ANNUAL REPORT

Baseline Survey of Avian fauna at and around Proposed Navi Mumbai International Airport (NMIA)

BNHS INDIA CONSERVING NATURE SINCE 1883

2012

CIDCO WE MAKE CITIES

Address of the BNHS
Bombay Natural History Society,
Hornbill House, S.B. Singh Road,
Mumbai 400 001, Maharashtra, India.
Tel.: (91-22) 2282 1811
Fax: (91-22) 2283 7615
Email – info@bnhs.org

Cover design and page layout: Mr. Sachin Chorge

Photo credits – NMIA team, BNHS.

Recommended citation
Narwade, S.S., M. V. Prabhu, P. A. Shaikh & A. R. Rahmani (2012): Baseline Survey of Avianfauna At And Around Proposed Navi Mumbai International Airport (NMIA). Submitted by BNHS, India. 87Pp.

Annual Report

Baseline Survey of Avianfauna At And Around Proposed Navi Mumbai International Airport (NMIA)

Principal Investigator

Asad R. Rahmani

Co-investigator

Sujit S. Narwade

Research fellows

Mr. Mrugank Prabhu

Ms. Parveen Shaikh

BNHS India Conserving Nature Since 1883

CIDCO We Make Cities

CONTENT

CONTENTS

Executive Summary of the Annual Report: 2011-2012

The Ministry of Civil Aviation, Govt. of India has granted approval to Govt. of Maharashtra for setting up a Greenfield airport through Public-Private Partnership (PPP) at Navi Mumbai, Maharashtra. The Govt. of Maharashtra in turn appointed City & Industrial Development Corporation Ltd. (CIDCO), as a Nodal Agency for the implementation of Navi Mumbai International airport project.

The Ministry of Environment and Forests (MoEF) has given the clearance to this project on the basis of some conditions. One of the conditions (condition no. xxxi provided under specific conditions) is that a baseline avifaunal study shall be carried out in consultation with BNHS by CIDCO, Navi Mumbai, Government of Maharashtra and details shall be put up every three months on the website.

CIDCO, Navi Mumbai, approached BNHS and awarded the project for conducting the abovementioned study for five years, including before construction, during construction, and during operational phases of the NMIA. Team mobilization and actual field visits by the BNHS team was started from December 2011.

This annual report discusses the documentation of bird diversity and species composition in the various habitats in a 10 km radius area of NMIA. Thus the total area covered was nearly 314 sq. km. A total of 220 species belonging to 52 families were recorded during the study period. Wetland birds were observed congregating and moving towards larger waterbodies as smaller waterbodies dry in summer. In summer our aim was to study the distribution and movement of birds in the survey area and compare it to the winter area. It was found that easy access to mangroves and mudflats during summer and late winter enabled us to reach in remote areas.

In monsoon, most of the creeks and coastal areas were inaccessible because of tall monsoon vegetation and heavy rains. Factors such as tide timing, hunting, and rapid changes in habitat are found to be influential in the distribution of birds. Therefore, impact of such factors on the avifauna of the region should be evaluated with the help of further scientific studies.

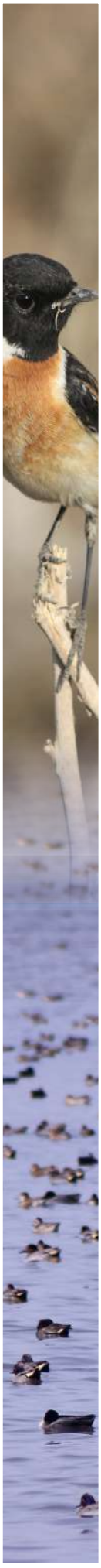
Chapter 1: This discusses the background of the project and project site details. It also includes information on the importance of bird hazard problem studies.

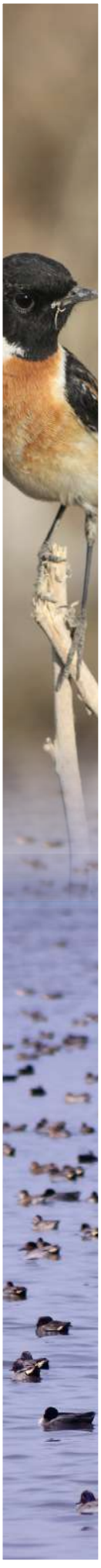
Chapter 2: This chapter includes review of literature from 1880 to 2012 on the avifauna of Mumbai and adjoining areas, and also contains some old and changed names of bird species and places to avoid confusion.

Chapter 3: This chapter covers details about the study area including maps, and details of the selected sites.

Chapter 4: This chapter covers the methodology used for the study as well as for writing the annual report.

Chapter 5: This chapter includes compilation of the bird hazard problems and in practice remedial measures adopted by various countries to avoid bird strikes.





