledge of the migratory and resident birds and their movement is very important. Thus bird hazard mitigation measures could be divided into two categories: bird hit prevention methods and habitat development to address the bird hazard issue at the proposed airport area, which are elaborated hereunder.

4) Specific Measures

Part I: bird hit prevention methods to be adopted at proposed airport site

Ecological method for long-term prevention of the risk, wherein most of the measures are of general use, could be considered as the first step. Following are the few measures that could be taken up at the airport site and its surrounding areas.

1. Development of a system for proper disposal of garbage, especially waste, which attract birds
2. Regulations to prevent feeding pigeons in the vicinity of the airport
3. Barb wires and metal spikes to prevent nesting of birds like pigeons in the airport premises

We have provided time series google earth images of Uran area from 2003 to 2017 to show how wetlands have been vanishing from the study area (See Figure 45). This may be a cause for the increase in bird counts over the years at the remaining wetlands. It is important to provide protection to such sites in a rapidly changing landscape of a metropolitan city like Mumbai. This is resulting in birds increasingly congregating in large numbers in smaller areas. The bird movement patterns will continue to be erratic until we ensure strong protection and habitat improvement measures at the sites suggested in the report. From air safety point-of-view, such measures will be most crucial since a majority of migratory birds exhibit strong site fidelity.

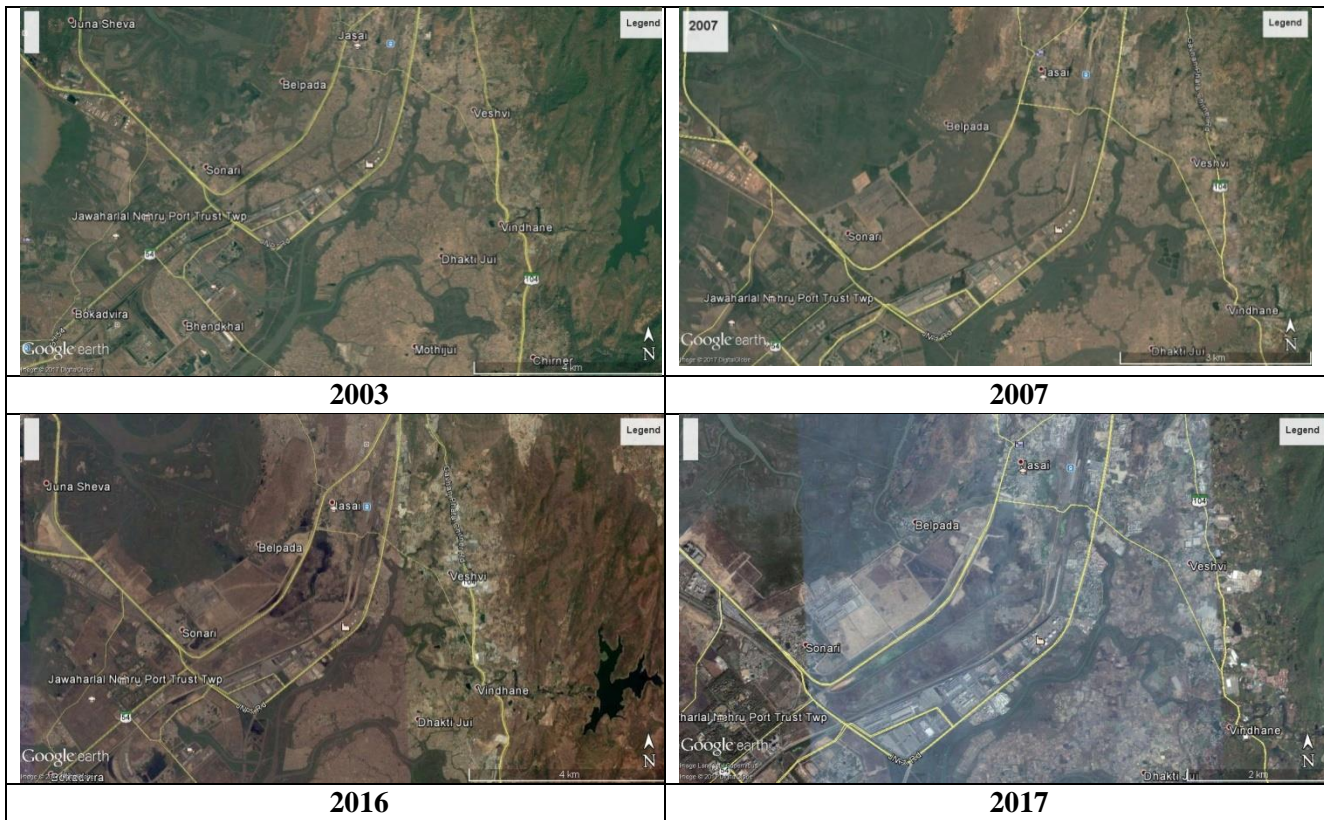


Figure 45 - Map showing historical and current imagery of google earth with rapidly depleting wetland areas in Uran

A five-year study conducted by BNHS to understand site fidelity among the wintering waders was carried out at Chilika in Odisha during 2000–2005 (Balachandran et al. 2005). The study revealed the importance of the sites for the survival of the wintering/staging birds which follow the same flyway year after year during the specific period of their annual cycle (please see table number 8 for further details).

A number of bird species of diverse orders and families, and with a diversity of habits and habitats roost together for at least a part of the year. In a few cases, such social gathering or roosting may be a simple consequence of the paucity of a suitable roosting site, forcing the birds to crowd together. However, in a majority of cases of communal roosting, the birds associate through some social attraction and do not disperse even if alternative roosting sites are available. Some of these social groups merely comprise feeding or migratory flocks, which remain together outside the roosting time as well.

Table 8 Ringing and recapture data of the birds showing almost same arrival time duration at particular sites at Chilika wetland (Balachandran et al. 2005).

Ring No.	Species Name	Date of Ringing	Date of Recapture	Time interval
A 147032	Little Stint	09-03-02	09-03-03	0 day
AB150624	Lesser Sand Plover	25.02.03	26.02.05	+ 1 day
AB 149995	Lesser Sand Plover	08-02-02	07-02-03	- 1 day
AB 150648	Curlew Sandpiper	27.02.03	28.02.04	+ 1 day
AB117998	Curlew Sandpiper	26.02.04	27.02.05	+ 1 day
AB153208	Lesser Sand Plover	20.12.03	18.12.04	- 2 days
AB 150183	Curlew Sandpiper	16.03.03	14.03.04	- 2 days
AB121451	Lesser Sand Plover	24.12.02	18.12.04	- 6 days
AB 149928	Curlew Sandpiper	18.12.01	04.12.03	- 14 days
AB 141979	Curlew Sandpiper	28.03.02	11.03.04	- 17 days
AB 153822	Curlew Sandpiper	28.03.03	30.03.04	+ 2 days
B65585	Pacific Golden Plover	27.12.02	30.12.04	+ 3 days
AB150536	Lesser Sand Plover	05.01.03	08.01.05	+ 3 days
AB 153573	Lesser Sand Plover	10.12.03	14.12.04	+ 4 days
AB148165	Lesser Sand Plover	14.12.03	18.12.04	+ 4 days
AB 150485	Curlew Sandpiper	09.12.02	20.12.03	+ 11 days
AB150479	Lesser Sand Plover	09.12.02	19.12.04	+ 10 days
AB 150166	Curlew Sandpiper	15.03.03	30.03.04	+ 14 days
A 247069	Little Stint	03.04.02	14.04.03	+ 11 days

It has been studied that the day-roost choice is affected by its distance from the feeding area and other microclimate factors (Rogers et al. 2006). At Roebuck Bay in Australia, study showed that birds selected day roosts closer to the feeding areas, but for the night roost, they opted for distant sites (Rogers et al. 2006). Similarly, there was an assessment of the effects of human development on the roosting behaviour of water birds in Cardiff Bay, and subsequently, the Cardiff Bay Development Corporation (CBDC) produced alternative roostsites within the bay to mitigate the loss of salt marsh (Donald & Clark 1991a). It was observed that through communal roosting, birds benefit by increased ability to spot approaching predators and opportunity to explore new feeding areas (Donald & Clark 1991b).

Secure roosts are essential for wading birds and wildfowl. It would be interesting to study the long-term impact of rapidly changing environment on the birds in the study area and correlate it with the status of birds in their breeding grounds. It will provide an idea about how a particular species is doing at the local as well as global level. Such a study would also help to better manage issues of air safety while at the same time exhibit caution on the measures adopted to keep the birds away from the airport zone.

The BNHS studies have shown that there is a need to give a protected status to some of the wetlands of Mumbai and Navi Mumbai. Along with Sewri in Mumbai, the following important areas (mudflat, mangroves and seashore as shown in Figure 46 and table 9) from southern Mumbai, where thousands of flamingo and waders visit every year, can be protected. These sites should be classified as No Development Zone and legal status accorded accordingly.

Table 9 - List of sites which should be classified as No Development Zone

Sr. No.	Name of sites	Coordinates of centre point	Size of the area in Ha
1.	Mahul-Sewri Zone	19° 0'0.57"N 72°52'33.58"E	559 ha mudflat core area and 179 ha buffer area (excluding proposed MTHL areas)
2.	Thane Creek eastern part	19° 6'48.29"N 72°58'38.73"E	424 ha mudflat and 697 ha of buffer area
3	TSC-NRI wetlands of Palm Beach Road, Navi Mumbai	1) TSC site - 19°0'56.92"N, 73°0'19.33"E 2) NRI site - 19° 0'18.02"N, 73° 0'43.68"E	682 ha of foraging area and 11.2 ha of roosting area of TSC wetland and 18.12 ha roosting area of NRI wetland
4	Panje-Funde Zone, Uran	18°54'3.04"N, 72°57'1.86"E	56.9 ha of foraging area at seashore and 166 ha of roosting area



Figure 46 - Map showing four sites of proposed Flamingo Sanctuary in Mumbai and Navi Mumbai area

The proposed conservation sites consist of two parts of which the core areas are mudflats while the buffer areas are primarily mangroves:

1. Mahul-Sewri Zone – Major foraging grounds for flamingos. Please see Figure 47 for further details. The proposed conservation site at this zone consists of two parts, the core area consists of mudflat while buffer areas are primarily mangroves (559 ha core area and 179 ha buffer area, excluding proposed MTHL areas)

2. Thane Creek eastern part – Core area of 424 ha is mudflat and 697 ha of buffer area is mangroves (Figure 48). This site is about ~11 km from the proposed airport (as the crow flies) and the western part of this creek is already part of the Thane Creek Flamingo Sanctuary; therefore, the eastern areas should be surveyed and explored for further protection and habitat improvement.
3. TSC–NRI wetlands of Palm Beach Road, Navi Mumbai – The proposed conservation site consist of two parts of which the core area consists of mudflat while buffer areas are primarily mangroves: TSC-NRI wetlands of Palm Beach Road, Navi Mumbai (Core comprises 783 ha of foraging area, 20 ha of roosting area of TSC wetland and 26 ha roosting area of NRI wetland. Buffer area is 568 ha and it is an important rest and roost habitat for waterbirds including flamingos during high tide. See Figure 49. It is ~6 km in aerial distance from the upcoming airport.
4. Panje-Funde Zone – Core area of 213 ha consists of foraging area at seashore and roosting area and the buffer area of 157 ha primarily consists of mangroves, which forms the rest and roost habitat for waders and other waterbirds (Figure 50). Since this site is about ~17 km from the proposed airport (as the crow flies) it can be a perfect site for the protection of birds. Some part of this wetland falls under proposed Special Economic Zone (SEZ) and therefore other adjoining areas should be surveyed and explored for further protection and habitat improvement.



Figure 47 - Proposed Flamingo Sanctuary at Sewri area (excluding MTHL areas)

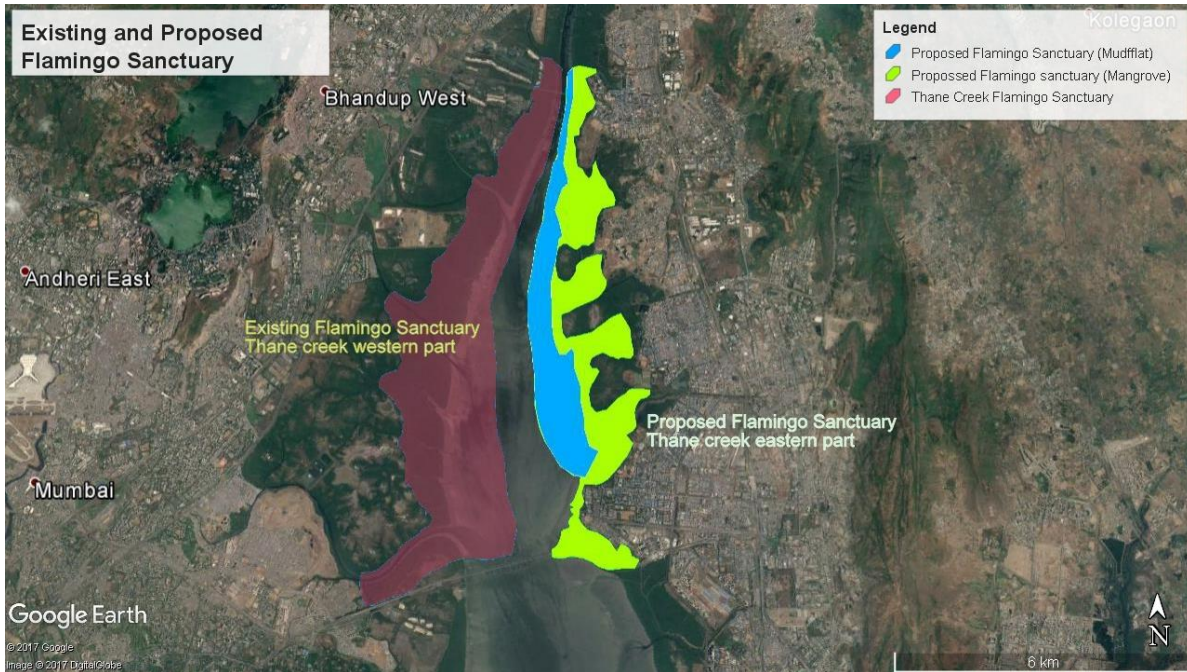


Figure 48 - Proposed Flamingo Sanctuary at Thane creek eastern part (western part in pink has already been declared as Flamingo Sanctuary)

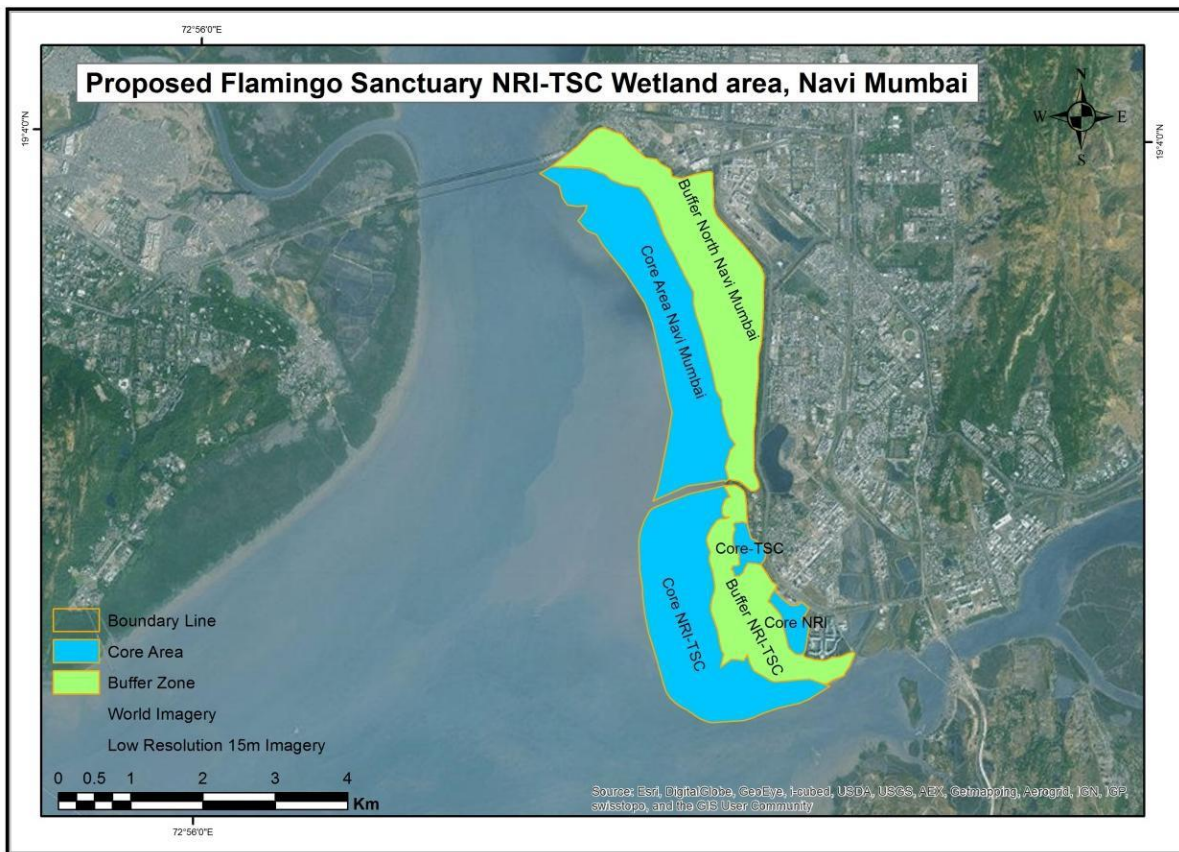


Figure 49 - Proposed Flamingo Sanctuary at Palm Beach road (wetlands behind TS Chanakya and NRI complex)

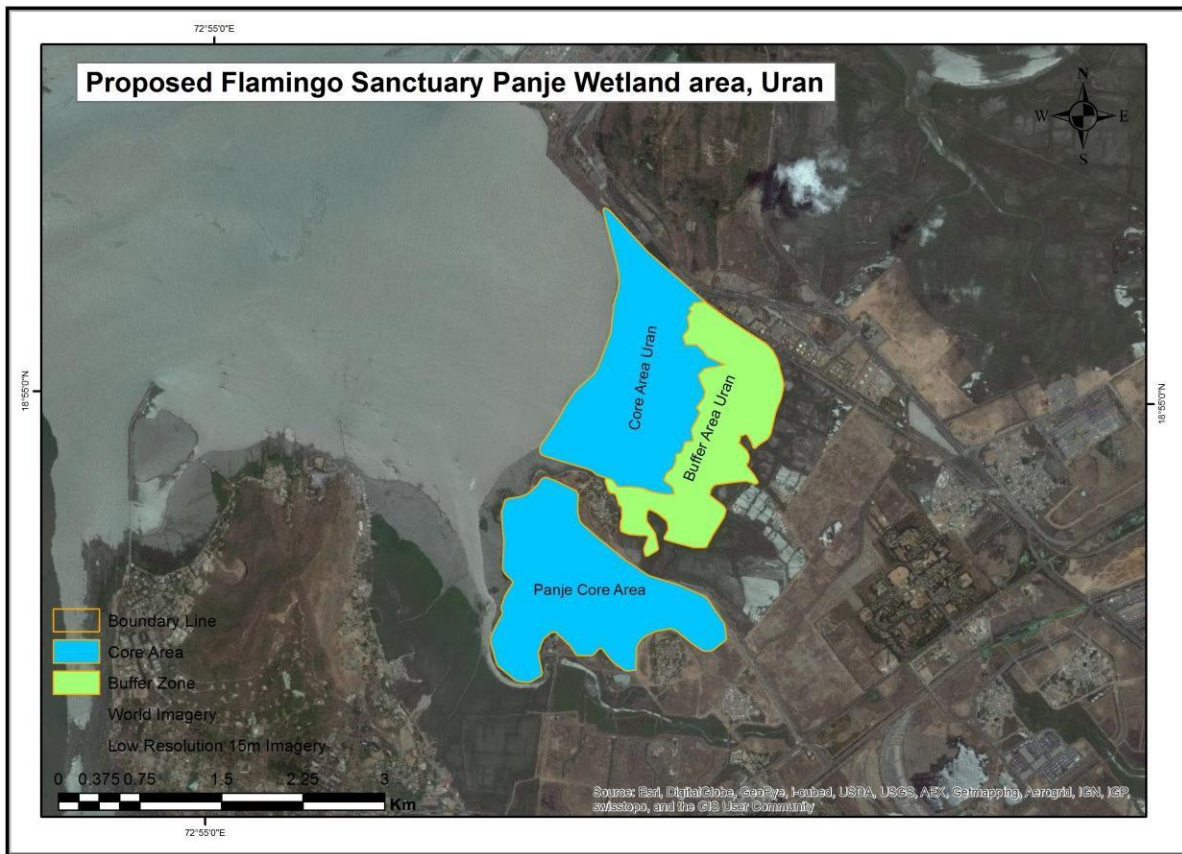


Figure 50 - Proposed Flamingo Sanctuary at Panje–Funde villages of Uran

Specific Issues of concern

1. Proposed Golf Course

A golf course has been proposed by CIDCO in about 80 ha land at Sector 60 which essentially consists of wetlands behind NRI and TSC (see Figure 51). It is our considered opinion that this is a wetland having all the essential wetland characteristics. This is an extraordinary wetland that is used by a large number of migratory and resident water birds. On average, around 40,000 to 50,000 birds including 10,000–15,000 Near Threatened Lesser Flamingos can be observed roosting at this site at high tides during winter season.

We have recommended this site to be declared as protected area in the studies carried out for proposed Navi Mumbai International Airport (NMIA) and Mumbai Trans-Harbour Link (MTHL). Conversion of this land to a different purpose (in this case, a golf course) will seriously jeopardise the air safety of the proposed airport as birds may start using the NMIA and its influence zone for roosting purposes in the absence of the above mentioned wetland. **Under no circumstances should this land be diverted to any other land use.**

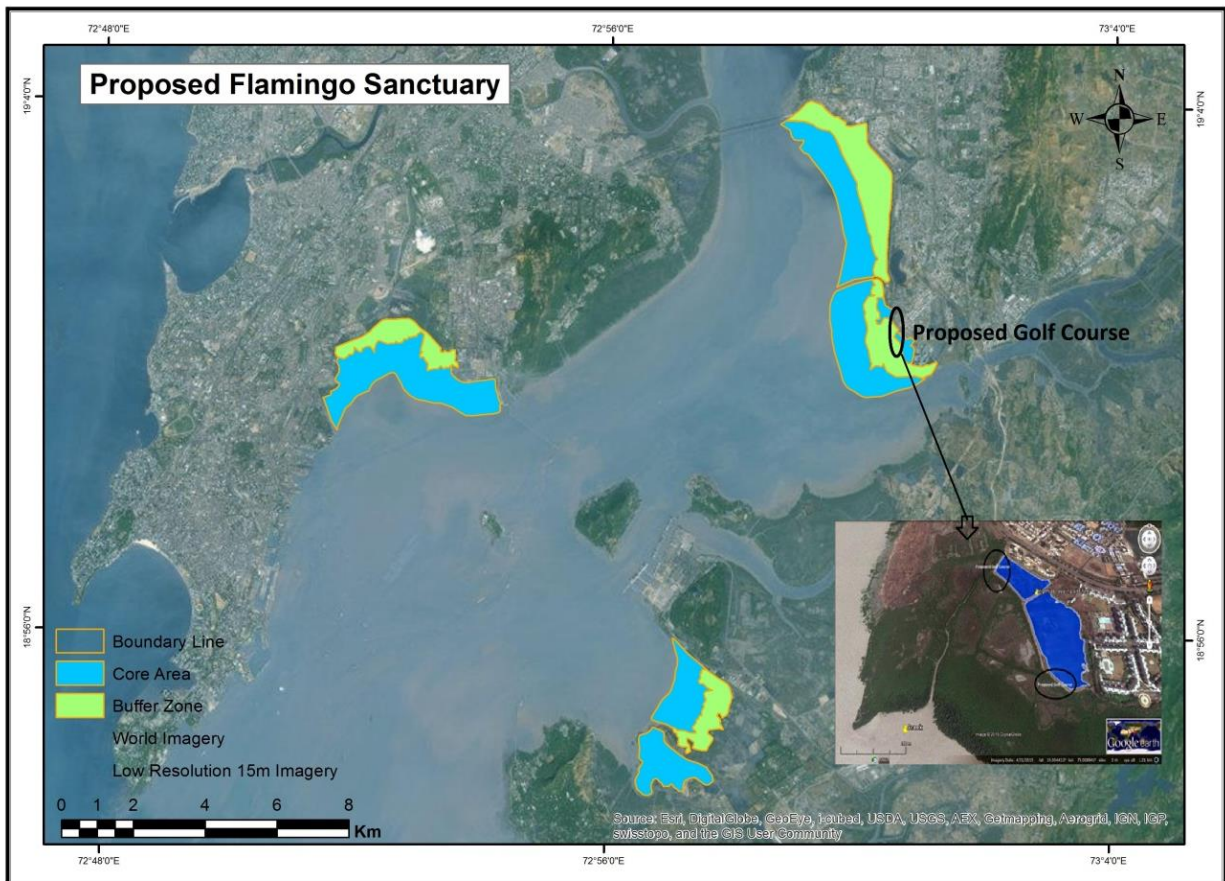


Figure 51 - Map showing locations of proposed Golf Course at Palm Beach road. The areas in black circle are roosting sites of birds and should be protected as Sanctuary

2. Proposed Mangrove Park near airport

Around 245 ha areas have been identified by CIDCO to be developed as a mangrove park around the proposed airport site near Vaghivali village (Figure 52). Mangroves interspersed with mudflats can attract tree roosting birds and high tide roosting birds respectively which could pose hazard to air safety at the proposed airport. Thousands of birds foraging and roosting near runway can increase chances of birds coming in the path of landing and take-off of the flights, in future.

Therefore, we suggest declaring Mangrove Park away from the airport influence zone, as it would help to address the bird hazard issue, as mentioned under mitigative measures (see Figures 46, 47, 48 and 49). The ideal site for the same would be Panje Funde region. At the current proposed mangrove park location, a mangrove genebank could be developed, that will prevent encroachments and garbage and other waste dumping.

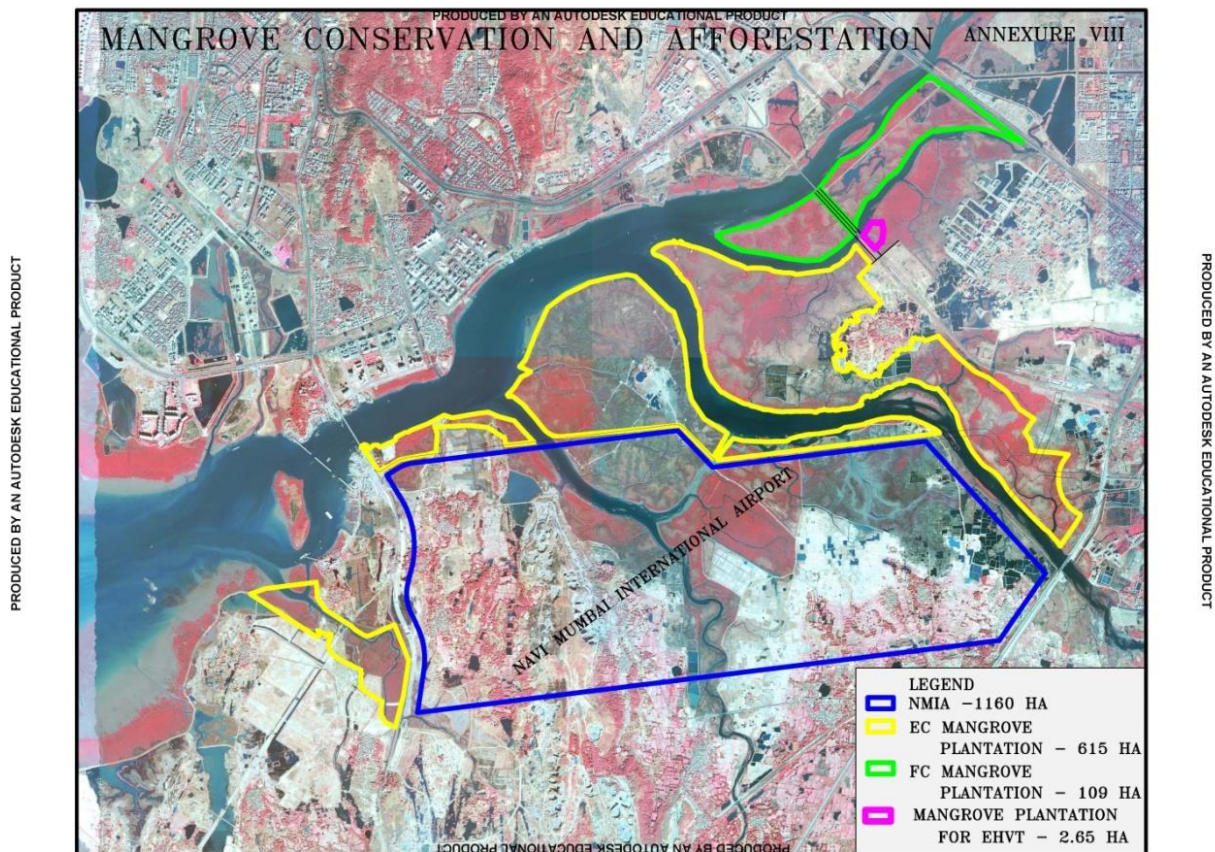


Figure 52 - Map showing proposed mangrove park around NMIA site (Source – Environment Department, CIDCO)

Additional cautions

1. The extent and spread of construction work should be strictly regulated and minimised at high bird congregatory sites, especially in winter, to avoid disturbance to birds which may pose a major threat to airport operations
2. No land-filling activities should be permitted, especially at important high tide roosting sites of birds and these sites should be declared as no development zones (NDZ) and notified accordingly.