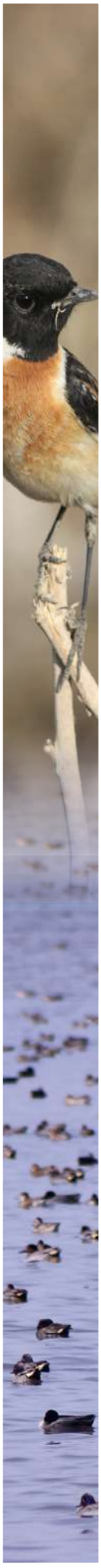
Chapter 6: Results of observations carried out extensively in 10 km radius area of NMIA and intensive surveys conducted in selected sites are provided in this chapter. Information on resident and migratory birds, along with information on impact of tide levels on their distribution and movement has also been provided. Additional notes on threatened birds, threats, and conservation are discussed. Finally we have given our conclusion, mentioning the way forward and the need for further study.

Abbreviations used:

1) **NMIA -** Navi Mumbai International Airport
2) **BNHS -** Bombay Natural History Society
3) **JNPT -** Jawaharlal Nehru Port Trust
4) **EIA -** Environmental Impact Assessment
5) **Habitats: P -** Paddyfield, **GS -** Mixed habitat of Grassland and Shrubland, RS - Rocky Seashore, **W -** Wetland, **MD -** Mudflats, **MC -** Mangrove and Creeks, **NH -** Near Human habitation, **F -** Forest
6) **Threat categories: EN -** Endangered, **VU -** Vulnerable, **NT -** Near threatened
7) **Type of movements: R -** Resident, **M -** Migratory

Demoiselle Crane

Chapter I : Introduction



1.1 Background

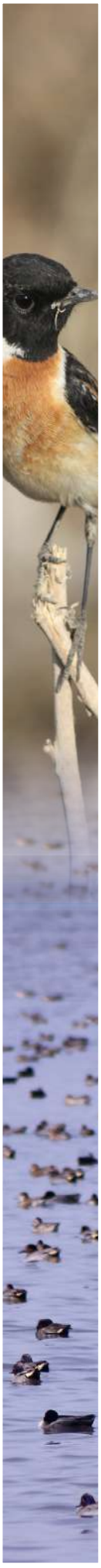
Navi Mumbai is a city on the west coast of Maharashtra, India. It was developed in 1972 as a twin city of Mumbai. Navi Mumbai lies on the mainland on the eastern shore of Thane Creek. The city limits stretch from Airoli near Thane in the north, to Uran in the south. When Navi Mumbai was developed in the 1970s, City and Industrial Development Corporation (CIDCO) was the authority that looked after the development and maintenance of the city. CIDCO prepared a developmental plan for Navi Mumbai, covering 95 villages from Thane and Raigad districts.

1.2 Brief description of the proposed airport project

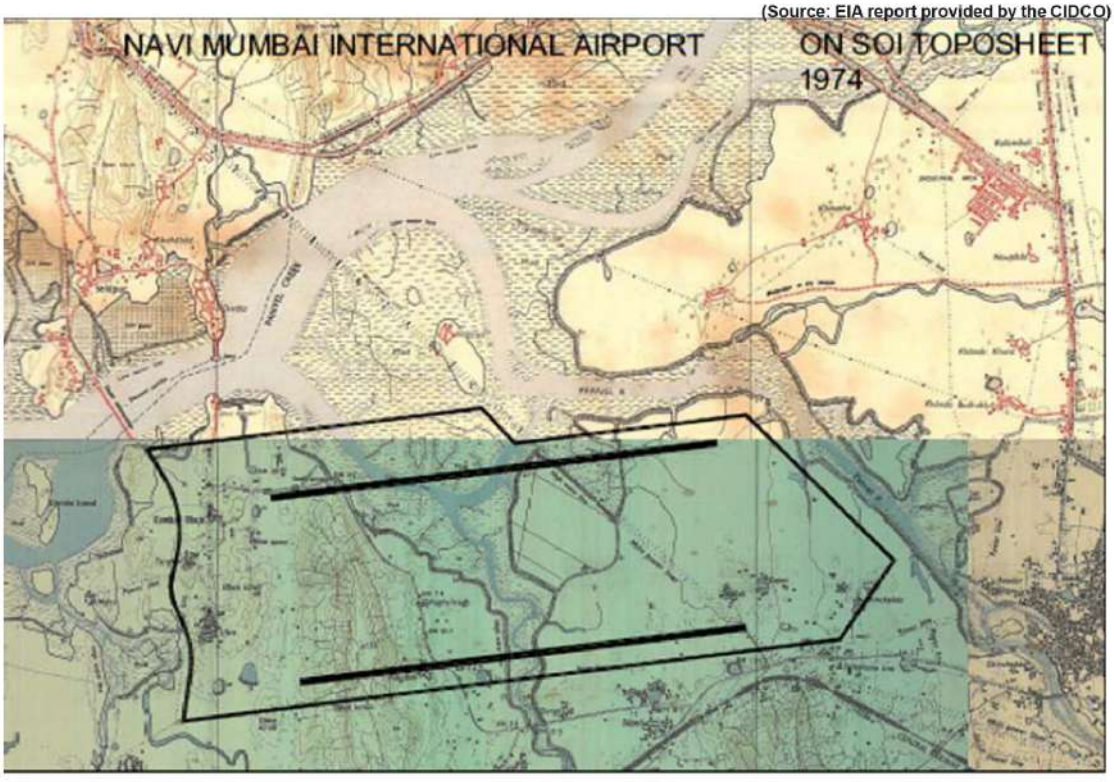
The need for a second airport in Mumbai region has become inescapable and imperative, as the existing airport at Mumbai is fast reaching saturation level and scope for further enhancement of passenger and cargo handling facilities, aircraft maintenance, and city side facilities are limited. Therefore CIDCO, Navi Mumbai proposes to set up a new international airport at Navi Mumbai, Maharashtra. The land required for the project is located in an area of 1,160 hectares (2,867 acres) accommodating two parallel runways for independent operation. It is proposed to be commissioned in 2014. The Ministry of Environment and Forests (MoEF) 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.

1.3 Location and description of site

The site is approachable from Mumbai-Pune Highway via Navi Mumbai. The International Airport area is surrounded by 10 villages, namely Kambad Bhuje, Ganeshpuri, Ulve, Mulgaon, Vaghiliwada, Owle, Pargaon, Kopar, Koli, and Chinchpada.



(Source: EIA report provided by the CIDCO)



1.4 Introduction to the Bird Strike Problem

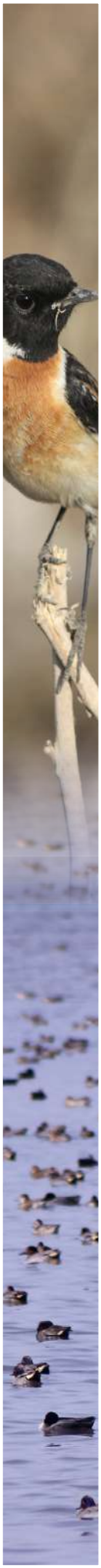
Throughout history, humans have been intrigued and inspired by the beauty of birds and their ability to fly. Birds first took to the air about 150 million years ago. Humans first began to share their airspace only 100 years ago. Unfortunately, when aircraft and birds attempt to use the same airspace at the same time, collisions occur.

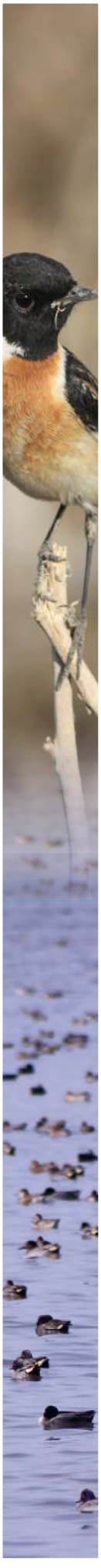
Bird strikes have been a concern to aviation safety from the early days of powered flight. The first fatality due to a bird strike was caused in 1912 when a Wright Flyer encountered a flock of gulls whilst conducting a demonstration flight along a beach. It was found that one of the gulls had jammed the rudder control, causing the aeroplane to dive into the surf. The pilot suffered a broken neck (Maragakis 2009).

1.5 Importance of wild life/bird hazard management

Collisions between aircraft and avifauna are a concern throughout the world because they threaten passenger safety (Thrope 1997), result in loss of revenue and costly repairs to aircraft (Milsom & Horton, 1995), and can 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 populations of certain bird species (e.g., gulls, crows, kites) 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 size in comparison to modern aircraft, the impact energy in collisions increases with the square of the relative impact speed (CAA UK-SRG, 2002).

Lesser Flamingoes in flight





Chapter II : Literature Review of The Bird Life of Mumbai and Adjoining Areas

Review of Literature on the avifauna of Mumbai and adjoining areas

Mumbai is bounded by the Arabian Sea to the west and geographically constituted by the erstwhile seven islands in the south and the suburbs stretching upto Dahisar and Mulund. Mumbai has always been a hotspot for many migratory birds because of the coastal habitat as well as continuity to the Western Ghats region.

"Birds of the southern portion of the Bombay Presidency" was one of the oldest available publications on birds of Mumbai (Butler 1880). Protection of wild birds in the Bombay Presidency was documented for the first time in the early 20th century (Anon. 1906). Some of the oldest 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). Another attempt at documentation was in the form of "The Common Birds of Bombay" carried out by Aitken (1947).

A series of publications by Humayun Abdulali laid the foundation of scientific study of birds in Mumbai and adjoining areas. His observations, notes, and sight records enriched the information on the birds of Mumbai. His literature on Koel brood parasitism (Abdulali 1931), the sun as a mortality factor among young birds (Abdulali 1939), local movements of Painted Partridge Francolinus pictus around Mumbai (Abdulali 1943), extension of breeding range of Stilt (Himantopus h. 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 Woodpecker Chrysocolaptes festivus and other nesting notes near Mumbai (Abdulali 1985) are some of the best natural history descriptions available on the birds of Mumbai.