ANNEX I: THREATENED BIRDS IN STUDY AREA

1. Great Knot *Calidris tenuirostris*

Great Knot is listed under the Endangered category because of the loss of intertidal stopover habitats in the Yellow Sea region and loss of wetlands, attributed to environmental pollution and reclamation activities (Birdlife International 2015). In Philippines, India and Australia, other threats are habitat degradation caused by intense fishing and over-harvesting of molluscs and bivalves, mangrove afforestation, aquaculture and oil spills (Leyrer et al. 2014). This species is a winter migrant in India.

We observed three individuals of Great Knot only in November 2014, during early winter at TSC wetland, Navi Mumbai. These three individuals were seen resting along with other waders for a few days.



Image 5 - Great Knot at seashore area of Palm Beach Road

2. Woolly-necked Stork *Ciconia episcopus*

The Woolly-necked Stork is listed under the Vulnerable category because it is suspected to be undergoing a rapid population decline owing primarily to habitat loss and persecution in South–East Asia (BirdLife International 2016). This species is a resident and local migrant in Deccan Maharashtra and reported as less common near Mumbai (Prasad 2003).

In Navi Mumbai, we observed Woolly-necked Stork during the five-year study period, usually from December to June. During the study period, we often observed a maximum of 5–7 individuals of this species resting along with egrets and other stork species. We observed the birds foraging at wetlands in Uran and the mudflats along the Palm Beach Road. We usually came across one or two birds soaring high above a number of wetlands in the study area.



Image 6 – Woolly-necked Stork in a paddyfield within the proposed NMIA site

3. Indian Skimmer *Rynchops albicollis*

Birdlife International justifies listing the Indian Skimmer as 'Vulnerable' because of its rapid decline in population and degradation of potential habitats such as lowland rivers and lakes (BirdLife International 2014). It is confined to Pakistan and India, north of Bangladesh (Padma–Meghna delta) and Myanmar. It was formerly widely distributed across the Indian Subcontinent but now rare all over Asia (Sundar 2004, Roberts 1991, Inskipp & Inskipp 1991). Though it is still seen around larger north Indian rivers, it is becoming uncommon everywhere (Rahmani 2012).

The Indian Skimmer is often seen in Maharashtra as is evident from many old and recent records (Rahmani et al. 2014). Burgess (1855) mentioned a few nests from the Bhīma River region and D'Abreu (1923) reported it from Vidarbha. A couple of birds were seen in August–September 1970 (Stairmand 1970) at Chedda Salt Pans, Mumbai. Several flocks of 10 to 50 birds were recorded on November 16, 1940 at Dharamtar creek, Raigad district, adjacent to Navi Mumbai and some birds in November 1950 (Stairmand 1970). There are few recent sighting records of

the species from Mumbai including Akshi Beach, Bhandup Pumping Station, Greater Mumbai and Alibag beach of Raigad District (Rahmani et al. 2014).

On January 10, 2013, we observed a high tide roost of waders at the wetland behind NRI Complex on the Palm Beach road in Navi Mumbai. The birds were disturbed because of the presence of an Osprey *Pandion haliaetus* flying above the wetland. All the three individuals of Indian Skimmers were adult, with black plumage above with white forehead and collar, and white underparts. During the subsequent visits, we observed the three adults up to February 5, 2013.

From October 15, 2013, to December 19, 2013 we observed four individuals of Indian Skimmer at a wetland near Navi Mumbai Special Economic Zone (SEZ) between Funde and Panje village of Uran. In December 2013, the wetland was completely dry; therefore, we surveyed other wetlands in the vicinity in search of Indian Skimmer. We did not spot the birds in other wetlands. On October 10, 2014 we observed the three individuals of Indian Skimmer at the same wetland near the SEZ in Uran. We have been observing about 2–4 individuals of Indian Skimmers visiting Navi Mumbai wetlands during the winter months since 2012. There is a need for intensive surveys to find out the local movement of these birds, considering the rapid development and the changing land use pattern in Navi Mumbai.



Image 7 - Indian Skimmer (front) seen at NRI wetland

4. Greater Spotted Eagle *Clanga clanga*

Greater Spotted Eagle is a 'Vulnerable' species, and the species winters in India across a range of geographies (BirdLife International 2014). Earlier, it was considered rare in peninsular India, but now there are many sights and photographic records, particularly from Kerala, Tamil Nadu and Karnataka (Rahmani 2012). Now we know this bird is known from many areas and its distribution is more widespread than it was believed to be previously. Prasad (2003) has compiled many records from Maharashtra, many of them being unconfirmed and taken from bird e-groups. It is an uncommon winter visitor to Uran, Kharghar Hills (Navi Mumbai), Sewri in

Mumbai, and Bhigwan in Pune district (Rahmani et. al. 2014). It is a regular winter visitor to Alibag in Raigad district (Prasad 2003).

One bird was seen at a series of wetlands spread between Sonari, Belpada, Jasai areas of Uran in Navi Mumbai during February 8–10, 2012, and again on January 10, 2012. It was usually seen flying in marshy areas.



Image 8- Greater Spotted Eagle at Belpada, Uran

5. Indian Spotted Eagle *Clanga hastata*

Due to confusion between Greater and Indian Spotted Eagles before the split in 2002, many earlier records could be of Greater Spotted Eagle. In Maharashtra, Indian Spotted Eagle is reported from many sites (Rahmani et al. 2014, Prasad 2003).

Two birds were observed, frequently sitting on the water pipeline and hunting migratory birds across the water bodies in Belpada–Sonari area of Uran in Navi Mumbai.

6. River Tern *Sterna aurantia*

River Tern has been up-listed to the 'Near Threatened' category because of increasing human footprint and the declining count in breeding birds (BirdLife International 2014). In Maharashtra, it is a common resident found along all the major rivers and wetlands. In the 19th century, it was considered as a straggler in the Deccan Plateau of Maharashtra (Sykes 1833, Fairbank 1876, Davidson 1882, Davidson and Wenden 1878), whereas it is now common (Vyawahare 1992). In Southern India also, it is now a common bird as it has benefited from the construction of large reservoirs as well as new irrigation schemes (BirdLife International 2014). River Tern is a resident species in India and was reported as a rare species near Mumbai before 1939 (Abdulali & Ali 1940). Monga (2003) recorded this from Uran, Navi Mumbai without providing any population data.

The presence of River Tern was recorded at various sites. The birds were seen across the study area, moving in search of foraging and roosting sites. We usually observed the species in a small flock of 4–5 individuals resting, foraging and preening along with other terns such as Gull-billed Tern *Gelochelidon nilotica* and Whiskered Tern *Chlidonias hybrida*. In summer, when most of the water bodies in the study area dried up, the terns were seen congregating in the wetlands along the Palm Beach Road. On January 11, 2013, we observed a group of 50 River Terns at a wetland near the Palm Beach Road, and this was the largest flock size observed in Navi Mumbai during the study period. The local movement of birds, corresponding to the availability of water, was observed at different wetlands in the study area. For example, a few birds were seen in Uran in winter and in wetlands along the Palm Beach Road in summer when the Uran wetlands dried up (Narwade et al. 2012, 2013). The bird's absence in the study area during the summer months indicates that birds move to other areas for breeding. Breeding records of River Tern in peninsular India are known from early March to early May (Unnithan and Unnithan 2002, Bharucha and Gogte 1988).



Image 9- River Tern at Belpada wetland, Uran

7. Alexandrine Parakeet *Psittacula eupatria*

Alexandrine Parakeet was declared as Near Threatened species in 2013 (BirdLife International 2013). It is a widespread bird, found in South and South-East Asia, ranging from Pakistan, through most of India (including the Andaman Islands and Narcondam Island), Sri Lanka, much of Nepal, Bhutan and Bangladesh (including Cocos Island), into southern and central Myanmar, central Thailand, southern and western Laos, much of Cambodia and southern Vietnam (Juniper and Parr 1998). This species inhabits a variety of moist and dry forests and woodlands, as well as cultivated areas, mangroves and plantations, mainly below 900 m, but reaching c.1,600 m locally (Juniper and Parr 1998). In Maharashtra, it is commonly found and was recorded mainly as pet species.

Around 15–20 birds were seen at Gokuldham, Goregaon, near Aarey Colony in June 2016 and a single bird was seen in Panvel area same time. Possibly these birds are escapees from cages as these are famous pet birds.



Image 10 - Alexandrine Parakeet in the monsoon season

8. Pallid harrier *Circus macrourus*

According to BirdLife International (2013), the Pallid Harrier is known to be undergoing a steep decline in Europe though the numbers are stable in the Asiatic region. Therefore, all over its wide range, it is said to be experiencing a moderately rapid population decline and so is classified as Near Threatened by IUCN.

The Pallid Harrier is a winter visitor to the Indian subcontinent and arrives in the month of August. These are found in open grasslands, open scrubland and paddy fields almost all over Maharashtra (Rahmani et al. 2014). We usually saw a single or occasionally couple of birds in open paddy fields in Uran.

9. Painted Stork *Mycteria leucocephala*

It is a Near Threatened (NT) species as per the IUCN Red List. Once it was common but now scarce in Pakistan, rare summer visitor in Nepal terai, straggler to coastal regions in Bangladesh, locally abundant in Sri Lanka, rare and possibly extinct in China, rare in Myanmar, on verge of extinction in Thailand, rare in Laos and Vietnam, resident in Cambodia with 4,000–5,000 pairs, vagrant in Peninsular Malaysia (BirdLife International

2014). It is a widespread and common resident in the plains of India, except in Andaman and Nicobar Island (Ali & Ripley 1983). It frequents freshwater marshes, lakes and reservoirs, rice paddies, river banks, intertidal mudflats and saltpans. Breeding falls from the monsoon to the arrival of winter (July to October).

Previously it was considered uncommon local migrant to Mumbai and adjoining areas (Abdulali 1981, Prasad 2003) but we found it in hundreds in winter and summer at Belpada and NRI Lake during night roosts. Scattered groups were seen foraging in wetlands, mudflats and seashore during day.

We observed the count varying at different sites depending on the season and water level in the wetland. The reason for the count fluctuation was drying of the wetlands during summer. During summer months, a few individuals were observed scattered at different sites and in mangroves behind these two locations. Post-monsoon, we observed few juveniles along with adults in the group at Belpada. Please see figures 53 and 54, showing monthly variation in Painted Stork counts from 2012–2016.



Image 11- Painted Stork foraging at Belpada wetland

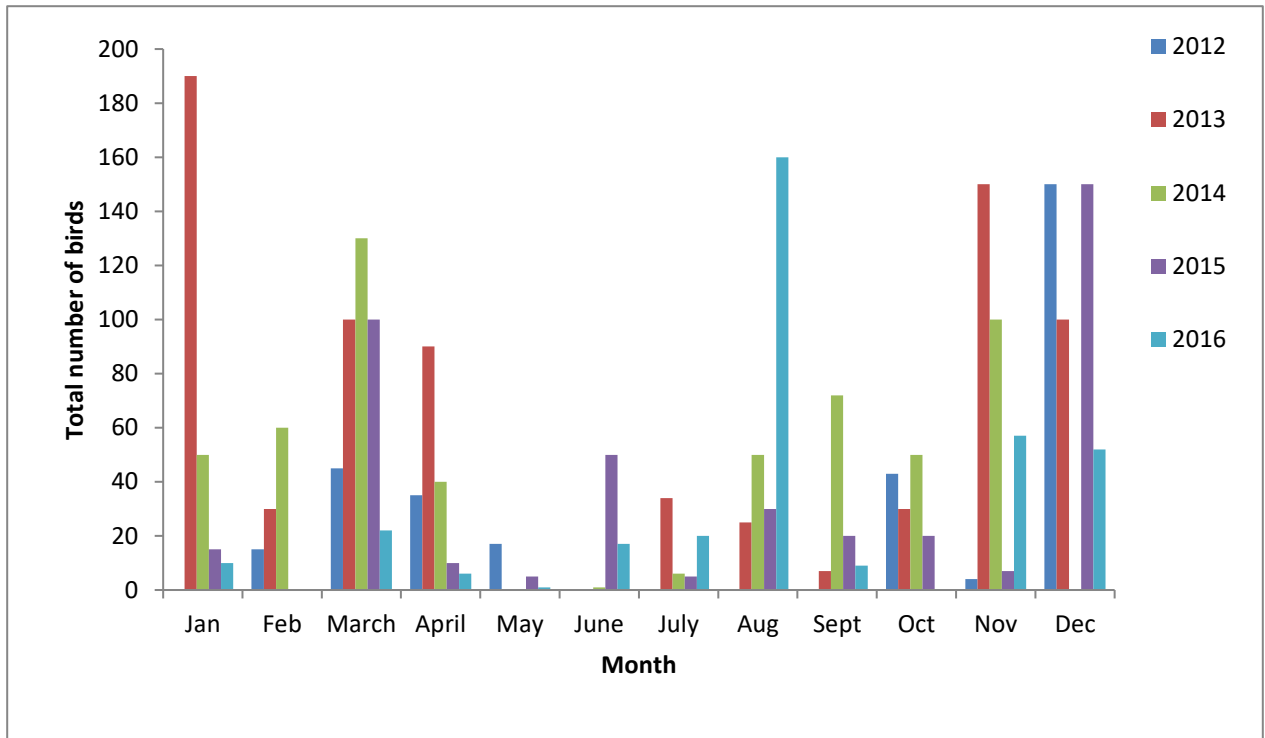


Figure 53 - Monthly variation in Painted Stork count from 2012–2016



Figure 54 - Proportion of seasonal variation in Painted Stork count from 2012–2016

10. Black-headed Ibis *Threskiornis melanocephalus*

It is a Near Threatened (NT) species as per the IUCN Red List. It is a wide spread species in South and South East Asia, occurs in China, Pakistan, Hong Kong, Nepal, Srilanka, Vietnam, Philippines, Cambodia, Malaysia, Bangladesh, and Indonesia (Bird Life International 2014), and distributed throughout India (Ali & Ripley 1983). It was previously reported as a local migrant and uncommon (Abdulali 1981) in Mumbai and adjoining areas. It was usually seen in aquatic grass, creeks and mangroves at Mahul (Verma et. al. 2001–02).

We observed this species as very common in all water bodies in the study area, occurring in small flocks of four to five individuals at all the sites. The species inhabits marshes, lakes, rivers, paddy fields, tidal creeks, mudflats and mangroves, tending to be nomadic in response to water levels and feeding conditions. We often observed 10–15 individuals resting at the proposed NMIA site and feeding at seashore, creeks, mudflats and inland water bodies. About 20–30 individuals were observed at Belpada in March 2013, and 30–40 individuals were seen at the proposed NMIA site in the same season. Please see figure 55 and 56 showing monthly variation in count of Black-headed Ibis from 2012–2016.

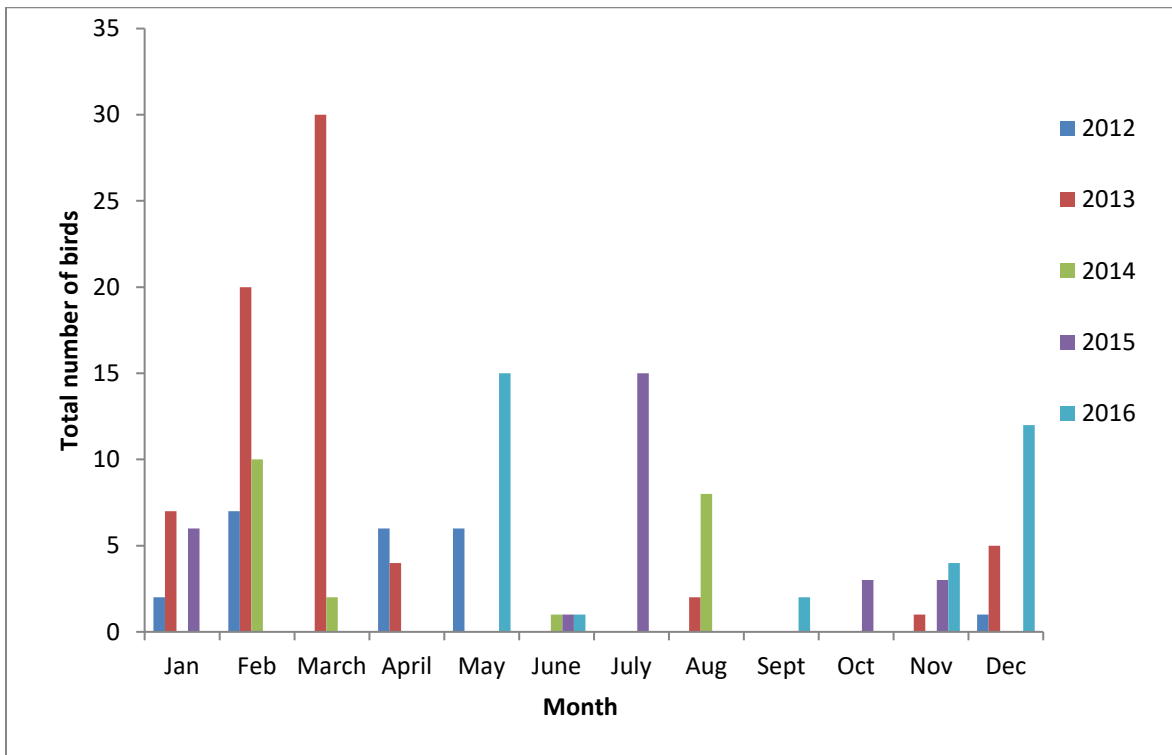


Figure 55 - Monthly variation in Black-headed Ibis count from 2012–2016

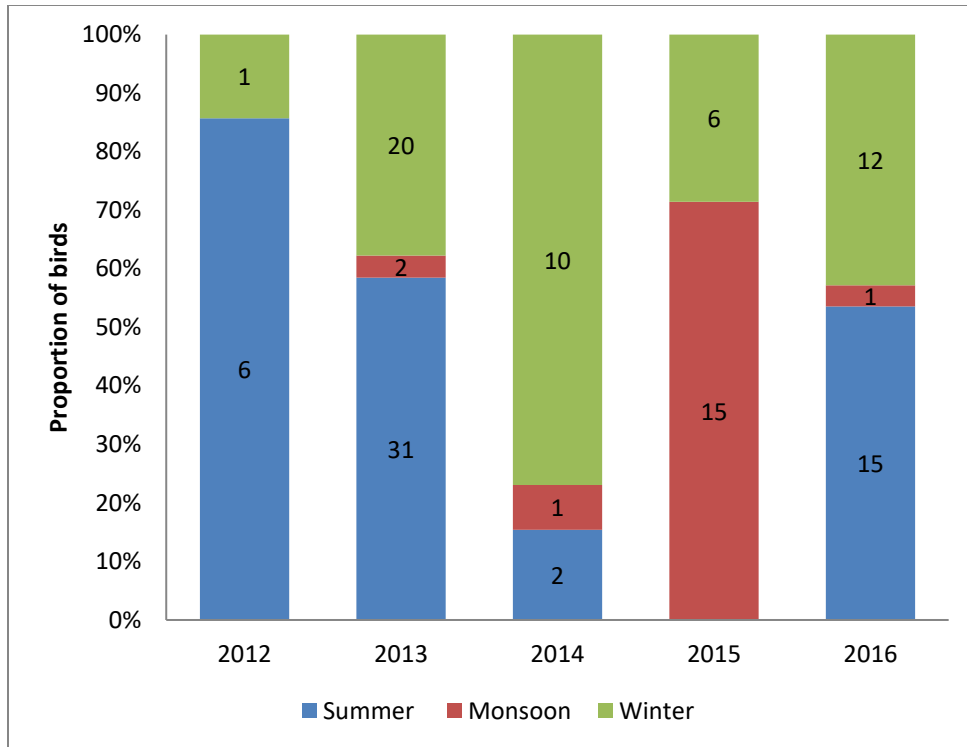


Figure 56 - Proportion of seasonal variation in Black-headed Ibis count from 2012–2016



Image 12 – Congregation on Black-headed Ibis in Uran area

11. Lesser Flamingo *Phoeniconaias minor*

It is a Near Threatened (NT) species as per IUCN Red List of Threatened Species. This species has major distribution in Africa and South Asia, and it breeds mainly in the Rift Valley lakes of East Africa in Ethiopia, Kenya and Tanzania with population of about 1.5–2.5 million birds (Delany and Scott 2006). Three smaller breeding congregations occur in West Africa, in southern Africa and in Asia, in India and Pakistan (BirdLife International 2014). This species makes extensive movements in response to adverse environmental conditions. The species breeds in huge colonies of many thousands of pairs often mixed with Greater Flamingo *Phoenicopterus roseus* (del Hoyo et al. 1992). The timing of breeding is irregular and varies geographically depending on the timing of the rains (Brown et al. 1982). It feeds almost entirely on microscopic blue–green algae and benthic diatoms found only in alkaline lakes and salt pans (del Hoyo et al. 1992).

Earlier, it was reported as stray or vagrant in the Mumbai region (Abdulali 1981), but from April 1984 onwards, Sowrirajan, working in Mumbai Port Trust, started seeing them in Sewri mudflats. He later published his findings in Hornbill (Sowrirajan 1994) that further highlighted the site. Since then many people have reported Lesser Flamingo in the Mumbai region. For example, Monga (2003) found flocks of up to 3,000 in Uran and Thane creeks. Woodward (2007) reported a flock of 20,000 individuals of Greater and Lesser Flamingo at Sewri.

In our study area, Lesser Flamingos were seen mainly after December with peak count in March and April. Around 12,000 birds were recorded during March 2015. After the onset of the monsoons, the count of flamingo was seen decreasing. Please see figure 57 and 58, showing monthly variation in count of Lesser Flamingo from 2012–2016.

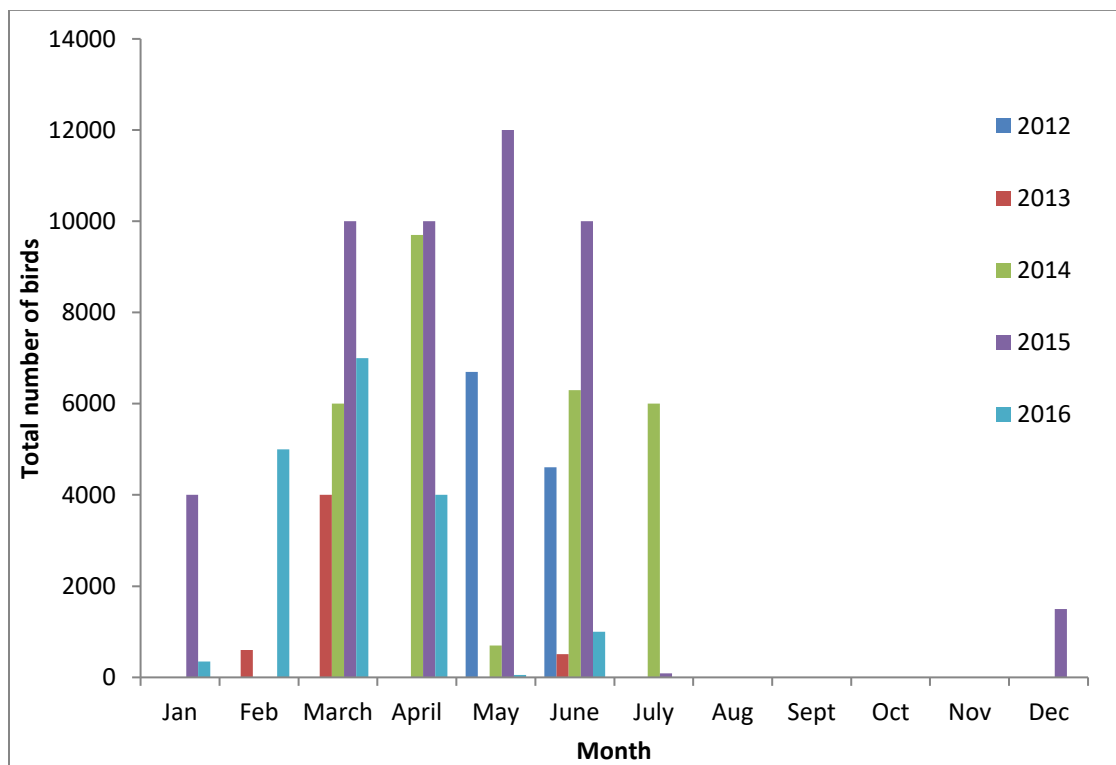


Figure 57 - Monthly variation in Lesser Flamingo count from 2012–2016

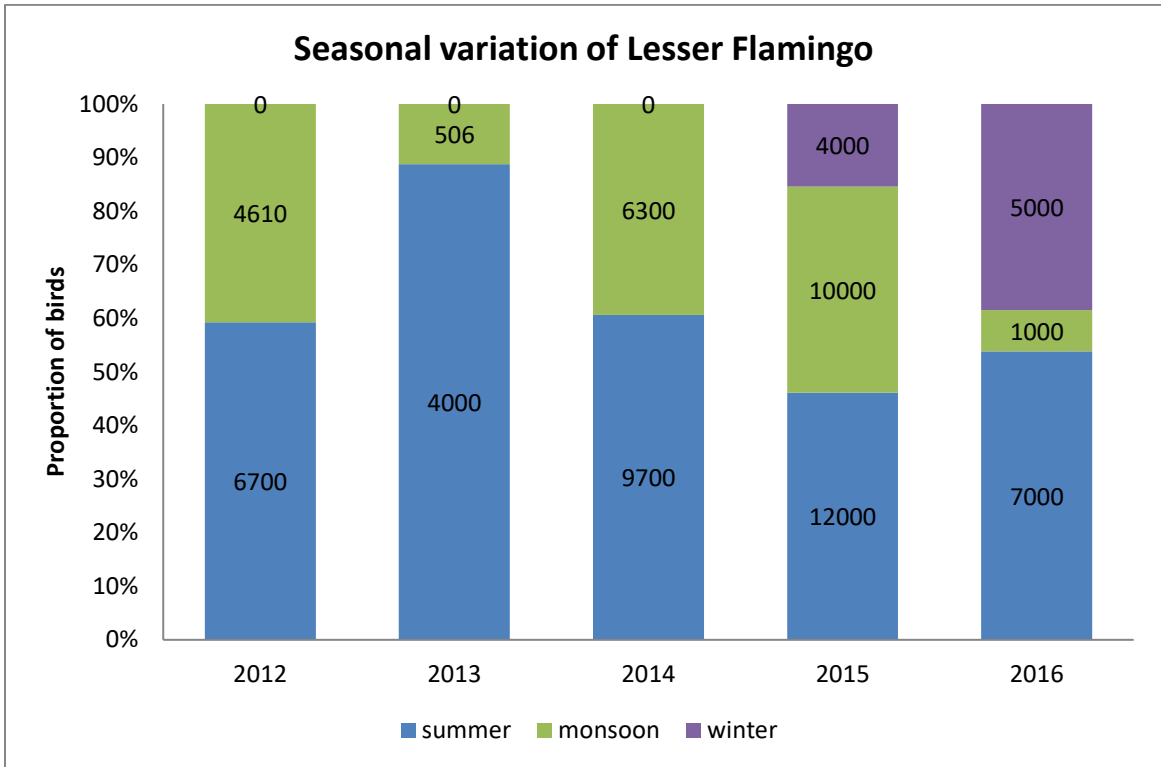


Figure 58 - Proportion of seasonal variation in Lesser Flamingo count from 2012–2016



Image 13- Lesser flamingo congregation at TSC wetland

12. ‘Western’ Black-tailed Godwit *Limosa limosa*

It is a winter migrant and a Near Threatened (NT) species as per the IUCN Red List of Threatened Species. It has a large but fragmented breeding range extending from Iceland to the eastern part of Russia, with wintering count in Europe, Africa, the Middle East and Australasia (del Hoyo et al. 1996). Migratory region extends from the Republic of Ireland to Australia, encompassing the Mediterranean, sub-Saharan Africa, and parts of the Middle East, India, Indochina, Taiwan, the Philippines, Indonesia, and Melanesia (Dutson 2011).

It is a winter visitor to India, most common in North India, diffusing eastwards to Bihar, Odisha and West Bengal, Southern India as well as Sri Lanka (Ali & Ripley 1983). The global population has recently been estimated at 634,000–805,000 individuals (Wetlands International 2014). It breeds from April to mid-June (Gunnarsson et. al. 2006). The species migrates towards wintering grounds between late-June and October. The return passage to the breeding grounds is usually between February and April (del Hoyo et al. 1996).

‘Western’ Black-tailed Godwits were reported to be occasional visitors in Mumbai and adjoining areas (Abdulali 1939). More recently they have been spotted in the marshy lands of Mahul Creek (Verma et. al. 2001–02) and have been reported in Raigad district (Prasad 2003)

We observed this species at all the wetlands in the study area but a variation in count was recorded as per the changing seasons and water level in the wetland. This species arrives and departs early as compared to the other winter migratory species of the study area. They were seen from September to March. In 2013 these birds arrived in September and were seen foraging continuously at Jaskhar and Belpada wetlands in large congregations of about 600–650 individuals. Later the birds were scattered in all the wetlands but it decreased to 50–60 individuals on the whole in the April 2014. Please see figure 59 and 60, showing monthly variation in count of Black-tailed Godwit from 2012–2016.