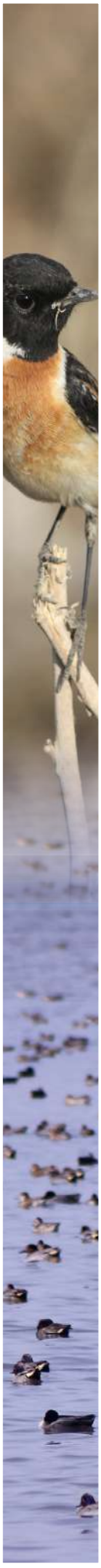
Occurrence of birds such as White-cheeked Bulbul in Salsette (Abdulali 1934), Grey-fronted Green Pigeon in Colaba (Abdulali 1935), swifts and terns at Vengurla Rocks (Abdulali 1940), Great Black Woodpecker in Mumbai region (Abdulali 1941), the terns and Edible-nest Swiftlets at Vengurla, west coast of India (1942), Wilson's Petrel (Abdulali 1948), Blue-tailed Bee-eater *Merops superciliosus javanicus* (Abdulali 1950a), White-winged Black Tern *Chlidonias leucopterus* (Abdulali 1950b), Red Spurfowl *Galloperdix spadicea* (Abdulali 1952), White-tailed Lapwing *Chettusia leucura* (Abdulali 1952b), *Cuculus canorus* bakeri (Abdulali 1954), Grey Junglefowl (Abdulali 1957), Large Whistling-Teal *Dendrocygna bicolor* (Abdulali 1958), Least Frigate Bird *Fregata ariel* (Abdulali 1960), Small Indian Swallow Plover presently known as Small Pratincole *Glareola lactea* (Abdulali 1962), Large White-rumped Swift *Apus pacificus leuconyx* (Abdulali 1963), Painted Partridge *Francolinus pictus* (Abdulali 1964, 1965), Finsch's Starling *Sturnus vulgaris poltaratskyi* (Abdulali 1965), Black-headed Munia *Lonchura m. malacca* (Abdulali 1965c), Black-necked Stork

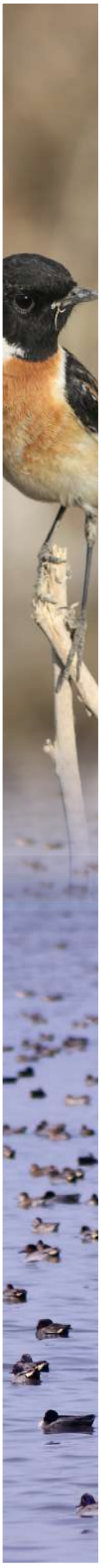
Xenorhynchus asiaticus (Abdulali 1967a), Swinhoe's Snipe *Capella megala* (Abdulali 1970), Common Grey Hornbill *Tockus birostris* and nesting of Tickell's Flycatcher (Abdulali 1979), Pink-footed Shearwater *Procellaria carneipes* (Abdulali & Grubh, 1982) and Black-eared Kite *Milvus migrans lineatus* (Abdulali & Sethna, 1982) were documented for the first time by Humayun Abdulali. His notes on Pied Myna and Bank Myna (Abdulali 1953), and extension of range of I*xobrychus minutus minutus* are first reported addition to the avifauna of Mumbai area (Abdulali & Grubh, 1966).

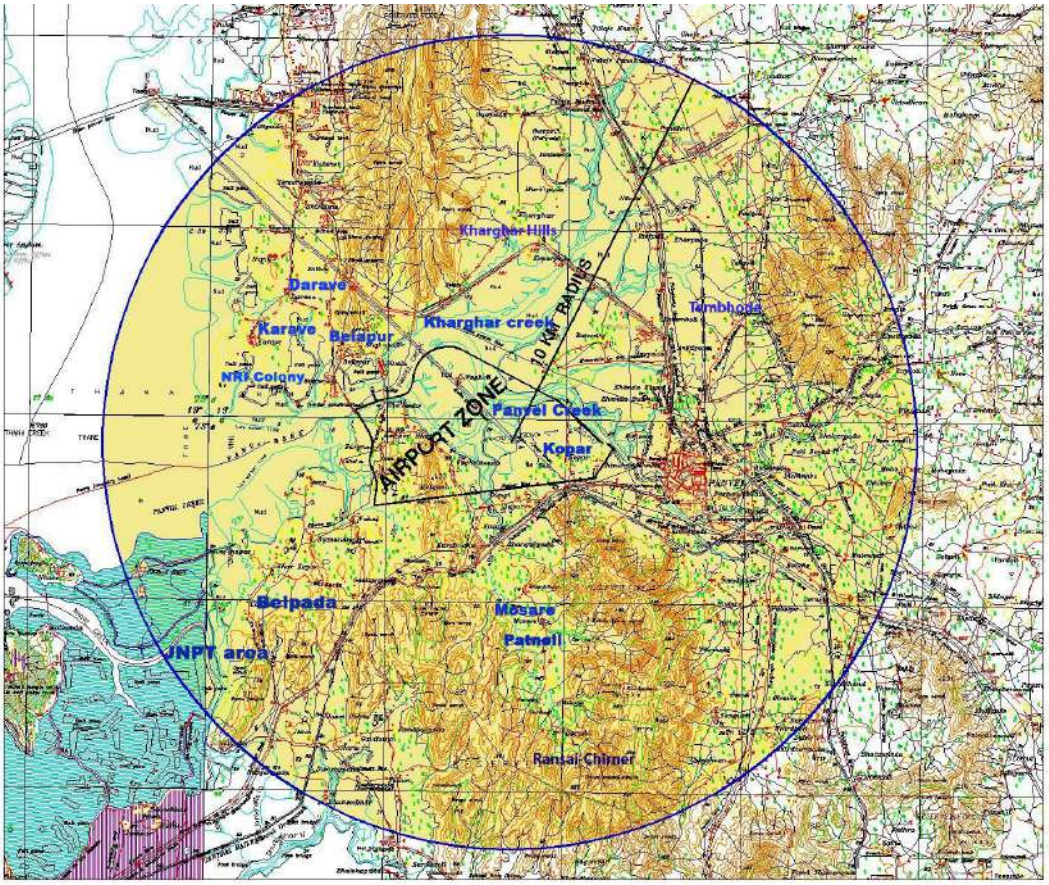
Apart from these publications, Humayun Abdulali published a comprehensive checklist of the birds of Borivli National Park, at present known as Sanjay Gandhi National Park, with notes on their status (Abdulali, 1981a, 1986) and checklist of the birds of Maharashtra with notes on their status around Mumbai (Abdulali& Ali 1940, Abdulali 1981b).