Image 14 - Black-tailed Godwits in Khargarh creek area

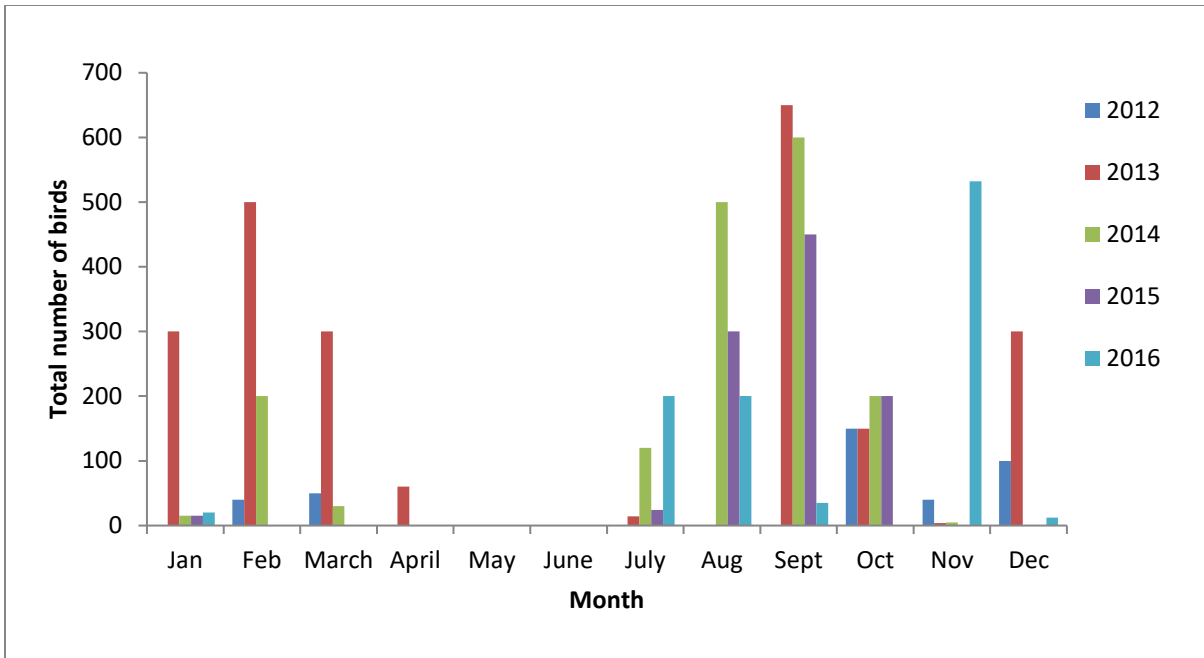


Figure 59 - Monthly variation in Black-tailed Godwit count from 2012-2016

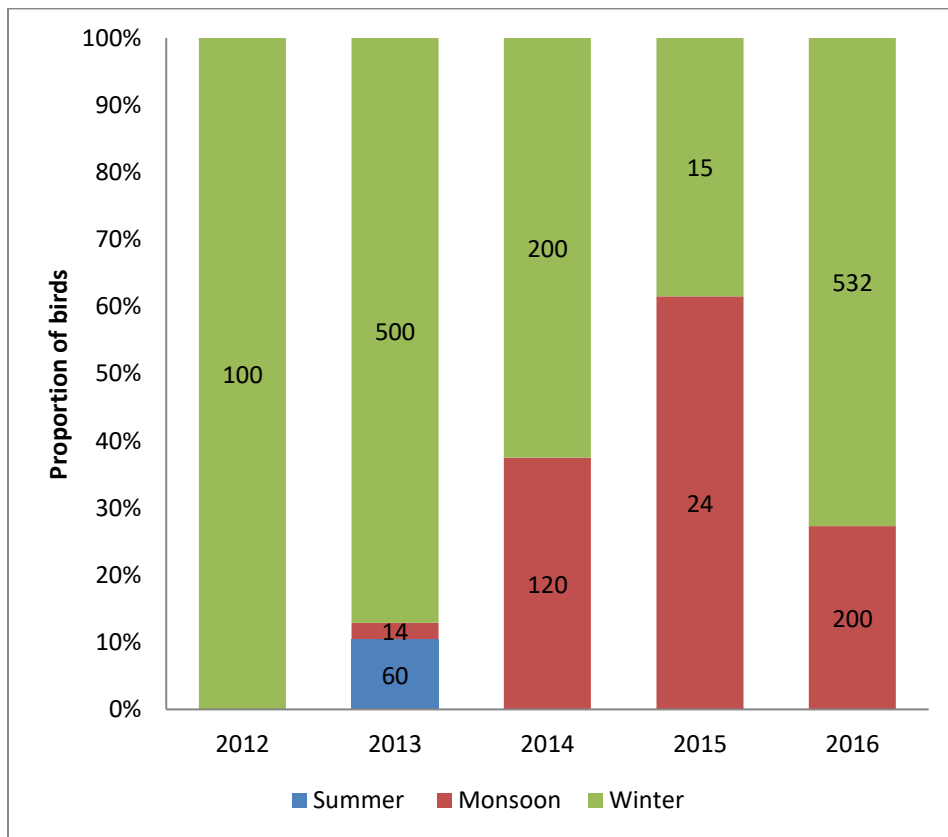


Figure 60 - Proportion of seasonal variation in Black-tailed Godwit count from 2012-2016

13. Eurasian Curlew *Numenius arquata*

It is a winter migrant and a Near Threatened (NT) species as per IUCN Red List of Threatened Species. It is widely distributed, breeding across Northern Europe from the British Isles and winters around the coasts of the Indian Subcontinent, South-East Asia, Japan and the Sundas (Bird Life International 2014). The species migrates to southern wintering grounds during October and November (del Hoyo et al. 1996) which return to their breeding areas in Northern ranges between April to August (Hayman *et. al.* 1986). The species departs its wintering grounds again from February through to May, and non-breeders may remain in the wintering areas all-year-round (del Hoyo et al. 1996). During winter, the species usually forages singly or in small groups (del Hoyo et al. 1996) occasionally aggregating into flocks of several thousand individuals, especially at roosting sites (Snow and Perrins 1998). Its diet consists chiefly of annelid worms and terrestrial insects (del Hoyo et al. 1996, Johnsgard 1981).

In the Mumbai region, it was previously reported by veteran ornithologist, Humayun Abdulali, based on his 40 years' experience, as occasional (Abdulali 1981), but now it appears to have become much more common winter visitor, perhaps due to spread of mudflats and salt pans. Prasad (2003), based on his compiled reports from many sources, has mentioned the Eurasian Curlew as a common winter visitor along the coast of Maharashtra. Verma et al. (2004) during two years of intensive studies in Mahul region, found it to be inhabiting marsh, salt pans and creeks.

This species was commonly observed in the study area at sites such as NRI Lake, TSC wetland and sea shore during different tide level and different seasons. These birds were present in the study area during the winter but some overwintering population was seen throughout the year. Interestingly, more than hundred years ago, Keswal (1886) has also reported some individuals in Konkan in all the months. Please see figure 61 and 62, showing monthly variation in count of Eurasian Curlew from 2012–2016.



Image 15- Eurasian Curlew seen at NRI wetland

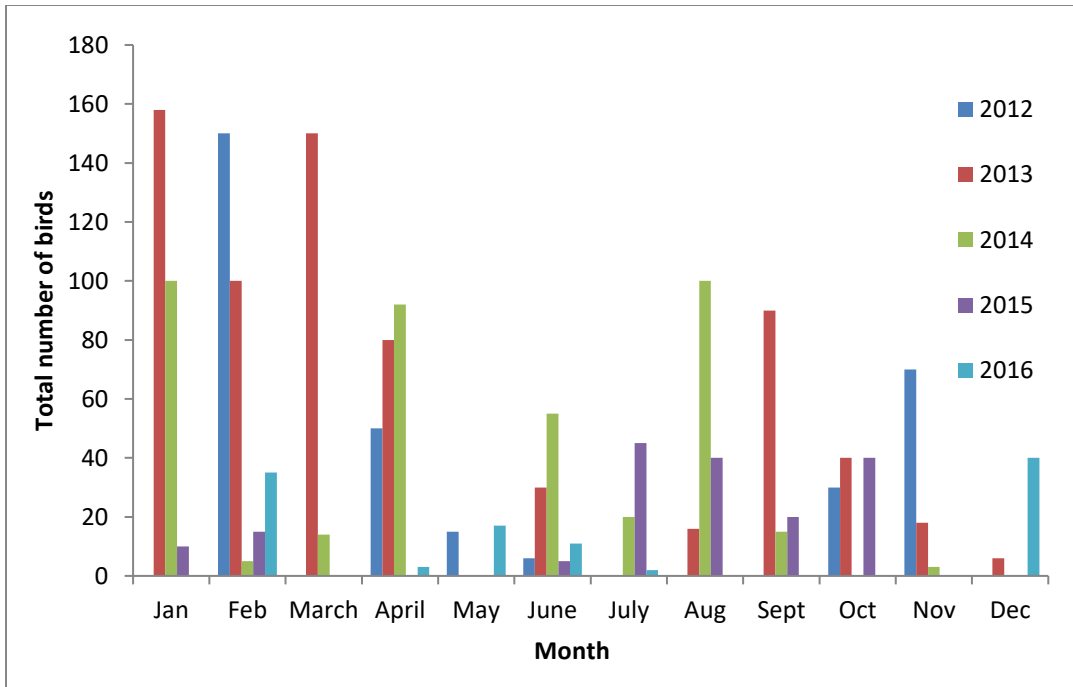


Figure 61 - Monthly variation in Eurasian Curlew count from 2012–2016

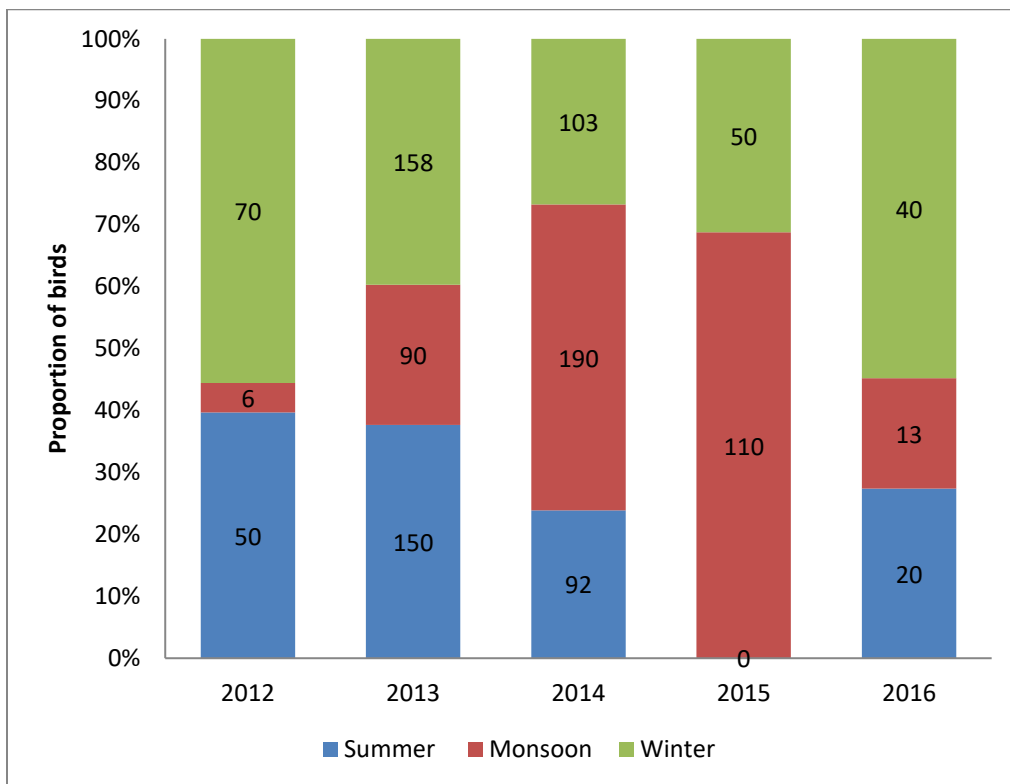


Figure 62 - Proportion of seasonal variation in Eurasian Curlew count from 2012–2016

14. Curlew Sandpiper *Erolia ferruginea*

It is a common winter migrant, found from, Yamal Peninsula to Russian Gulf in Arctic Siberia, winters from sub-Saharan Africa through South Asia to Australasia (BirdLife International 2014). Arrival to the breeding grounds begins late-April to May, with arrival in the Arctic beginning in early-June, and breeding period is from June to July (del Hoyo et al. 1996). It is distributed throughout the Indian subcontinent during wintering period (Ali & Ripley 1983). Many first-year birds remain on the wintering grounds (del Hoyo et al. 1996). In winter, it chiefly occurs on coastal brackish lagoons, tidal mudflats salt marshes (del Hoyo et al. 1996, Snow and Perrins 1998), exposed rocky shores (Urban et al. 1986), and also inland on the muddy edges of marshes and lakes (both saline and freshwater), irrigated land (del Hoyo et al. 1996), dams (Urban et al. 1986) and saltpans (Khomeenko 2006).

Previous records from Mumbai and surrounding areas (Prasad 2003), (Ali & Abdulali 1981) reported it as 'common but overlooked' and was seen at Dativare, Nala Sopara (Monga 2003) and Mahul Creek (Verma et al. 2001–02) and Prasad (2003) found it common on the coasts but rare inland.

We observed this species congregating in huge flocks of a couple of thousand individuals along with other waders in inland wetlands during high tide, and dispersing along the seashore for foraging during the low tide. This species was observed in the study area from October to June. Usually we could see around 3000–4000 birds but a large congregation of 8,000–9,000 individuals of this species was observed in October 2012. This large congregation was not observed in the later months, which indicates that some population may be using this area as a stopover site. After April, the count started declining as the birds started their return migration. Please see figure 63 and 64, showing monthly variation in count of Curlew Sandpiper from 2012–2016.



Image 16- Curlew Sandpiper congregation at Panvel creek

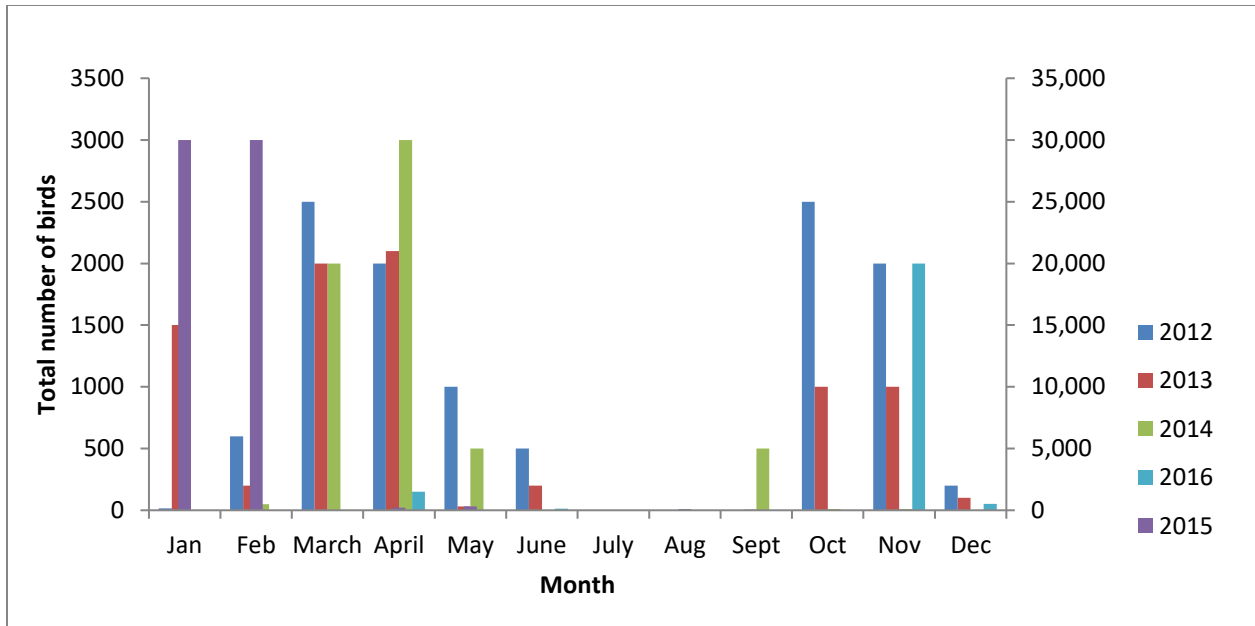


Figure 63 - Monthly variation in Curlew Sandpiper count from 2012–2016

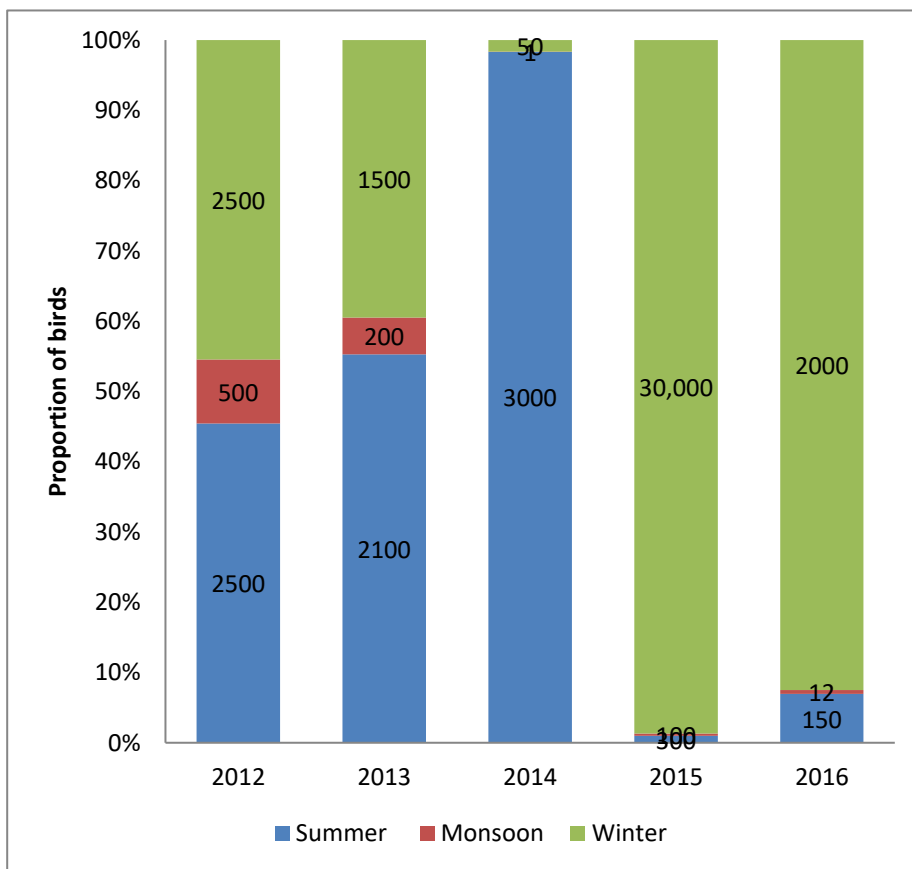


Figure 64 - Proportion of seasonal variation of Curlew Sandpiper from 2012–2016

ANNEX II) SEASONAL CHANGES IN COUNT OF CONGREGATING BIRDS OTHER THAN THREATENED SPECIES

1. Indian Cormorant or Indian Shag *Phalacrocorax fuscicollis*

It is a resident species found in Bangladesh, Bhutan, Cambodia, Pakistan, Sri Lanka East to Thailand and Vietnam (BirdLife International 2014) and distributed throughout India but in the Himalaya it is not seen beyond the foothills (Ali and Ripley 1983). Breeding season is variable, depending on region, local water conditions and monsoon during July–February (Del Hoyo et al., 1992). As per the previous records from Mumbai and adjoining areas, Indian Cormorant was reported as an uncommon species by Abdulali (1981), common by Monga (2003), and Prasad (2003) reported its breeding at Thane and Dombivali during the rainy season.

In the study areas, we observed this species at all the wetlands along with other cormorant species. It was seen in inland as well as marine habitats, including lakes, mangrove creeks, rivers and tidal estuaries. This species was always observed foraging or resting on the edges of the wetland and on mangroves. The species was seen throughout the year though the count did fluctuate. Around 500 individuals were recorded during February 2012. Please see figure 65 and 66, showing monthly variation in count of Indian Cormorant from 2012–2016.



Image 17- Indian Cormorant during low tide in Panvel creek

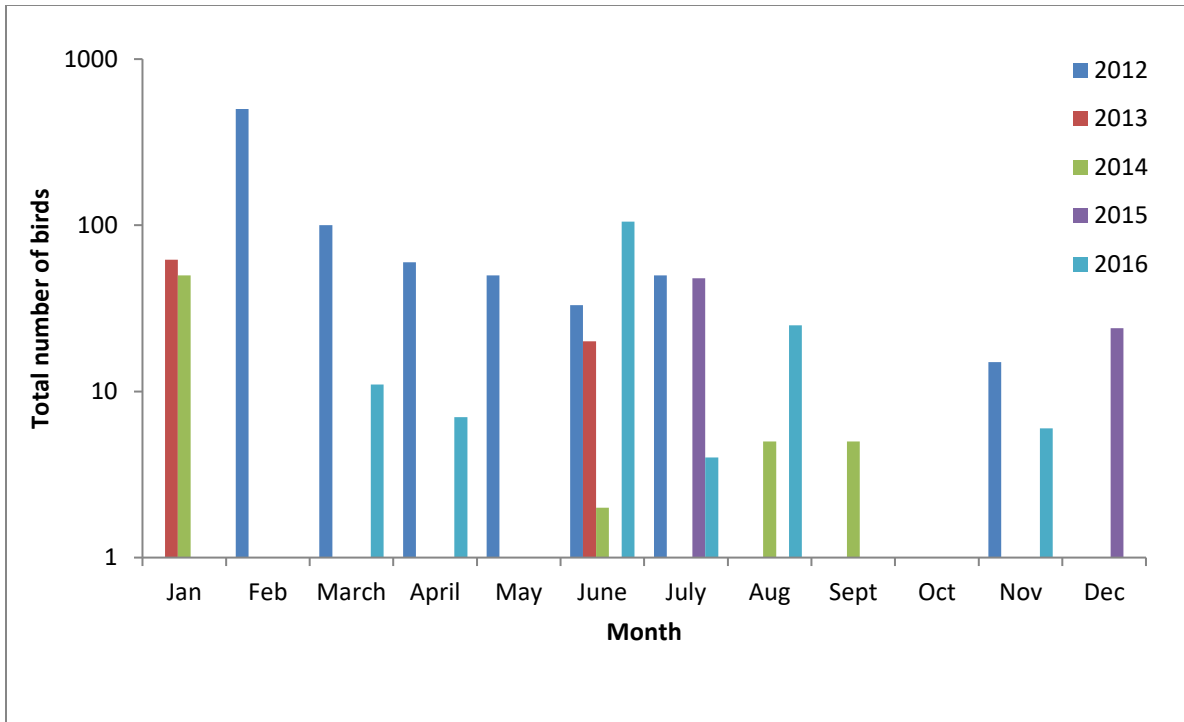


Figure 65 - Monthly variation in Indian Cormorant count from 2012–2016

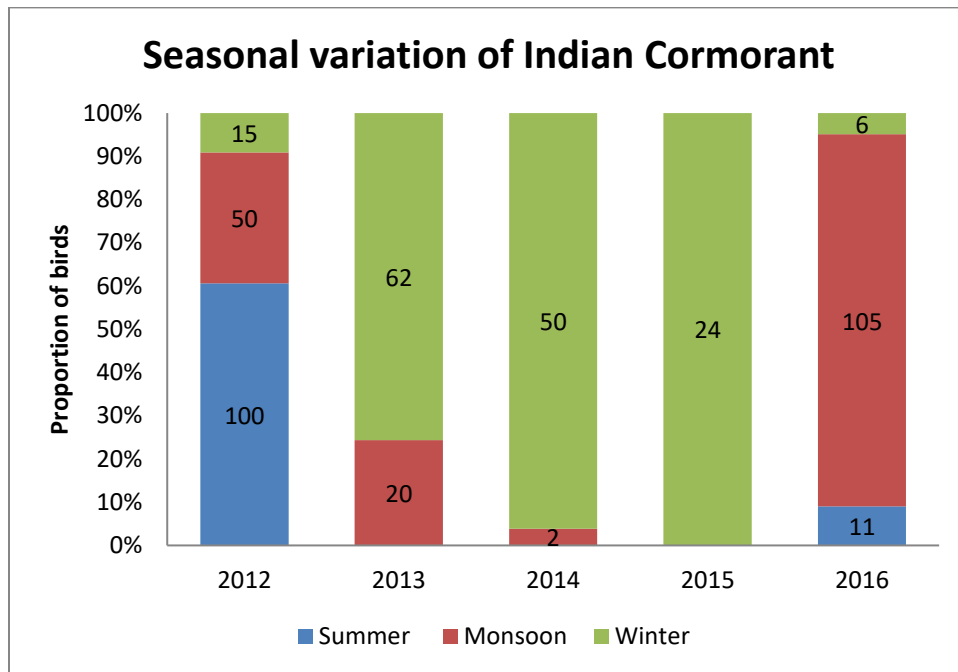


Figure 66 - Proportion of seasonal variation in Indian Cormorant count from 2012–2016

2. Little Cormorant *Microcarbo niger*

It is a resident bird and occurs from Indian and Indochinese Sub region to Java (BirdLife International 2014). It is distributed throughout the Indian subcontinent except the Himalaya (Ali and Ripley 1983). It typically breeds in trees or bushes in flooded areas. Food comprises mainly small freshwater fish, frogs and tadpoles. It feeds by diving and sometimes it fishes cooperatively. Breeding season is very variable, depending on the region, but mainly during June-August (Del Hoyo et. al. 1992). It was commonly seen in Mumbai in the 1980s (Abdulali 1981) and continues to be spotted. It is a fairly common resident and a local migrant with breeding records from November to February and April to September (Prasad 2003), common all over Mumbai (Monga 2003) and frequently sighted at open water bodies at Mahul (Verma et al. 2001–02).

We observed Little Cormorant throughout the year at all the wetlands, mangroves and creeks in the study area. We observed this species either feeding on fishes or resting on the edges of wetland and in mangroves. The count fluctuated throughout the years and around hundred birds were observed resting at proposed NMIA site, usually in winter and summer. They were found mostly basking in groups of 30–40 birds in the NMIA area. Our team observed this species well distributed in all the wetlands during winter but in, congregating at Panvel and Kharghar creek area. Please see figure 67 and 68, showing monthly variation in count of Little Cormorant from 2012–2016.



Image 18 - Little Cormorant at Panje-Funde wetland

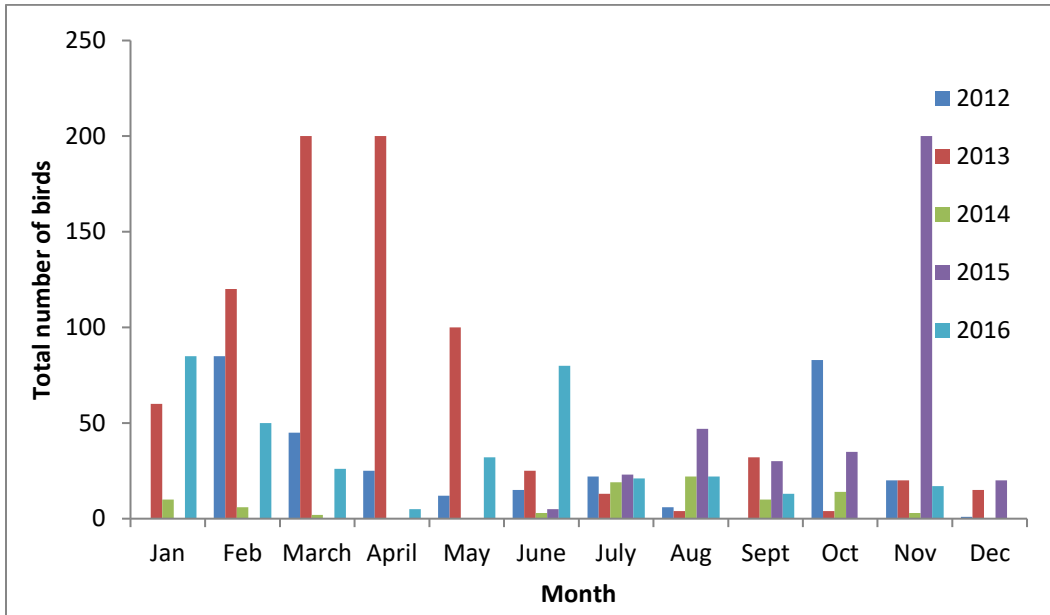


Figure 67 - Monthly variation in Little Cormorant count from 2012–2016

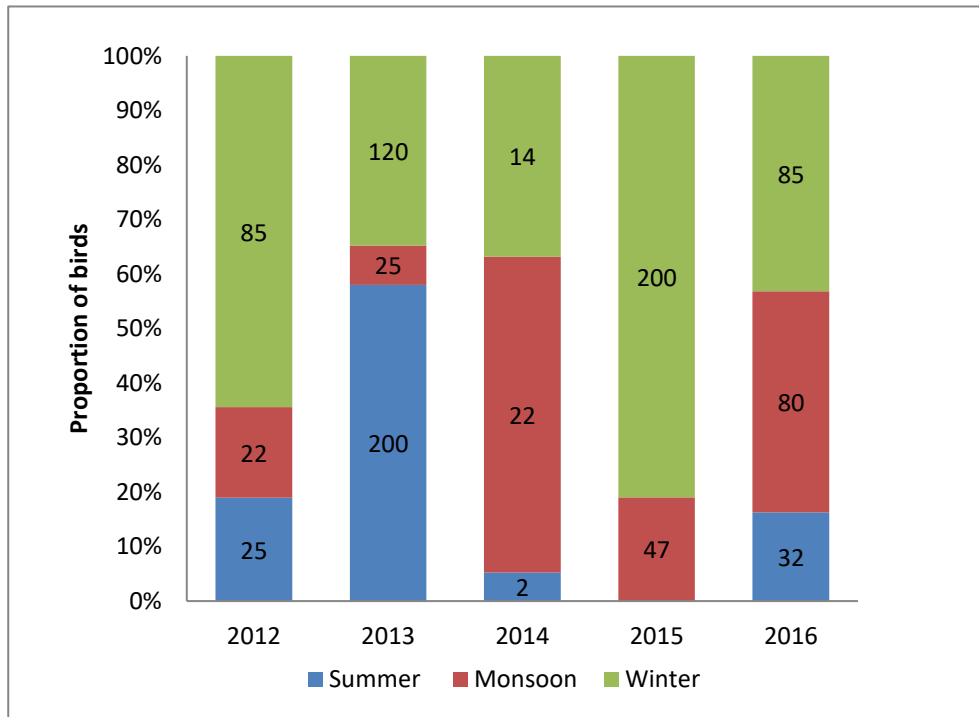


Figure 68 - Proportion of seasonal variation in Little Cormorant count from 2012–2016

3. Eastern Cattle Egret *Bubulcus coromandus*

This species is known to disperse long distances in search of food depending on the rains (del Hoyo et al. 1992). This species is known to breed throughout the year in tropical regions and has different peaks in different regions (del Hoyo et al. 1992). The peaks in breeding are dependent on food availability (Kushlan and Hancock 2005). In the non-breeding season this species is seen to be social (Brown et al. 1982, del Hoyo et al. 1992) and can be seen feeding in flocks of 10–20 individuals (Brown et al. 1982) or in large numbers of hundreds or thousands in areas where food is in abundance (del Hoyo et al. 1992). This species is generally seen with grazing animals and livestock (Kushlan and Hancock 2005). Eastern Cattle Egret is generally seen in grasslands, livestock pastures, marshes and mangroves; it is also occasionally seen in saline or coastal areas (Kushlan and Hancock 2005, del Hoyo et al. 1992). Eastern Cattle Egret generally feeds on invertebrates such as insects such as locusts, grasshoppers (del Hoyo et al. 1992, Kushlan 1984, Hancock and Kushlan 1984). It is also known to feed on frogs, tadpoles, molluscs, fish, lizards, small birds, rodents and vegetable occasionally (del Hoyo et al. 1992).