Some other publications include literature on pitta and crows (Soman 1963), pugnacious behaviour of breeding White-browed Fantail Flycatcher at Cumballa Hills, Mumbai (Tyabji 1964), strange feeding habit of Little Green Bittern (Rao 1965), 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), adult birds' concern for young of other birds (Serrao 1973), Jungle Babblers at Pali Hill, Bandra (Ali 1974), sandpipers at a suburban marsh (Akhtar 1977), lack of traffic sense amongst Indian Rollers observed on Mumbai-Goa Highway (Goenka 1986), biometrics and food of some harriers (Satheesan et al. 1991) and scavenging by Cattle Egret (Serrao 1993).

Flamingos were found continuously visiting Sewri in thousands (Sowrirajan 1994, Ali 2006, Woodward 2007). Threatened birds such as Indian Darter, Lesser Flamingo, Indian White-backed Vulture, Greater Spotted Eagle, Eastern Imperial Eagle, and Black-bellied Tern were observed during a preliminary survey carried out at Mahul Creek (Verma *et al*. 2004). This led to the declaration of the area as an Important Bird Area (IBA) (Islam & Rahmani 2004). Due to land filling and development of Jawaharlal Nehru Port at Uran, the habitat in Navi Mumbai has changed drastically (BUCEROS newsletter special issue 2010, Sarkar 2007). 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 Khargar Hills in Navi Mumbai. Threatened birds such as Greater Spotted Eagle *Aquila clanga* (VU) and Pallid Harrier *Circus macrourus* (NT) 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 birding 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) of Navi Mumbai (Vaylure *et al*. 2008).






Kharghar Hills
Darave
Karave
Belapur
Kharghar creek
10 KM RADIUS
Tembhona
NRI Colony
AIRPORT ZONE
Panvel Creek
Kopar
Belpada
Mosare
Patnell
JNPT area
Ransai Chirner


Kharghar Hill
Kharghar Creek
Seashore
NRI Lake
NMIA Site
Mosare
Dastan fata Lake
Morbe area
Chirner
Karnala Bird Sanctuary
Ransai Forest

Chapter III : Study area (Map 2)

Initially the entire 10 km radius area around NMIA was surveyed. Later the study was concentrated in the following areas excluding industrial areas and dense human habitations. (For details please see table no. 1 and maps provided on page 8.)

As compared to earlier studies of first (winter) and second (summer) tri-monthly surveys (December 2011 to May 2012), in monsoon we were able to reach fewer areas because of restrictions in road accessibility due to heavy rain and tall vegetation.

1. Proposed site of NMIA: This includes mangroves and backwaters near villages such as Kombadbhuja, Ulve, Dungi, Pargaon, Chinchpada, and Kopar, as well as creeks of Gadhi, Ulve, Kalamboli and Panvel. Data was collected from wetlands, creeks, paddyfields, mangroves, mudflats, open scrubland/shrubland, and from near human habitation.

2. North-West: This includes grassland/shrubland and seashore area parallel to Palm Beach Road and part of Airoli Creek, water bodies in between NRI Complex-DPS School, behind TS Chanakya (Karave area) on Palm Beach Road, Belapur Pond and part of Parsik Hills.

3. North-East: This block includes areas of Taloja, Panvel, Tembhode, Kewale, Nere, and Pali. Area near Pali and Nere is hilly.

4. South-West (Uran-JNPT area): Includes small wetlands and mangroves spread all over the region near the villages Jasai, Sonari-Belpada, Gawhan, Uran, Jaskhar, and Funde.

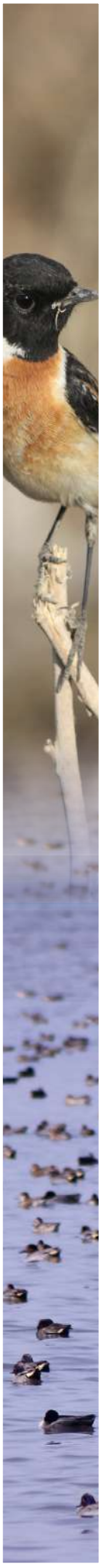
5. South-East (Hilly areas): This block mainly consists of the reserve forest patches in areas adjoining villages such as Mosare, Patnoli, and Ransai. This southern moist mixed deciduous forest patch was recently added to Karnala Bird Sanctuary. National Highway 17 cuts through this Sanctuary.

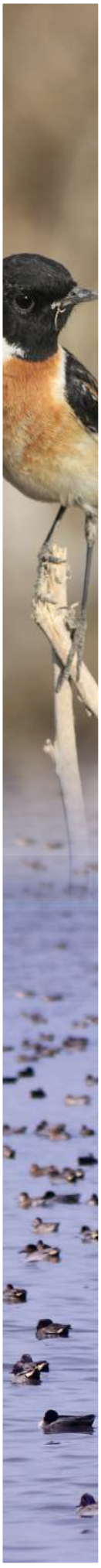
Based on earlier surveys from December 2011 to May 2012, we focused on the following areas for study of distribution and movement of birds.

1. 1) Sonari-Belpada: This is an area near village Sonari-Belpada reachable from Panvel-JNPT road, 2 to 3 km from Jasai village. Main wetland is just 500 m from the toll plaza towards the container yard of Speedy Company. It is surrounded by a large landfilled area with grasses and shrubs on three sides and Speedy Company on the fourth side. Towards the village area there are saltpans followed by mangroves and coastal mudflats. Many waders were seen foraging here during low tide. Such mosaic habitats attract large numbers of birds.

2. Panvel Creek: Lies on the boundary of the proposed airport area near Kopar and Pargaon villages, where flocks of waders were usually seen on the rock bed during low tide.

3. Kharghar Creek: Lies between Kharghar and Mansarovar stations. It is a mangrove rich area





and many birds were sighted on the edges of the creek during low tide.

4. Palm Beach Road: The two most important wetlands in this region, one behind NRI Complex and the second behind TS Chanakya of Palm Beach Road. These wetlands are followed by paddy fields, trees, mangroves, and finally seashore from Palm Beach Road towards seaside. It was observed that the majority of waterbirds preferred to congregate in this area during summer season.

5. Mosare-Patnoli: This area lies on the eastern side of Panvel-JNPT road and consists of a rich forest with less human disturbance where many raptor species were observed.

6. Ransai-Chirner: This is a hilly area and can be reached from two sides, viz. from Panvel-JNPT road as well as from Panvel-Goa road (for details please see map). The area shares a boundary with Karnala Bird Sanctuary. Many forest dwelling birds can be sighted here.

7. JNPT area: There are many small scattered wetlands across the JNPT-Uran area used by waders during low tide. For example, in a wetland near Jaskhar village, Black-tailed Godwit were observed till the end of the summer season.

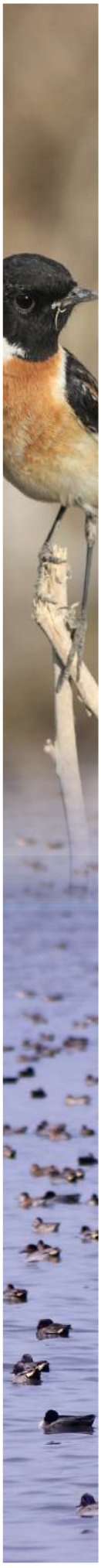
8. Proposed NMIA site: As there is no construction activity going on in this area at the moment, many birds were observed in the mangroves interspersed by smaller waterbodies.

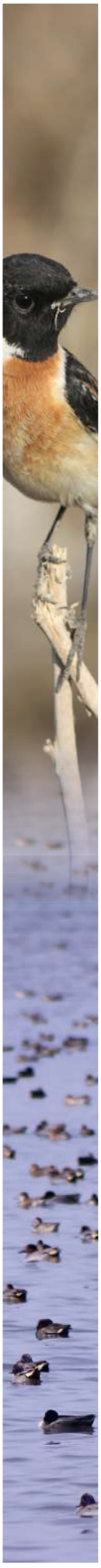
9. Other areas: Occasional surveys were also carried out at Morbe dam, Prabal Machi, Uran and adjoining areas outside the 10 km radius area of NMIA.