It has been seen usually in small flocks all over Mumbai and adjoining areas (Abdulali 1981, Monga 2003) in flooded agricultural fields, wetlands and marshes. Verma et al. (2002) reported it from Mahul. During the surveys we observed this species as very common and everywhere distributed in the study area. Please see Figure 69 and 70, showing monthly variation in Eastern Cattle Egret count from 2012–2016.



Image 19- Eastern Cattle Egret seen at garbage dumps along Kharghar creek

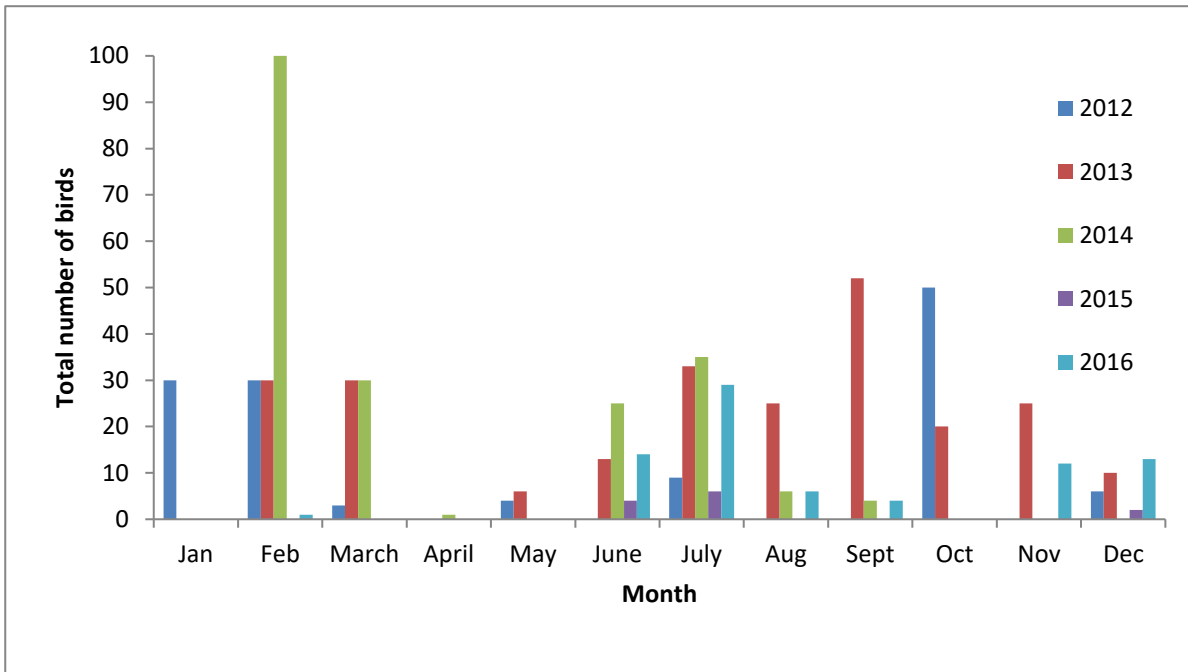


Figure 69 - Monthly variation in Eastern Cattle Egret count from 2012–2016

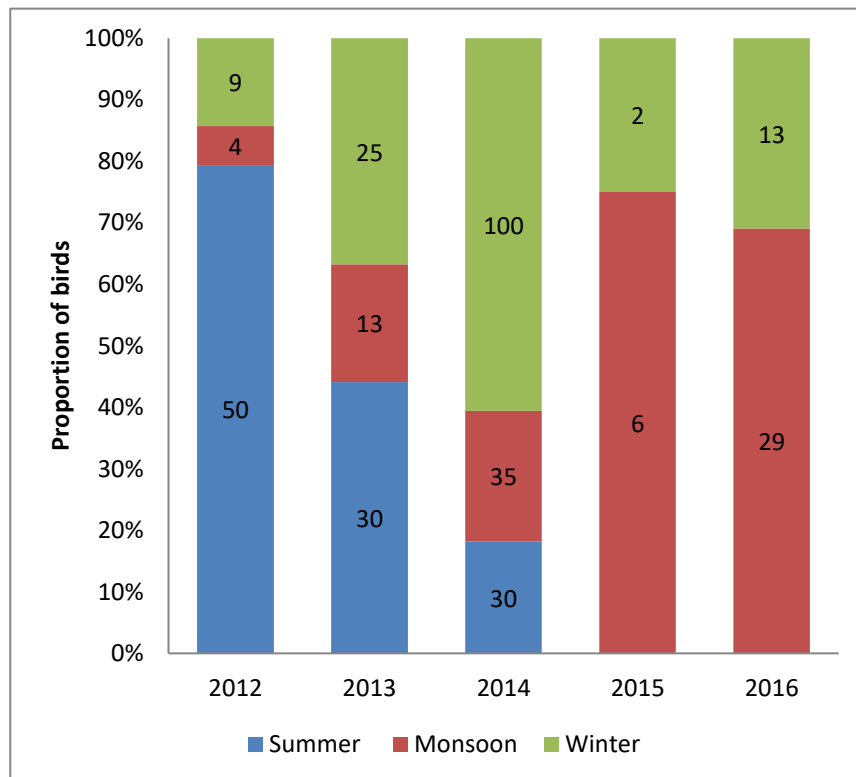


Figure 70 - Proportion of seasonal variation in Eastern Cattle Egret count from 2012–2016

4. Eurasian Spoonbill *Platalea leucorodia*

This species is found to be resident and is found from South Spain, Holland and South East Europe to Central & Eastern Asia, Persian Gulf, Sri Lanka, West East Africa and South East China (BirdLife International 2014). In India it occurs throughout the plains and it is partly resident and nomadic (Ali & Ripley 1983). The breeding population in Euro–Siberian region is migratory (del Hoyo et al. 1992) but the migration might be restricted to short distances (Snow and Perrins 1998). The rest of the count of this species is found to be resident and nomadic (del Hoyo et al. 1992). It is generally found in shallow muddy wetlands and avoids wetlands with rocky bottoms, vegetation or rapid currents (Hancock et al. 1992). It generally feeds on adult and larval insects, mollusks, crustaceans, worms, tadpoles and small fish (del Hoyo et al. 1992, Hancock et al. 1992).

This species is a flocking species and has been reported as occasional and local migrant (Abdulali 1981). Eurasian Spoonbill is an uncommon resident, and breeding was observed in Deccan Maharashtra between January and May (Prasad 2003). This species can also be seen in mixed flocks Painted Storks *Mycteria leucocephala* (Sarkar 2008).

We observed this species mostly feeding while walking and sweeping a partly open beak from side to side and sometimes resting. They were often observed in compact flocks of 30–40 individuals at Belpada. This species was present during winter and summer in the study area but only a few individuals were seen during monsoon. We regularly observed the individuals roosting and feeding in flocks of hundreds. During winter, 200–250 individuals were observed at Belpada and later in summer no individuals were observed as there was no water in the lake. In summer these birds shifted to the NRI Lake, TSC wetland and wetlands at NMIA site. Please see Figure 71 and 72, showing monthly variation in Eurasian Spoonbill count from 2012–2016.



Image 20 - Eurasian Spoonbill seen foraging in Belpada wetland

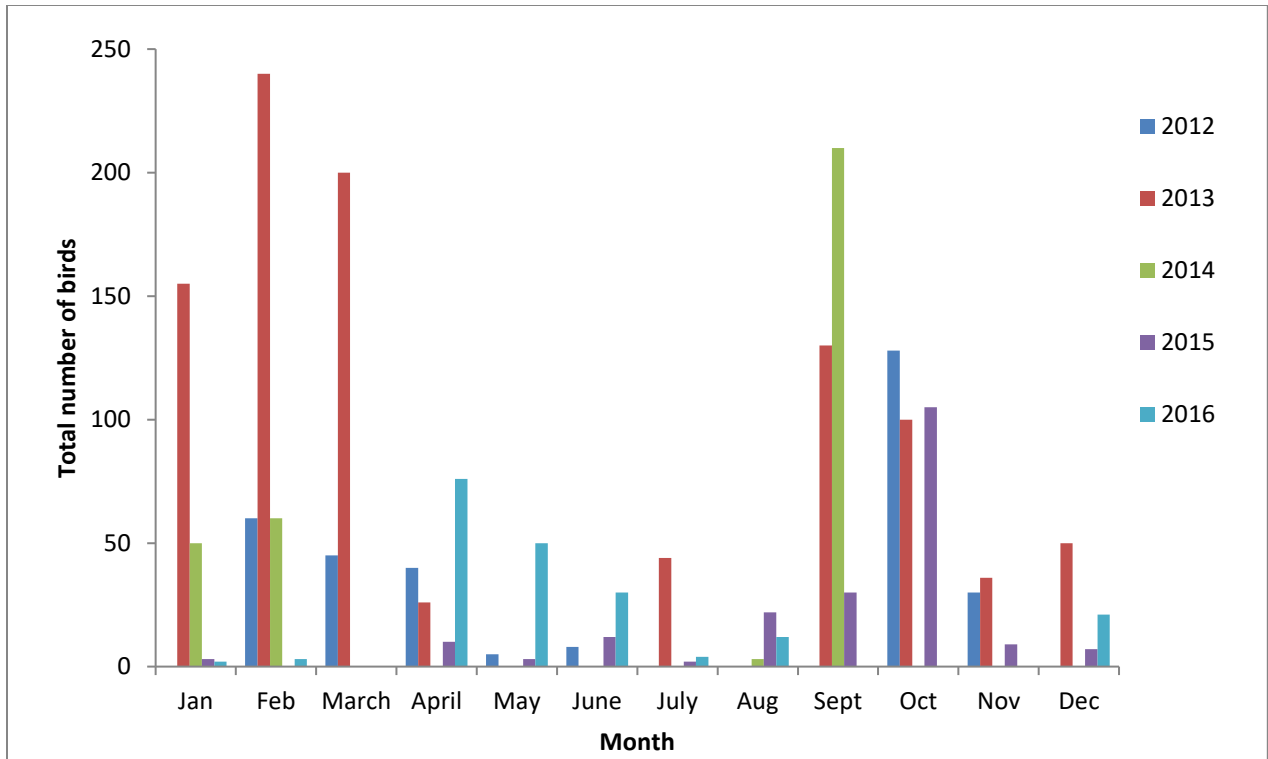


Figure 71 - Monthly variation in Eurasian Spoonbill count from 2012–2016

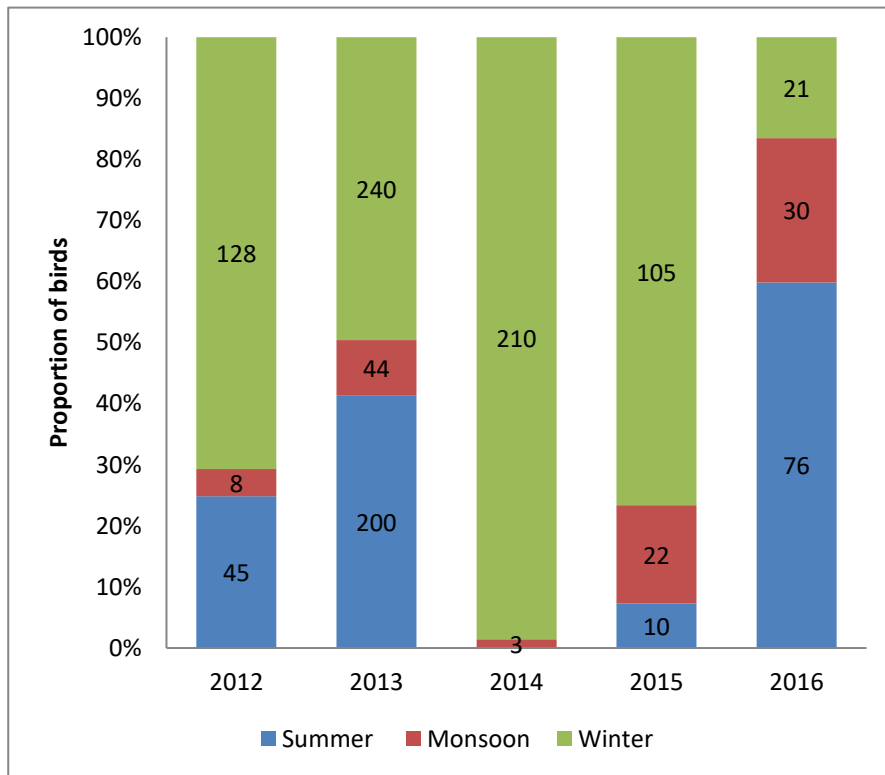


Figure 72 - Proportion of seasonal variation in Eurasian Spoonbill count from 2012–2016

5. Northern Pintail *Anas acuta*

Northern Pintail is a winter migrant and is found in Nearctic (North America, Greenland, Mexico) and Palearctic (Euro–Siberian) regions. It generally breeds from July to August (Scott and Rose 1996) after which it moves southwards for wintering (Madge and Burn 1988, Scott and Rose 1996). This species is seen to be highly gregarious in winter and are found to form large flocks during migration (Madge and Burn 1988, Scott and Rose 1996). The flock size generally depends on the wetland (Snow and Perrins 1998) and it generally tends to inhabit large inland lakes in winters (Scott and Rose 1996). This species is an omnivore (del Hoyo et al. 1992) and an opportunistic feeder (Johnsgard 1978).

The Northern Pintail was found in flocks (Abdulali 1981) and was recorded by Prasad (2003) in Borivali which is a northern suburb of Mumbai. It was reported in small numbers in Mumbai (Abdulali & Ali 1981) and mostly observed in salt–pans and open water bodies at Mahul (Verma et. al. 2001–02).

The Northern Pintail is a predominant winter visitor. In the study area, they arrived in October and subsequently their numbers increased in the later months.. Post February, the count declined as the birds started migrating back to the breeding grounds and we did not observe any individuals from April to September. Nearly 1300 individuals were observed at NRI in November 2016. Please see Figure 73 and 74 showing monthly variation in count of Northern Pintail from 2012–2016.



Image 21 - Northern Pintail in NRI wetland

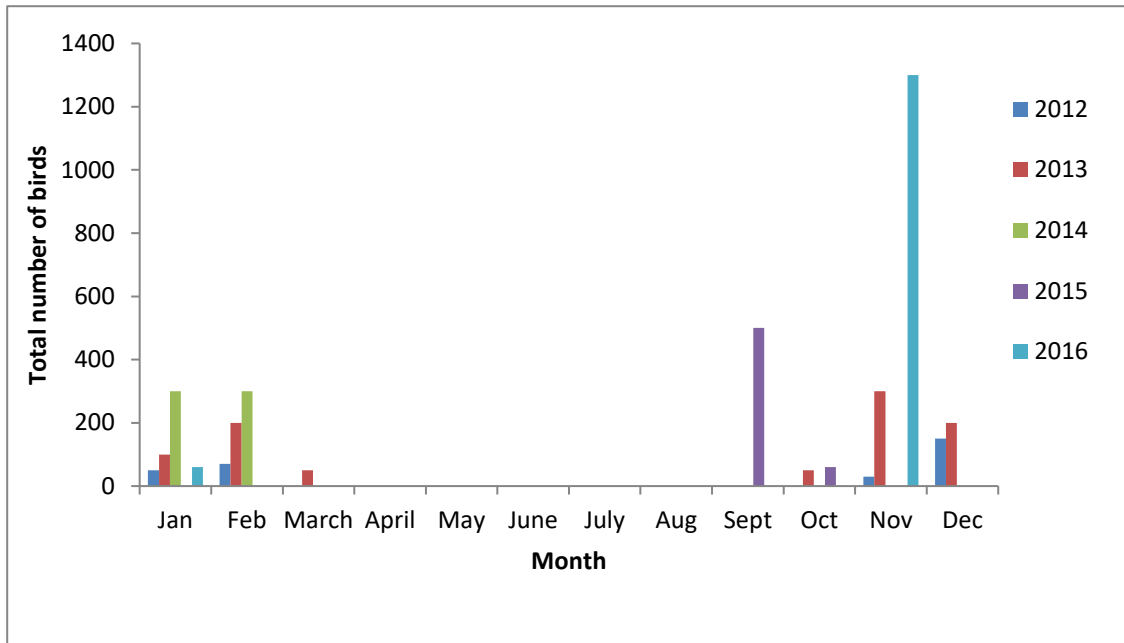


Figure 73 - Monthly variation in Northern Pintail count from 2012–2016

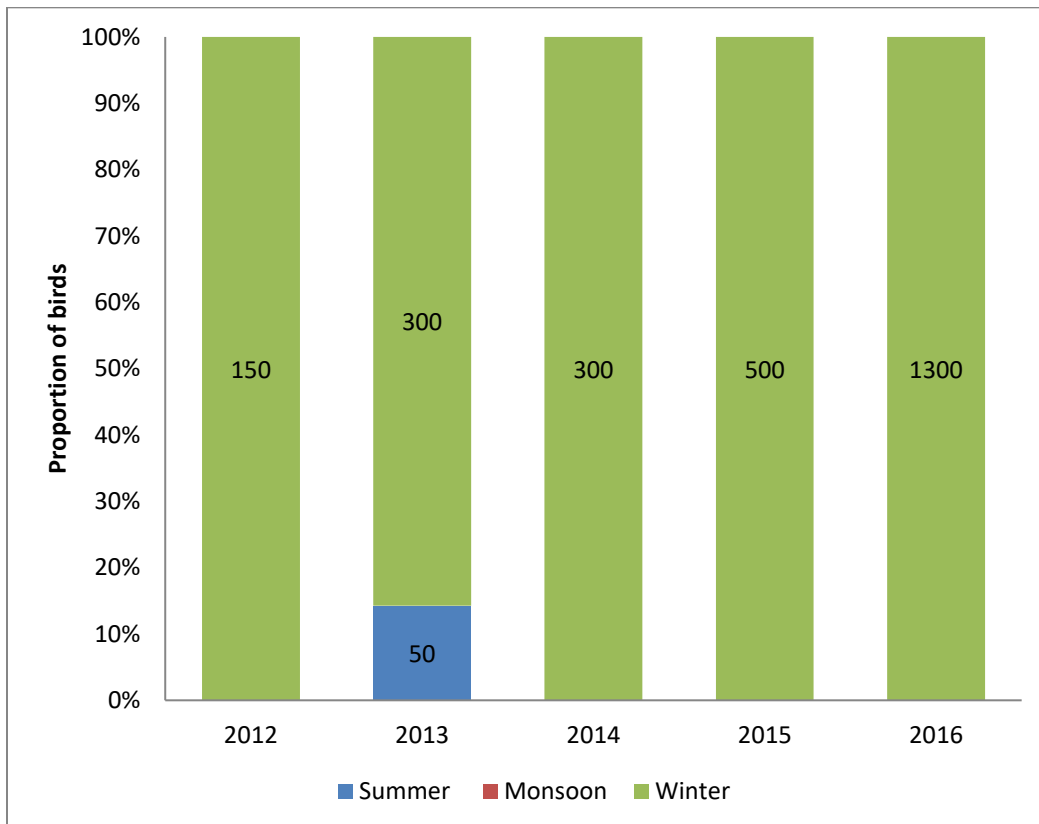


Figure 74 - Proportion of seasonal variation in Northern Pintail count from 2012–2016

6. Common Teal *Anas crecca*

It is a winter migrant species and is seen throughout India (Ali & Ripley 1983). This species is found in most of North and Central Palearctic (Euro–Siberian) region (BirdLife International 2014). It breeds May onwards and the migration towards the wintering grounds is between October and November while their return back generally begins from late February (Scott and Rose 1996). This species tends to form large concentrations in winters; large flocks of 30–40 and sometimes hundreds of individuals can be observed at winter roosting sites (Madge and Burn 1988). This species generally inhabits marshes and lakes, habitats with high productivity and abundant vegetation (Brown et al.1982, Kear 2005b). It is also observed in artificial reservoirs (Snow and Perrins 1998). The diet of this species generally contains seeds of aquatic plants (del Hoyo et al. 1992) grasses and agricultural grain (del Hoyo et al. 1992).

Common Teal is a flocking species (Abdulali, 1981) and is seen throughout western Maharashtra and its adjoining areas (Prasad 2003). In Mahul it was mainly observed in salt–pans and open water bodies (Verma et. al. 2001–02).

We observed this species in winter in the study area and they were restricted only to Belpada Lake and NRI Lake. These birds started arriving in the study area during December and we counted around 100 individuals each at NRI Lake and Belpada Lake. In the later months there was a gradual increase in the count. In January, the flock from NRI Lake moved to the Belpada Lake and therefore we counted 300 individuals at the Belpada Lake. In summer the count declined as the birds started migrating back to the breeding grounds and we did not observe any individuals from April to November. In November 2016, 600 individuals were observed at NRI wetland. Please see Figure 75 and 76, showing monthly variation in the count of Common Teal from 2012–2016.



Image 22- Common Teal at Belpada wetland

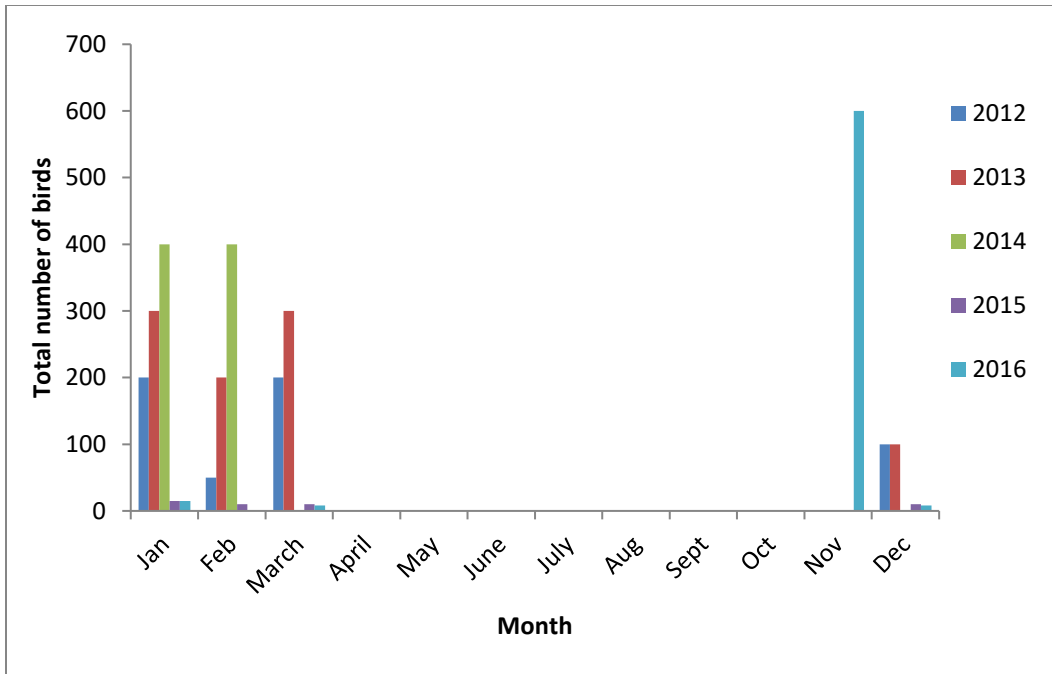


Figure 75 - Monthly variation in Common Teal count from 2012–2016

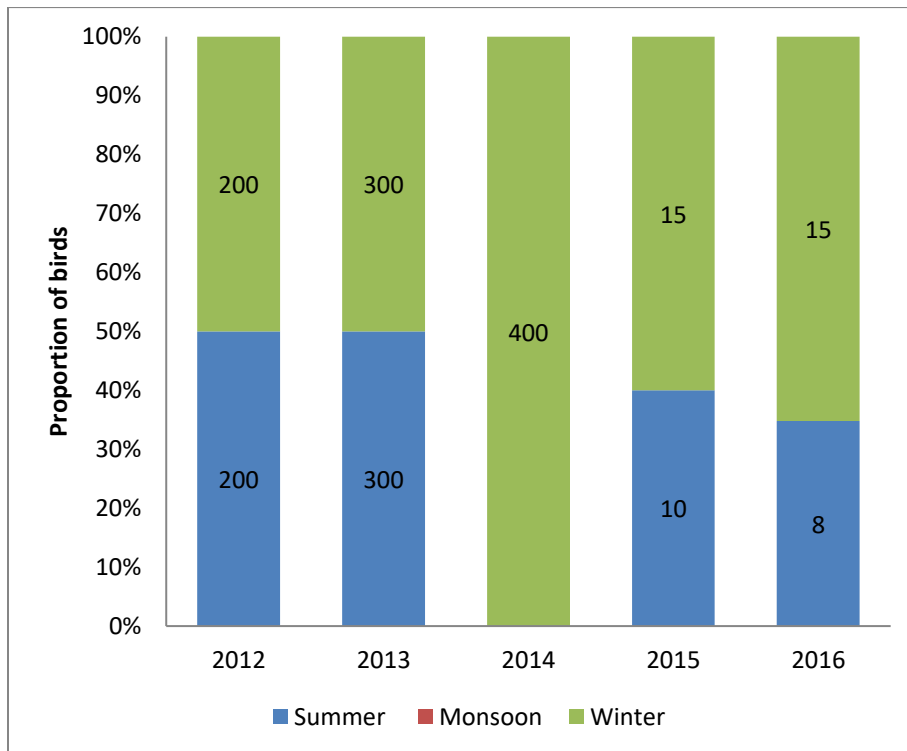


Figure 76 - Proportion of seasonal variation in Common Teal count from 2012–2016

7. Northern Shoveler *Spatula clypeata*

Northern Shoveler is found in most of Nearctic (North America, Greenland and Mexico), Palearctic (Euro–Siberian) regions (BirdLife International). It is a winter migrant and found all over India (Ali & Ripley 1983). This species forages diurnally and roosts communally at night (Brown et al. 1982). Northern Shoveler can generally be found in well–vegetated lakes and marshes which have muddy shores and substrates (Madge and Burn 1988, del Hoyo et al. 1992, Kear 2005, Johnsgard 1978, Brown et al. 1982). It can also be observed in artificial waters (Snow and Perrins 1998), tidal mudflats (del Hoyo et al. 1992, Kear 2005b), and estuaries (Madge and Burn 1988). Its diet mainly consists of aquatic invertebrates such as adult and larval insects (del Hoyo et al. 1992, Johnsgard 1978, Brown et al. 1982).

This species has been reported as a flocking species (Abdulali 1981) but was recorded in very small numbers around Mumbai during 2000–02 (Prasad 2003). However, this species is seen regularly near the wetlands in Uran (Sarkar 2011).

We observed this duck species in Belpada Lake and NRI Lake during October to March. These birds started arriving in the October. In January the flock moved from NRI Lake to the Belpada Lake and we counted around 150 individuals resting and foraging along with the other duck species at Belpada Lake. Over 1500 individuals were spotted at NRI wetland in November 2016. In summer, the count started declining as the birds started migrating back to the breeding grounds and we did not observe any individuals from April to September in the study area. Please see figure 77 and 78 showing monthly variation in Black–headed Ibis count from 2012–2016.