Sea shore during low tide behind T S Chankya

Forested areas of Mosare and Chirner during monsoon

NMIA area During monsoon





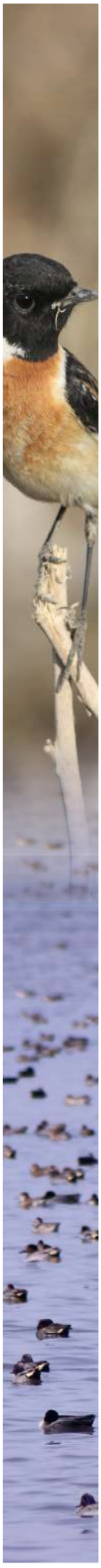
Lush green grass near human habitations

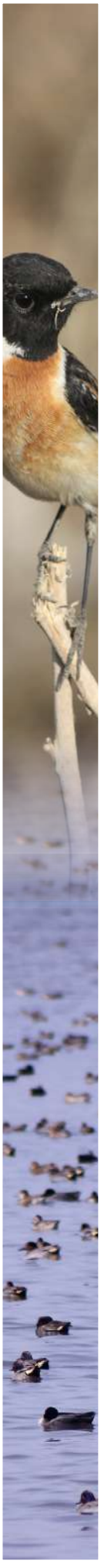
In monsoon rocky seashore seldomly get exposed

Paddy fields

Open mudflat creek areas during low tide

NMIA area during high tide





Chapter IV : Methodology

The areas were surveyed using binoculars and digital camera for authentic bird records. The bird species were recorded (sighting or call) in the field. Direct observations were made by walking along roads, hills, forest paths, wetlands, mangroves, and creek areas. Birds were identified following Ali & Ripley (1983), Grimmett *et al*. (2000) and Rasmussen & Anderton (2005). The list of birds was arranged familywise following Manakadan & Pittie (2001). GPS locations were taken for the preparation of distribution maps. Details of the coordinates of the sites visited are given in Table 1. The known roosting and foraging areas were monitored at the same time to study the movement of the birds.

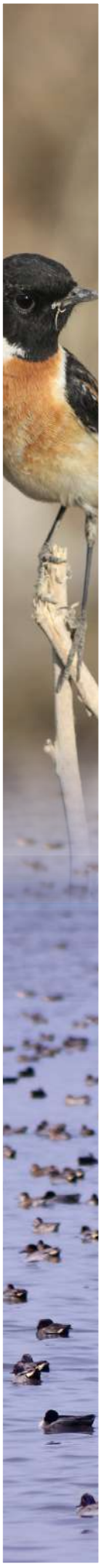
Point count method was used for counting birds heard and seen from a point count site for a defined period of time. A series of point counts completed over the fixed route was used for comparative analysis of seasonal variation and temporal variation (Bibby *et al*. 2000).

Total count method was used to count congregating water birds and waders, especially in summer when the birds were seen roosting only in a few wetlands. Data from different point counts will be used in future during the construction and operational phase for comparative analysis to find temporal (annual and seasonal) variations in bird population in the study area. Data collected in the first year study will be used for deciding the remedial measures to avoid bird strikes in future at the proposed NMIA site.

Direct counting method was used to count flocking and migrating birds, if the congregation was no more than 3000 birds. 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 colours 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. individuals) according to the size of the flock. Counts were repeated several times and final population figure was noted after consensus within team members (Bibby *et al*. 2000).

In case of waders at high tide roost sites counts were made. To locate roosts, or suitable habitats such as salt pans, lakes, creeks, beach, were visited on rising tide when birds were seen congregating. In small roosts individual birds can usually be counted from a suitable vantage point at high tide when all the birds were in the roosts (Bibby *et al*. 2000). Regular counts of waders and wild fowl at selected sites are usually used in bird monitoring programmes worldwide and form basic part of many scientific research programme. From them it is possible to derive imprecise population trend estimates for waders (Howe *et al* 1989), produce maps showing generalised population density (Durinck et al. 1994; Skov *et al*. 1995), asses conservation needs (Tucker and Heath 1994), asses ecological and management needs (Piersma and Ntiamoa-Baidu 1995) and monitor general environmental condition of an area (Furness and Green wood 1993)

Chapter V : Review of Literature on Bird Hazard Promblem nad Remedial Measures



The literature survey revealed that bird strikes have been a concern for aviation safety for over a decade. There is no straightforward relationship between the number of birds at a particular geographic location and the risk of bird strikes. Location factors (e.g. aerodrome or landfill sites) as well as flock size and flight line patterns play a significant role, as has been shown in past research (Dekker 1994). The seasonal pattern of bird strikes is confirmed from all sources, indicating that the highest number of bird strikes occurs in the months between April and October. It is not random that this period coincides with the airline summer schedule of increased air traffic activity. However, after using normalized data there appears to be a seasonal pattern for bird strikes in spring time and autumn (Maragakis 2009). The seasonal pattern may also affect the altitudes with the highest risk of bird strike. For example, July to November are considered the worst months for damaging strikes in the airport environment (below 500 ft. AGL). During late summer bird populations are at their highest levels and contain many young birds that are not skilled fliers. Above 500 ft., September to November and March are considered the most dangerous months because these are the peak times of migration (Dolbeer 2004).