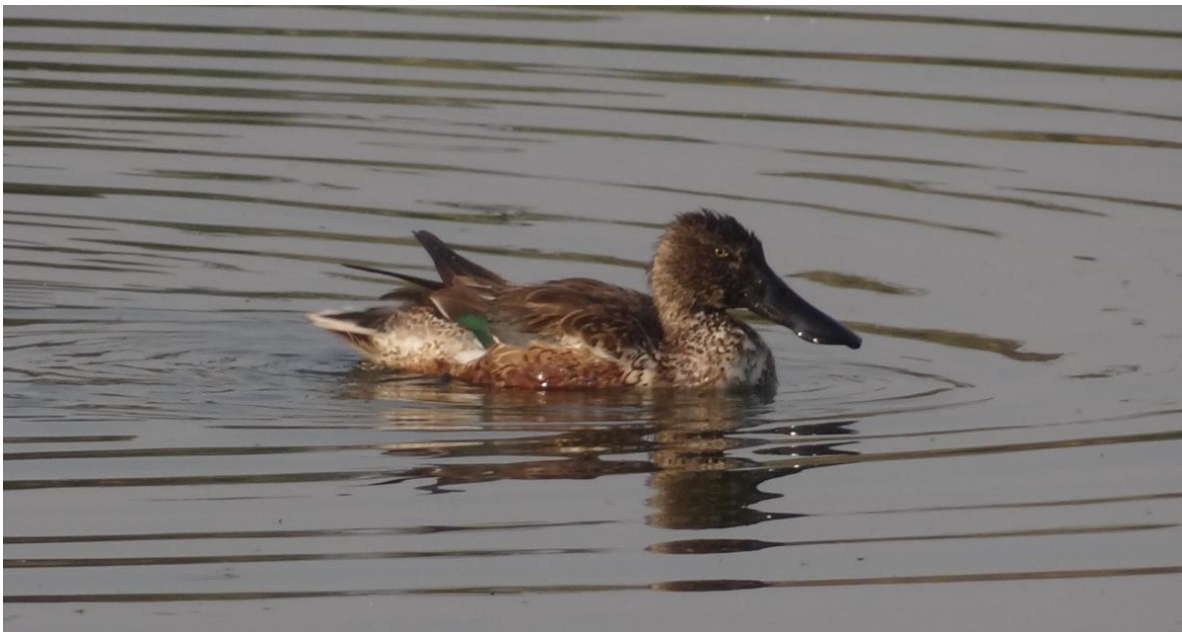


Image 23- Northern Shoveler at NRI wetland

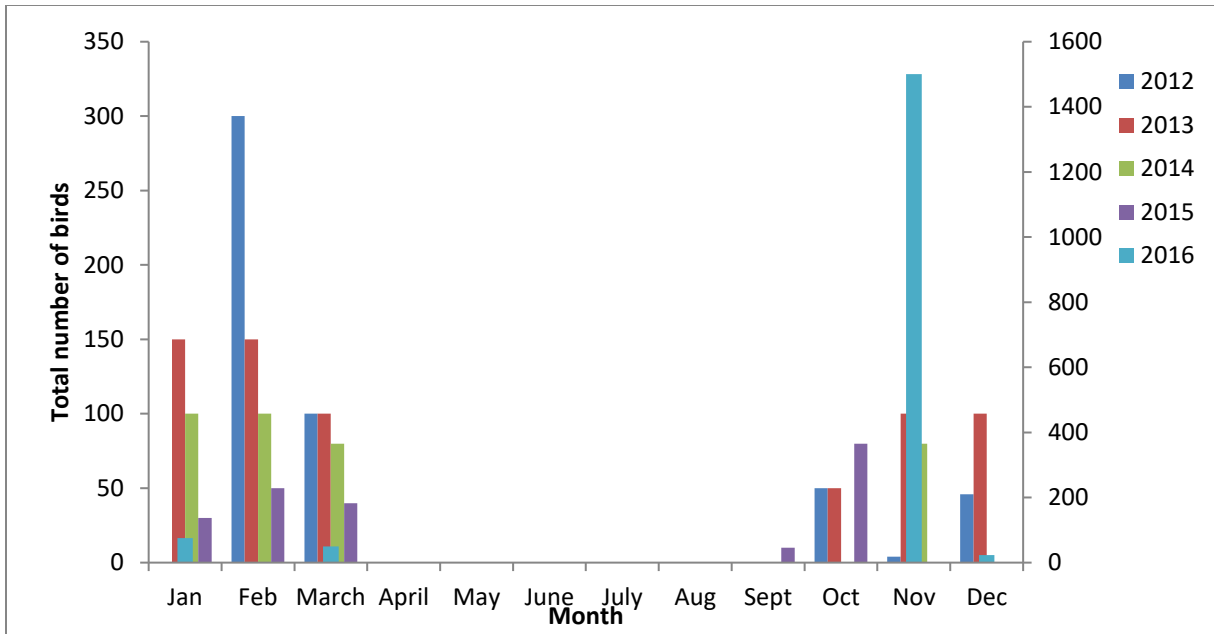


Figure 77 - Monthly variation in Northern Shoveler count from 2012–2016

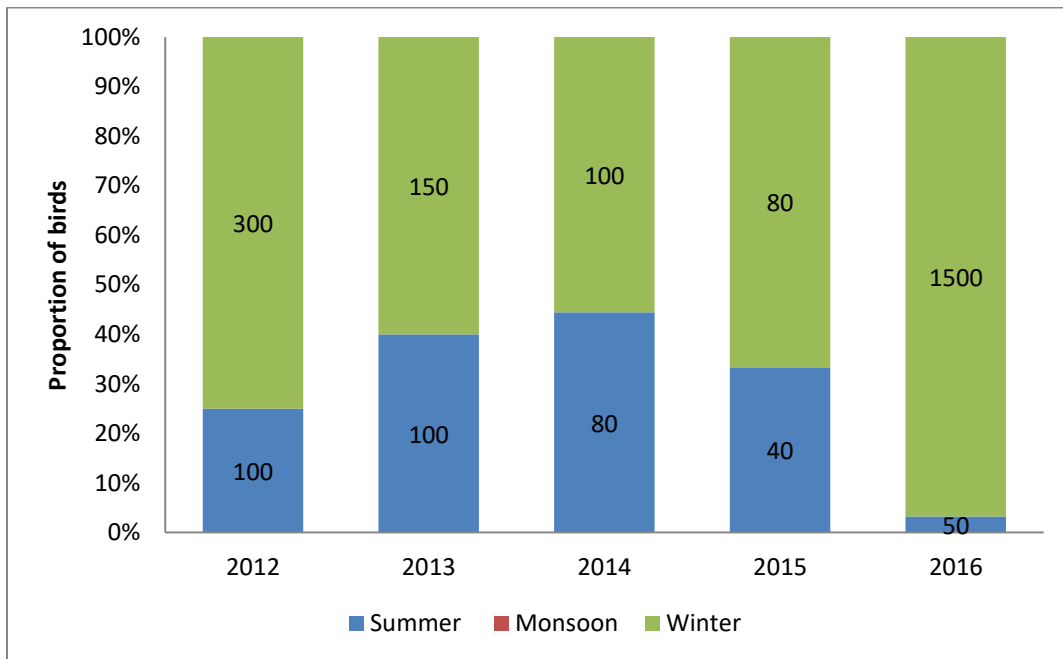


Figure 78 - Proportion of seasonal variation in Northern Shoveler count from 2012–2016

8. Eurasian Coot *Fulica atra*

This species is found in Europe, North Africa, and Central Asia to Japan and South to Indian Sub-continent and Sri Lanka, and is a local migrant. The wintering range of this species is South to West and North-East Africa, South-East Asia and Philippines (del Hoyo et al. 1996). It is found through India in the winter season (Ali & Ripley 1983). It is observed that most of the count in warm and temperate regions are resident and often make nomadic dispersive movements with respect to water levels and rainy season (Urban et al. 1986, del Hoyo et al. 1996). The Southward movement generally occurs during mid-August to November (Taylor and van Perlo 1998), while the return passage occurs from late February (Taylor and van Perlo 1998) to May (del Hoyo et al. 1996). Shallow waters with adjacent deeper water (Taylor and van Perlo 1998) and muddy substrates, marginal, emergent, floating or submerging vegetation is preferred by this species. This species is considered as omnivorous but mainly feeds on vegetable matter (del Hoyo et al. 1996).

Abdulali (1981) mentioned it as an occasional migrant and flocking species; breeding records are recorded from Mahalaxmi, Mumbai from July to December (Prasad 2003).

We observed this species mainly at Belpada wetland and only a few individuals were sighted at NRI Lake of Palm Beach Road. We observed an increasing trend in the count from the July to January. In July only 3 individuals were observed at NRI Lake but later in August, 10 individuals were seen and this count increased to 170 individuals in January. There were no birds from February to June as the birds migrate locally for breeding. We observed few juveniles along with adults during August and September. Please see figure 79 and 80, showing monthly variation in count of Eurasian Coot from 2012–2016.



Image 24 - Eurasian Coot at Belpada wetland

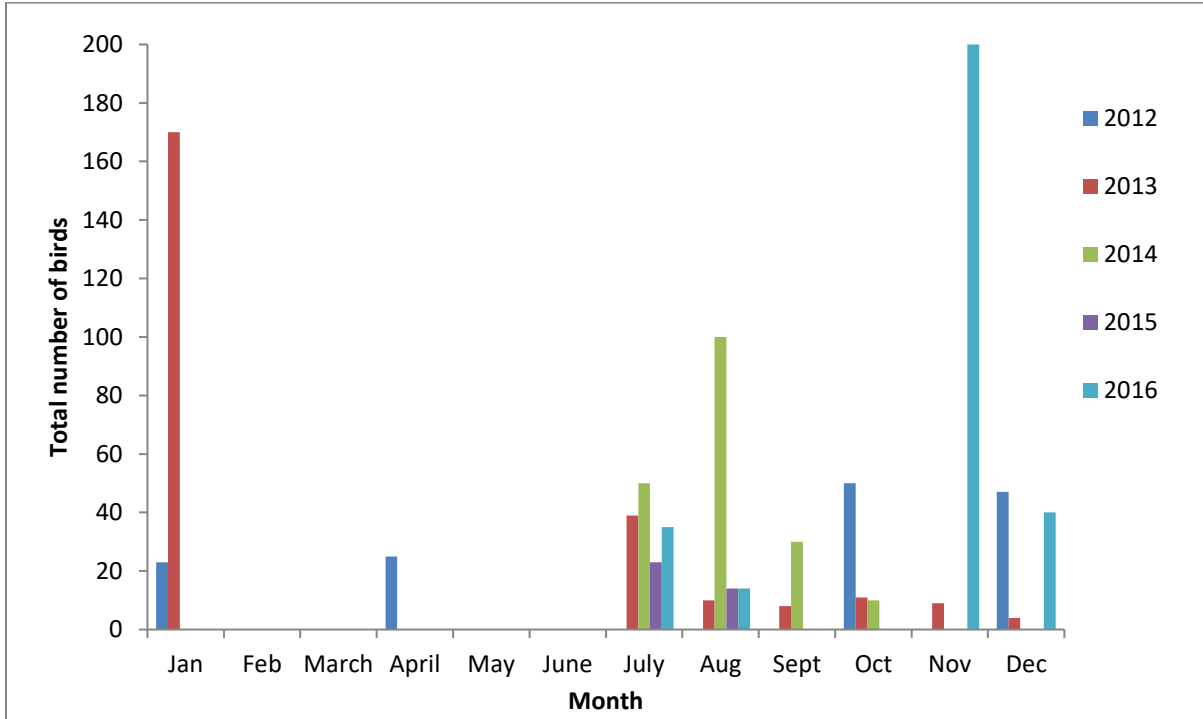


Figure 79 - Monthly variation in Common Coot count from 2012–2016

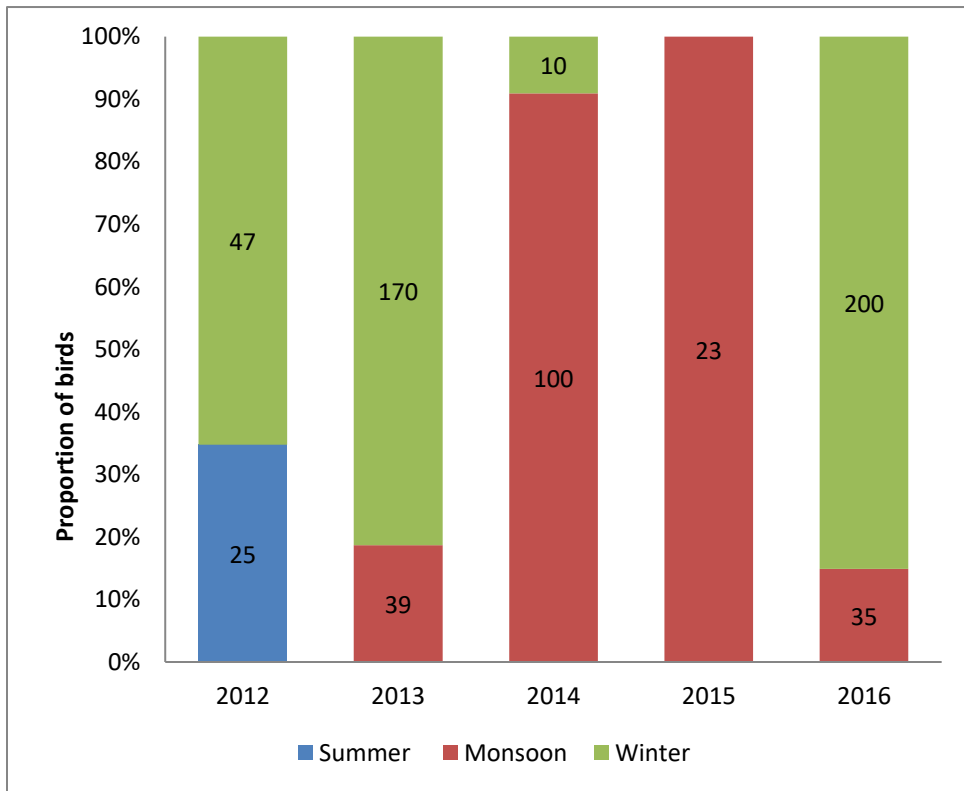


Figure 80 - Proportion of seasonal variation in Northern Shoveler count from 2012–2016

9. Lesser Sand Plover *Charadrius mongolus*

They are a migratory species distributed from Central Asia and Siberia wintering in South–East Africa to India. Subspecies *Charadrius mongolus atrifrons* Wagler 1829 is found in the Himalaya and Southern Tibet. It arrives in India, South Arabia and East Africa from August to mid–September from its breeding grounds in central Siberia (del Hoyo et al. 1996). Within Indian limits, it is a common winter visitor to coastal India (Ali & Ripley 1983) and breeds in the higher regions of the Himalaya.

Previously it was reported as stray or vagrant (Abdulali 1981) but recently it has been recorded as a common winter visitor along the coast and rare inland wetlands (Prasad 2003). The earliest migration was recorded in August by Stairmand in 1969 and in March by Ali & Abdulali in 1939. Regular sightings were recorded from Sewri mudflats on the eastern coast of Mumbai (Woodward 2007) and at Mahul Creek (Verma et. al. 2001–02).

We observed this species is very common in our study area and they were often seen resting in inland water bodies during high tide and flying towards seashore for foraging during low tide. This species was observed arriving in the study area during October. A count of 10,000 individuals was observed for a week at the wetland behind TSC in October but later a stable count of 1500–2500 individuals was seen at wetlands behind NRI, TSC and adjoining seashore areas of the study area. Thus we assume that some of the birds use this study area as a stopover site. Please see figure 81 and 82, showing monthly variation in count of Lesser Sandplover from 2012–2016.



Image 25 - Lesser Sandplover in flight at TSC wetland

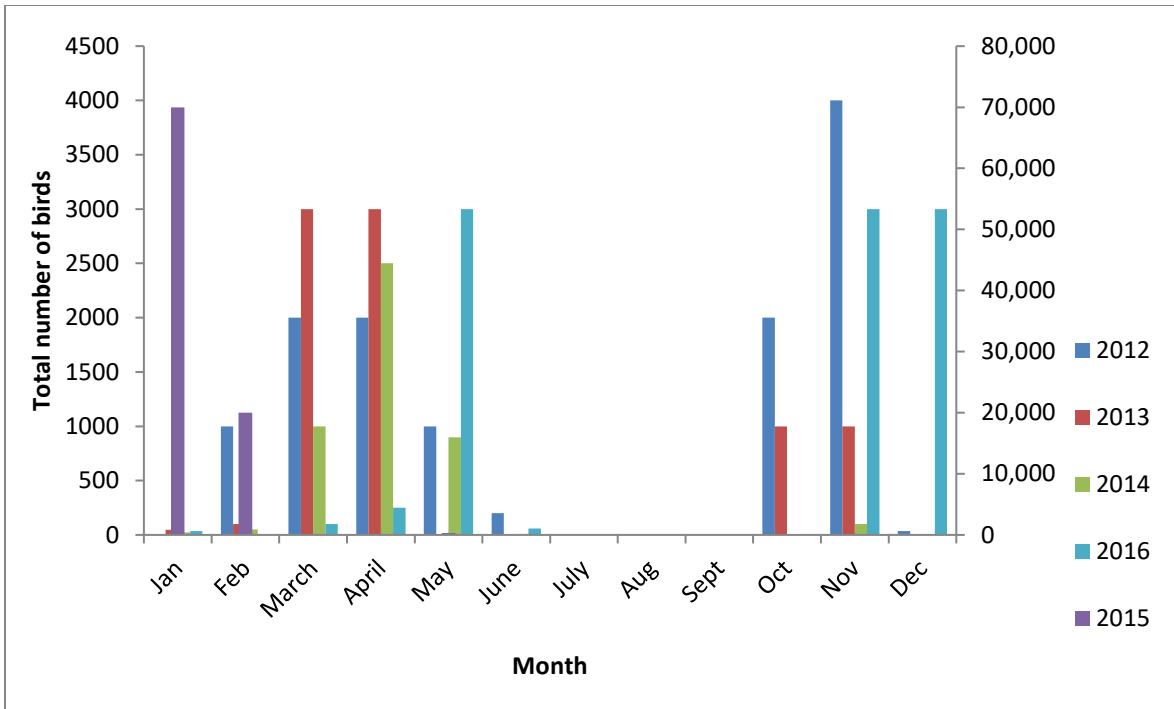


Figure 81 - Monthly variation in Lesser Sand Plover count from 2012–2016

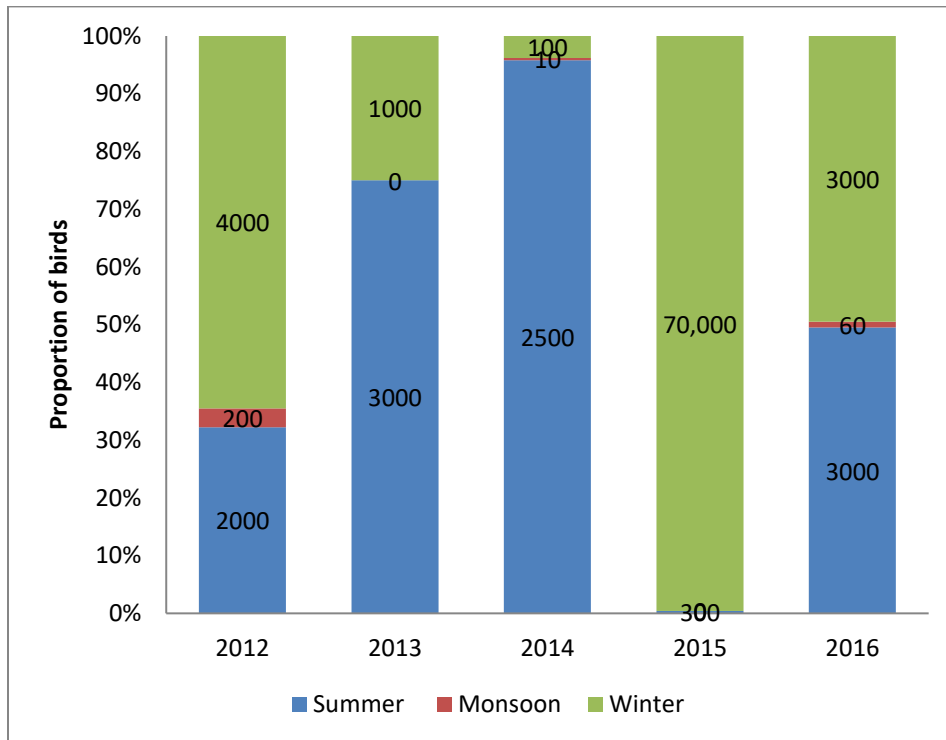


Figure 82 - Proportion of seasonal variation in Lesser Sand Plover count from 2012–2016

10. Common Redshank *Tringa tetanus*

It is a winter visitor to India and is present throughout except in Andaman and Nicobar Islands (Ali & Ripley 1983). The breeding period of the Common Redshank is from March to August (Hayman et. al. 1986) and they arrive in wintering grounds from June to October. It forages singly or in small groups (del Hoyo et. al. 1996) or occasionally in larger flocks of up to 300 individuals, especially at roosting sites. It is often seen in varied habitats such as coastal areas, rocky, muddy and sandy beaches, mangroves, salt marshes and tidal mudflats. It was reported as a congregatory species (Abdulali 1981), more common along the west coastline (Prasad 2003). The earliest date of its arrival was recorded to be July 29, and the departure record is May 25, 1939 in Mumbai (Ali & Abdulali 1939) and it was observed in marshes, salt pans and creeks at Mahul.

We observed Common Redshank at all the wetland areas with changing count depending on water level in particular wetlands in different seasons. This species was usually seen foraging as a solitary bird or in a closed group of about 5–10 birds each, and sometimes seen roosting in a group of 100 to 200 birds. These birds were observed from September to May and were seen not restricted to any specific wetland. They were observed foraging and resting in creek, inland wetland, mangroves and mudflats all over the study area. A count of 150–200 individuals was seen resting in mangroves of Kharghar Creek as well as Panvel Creek in early winter season. Please see figure 83 and 84, showing monthly variation in count of Common Redshank from 2012–2016.



Image 26- Common Redshank seen during low tide in Panvel creek

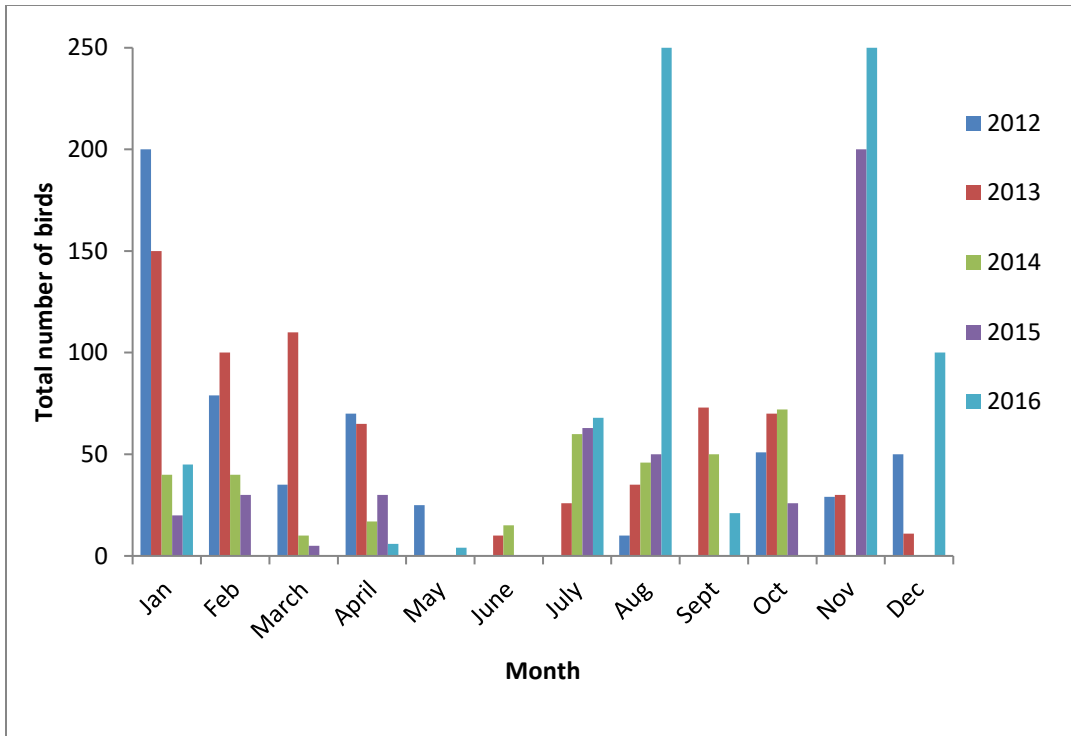


Figure 83 - Monthly variation in Common Redshank count from 2012–2016

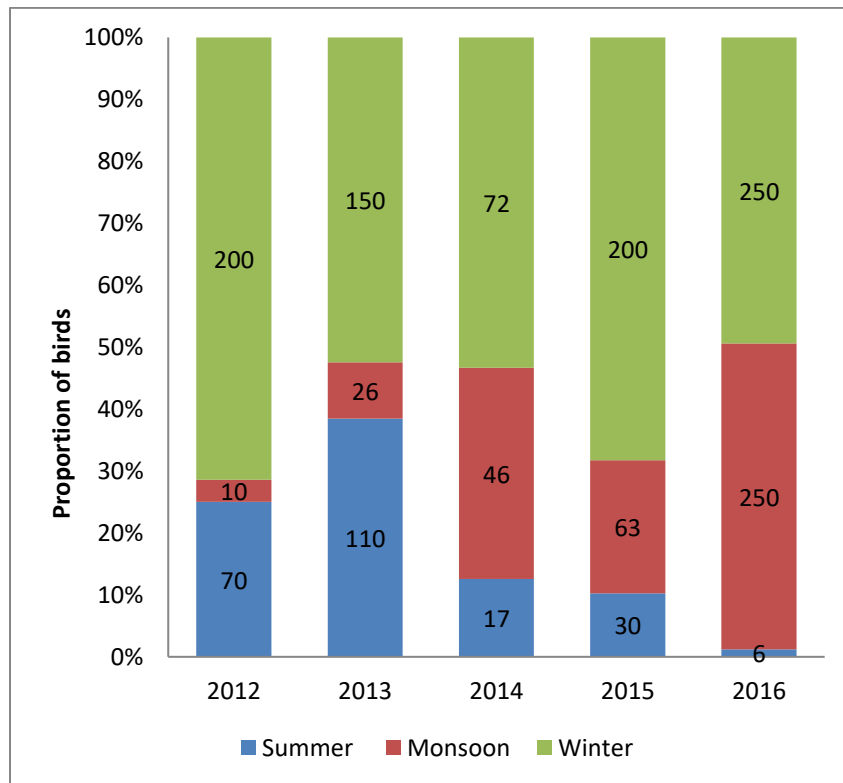


Figure 84 - Proportion of seasonal variation in Common Redshank count from 2012–2016

11. Little Stint *Ereunetes minuta*

It is a winter visitor and occurs from Northern Europe and North-West and North-Central Siberia to New Siberian region, wintering from Mediterranean and Africa through Arabian Peninsula and Persian Gulf, East to the Indian Subcontinent and Myanmar (BirdLife International 2014). Its range covers the coastal region of entire Indian subcontinent (Ali & Ripley 1983). It moves to wintering grounds between July and November and return migration occurs between mid-May to early-June (del Hoyo et al. 1996) for breeding. This species is highly sociable in winter (Snow and Perrins 1998) and occurs in small groups culminating in larger groups at high tide roosts at night (Urban et al. 1986, Hockey et al. 2005). The diet of this species consists chiefly of invertebrates (del Hoyo et al. 1996, Snow and Perrins 1998).

The Little Stint has been reported as a congregatory species in Mumbai (Abdulali 1981). It has been sporadic in southern Maharashtra on the coast (Prasad 2003) and was seen in the marshes, salt pans and creeks at Mahul (Verma et. al. 2001–02).

It is a common flocking species of the study area and we often observed it in a mixed group of other small waders. We observed it foraging on the seashore during the low tide and returning back to the inland water bodies during the high tide for resting. We observed two peaks in count, one during arrival and other during departure period of migration at TSC wetland which serves as a stopover site. Please see figure 85 and 86, showing monthly variation in count of Little Stint from 2012–2016.



Image 27 - Congregation of Little Stint at TSC wetland

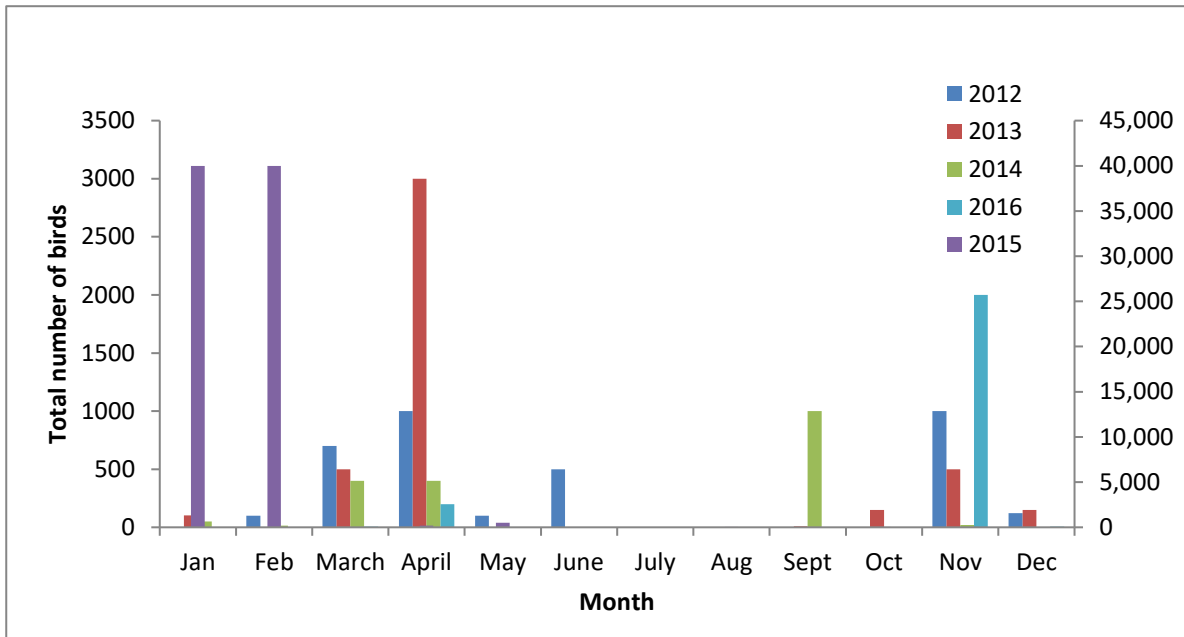


Figure 85 - Monthly variation in Little Stint count from 2012–2016

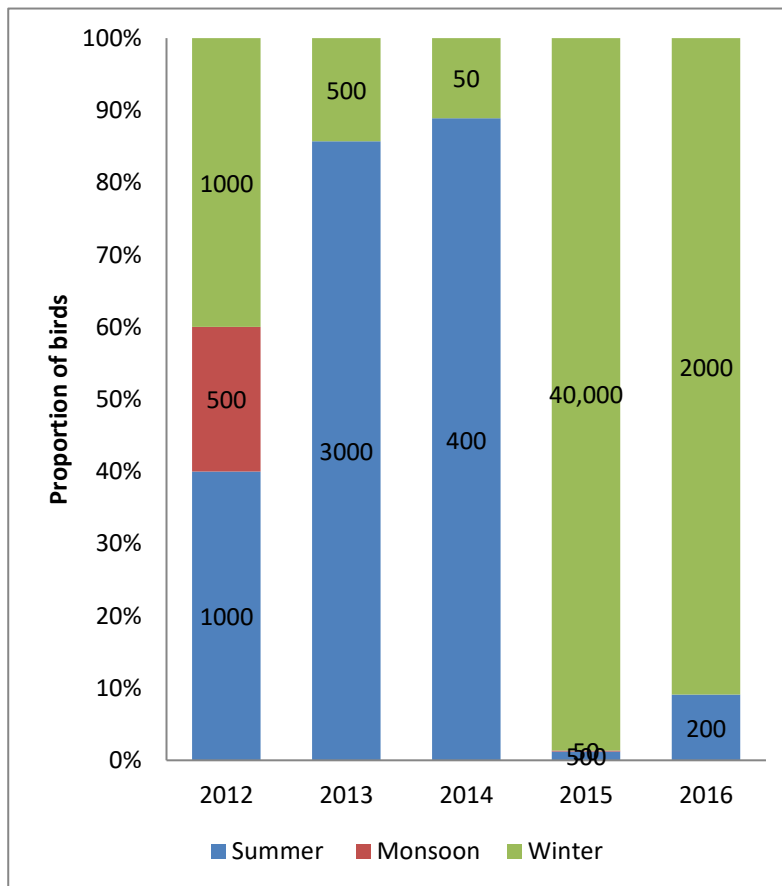


Figure 86 - Proportion of seasonal variation in Little Stint count from 2012–2016

12. Pied Avocet *Recurvirostra avosetta*

Pied Avocets are winter migrants occurring from Europe through West and Central Asia to South-East Siberia and North-East China, and locally through North Africa to East-South Africa; it winters from West Europe and Africa through Middle East. The northern population migrate south between August and October and return to the breeding grounds between March and May. They breed regularly or sporadically in North Baluchistan and Kutch. They are common winter visitors in north-west India, less common, sporadic, or occasional in the rest of India including coastal Maharashtra (Ali & Ripley 1983). Foraging happens in groups of 5–30 individuals (Urban et al. 1986) and they roost in large flocks of several thousand individuals (Hayman et al. 1986). They predominantly feed on aquatic invertebrates 4–15 cm long (del Hoyo et al. 1996) and plant matter (Urban et al. 1986).

In Mumbai they were previously reported as an occasional winter migrant (Abdulali 1981). Across time, they were claimed to be common along the coast (Prasad 2003); rare inland and seen in open water bodies at Mahul (Verma et. al. 2001–02). Sighting of about 100–200 individuals were consistently recorded in Uran area by Sarkar (2011).

We observed this species at Belpada and NRI wetlands, from October to April. They were always observed in flocks of 30–35 individuals scattered all over the area and continuously foraging in shallow water. About 300 individuals were observed congregating in January at NRI Lake. The population started decreasing from March and no birds were observed from May to September. Please see figure 87 and 88, showing monthly variation in count of Pied Avocet from 2012–2016.



Image 28- Flock of Pied Avocet in flight at seashore along Palm Beach Road

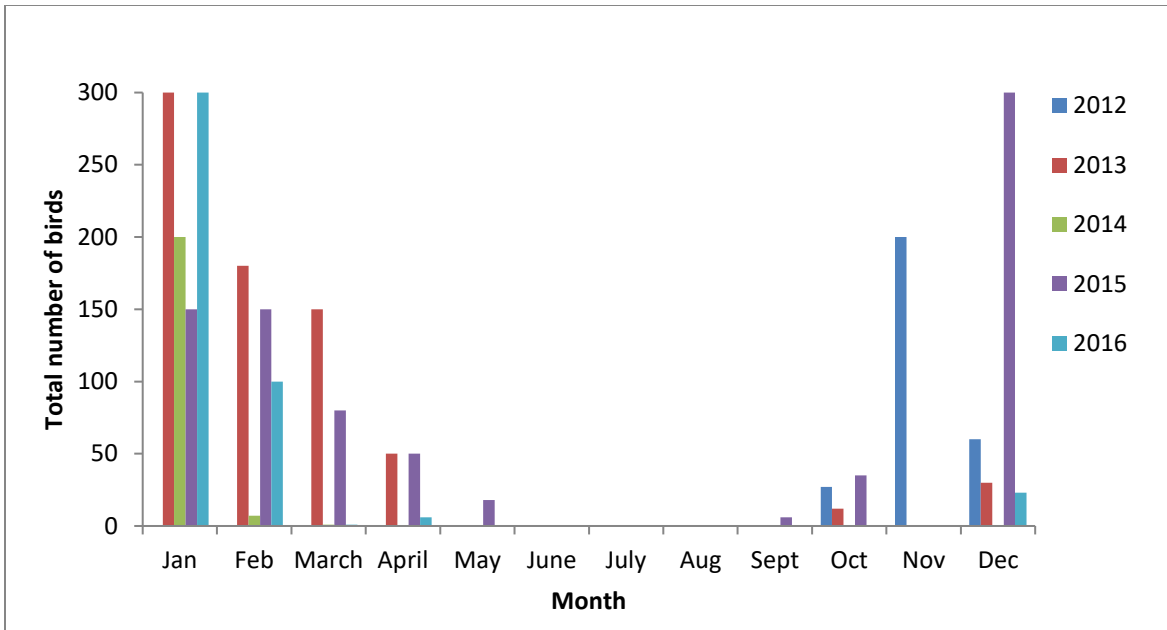


Figure 87 - Monthly variation in Pied Avocet count from 2012–2016

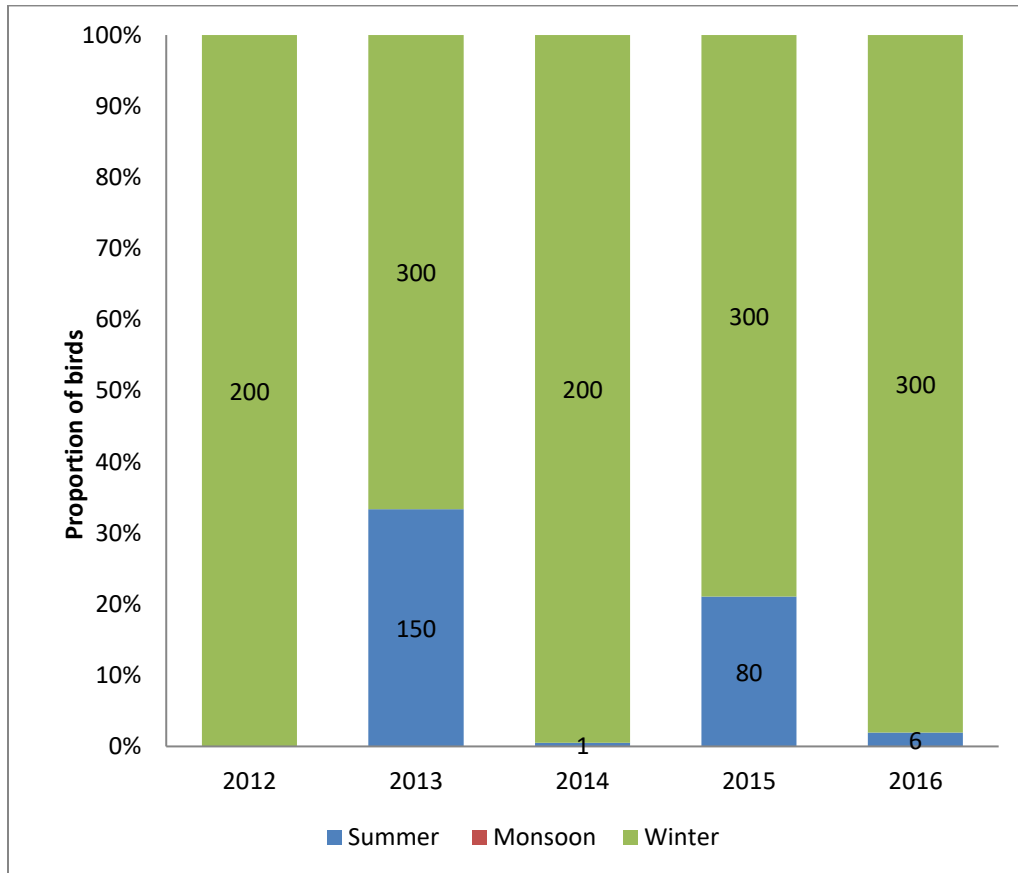


Figure 88 - Proportion of seasonal variation in Pied Avocet count from 2012–2016

13. Gull-billed Tern *Gelochelidon nilotica*

They breed in the warmer parts of the world in southern Europe in very small isolated population in northern Germany and Denmark, temperate and eastern Asia, coasts of central and southern North America, the north-west and eastern coasts of South America and Australia. Their wintering range includes much of south Asia, Central America, New Zealand and parts of Central Africa (del Hoyo et al. 1996). They breed locally in Northwest India (Las Bela and Punjab) and are found commonly in India and during the winter (Ali & Ripley 1983). They are opportunistic feeders and are largely insectivorous (del Hoyo et al. 1996, Richards 1990) as well as spiders, earthworms, small reptiles, frogs, small fish (6–9 cm long), aquatic invertebrates and rarely voles and small birds (del Hoyo et al. 1996).

Previously they have been recorded as local migrants, and a common congregatory species (Abdulali 1981). Their population was stated to be declining near Mumbai (Monga 2001) and was usually seen in the marshes, salt pans and creek at Mahul (Verma et. al. 2001–02). Like most other waders they are common species found on the west coast (Prasad 2003).

We observed this species as a common winter visitor in the study area. These birds were observed resting in flocks at NRI and TSC in late winter. Few individuals were also observed at Belpada, proposed NMIA area, Panvel creek. During low tide they moved to the sea shore for foraging. During summer they were observed congregating with the other waders at NRI Lake and wetland behind TSC of Palm Beach Road. Please see figure 89 and 90, showing monthly variation in count of Gull-billed Tern from 2012–2016.



Image 29- Gull-billed Tern in flight at TSC wetland

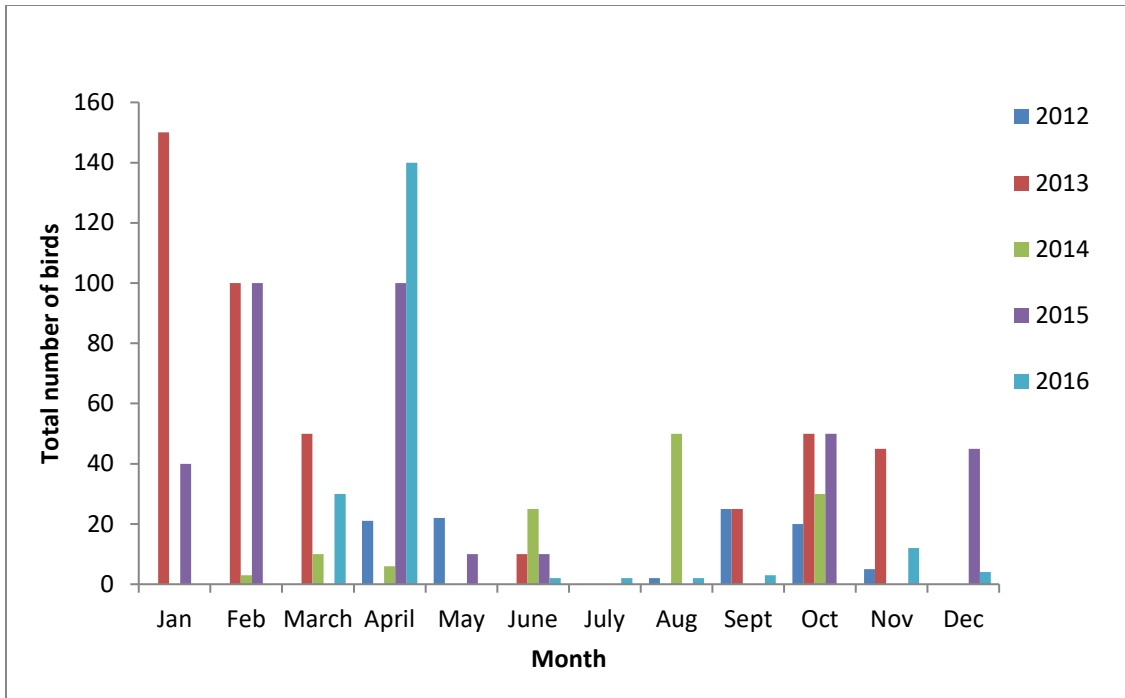


Figure 89 - Monthly variation in Gull-billed Tern count from 2012–2016

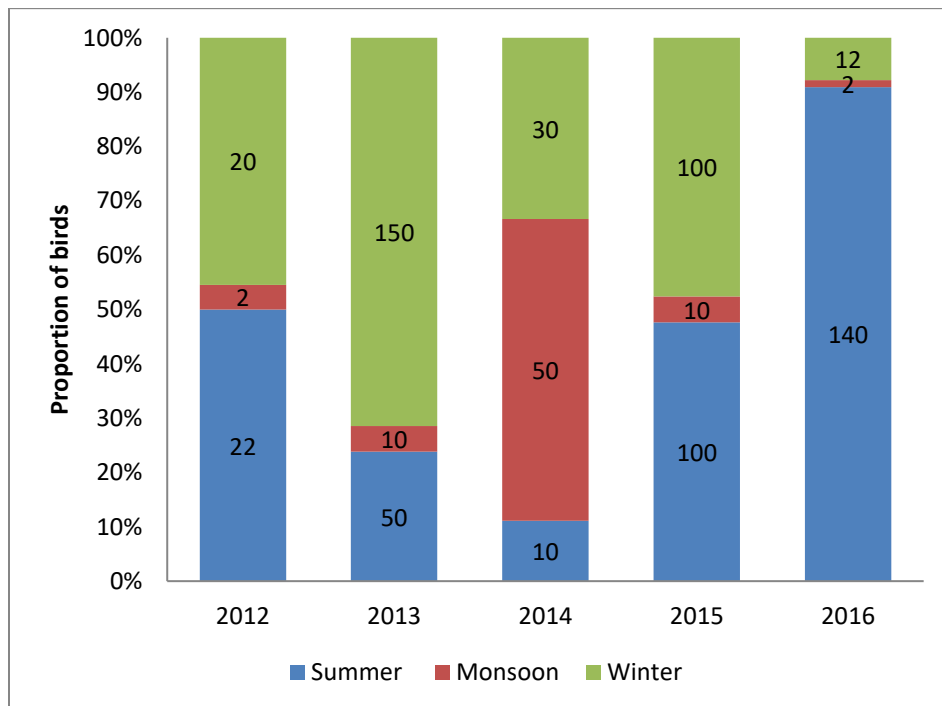


Figure 90 - Proportion of seasonal variation in Gull-billed Tern count from 2012–2016

14. Caspian Tern *Hydroprogne caspia*

It is a winter migrant and has a cosmopolitan but scattered distribution. Its breeding habitat is large lakes and ocean coasts in North America and locally in Europe Asia, Africa, and Australasia (Australia and New Zealand). The breeding season is between April and June (northern Hemisphere) or between September and December (southern Hemisphere) (del Hoyo et. al. 1996). It breeds locally in Northwest India (Las Bela and Punjab) and is wide spread in winter (Ali & Ripley 1983). During the non-breeding season, it forms loose flocks that are not gregarious (Urban et. al. 1986) and during the winter it feeds in variable congregations (del Hoyo et. al. 1996). Its diet consists predominantly of fish 5–25 cm in length as well as eggs and young of other birds, carrion (del Hoyo et. al. 1996), aquatic invertebrates and earthworms (Shuford and Craig 2002).

In the past it has been previously reported as an occasional visitor (Abdulali 1981), common on the coast; uncommon inland (Prasad 2003) and mainly seen at the Mahul Creek (Verma et. al. 2001–02).

We have commonly observed this species in our study area. These birds were observed foraging mainly at seashore as well as in all the wetlands in the study area but roosting primarily at NRI Lake and Wetland behind TSC of Palm Beach Road area, along with other waders. Individuals of this species started arriving in the September and a maximum count of 200 individuals was observed in February. In the later months, the count started to decline as the birds started returning back to their breeding ground. Please see figure 91 and 92, showing monthly variation in count of Caspian Tern from 2012–2016.



Image 30- Caspian Tern in flight at TSC wetland

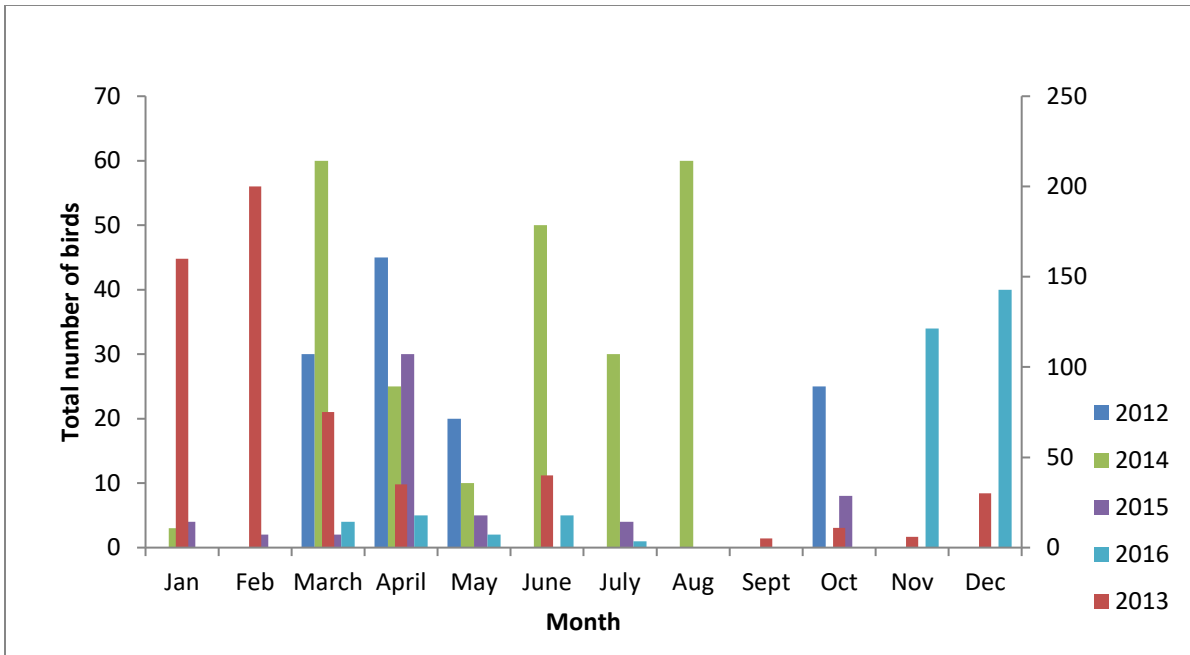


Figure 91 - Monthly variation in Caspian Tern count from 2012–2016

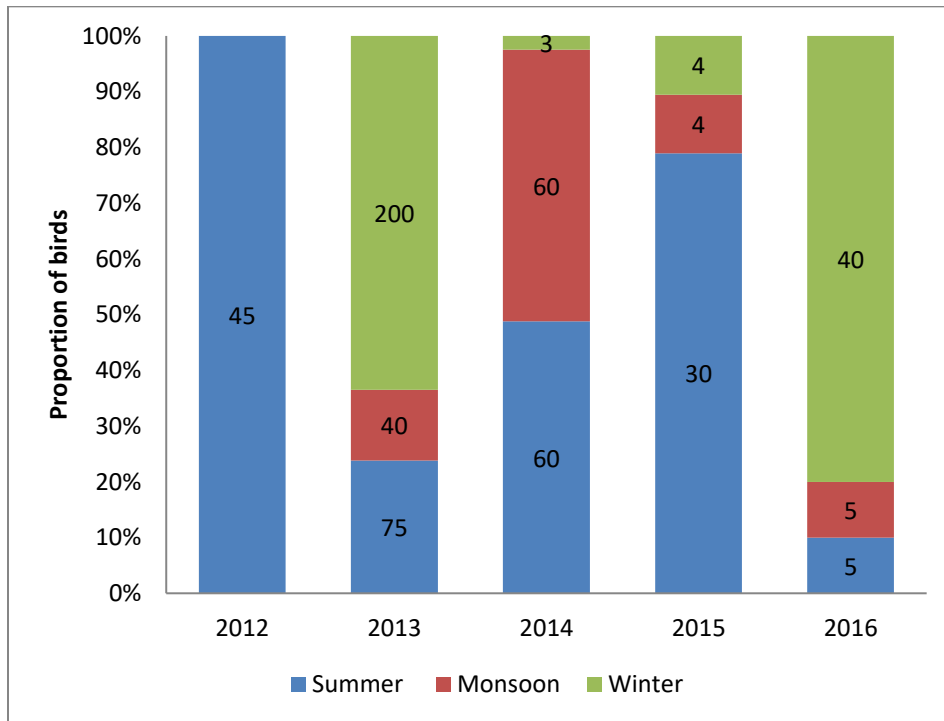


Figure 92 - Proportion of seasonal variation in Caspian Tern count from 2012–2016

15. Brown-headed Gull *Larus brunnicephalus*

The breeding range of the Brown-headed Gull is the mountains of south-central Asia from Turkestan in the west, China in east, and Tibet in the south. It winters on the coast of India, northern Sri Lanka and south-east Asia, and sparingly to the west of India up to the Arabian Peninsula (del Hoyo et. al. 1996). It breeds in Ladhak and is a common winter visitor in the sea coasts throughout India (Ali & Ripley 1983). During the wintering season the species forms large concentrations, with large flocks of 30–40 and sometimes hundreds of individuals gathering at winter roosting sites (Brown et al. 1982, Madge and Burn 1988). It is frequently found in marshes, lakes and other sheltered waters with high productivity and abundant vegetation (Kear 2005b).

It was earlier listed as a common congregatory species (Abdulali 1981) and is presently common on the seashore and seldom found in inland water bodies (Prasad 2003). It has also been commonly seen at Mahul creek (Verma et. al 2001–02).

This species is a common winter migrant in the study area. We observed it at all the wetlands of the study area, with a count of 500–600 individuals at NRI Lake, Uran and DPS wetland during winter. Post-winter this species was observed congregating at NRI Lake and later the count was restricted to TSC wetland and seashore area. Please see figure 93 and 94, showing monthly variation in count of Brown-headed Gull from 2012–2016.



Image 31- Flock of Brown-headed Gull at TSC wetland

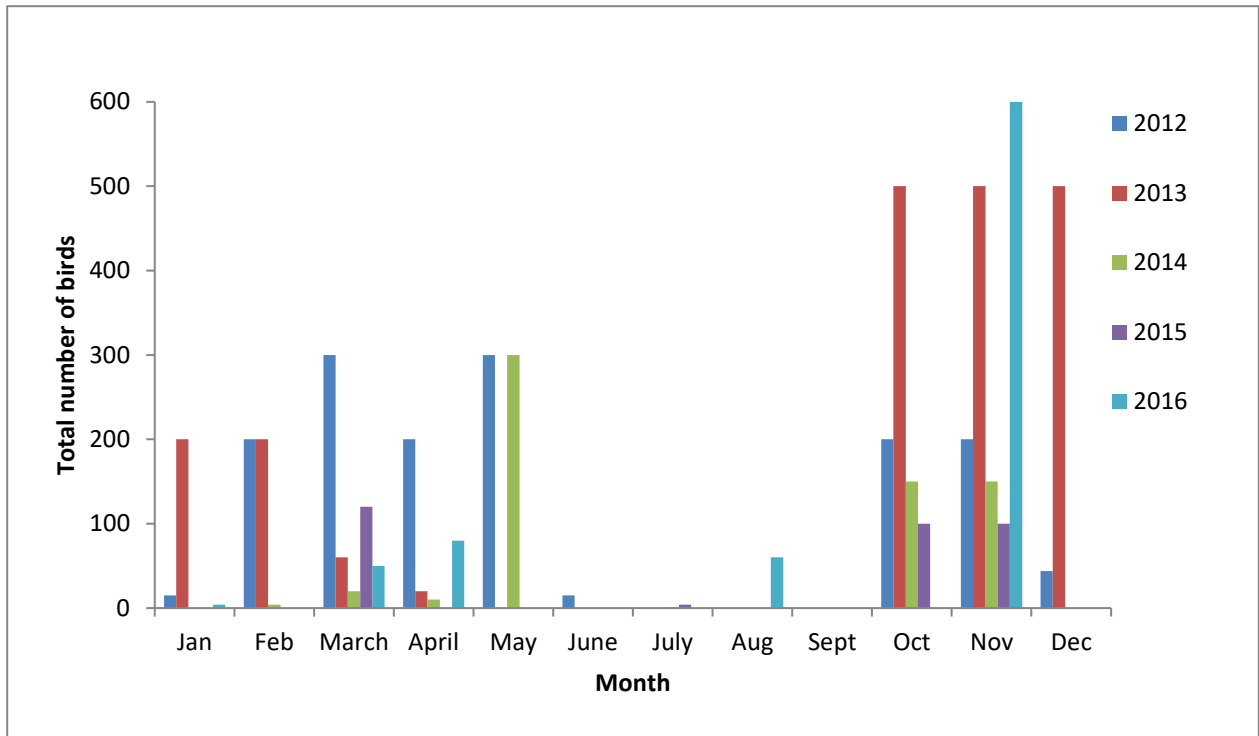


Figure 93 - Monthly variation in Brown-headed Gull count from 2012–2016

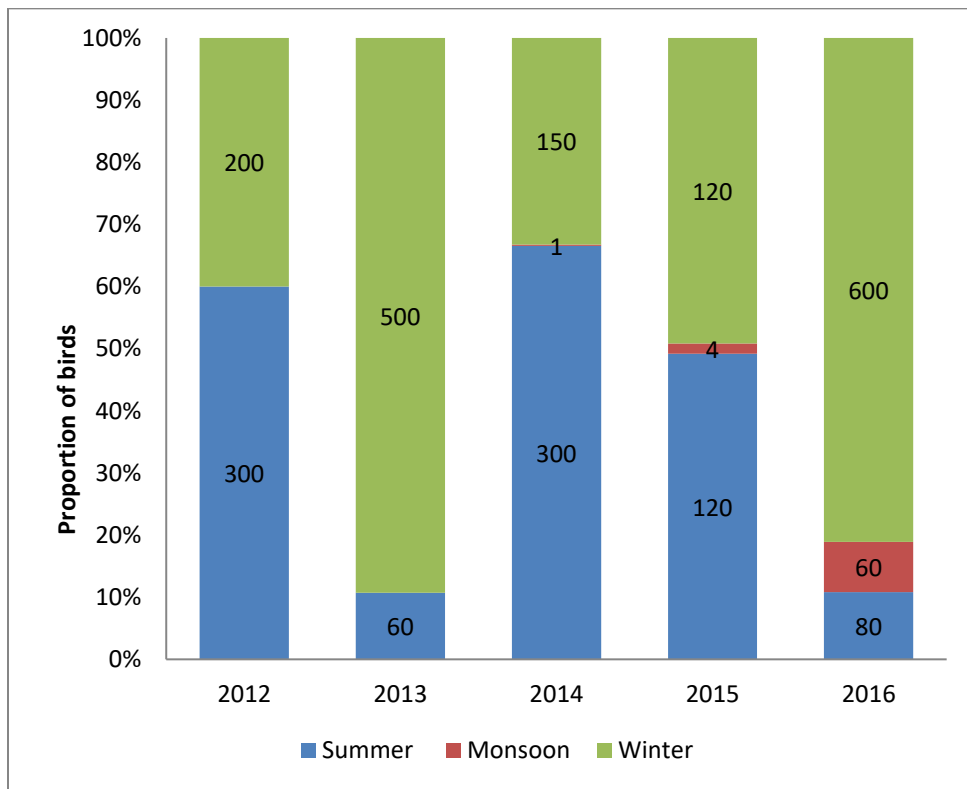


Figure 94 - Proportion of seasonal variation in Brown-headed Gull count from 2012–2016

ANNEX III) BREEDING BIRDS IN THE STUDY AREA

During the study period from 2012 to 2016, we observed many bird species breeding in different habitats in the study area. We observed Eurasian Coot *Fulica atra*, Pheasant-tailed Jacana *Hydrophasianus chirurgus*, Black-winged Stilt *Himantopus himantopus*, Spot-billed Duck *Anas poecilorhyncha*, and Lesser Whistling Teal *Dendrocygna javanica* breeding in wetlands.

We observed nest and hatchlings of Eurasian Coot *Fulica atra*, Black-winged Stilt *Himantopus himantopus*, Pheasant-tailed Jacana *Hydrophasianus chirurgus*, and Spot-billed Duck *Anas poecilorhyncha*, Purple Swamphen *Porphyrio porphyrio*, Common Moorhen *Gallinula chloropus*, and Bronze-winged Jacana *Metopidius indicus* were seen pairing with the mate and carrying nest material during this period. Thick-billed Flowerpecker *Dicaeum agile*, Purple Sunbird *Cinnyris asiaticus*, Orange-headed Thrush *Geokichla citrina*, Black-naped Monarch *Hypothymis azurea*, White-rumped Shama *Copsychus malabaricus*, and Tawny-bellied Babbler *Dumetia hyperythra* were observed to be breeding in Karnala Bird Sanctuary, and the forest areas at Mosare, Chirner, and Morbe.

We also observed breeding of local migrant species such as Black-backed Dwarf Kingfisher *Ceyxerithaca* and Indian Pitta *Pitta brachyura* in these areas. The grassland habitats were used by Red-wattled Lapwing *Vanellus indicus*, Zitting Cisticola *Cisticola juncidis*, Scaly-breasted Munia *Lonchura punctulata*, and Baya Weaver *Ploceus philippinus* for nesting. In the mangroves, we observed frequent calling and display activity of Indian Reed Warbler *Acrocephalus stentoreus brunnescens*, White-cheeked Bulbul *Pycnonotus leucotis*, and Ashy Prinia *Prinia socialis* during breeding period, and saw a nest of Indian Reed Warbler *Acrocephalus stentoreus brunnescens*. Black Kites *Milvus migrans* were seen nesting, primarily on human-made structures like transmission towers, electric poles, etc. Below are the details about nesting activity in a few bird species, observed:

1. Eurasian Coot *Fulica atra*

Eurasian Coot is known to breed at Mahalaxmi area in Mumbai (Navarro 1980), and breeding season was recorded from July to December (Pittie 1999, Navarro 1980, Khacher 1978, Khacher 1979, Betham 1904, Betham 1902, Burgess 1855) in Maharashtra.

This species was seen breeding in wetlands in the study area during May and June. Birds were seen establishing and maintaining territories with vigor. Nest, a floating raft made out of grass blades, twigs and other plant materials, was built on logs in the water by both the parents, followed by incubation, and the care of the young. We observed three to four fledglings with parents in Jasai wetlands near Belpada.

2. Indian Spot-billed Duck *Anas poecilorhyncha*

Though it is a common bird, its breeding records are not available from Mumbai area, and the only published record is from Pune (Gole 1984), and from Niphad in Nasik district (Abdulali & Ali 1940) of Maharashtra.

We have observed this species nesting in the wetlands from April to July. Individuals of this species were observed gathering at Belpada wetland before the breeding season, probably as a courtship gathering, to select a mate for nesting. Fifteen nests were seen in the entire study area.

The nest was made by both the parents, with the available vegetation, followed by incubation, and care of the young. We observed the maximum of seven and a minimum of four fledglings foraging with the parents during single breeding season.

3. Pheasant-tailed Jacana *Hydrophasianus chirurgus*

This species has been recorded breeding in Mumbai during August to September period (Ali & Abdulali 1939, 11/9/2001 <birdsofMumbai@yahoo.com>). The Pheasant-tailed Jacanas are observed to be polyandrous; the female mates with several males. The breeding behaviour is reversed, with the male performing most of the nesting duties, such as to build the nest, to incubate and to brood the eggs, and to accompany the precocial chicks when feeding. The female, on the other hand, performs predator defence, preening and resting in the vicinity of the young, looking out for intruders and predators, while the young are feeding.

We found that this species was breeding during April to July period in the study area. The nest, built on floating vegetation, is made with stems and pieces of aquatic plants. We observed a clutch of four eggs in two nests.

4. Black-winged Stilt *Himantopus himantopus*

Breeding recorded at Mumbai from May to July (Abdulali 1951). We observed this species nesting at the landfilled Belpada wetland in July 2015. A total of 14 nests were observed in two clusters. Around 6–7 nests had a clutch size of four eggs per nest; a few nests were seen with three or two eggs. Very few nests had a single egg. Nests were built on raised surfaces, three to five inches above ground level. The nests were built by arranging small stones and sticks in a circular pattern. The average diameter of the nests was around 21 centimetres. In July 2015, on a heavy shower day, because of water logging, all the nests were washed off. Only one hatchling was seen in the nesting area, which was killed by a mob of House Crows *Corvus splendens*.

5. Indian Reed Warbler *Acrocephalus stentoreus brunnescens*

Breeding period of this species is from May to July as observed in the study area. In June, we observed increased activity of this species in the mangroves. The birds were heard frequently calling from various directions (probably singing for mate or territorial display). We found a few cup-shaped nests made with fine grass blades and perched about four feet above the ground on *Avicennia marina* trees. The nests were well camouflaged in the mangroves.

6. Indian Baya Weaver *Ploceus philippinus*

This bird is known to breed in Mumbai (Aitken 1900, Ali & Abdulali 1938) and almost all over the Maharashtra during July to October (Mahabal & Lamba 1987, Ali & Abdulali 1938, Aitken 1900, Davidson 1882, Vidal 1880, Davidson & Wenden 1878). Baya Weavers are best known for their elaborately woven nests. They nest in colonies of up to 20–30 pairs, in close proximity to the source of food, nesting material, and water. The nests are often built hanging over water. Pendulous nests are retort shaped, with a central nesting chamber, and a long vertical tube that leads to a side entrance to the chamber. The nests are woven with long stripes of paddy blades, rough grasses, and palm fronds. During breeding season, the males begin building nests, and display by flapping their wings and calling while hanging to the partially finished nests to attract females. The females inspect and choose a nest before signalling their approval to a male. Males complete the nest only after they are chosen by a female. The males are polygynous, mating with

two to three females one after another. After mating, the female lays two to four white-coloured eggs and incubates them. The females are solely responsible for incubating, and raising the brood. After mating with a female, the male goes on to woo more females with the other nests. We found Baya colonies at the proposed site for NMIA, Belpada, and Uran area.

7. Thick-billed Flowerpecker *Pachyglossa agile*

Breeding records of this species are available from Kihim, Raigad district (Ali & Whistler 1933) and Mumbai (Ali & Abdulali 1938, Aitken 1900). This bird was seen nesting in Karnala Bird Sanctuary during April. The nest is a purse-like bag, made out of plant fibres, cobweb, and is suspended a thin horizontal branch of a tree, at about five meters above the ground. The female was seen making the nest and incubating the eggs.

8. Black-backed Dwarf Kingfisher *Ceyx erithaca*

Historic breeding records for this species are reported from Powai, Mumbai. It was observed in a hole on July 5, 1936 and two hatchlings with two eggs in a hole at Suryamal, Thane district, in the monsoons of 1936 (Abdulali & Ali 1940). This species breeds in June, with the onset of Southwest monsoons. We observed a nest in Karnala Bird Sanctuary. The nest was a horizontal burrow, about a meter in depth, on the banks of a water stream. Both the parents were involved in preparing the nest, and incubation. The parents were seen carrying food into the nest chamber.

9. Black-naped Blue Monarch *Hypothymis azurea*

Breeding records of this species are known from Kihim, Mumbai, (Ali & Abdulali 1937) during May to July (Ali & Abdulali 1937, Barnes 1889a). We observed the nest of this species at Karnala Bird Sanctuary and Chirner forest area. Nesting was seen in a multi-pronged stem-fork, at the height of about four metres from the ground. The nest was a deep, compact cup of fibre and bark-like material; and cob web were used as an anchoring material to attach green moss. Both, male and female, were seen building the nest but female participated predominantly.

10. Tawny-bellied Babbler *Dumetia hyperythra*

This species is known to breeding from Thane district (Butler 1881) and Mumbai area (Ali & Abdulali 1936, Barnes 1889b) during the monsoons between May and September. We observed a nest in a thicket of shrubs at Mosare in July 2015. The ball-shaped nest, made up of leaves and grass blades, was built very close to the ground, camouflaged among dead leaves. We observed four, off-white coloured eggs in the nest.

Table 10: Birds breeding in the study area (alphabetically arranged)

Sr. No.	Species Name	Nesting Habitat	Nesting Month	Breeding Season	Site	Nest Description
1.	Black-naped Monarch <i>Hypothymis azurea</i>	Forest	July	Summer/ Monsoon	Karnala	Cup-shaped nest made up of fungal hyphal clumps, cob webs, spider egg sacks, green moss, etc.
2.	Ashy Prinia <i>Prinia socialis</i>	Grassland	June	Monsoon	Belpada	Nests close to ground in bushes or grass. Purse-like nest made of grass blades, grass stems etc.
3.	Baya weaver <i>Ploceus philippinus</i>	Grassland	June	Monsoon	NMIA, Belpada	Hanging pendulous nests woven with long stripes of paddy leaves, rough grasses, etc.
4.	Black Kite <i>Milvus migrans</i>	Grassland	January	Winter	Uran	Large stick-nests on a tree. They sometimes nest on hill cliffs and manmade objects like buildings, electricity pylons, etc.
5.	Black-crowned Night Heron <i>Nycticorax nycticorax</i>	Near Human Habitation	July	Monsoon	Panvel	Nests located in large trees at a height of about 10m. Herons nest in colonies. Nest is a small platform made up of twigs.
6.	Black-winged Stilt <i>Himantopus himantopus</i>	Grassland	July	Monsoon	Belpada	Shallow scrape nest on a raised ground in or near wetland. Nest is made using small sticks and /pebbles.
7.	Cattle Egret <i>Bubulcus ibis</i>	Near Human Habitation	July	Late summer and Monsoon	Panvel	Nest is made using sticks and twigs. Nest is located on trees. Egrets mostly live in colonies.
8.	Common Coot <i>Fulica atra</i>	Wetland	May	Pre-monsoon	Uran	Nests are generally built on vegetation in shallow water and are sometimes based on trampled grass
9.	Common Kingfisher <i>Alcedo atthis</i>	Wetland	June	Monsoon	Belpada	Nest is a burrow ending in an enlarged chamber.
10.	Indian Pond Heron <i>Ardeola grayii</i>	Near Human Habitation	July	Late summer and Monsoon	Panvel	Nests in colonies are located in large trees at a height of about 10m. Nest is a small platform made up of twigs.

Sr. No.	Species Name	Nesting Habitat	Nesting Month	Breeding Season	Site	Nest Description
11.	Indian Reed Warbler <i>Acrocephalus Stentoreus [brunnescens]</i>	Mangrove	June	Late summer and Monsoon	NMIA area	Deep cup-shaped nest made up of reeds placed above water in deep vegetation
12.	Indian Shag <i>Phalacrocorax fuscicollis</i>	Near Human Habitation	June	Monsoon and Winter	Panvel	Communal nesting. Nests are built on trees using twigs. Nests are usually found near or inside the heronries.
13.	Lesser Whistling Duck <i>Dendrocygna javanica</i>	Wetland	June	Mainly Monsoon	Uran	Nests are built near water body. Nests are usually built on tall reeds, or in hollow logs or on abandoned nests
14.	Little Cormorant <i>Microcarbo niger</i>	Near Human Habitation	June	Monsoon and Winter	Panvel	Large stick-nests on trees. Often inside or near heronries
15.	Oriental Dwarf Kingfisher <i>Ceyx erithaca</i>	Forest	June	Monsoon	Karnala	Horizontal tunnel or a burrow on the bank up to a meter or two in length
16.	Pheasant-tailed Jacana <i>Hydrophasianus chirurgus</i>	Wetland	June	Monsoon	Belpada	The nest is built on floating vegetation. Nest is made up of stems and aquatic plants.
17.	Purple Swamp Hen <i>Porphyrio porphyrio</i>	Wetland	May	Pre-monsoon	Belpada	Nests are built on thick floating vegetation near the bank of the pond. Nesting material consists of plants, stems and leaves.
18.	Purple-rumped Sunbird <i>Leptocoma zeylonica</i>	Forest	May	Throughout the year but mainly in summer	Ransai	Pendular nest made of plant fibres, cob webs, lichens, bark species etc.
19.	Red Wattled Lapwing <i>Vanellus indica</i>	Grassland	May	Summer and Monsoon	Panje, Belpada, TSC, Kharghar creek	Ground nest. Eggs are laid directly on the ground having depression and are sometimes lined by goat droppings or pebbles.
20.	Red-naped Ibis <i>Pseudibis papillosa</i>	Wetland	May	Summer and Monsoon	Morbe	Nests near water body. Shallow cup-shaped nests made up of sticks, grasses or reeds. They sometimes use abandoned nests.

Sr. No.	Species Name	Nesting Habitat	Nesting Month	Breeding Season	Site	Nest Description
21.	Scaly-breasted Munia <i>Lonchura punctulata</i>	Mangrove associated	June	Late Summer and Monsoon	NMIA area	Dome shaped nest with a side entrance. It is made using grass and leaves. Well hidden nest.
22.	Spot-billed duck <i>Anas poecilorhyncha</i>	Wetland	June	Monsoon	Belpada	Nest is built on the ground near a water body. Nest is concealed in the vegetation. It is built using grass and weed.
23.	Tawny-bellied Babbler <i>Dunutia hyperythra</i>	Forest	July	Summer and Monsoon	Mosare	Loose nest, dome-shaped with a side entrance. Nest is located in a dense foliage and is made up of coarse grasses, dead leaves etc.
24.	Thick-billed Flowerpecker <i>Dicaeum agile</i>	Forest	April	Winter/Summer/Monsoon	Karnala	Purse-like bag nest made up of plant fibres, webs and plant downs.
25.	White-bellied Drongo <i>Dicrurus caerulescens</i>	Forest	May	Summer	Ransai	Cup-shaped nest, made up of twigs and grass
26.	White-rumped Shama <i>Copsychus malabaricus</i>	Forest	June	June to September but mainly in Summer	Karnala	Nests generally in hollow areas of the tree trunks, Nest is built using fern, stems, roots & leaves.
27.	Zitting Cisticola <i>Cisticola juncidis</i>	Grassland	June	Monsoon	Belpada	Cup-shaped nest built in deep grass; nest is built using plant downs, cobwebs and grass. Nest usually has a canopy for camouflage

Annex IV) other congregating birds which were not observed at high tide roosts

Here we have provided brief information about congregatory birds which were not found at wetland, high tide roost or any fix tree roosts. These are the birds usually seen in small flocks foraging in open areas and resting in in hundreds on power lines, mangroves and other similar perching structures.

1. Blue Rock Pigeon *Columba livia*

The species has very large geographical range, widespread in North America, Mexico, Caribbean Islands, Ireland, United Kingdom, North Africa, Europe, Middle East, India, Pakistan, Afghanistan, Mongolia, and Australia (BirdLife International 2014).

It is a resident and well adapted to the urban life and a very common bird in India (Ali & Ripley 1983). Abdulali (1981) and Prasad (2003) mentioned it a flocking and common species in Mumbai and adjoining areas.

We observed it across the study area. There is no permanent *Kabootar khana* in the study area but birds were seen moving at various areas. Shop owners at different sectors were occasionally seen throwing grains for the pigeons. In the afternoon, the count at roosting/feeding sites was low as birds were seen scattered all over the area and occupying windows, parking lots, galleries of closed houses, etc. in residential areas. In the evening, pigeons were seen mainly feeding on grass seeds and garbage available in open or landfilled areas.

Groups of 30-40 individuals were often seen foraging at garbage dumps, open grasslands, mangroves, and rooftops of the buildings. Many a times, flocks of 100-120 birds were seen foraging in the land filled open areas. Sometimes more than 300-400 pigeons were seen feeding on grains or food remnants regularly thrown by people along roads, non-functional railway platforms. They were mainly seen resting on power lines or building rooftops.



Image 32 - Blue Rock Pigeons on power lines at Kamothe area



Image 33 - Blue Rock Pigeons mainly feed on grains thrown by people

2. Barn Swallow *Hirundo rustica*

It is a widely distributed species; the wintering grounds are in South America, Central America, Mexico, South Africa, Indian subcontinent, Indonesia, Malaysia, and North Australia (del Hoyo et. al. 1996). The breeding grounds are in the parts of Europe, North Africa, Asia, and Russia. Roosts in large congregation amongst reed-beds and thickets standing in water (del Hoyo et. al. 1996).

A common wintering bird in India (Ali and Ripley 1983) and mentioned earlier as occasional in Mumbai by Abdulali (1981), common throughout Western Maharashtra as noted by Prasad (2003).

We observed 50–100 birds usually perching on electric wires and foraging in paddy fields, and garbage dumps in the study area. These birds usually feed in open areas and are aerial insectivores. Sometimes these can be seen roosting in hundreds.



Image 34 - Barn Swallow was seen foraging on garbage dump in Uran area

3. Red-headed Bunting *Emberiza bruniceps*

It is found in the Middle East and Central Asian countries like Kazakhstan, Uzbekistan, Turkmenistan and winters in western India (del Hoyo et. al. 1996). This species winters in most of the Indian peninsula plains (Ali & Ripley 1983).

It was reported as uncommon winter migrant, occasionally in flocks in Mumbai area, by Abdulali (1981) and uncommon by Prasad (2003).

An inhabitant of grassland, cultivated lands, we observed these birds in flocks of 30-40 in the grasslands at Belpada and the proposed site of NMIA, interspersed with bushes and Babul *Vachellia nilotica*. It was often observed in dry paddy fields, close to study sites.



Image 35 - Red-headed Bunting seen in Uran area

4. Black-headed Bunting *Emberiza melanocephala*

Uncommon winter migrant, breeds in south east Europe to Central Asian countries and some Middle East countries, common winter visitor to Western and Central India in Rajasthan, Gujarat, Madhya Pradesh (east to Saugor), Maharashtra (east to Nagpur and Nanded) (Ali & Ripley 1983). The wintering ground is in West India. Inhabitant of the grasslands, cultivations and fields, interspersed with bushes and Babul *Vachellia nilotica*.

Earlier seen commonly in flocks in the Mumbai region by Abdulali (1981), reported as rare in south Konkan by Prasad (2003). The survey team observed about 400–500 birds in a flock at Belpada and the proposed site of NMIA, feeding in the grasslands and roosting in the nearby mangroves.



Image 36 – Black-headed Bunting roosting in mangroves of NMIA site



Image 37 – - Black-headed Bunting in paddy fields of NMIA site

5. Rosy Starling *Sturnus roseus*

It is common winter migrant, breeds regularly from South Ukraine East to lower Volga steppes, Central and East Kazakhstan, West Altai and West Mongolia, South to East Turkey, South Iran, Afghanistan and North West China; occasionally South East Europe, West to Czech Republic, Hungary and Italy, and possibly now breeding annually in Bulgaria, also occasionally farther East in Russia to upper R Yenisey (del Hoyo et. al. 1996).

Non-breeding birds are found in India and Sri Lanka, most common in Gujarat and the Deccan, decreasingly through South India, vagrant in Andaman (Ali & Ripley 1983). Earlier mentioned to be seen in flocks in Mumbai (Abdulali, 1981) and observed in the mangroves at Mahul by Verma et. al. (2001–02).

We observed these birds at all sites of the study area during winters, with flock-size ranging from 10 to 200 individuals. It was usually seen feeding in the mangroves and perching on the adjoining trees. In early winter of 2013, a number of juveniles were observed in flocks, perching on the power transmission lines.



Image 38 – Rosy Starling feeding on garbage at Belpada, Uran

6. Asian Pied Starling *Gracupica contra*

Found in extreme East Pakistan (Lahore area), South west China, South and east Myanmar, South China, Thailand (except east), North west Laos and Cambodia, South Nepal and Bangladesh (del Hoyo et al. 1996) North & Central India (East to West Assam, South to extreme Karnataka and North Andhra Pradesh), North East India (Ali and Ripley 1983). It was reported as a common resident in Mumbai by Abdulali (1981), with breeding season extending from June to July (Prasad 2003).

It was observed that this bird preferred the neighbourhood of the villages; towns and cities where garbage dumps offer attractive feeding opportunities. Sometimes it was seen in flocks of 30–40 individuals, sitting on power transmission wires, feeding on garbage and perching on the trees and mangroves.

ANNEX V) LIST OF BIRDS OBSERVED IN STUDY AREA

Sr. No.	Common/scientific names	Habitat	WPA schedule	IUCN status	R/M	Sites
	Family Podicipedidae					
1.	Little Grebe <i>Tachybaptus ruficollis</i>	W	IV	LC	R	Dastan Phata, DPS Wetland
	Family Phalacrocoracidae					
2.	Indian Shag <i>Phalacrocorax fuscicollis</i>	W	IV	LC	R/LM	All wetlands
3.	Great Cormorant <i>Phalacrocorax carbo</i>	W	IV	LC	R/LM	NRI Wetland
4.	Little Cormorant <i>Microcarbo niger</i>	W	IV	LC	R/LM	All wetlands
	Family Ardeidae					
5.	Western Reef-heron <i>Egretta gularis</i>	W/MD	IV	LC	R/LM	Dastan Phata, Sonari–Belpada
6.	Little Egret <i>Egretta garzetta</i>	W/P/C	IV	LC	R/LM	All wetlands
7.	Great Egret <i>Egretta alba</i>	W	IV	LC	R	All wetlands
8.	Intermediate Egret <i>Egretta intermedia</i>	W/P	IV	LC	R/LM	All wetlands
9.	Eastern Cattle Egret <i>Bubulcus coromandus</i>	W/P	IV	LC	R/LM	All wetlands
10.	Grey Heron <i>Ardea cinerea</i>	W/C	IV	LC	R/LM	All wetlands
11.	Purple Heron <i>Ardea purpurea</i>	W/C	IV	LC	R/LM	All wetlands
12.	Indian Pond-heron <i>Ardeola grayii</i>	W	IV	LC	R/LM	All wetlands
13.	Black–crowned Night-heron <i>Nycticorax nycticorax</i>	W	IV	LC	R/LM	Kharghar Creek, NRI Wetland, Kalundre River
14.	Striated Heron <i>Butorides striata</i>	W	IV	LC	R	Panje
15.	Black Bittern <i>Dupetor flavicollis</i>	W	IV	LC	R/LM	NRI Wetland
16.	Chestnut Bittern <i>Ixobrychus cinnamomeus</i>	W	IV	LC	R/LM	Mosare, Sonari–Belpada
	Family Ciconiidae					
17.	Asian Openbill <i>Anastomus oscitans</i>	W	IV	LC	R/LM	Dastan Phata
18.	Woolly-necked Stork <i>Ciconia episcopus</i>	W	IV	VU	R	Dastan Phata, Mosare

Sr. no.	Common/scientific names	Habitat	WPA schedule	IUCN status	R/M	Sites
19.	Painted Stork <i>Mycteria leucocephala</i>	W	IV	NT	R/LM	Sonari-Belpada, NRI Wetland
20.	Black Stork <i>Ciconia nigra</i>	W	IV	LC	M	Uran
	Family Threskiornithidae					
21.	Glossy Ibis <i>Plegadis falcinellus</i>	W	IV	LC	M	Sonari-Belpada
22.	Black-headed Ibis <i>Threskiornis melanocephalus</i>	W/C	IV	NT	R/LM	All wetlands and mangroves
23.	Eurasian Spoonbill <i>Platalea leucorodia</i>	W	I	LC	R/LM	Jasai, Sonari-Belpada
24.	Indian Black Ibis <i>Pseudibis papillosa</i>	W	IV	LC	R/LM	On old Mumbai-Pune highway near Shedung village.
	Family Phoenicopteridae					
25.	Greater Flamingo <i>Phoenicopterus roseus</i>	W	I	LC	LM	Sonari-Belpada, NRI Wetland
26.	Lesser Flamingo <i>Phoeniconaias minor</i>	W	I	NT	LM	NRI Wetland, Panje, TSC Wetland
	Family Anatidae					
27.	Greylag Goose <i>Anser anser</i>	W	IV	LC	M	Sonari-Belpada
28.	Lesser Whistling-duck <i>Dendrocygna javanica</i>	W	IV	LC	R/LM	Dastan Phata, Sonari-Belpada, NRI Wetland
29.	Ruddy Shelduck <i>Tadorna ferruginea</i>	W	IV	LC	M	Sonari-Belpada, Panje
30.	Knob-billed Duck <i>Sarkidiornis melanotos</i>	W	IV	LC	R	Dastan Phata
31.	Common Teal <i>Anas crecca</i>	W	IV	LC	M	Sonari-Belpada
32.	Garganey <i>Querquedula querquedula</i>	W	IV	LC	M	Sonari-Belpada
33.	Gadwall <i>Mareca strepera</i>	W	IV	LC	M	Sonari-Belpada

Sr. no.	Common/scientific names	Habitat	WPA schedule	IUCN status	R/M	Sites
34.	Eurasian Wigeon <i>Mareca Penelope</i>	W	IV	LC	M	Sonari–Belpada
35.	Northern Shoveler <i>Spatula clypeata</i>	W/C	IV	LC	M	Kharghar Creek
36.	Northern Pintail <i>Anas acuta</i>	W	IV	LC	M	Sonari-Belpada
37.	Indian Spot-billed Duck <i>Anas poecilorhyncha</i>	W/C	IV	LC	R	All wetlands
38.	Mallard <i>Anas palatyrhynchos</i>	W	IV	LC	M	NRI Wetland
39.	Cotton Teal <i>Nettapus coromandelianus</i>	W	IV	LC	R/LM	Dastan Phata
	Family Accipitridae					
40.	Black-winged Kite <i>Elanus caeruleus</i>	All	I	LC	R	All wetlands
41.	Brahminy Kite <i>Haliastur indus</i>	W/P	I	LC	R	Sonari–Belpada, Dastan Phata
42.	Black Kite <i>Milvus migrans migrans/govinda</i>	All	I	LC	R	All wetlands
43.	‘Black-eared’ Kite <i>Milvus [migrans] lineatus</i>	W	I	LC	M	Sonari–Belpada
44.	Shikra <i>Accipiter badius</i>	All	I	LC	R	Ransai, Mosare
45.	Long-legged Buzzard <i>Buteo rufinus</i>	F	I	LC	M	Mosare
46.	Oriental Honey-buzzard <i>Pernis ptylorhynchus</i>	F	I	LC	R	Mosare
47.	White-eyed Buzzard <i>Butastur teesa</i>	F	I	LC	R	Jasai
48.	Crested Serpent-eagle <i>Spilornis cheela</i>	F	I	LC	R/LM	Ransai, Mosare
49.	Short-toed Eagle <i>Circaetus gallicus</i>	GS	I	LC	R	Chirner road
50.	Booted Eagle <i>Hieraaetus pennatus</i>	F	I	LC	M	Mosare
51.	Crested Hawk-eagle <i>Nisaetus cirrhatus</i>	F	I	LC	R	Ransai
52.	Black Eagle <i>Ictinaetus malayensis</i>	F	I		R	Karnala Bird Sanctuary
53.	Indian Spotted Eagle <i>Clanga hastata</i>	W	I	VU	R	Sonari-Belpada
54.	Greater Spotted Eagle <i>Clanga clanga</i>	F	I	VU	M	Sonari-Belpada, Mosare

Sr. no.	Common/scientific names	Habitat	WPA schedule	IUCN status	R/M	Sites
55.	Steppe Eagle <i>Aquila nipalensis</i>	F	I	NT	M	Sonari-Belpada, Mosare
56.	White-bellied Sea-eagle <i>Haliaeetus leucogaster</i>	W	I	LC	R	Panje
57.	Montagu's Harrier <i>Circus pygargus</i>	W	I	LC	M	Panje
58.	Pallid Harrier <i>Circus macrourus</i>	W	I	NT	M	Panje
59.	Pied Harrier <i>Circus melanoleucos</i>	W	I	LC	M	Panje
60.	Western Marsh Harrier <i>Circus aeruginosus</i>	W	I	LC	M	All wetlands
	Family Pandionidae					
61.	Western Osprey <i>Pandion haliaetus</i>	W/C	I	LC	M	Kharghar Creek, Sonari-Belpada
	Family Falconidae					
62.	Common Kestrel <i>Falco tinnunculus</i>	GS	IV	LC	R/LM	Chirner, Sonari-Belpada
63.	Peregrine Falcon (Shaheen) <i>Falco peregrinus perigrinator</i>	F	IV	LC	R/LM	Karnala
64.	Peregrine Falcon <i>Falco peregrinus calidus</i>	W	IV	LC	R/LM	Karnala
	Family Phasianidae					
65.	Grey Francolin <i>Francolinus pondicerianus</i>	GS	–	LC	R	Taloja industrial area
66.	Painted Francolin <i>Francolinus pictus</i>	GS	–	LC	R	Taloja industrial area
67.	Rain Quail <i>Coturnix coromandelica</i>	P	–	LC	R/LM	Chirner
68.	Jungle Bush-quail <i>Perdicula asiatica</i>	F	–	LC	R	Ransai, Chirner Road
69.	Red Spurfowl <i>Galloperdix spadicea</i>	F	–	LC	R	Kharghar hills
70.	Grey Junglefowl <i>Gallus sonneratii</i>	F	–	LC	R	Karnala
71.	Indian Peafowl <i>Pavo cristatus</i>	F	I	LC	R	Mosare
	Family Turnicidae					
72.	Barred Buttonquail <i>Turnix suscitator</i>	P	–	LC	R	Chirner

Sr. no.	Common/scientific names	Habitat	WPA schedule	IUCN status	R/M	Sites
73.	Yellow-legged Buttonquail <i>Turnix tanki</i>	P	-	LC	R/LM	Chirner
	Family Gruidae					
74.	Demoiselle Crane <i>Grus virgo</i>	W		LC	M	Sonari-Belpada
	Family Rallidae					
75.	Slaty-breasted Rail <i>Gallirallus striatus</i>	W/C	IV	LC	R	Kharghar Creek, Kalundre River
76.	Ruddy-breasted Crake <i>Porzana fusca</i>	W/C	IV	LC	R/LM	Kharghar Creek, Kalundre River
77.	Brown Crake <i>Porzana akool</i>	W/C	IV	LC	R	Chirner, Panje
78.	White-breasted Waterhen <i>Amaurornis phoenicurus</i>	W/C	IV	LC	R	Sonari-Belpada
79.	Watercock <i>Gallicrex cinerea</i>	W	IV	LC	R/LM	Sonari-Belpada (In September 2013)
80.	Purple Swamphen <i>Porphyrio [porphyrio] poliocephalus</i>	W	IV	LC	R	Sonari-Belpada
81.	Common Moorhen <i>Gallinula chloropus</i>	W	IV	LC	R	Sonari-Belpada
82.	Eurasian Coot <i>Fulica atra</i>	W	IV	LC	R/LM	Sonari-Belpada
	Family Jacanidae					
83.	Bronze-winged Jacana <i>Metopidius indicus</i>	W	IV	LC	R	Sonari-Belpada
84.	Pheasant-tailed Jacana <i>Hydrophasianus chirurgus</i>	W	IV	LC	R/LM	Sonari-Belpada
	Family Rostratulidae					
85.	Greater Painted Snipe <i>Rostratula benghalensis</i>	W	IV	LC	R	Sonari-Belpada
	Family Charadriidae					
86.	Grey Plover <i>Pluvialis squatarola</i>	W/MD	IV	LC	M	NRI Wetland, TSC Wetland
87.	Pacific Golden Plover <i>Pluvialis fulva</i>	W/MD	IV	LC	M	Kalundre river, TSC Wetland
88.	Greater Sand Plover <i>Charadrius leschenaultia</i>	W/MD	IV	LC	M	NRI Wetland

Sr. no.	Common/scientific names	Habitat	WPA schedule	IUCN status	R/M	Sites
89.	Lesser Sand Plover <i>Charadrius mongolus</i>	W/MD	IV	LC	M	All wetlands
90.	Common Ringed Plover <i>Charadrius hiaticula</i>	W/MD	IV	LC	M	Panje
91.	Little Ringed Plover <i>Charadrius dubius curonicus</i>	W/MD	IV	LC	R	All wetlands
92.	Kentish Plover <i>Charadrius alexandrinus seebohmi</i>	W/MD	IV	LC	M	All wetlands
93.	Red-wattled Lapwing <i>Vanellus indicus</i>	ALL	IV	LC	R	All wetlands
	Family Scolopacidae					
94.	Common Snipe <i>Gallinago gallinago</i>	W	IV	LC	M	Sonari-Belpada, Dastan Phata
95.	'Western' Black-tailed Godwit <i>Limosa limosa</i>	W	IV	NT	M	Sonari-Belpada,
96.	Eurasian Curlew <i>Numenius arquata</i>	W	IV	NT	M	NRI Wetland
97.	Eurasian Whimbrel <i>Numenius phaeopus</i>	W	IV	LC	M	Sonari-Belpada
98.	Terek Sandpiper <i>Xenus cinereus</i>	W/MC	IV	LC	M	Kharghar Creek, Kopar
99.	Common Greenshank <i>Tringa nebularia</i>	W/RS	IV	LC	M	Sonari-Belpada, NRI Wetland, TSC Wetland
100.	Wood Sandpiper <i>Tringa glareola</i>	W/MC	IV	LC	M	All wetlands
101.	Green Sandpiper <i>Tringa ochropus</i>	W/MC	IV	LC	M	Sonari-Belpada
102.	Common Sandpiper <i>Actitis hypoleucos</i>	W/MC	IV	LC	M	All wetlands
103.	Marsh Sandpiper <i>Tringa stagnatilis</i>	W	IV	LC	M	All wetlands
104.	Common Redshank <i>Tringa tetanus</i>	W/MC	IV	LC	M	All wetlands
105.	Spotted Redshank <i>Tringa erythropus</i>	W/MC	IV	LC	M	Jasai
106.	Ruddy Turnstone <i>Arenaria interpres</i>	W/RS	IV	LC	M	TSC Wetland
107.	Broad-billed Sandpiper <i>Limicola falcinellus</i>	W	IV	LC	M	Belpada, NRI Wetland, TSC Wetland
108.	Ruff <i>Philomachus pugnax</i>	W	IV	LC	M	Belpada, Panje

Sr. no.	Common/scientific names	Habitat	WPA schedule	IUCN status	R/M	Sites
109.	Great Knot <i>Calidris tenuirostris</i>	W	IV	EN	M	TSC Wetland
110.	Curlew Sandpiper <i>Erolia ferruginea</i>	W	IV	NT	M	Sonari-Belpada, Dastan Phata, NRI Wetland
111.	Dunlin <i>Ereunetes alpina</i>	W	IV	LC	M	Panje
112.	Temminck's Stint <i>Ereunetes temminckii</i>	W	IV	LC	M	All wetlands
113.	Little Stint <i>Ereunetes minutus</i>	W	IV	LC	M	All wetlands
114.	Sanderling <i>Ereunetes albus</i>	W	IV	LC	M	NMIA Creek
	Family Recurvirostridae					
115.	Pied Avocet <i>Recurvirostra avosetta</i>	W	IV	LC	M	Jasai, NRI Wetland
116.	Black-winged Stilt <i>Himantopus himantopus</i>	W	IV	LC	R/LM	All wetlands
	Family Phalaropidae					
117.	Red-necked Phalarope <i>Phalaropus lobatus</i>	W	IV	LC	M	Uran
	Family Laridae					
118.	Heuglin's Gull <i>Larus fuscus heuglini</i>	W	IV	LC	M	NRI Wetland, TSC Wetland, Panje
119.	Great Black-headed Gull <i>Ichthyaetus ichthyaetus</i>	W	IV	LC	M	Wetlands of NRI, TSC and Panje
120.	Slender-billed Gull <i>Chriococephalus genei</i>	W	IV	LC	M	NRI Wetland, TSC Wetland
121.	Brown-headed Gull <i>Chriococephalus brunnicephalus</i>	W	IV	LC	M	All wetlands
122.	Common Black-headed Gull <i>Chriococephalus ridibundus</i>	W	IV	LC	M	All wetlands
123.	Saunders' Tern <i>Sternula saundersi</i>	W/C	IV	LC	M	NRI Wetland, TSC Wetland
124.	Common tern <i>sterna hirundo</i>	W	IV	LC	M	Uran
125.	White-cheeked Tern <i>Sterna repressa</i>	W	IV	LC	M	Jasai Wetland
126.	Gull-billed Tern <i>Gelochelidon nilotica</i>	W	IV	LC	M	All wetlands
127.	River Tern <i>Sterna aurantia</i>	W/C	IV	LC	R/LM	All inland wetlands

Sr. no.	Common/scientific names	Habitat	WPA schedule	IUCN status	R/M	Sites
128.	Caspian Tern <i>Hydroprogne caspia</i>	W/C	IV	LC	M	NRI Wetland, TSC Wetland, Panje
129.	Whiskered Tern <i>Chlidonias hybrid</i>	W/C	IV	LC	M	NRI Wetland, TSC Wetland, Panje
	Family Rynchopidae					
130.	Indian Skimmer <i>Rynchops albicollis</i>	W	IV	VU	R/LM	NRI Wetland, Panje
131.	Family Columbidae					
132.	Rock Pigeon <i>Columba livia</i>	All /NH		LC	R	All areas
133.	Laughing Dove <i>Spilopelia senegalensis</i>	All	IV	LC	R	All areas
134.	Spotted Dove <i>Spilopelia chinensis</i>	All	IV	LC	R	All areas
135.	Eurasian Collared-dove <i>Streptopelia decaocto</i>	GS	IV	LC	R	All areas
136.	Grey-fronted Green-pigeon <i>Treron affinis</i>	F	IV	LC	R	Karnala Bird Sanctuary
137.	Yellow-footed Green-pigeon <i>Treron phoenicopterus chlorigaster</i>	F	IV	LC	R	Chirner, Mosare
	Family Psittacidae					
138.	Plum-headed Parakeet <i>Psittacula cyanocephala</i>	F	IV	LC	R	Karnala Bird Sanctuary
139.	Rose-ringed Parakeet <i>Psittacula krameri</i>	All	IV	LC	R	All areas
140.	Alexandrine Parakeet <i>Psittacula eupatria</i>	F	IV	NT	R	Chirner
	Family Cuculidae					
141.	Jacobin Cuckoo <i>Clamator jacobinus</i>	F	IV	LC	SM	Chirner, Karnala Bird Sanctuary
142.	Asian Koel <i>Eudynamys scolopaceus</i>	All	IV	LC	R	All areas
143.	Indian Cuckoo <i>Cuculus micropterus</i>	F	IV	LC	R	Chirner, Ransai, Mosare
144.	Common Hawk-cuckoo <i>Hierococcyx varius</i>	All	IV	LC	R	Mosare, Ransai
145.	Blue-faced Malkoha <i>Phaenicophaeus viridirostris</i>	All	IV	LC	R	Mosare

Sr. no.	Common/scientific names	Habitat	WPA schedule	IUCN status	R/M	Sites
146.	Sirkeer Malkoha <i>Taccocua leschenaultia</i>	All	IV	LC	R	Mosare
147.	'Southern' Coucal <i>Centropus [sinensis] parroti</i>	All	IV	LC	R	All areas
	Family Tytonidae					
148.	Common Barn-owl <i>Tyto alba</i>	NH	IV	LC	R	
	Family Strigidae					
149.	Indian Eagle-owl <i>Bubo bengalensis</i>	NH	IV	LC	R	Jasai
150.	Mottled Wood-owl <i>Strix ocellata</i>	F	IV	LC	R	Chirner
151.	Spotted Owlet <i>Athene brama</i>	F/NH	IV	LC	R	Mosare, Ransai
152.	Jungle Owlet <i>Glaucidium radiutum</i>	F	IV	LC	R	Karnala
	Family Caprimulgidae					
153.	Indian Jungle Nightjar <i>Caprimulgus indicus</i>	F	IV	LC	R	Ransai
154.	Indian Little Nightjar <i>Caprimulgus asiaticus</i>	A/GS	IV	LC	R	Ransai
	Family Apodidae					
155.	Asian Palm-swift <i>Cypsiurus balasiensis</i>	F/NH		LC	R	All areas
156.	Little Swift <i>Apus affinis</i>	NH		LC	R	All areas
	Family Alcedinidae					
157.	Black-capped Kingfisher <i>Halcyon pileata</i>	W/F	IV	LC	M	NRI Wetland
158.	White-throated Kingfisher <i>Halcyon smyrnensis</i>	All	IV	LC	R	All areas
159.	Common Kingfisher <i>Alcedo atthis</i>	W	IV	LC	R	All wetlands
160.	Lesser Pied Kingfisher <i>Ceryle rudis</i>	W	IV	LC	R	Panje
161.	Black-backed Dwarf Kingfisher <i>Ceyx erithaca</i>	F	IV	LC	BM	Mosare, Karnala Bird Sanctuary
	Family Meropidae					
162.	Blue-cheeked Bee-eater <i>Merops persicus</i>	GS/W		LC	PM	Sonari-Belpada, Panje
163.	Blue-tailed Bee-eater <i>Merops philippinus</i>	F/MC		LC	PM	Kharghar Creek, Panje, Sonari-Belpada

Sr. no.	Common/scientific names	Habitat	WPA schedule	IUCN status	R/M	Sites
164.	Little Green Bee-eater <i>Merops orientalis</i>	All		LC	R	All areas
	Family Coraciidae					
165.	European Roller <i>Coracias garrulous</i>	All	IV	LC	PM	Panje
166.	Indian Roller <i>Coracias benghalensis</i>	All	IV	LC	R	All wetlands areas
	Family Upupidae					
167.	Common Hoopoe <i>Upupa e. epops</i>	MC/GS		LC	R/LM	All areas
	Family Bucerotidae					
168.	Indian Grey Hornbill <i>Ocyrceros birostris</i>	F	I	LC	R	Mosare, Ransai
	Family Capitonidae					
169.	Coppersmith Barbet <i>Megalaima haemacephala</i>	F	IV	LC	R	Mosare, Ransai
170.	White-cheeked Barbet <i>Megalaima viridis</i>	F	IV	LC	R	All Forest areas
171.	Brown-headed Barbet <i>Megalaima zeylanica</i>	F	IV	LC	R	Mosare, Ransai
	Family Picidae					
172.	Eurasian Wryneck <i>Jynx torquilla</i>	F	IV	LC	M	Sonari-Belpada
173.	Heart-spotted Woodpecker <i>Hemicircus canente</i>	F	IV	LC	R	Karnala Bird Sanctuary
174.	Indian Pygmy Woodpecker <i>Dendrocopos nanus</i>	F	IV	LC	R	Karnala Bird Sanctuary
175.	Yellow-fronted Pied Woodpecker <i>Dendrocopos mahrattensis</i>	F	IV	LC	R	Mosare, Karnala Bird Sanctuary
176.	Rufous Woodpecker <i>Micropternus brachyurus</i>	F	IV	LC	R	Chirner, Karnala Bird Sanctuary
177.	Black-rumped Flameback <i>Dinopium benghalense</i>	F	IV	LC	R	Ransai, Karnala Bird Sanctuary
178.	Greater Flameback <i>Chrysocolaptes guttacristatus</i>	F	IV	LC	R	Ransai, Karnala
	Family Pittidae					
179.	Indian Pitta <i>Pitta brachyura</i>	F	IV	LC	BM	Mosare, Karnala

Sr. no.	Common/scientific names	Habitat	WPA schedule	IUCN status	R/M	Sites
	Family Alaudidae					
180.	Malabar Lark <i>Galerida malabarica</i>	ALL	IV	LC	R	All wetlands areas
181.	Ashy-crowned Finch-lark <i>Eremopterix griseus</i>	GS	IV	LC	R	Uran
182.	Rufous-tailed Lark <i>Ammomanes phoenicura</i>	All	IV	LC	R	All Grassland areas
183.	Greater Short-toed Lark <i>Calendrella brachydactyla longipennis</i>					
	Family Hirundinidae					
184.	Dusky Crag Martin <i>Ptyonoprogne concolor</i>	All	IV	LC	R	All areas
185.	Barn Swallow <i>Hirundo rustica</i>	W	IV	LC	M	All areas
186.	Wire-tailed Swallow <i>Hirundo smithii</i>	All	IV	LC	R	All areas
	Family Motacillidae					
187.	Yellow Wagtail <i>Motacilla flava</i>	W/M	IV	LC	M	All areas
188.	Grey Wagtail <i>Motacilla cinerea</i>	W	IV	LC	M	All areas
189.	Citrine Wagtail <i>Motacilla citreola</i>	W/M	IV	LC	M	All areas
190.	White Wagtail <i>Motacilla alba dukhunensis</i>	W	IV	LC	M	All areas
191.	White-browed Wagtail <i>Motacilla maderaspatensis</i>	W	IV	LC	R	All areas
192.	Tree Pipit <i>Anthus t. trivialis</i>	P/GS	IV	LC	M	All areas
193.	Paddyfield Pipit <i>Anthus rufulus</i>	ALL	IV	LC	R	All areas
	Family Campephagidae					
194.	Common Woodshrike <i>Tephrodornis pondicerianus</i>	F	IV	LC	R	Mosare
195.	Black-headed Cuckoo-shrike <i>Lalage melanoptera</i>	F	IV	LC	R	Ransai
196.	Large Cuckoo-shrike <i>Coracina macei</i>	F	IV	LC	R	Ransai
197.	Orange Minivet <i>Pericrocotus flammeus</i>	F	IV	LC	R	Ransai
198.	Small Minivet <i>Pericrocotus cinnamomeus</i>	F	IV	LC	R	Mosare
	Family Pycnonotidae					

Sr. no.	Common/scientific names	Habitat	WPA schedule	IUCN status	R/M	Sites
199.	Red-vented Bulbul <i>Pycnonotus cafer</i>	All	IV	LC	R	All areas
200.	Red-whiskered Bulbul <i>Pycnonotus jocosus</i>	F/MC	IV	LC	R	All areas
201.	White-eared Bulbul <i>Pycnonotus leucotis</i>	MC	IV	LC	R	All areas
202.	White-browed Bulbul <i>Pycnonotus luteolus</i>	F	IV	LC	R	Chirner
	Family Irenidae					
203.	Common Iora <i>Aegithina tiphia</i>	F	IV	LC	R	Ransai
204.	Gold-fronted Leafbird <i>Chloropsis aurifrons</i>	F	IV	LC	R	Ransai, Mosare
	Family Laniidae					
205.	'Rufous-backed' Long-tailed Shrike <i>Lanius schach erythronotus group</i>	All	IV	LC	R/LM	All areas
206.	Great Grey Shrike <i>Lanius excubitor lathora/pallidirostris</i>	GS	IV	LC	R	Chirner
207.	Isabelline Shrike <i>Lanius isabellinus</i>	GS	IV	LC	R	Belpada
208.	Bay-backed Shrike <i>Lanius vittatus</i>	All	IV	LC	R	All areas
	Family Muscicapidae					
	Subfamily: Turdinae					
209.	Blue Rock-thrush <i>Monticola solitaries</i>	GS	IV	LC	M	Karnala Bird Sanctuary
210.	Blue-headed Rock-thrush <i>Monticola cinclorhynchus</i>	F	IV	LC	M	Karnala Bird Sanctuary
211.	Orange-headed Thrush <i>Zoothera citrina</i>	F	IV	LC	R/LM	Ransai
212.	Malabar Whistling-thrush <i>Myophonus horsfieldi</i>	F	IV	LC	R	Ransai
213.	Bluethroat <i>Luscinia s. svecica</i>	MC	IV	LC	M	Sonari-Belpada, Kharghar Creek,
214.	Oriental Magpie-robin <i>Copsychus saularis</i>	All	IV	LC	R	All areas
215.	White-rumped Shama <i>Copsychus malabaricus</i>	F	IV	LC	R	Ransai
216.	Indian Black Robin <i>Copsychus fulicatus</i>	All	IV	LC	R	All areas

Sr. no.	Common/scientific names	Habitat	WPA schedule	IUCN status	R/M	Sites
217.	Black Redstart <i>Phoenicurus ochruros rufiventris</i>	GS	IV	LC	M	Mosare
218.	Pied Bushchat <i>Saxicola caprata</i>	All	IV	LC	R	All areas
219.	Siberian Stonechat <i>Saxicola m. maurus/indicus</i>	All	IV	LC	M	All areas
220.	Isabelline Wheatear <i>Oenanthe isabellina</i>	GS	IV	LC	M	Uran
221.	Desert Wheatear <i>Oenanthe d. deserti</i>	GS	IV	LC	M	Uran
	Subfamily: Timaliinae					
222.	Indian Scimitar-babbler <i>Pomatorhinus horsfieldii</i>	F	IV	LC	R	Chirner, Mosare
223.	Tawny-bellied Babbler <i>Dumetia hyperythra</i>	F	IV	LC	R	Mosare
224.	Yellow-eyed Babbler <i>Chrysomma sinense</i>	F	IV	LC	R	Chirner
225.	Jungle Babbler <i>Turdoides striata</i>	F	IV	LC	R	Ransai, Mosare
226.	Puff-throated Babbler <i>Pellorneum ruficeps</i>	F	IV	LC	R	Mosare
227.	Brown-cheeked Fulvetta <i>Alcippe poioicephala</i>	F	IV	LC	R	Ransai
	Subfamily: Sylviinae					
228.	Zitting Cisticola <i>Cisticola juncidis</i>	MC	IV	LC	R	Sonari-Belpada
229.	Ashy Prinia <i>Prinia socialis</i>	All	IV	LC	R	All areas
230.	Grey-breasted Prinia <i>Prinia hodgsonii</i>	G	IV	LC	R	Mosare
231.	Jungle Prinia <i>Prinia sylvatica</i>	F	IV	LC	R	Karnala
232.	Plain Prinia <i>Prinia inornata</i>	All	IV	LC	R	All areas
233.	Blyth's Reed-Warbler <i>Acrocephalus dumetorum</i>			LC		
234.	Paddyfield Warbler <i>Acrocephalus Agricola</i>	M		LC	M	NRI
235.	Indian Reed-warbler <i>Acrocephalus [stentoreus] brunnnescens</i>	MS	IV	LC	R/LM	All mangrove areas
236.	Common Tailorbird <i>Orthotomus sutorius</i>	All	IV	LC	R	All areas
237.	Siberian Chiffchaff <i>Phyloscopus [collybita] tristis</i>			LC	M	NRI

Sr. no.	Common/scientific names	Habitat	WPA schedule	IUCN status	R/M	Sites
238.	Sulphur-bellied Warbler <i>Phyloscopus griseolus</i>			LC	M	Karnala
239.	Lesser Whitethroat <i>Sylvia curruca halimodendri</i>	GS	IV	LC	M	Panje
	Subfamily: Muscicapinae					
240.	Tickell's Blue Flycatcher <i>Cyornis tickelliae</i>	F	IV	LC	R/LM	Ransai, Karnala Bird Sanctuary, Morbe
241.	Asian Brown Flycatcher <i>Muscicapa latirostris</i>	MC	IV	LC	R/LM	Kopar
242.	Red-breasted Flycatcher <i>Ficedula parva</i>	GS/F	IV	LC	M	Mosare
243.	Grey-headed Canary-flycatcher <i>Culicicapa ceylonensis</i>	F	IV	LC	R/LM	Ransai
	Subfamily: Monarchinae					
244.	Asian Paradise Flycatcher <i>Terpsiphone paradisi</i>	F	IV	LC	R/BM	Ransai, Karnala Bird Sanctuary, Chirner
245.	Black-naped Blue Monarch <i>Hypothymis azurea</i>	F	IV	LC	R	Karnala Bird Sanctuary, Morbe
	Subfamily: Rhipidurinae					
246.	White-browed Fantail <i>Rhipidura albicollis</i>	MC	IV	LC	R	NRI Wetland
247.	White-spotted Fantail <i>Rhipidura albogularis</i>	MC	IV	LC	R	NRI Wetland
	Family Paridae					
248.	Cinereous Tit <i>Parus cinereus</i>	NH	IV	LC	R	Panje
	Family Dicaeidae					
249.	Thick-billed Flowerpecker <i>Pachyglossa agile</i>	F	IV	LC	R	Ransai, Karnala Bird Sanctuary, Chirner.
250.	Pale-billed Flowerpecker <i>Dicaeum erythrorhynchos</i>	F	IV	LC	R	Ransai, Karnala
	Family Nectariniidae					
251.	Purple Sunbird <i>Cinnyris asiaticus</i>	All	IV	LC	R	Ransai, Karnala

Sr. no.	Common/scientific names	Habitat	WPA schedule	IUCN status	R/M	Sites
252.	Purple-rumped Sunbird <i>Leptocoma zeylonica</i>	GS	IV	LC	R	Ransai, Karnala Bird Sanctuary, Chirner
253.	Small Sunbird <i>Leptocoma minima</i>	F	IV	LC	R	Ransai
254.	Vigors' Sunbird <i>Aethopyga vigorsii</i>	F	IV	LC	R	Ransai
255.	Loten's Sunbird <i>Cinnyris lotenius</i>	F	IV	LC	R	Karnala Bird Sanctuary
	Family Emberizidae					
256.	Black-headed Bunting <i>Emberiza melanocephala</i>	GS	IV	LC	M	NMIA
257.	Red-headed Bunting <i>Emberiza bruniceps</i>	GS	IV	LC	M	NMIA
258.	Grey-necked Bunting <i>Emberiza buchanani</i>	GS		LC	M	
	Family Fringillidae					
259.	Common Rosefinch <i>Erythrina erythrina roseate</i>	GS	IV	LC	M	Mosare
	Family Estrildidae					
260.	Indian Silverbill <i>Euodice malabarica</i>	P	IV	LC	R	All areas
261.	Red Avadavat <i>Amandava amandava</i>	W/MC	IV	LC	R	Sonari-Belpada, TSC Wetland
262.	Tricoloured Munia <i>Lonchura Malacca</i>	MC	IV	LC	R	Kharghar Creek, TSC Wetland
263.	Scaly-breasted Munia <i>Lonchura punctulata</i>	MC/F	IV	LC	R	Kharghar Creek, TSC Wetland, Mosare
264.	White-rumped Munia <i>Lonchura striata</i>	F	IV	LC	R	Mosare
	Family Passeridae					
	Subfamily Passerinae					
265.	House Sparrow <i>Passer domesticus</i>	All	IV	LC	R	All areas
266.	Yellow-throated Sparrow <i>Gymnoris xanthocollis</i>	F/GS	IV	LC	R	Uran, Mosare
	Subfamily Ploceinae					

Sr. no.	Common/scientific names	Habitat	WPA schedule	IUCN status	R/M	Sites
267.	'Indian' Baya Weaver <i>Ploceus p. philippinus</i>	All	IV	LC	R	All areas
268.	Streaked Weaver <i>Ploceus manyar</i>	GS				Belpada
269.	Black-breasted Weaver <i>Ploceus benghalensis</i>	All	IV	LC	R	All areas
	Family Sturnidae					
270.	Rosy Starling <i>Pastor roseus</i>	All	IV	LC	M	All areas
271.	Brahminy Starling <i>Sturnia pagodarum</i>	GS	IV	LC	R	All areas
272.	Grey-headed Starling <i>Sturnia malabarica</i>	GS	IV	LC	R/LM	TSC Wetland
273.	Malabar White-headed Starling <i>Sturnia blythii</i>	GS	IV	LC	R	TSC Wetland
274.	Asian Pied Starling <i>Gracupica contra</i>	GS	IV	LC	R	All areas
275.	Common Myna <i>Acridotheres tristis</i>	All	IV	LC	R	All areas
276.	Jungle Myna <i>Acridotheres fuscus</i>	All	IV	LC	R	All areas
	Family Oriolidae					
277.	Indian Golden Oriole <i>Oriolus kundoo</i>	All	IV	LC	R/LM	All areas
278.	Black-hooded Oriole <i>Oriolus xanthornus</i>	F	IV	LC	R	Ransai
279.	Black-naped Oriole <i>Oriolus chinensis diffuses</i>	F	IV	LC	M	Ransai
	Family Dicruridae					
280.	Black Drongo <i>Edolius macrocercus</i>	All	IV	LC	R	All areas
281.	Ashy Drongo <i>Edolius leucophaeus</i>	F	IV	LC	M	Ransai
282.	Bronzed Drongo <i>Chaptia aenea</i>	F	IV	LC	R	Karnala
283.	White-bellied Drongo <i>Edolius caerulescens</i>	F	IV	LC	R	Ransai
284.	Greater Racket-tailed Drongo <i>Dicrurus paradiseus</i>	F	IV	LC	R	Ransai, Karnala
	Family Corvidae					
285.	House Crow <i>Corvus splendens</i>	NH	V	LC	R	All areas
286.	Indian Jungle Crow <i>Corvus [macrorhynchos] culminatus</i>	All	IV	LC	R	All areas
287.	Rufous Treepie <i>Dendrocitta vagabunda</i>	F	IV	LC	R	Mosare

ANNEX VI) GLIMPSES OF STUDY SITES



Image 39 – Wetland behind TS Chanakya, Palm Beach road



Image 40 Wetland behind NRI complex, Palm Beach road



Image 41 – Wetland near DPS, Palm Beach Road



Image 42 Avifauna in various wetlands differs according to the water level. While gulls and coots can be seen feeding in deep water, waders are usually found in shallow areas



Image 43 Belpada wetland before landfilling



Image 44 – Belpada wetland in 2014, after landfilling



Image 45 Belpada wetland before landfilling during monsoon season



Image 46 Belpada wetland after landfilling during dry season



Image 47 View of proposed NMIA site from Kalamboli-Uran road



Image 48 Panje-Funde wetland, Uran



Image 49 Karnala Bird Sanctuary



Image 45 Moist deciduous forest patch at Ransai



Image 51 Moist deciduous forest patch at Mosare



Image 46 Moist deciduous forest patch Chirner

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