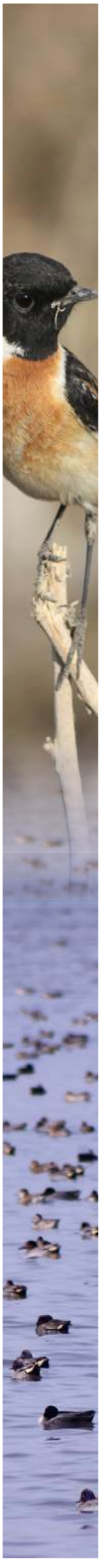
It was found that the highest number of accidents occurred during the take-off phase (48%), followed by the approach (30%) and the en route phase (15%). It should be noted that the en route phase also includes the phase of climb and descent. During the take-off phase (acceleration and lift-off), an aircraft is more susceptible to partial or total loss of control if a bird strike occurs, compared to other phases of flight. Damage to the engines was sustained in 44% of all bird strike accidents. Regarding the type of bird species involved in the accidents, only in 60% of the accidents is the species known. The majority of birds involved were flocks of large birds (45%) followed by strikes from single large birds (31%) such as geese, ducks, cormorants, and hawks (Maragakis 2009).

1. Wildlife attractants on or near Airports

Wildlife is attracted to airports because, airports provide food, habitat, shelter, water, and secure environment:

A) Food

Birds are attracted to airports because of the availability of rodents, birds, and other small animals as these sources of bird food are harboured by tall, poorly maintained grass stands and borders. Occasionally, food becomes available through careless waste disposal by restaurants and airline flight kitchens. Many airports have inadequate garbage disposal systems that permit access to various food items. Nearby landfills or sewage outlets may also provide food for birds and other wildlife. Landfills are often located on or near airports because both are often built on publicly owned lands. Landfills contribute to bird strike hazards by providing food sources and



loitering areas that attract and support thousands of crows, mynas, egrets, and other species.

B) Water

Birds of all types are drawn to open water for drinking, bathing, feeding, loitering, roosting, and protection. Rains provide temporary water pools at airports. Many airports have permanent waterbodies near or between runways for landscaping, flood control, or wastewater purposes. These permanent sources of water provide a variety of bird food, including small fish, tadpoles, frogs, insect larvae, other invertebrates, and edible aquatic plants.

C) Cover

Birds need cover for resting, loitering, roosting, and nesting. Trees, brush, weed patches, shrubs, and airport structures often provide suitable habitats to meet these requirements. Almost any area that is free from human disturbance may provide a suitable roosting site for one or more species of birds.

Using various sources of raw and derived data it was concluded that most of the bird strikes (95%) occur below 2500 ft and around 70% occur below 200 ft (Eschenfelder 2005). At Kavala Airport, potentially dangerous birds were observed within an 8 km radius (general zone) of the runway centre line because most bird-aircraft collisions occur when aircraft are at low altitudes (Lykos *et al*. 2005). Turbine powered aircraft normally reach 601 m above ground level (AGL) before leaving the general zone and 88%, at least in the USA, of bird strikes occur below 610 m AGL (Clearly *et al*. 997). Clearly *et al*. (1997) emphasized areas within the 3.2 km radius of the runway centre line (critical zone) because turbine powered aircraft are usually under 150 m AGL and 72% of the USA bird strikes occur at or below this level.

Various sources quote different percentages for each altitude threshold, but they all concur that most occurrences take place very close to the ground. This highlights the fact that the risk of bird strikes can be mitigated by measures taken primarily at an airport level, such as avifauna assessment and management.

Although in recent years the overall bird population has declined in Europe by over 10%, the bird strike hazard for aviation has not reduced proportionally. The reason is that not all birds pose the same hazard to aviation safety, as this depends on the size of the birds and their foraging or migratory patterns. Birds may pose a threat to aviation due to their individual size or due to their tendency to fly in large flocks. It is likely that the smaller the birds, the greater their need to travel in flocks in order to avoid predators (Maragakis 2009). Thus small birds can be equally hazardous.

In the category of flocking birds, some of the most hazardous are considered to be gulls and starlings. Gulls are considered high-risk because of their tendency to feed on soil invertebrates on airports and nearby farmland as well as landfill sites. It has been observed that flight of gulls is most likely to occur between landfill areas and roost sites, causing great concern. Starlings *Sturnus vulgaris* are another bird species considered a hazard to aviation activities as they usually fly in dense flocks of upto 100,000 individuals (Feare *et al*. 1999). With a mass density 27% greater than

that of gulls, they are considered a great bird strike risk, though they are involved in a small percentage of bird strikes (CAA UK, 2008). In the past 35 years the general population of European Starlings is believed to have decreased by almost 50%. Changes in their population might not reflect a proportional decrease in the risk to aviation.

Large birds pose a risk primarily due to their individual size. In this category belong birds such as waterfowl (loons, ducks, geese, and swans) or wild predatory birds such as raptors or eagles. Particular case for Europe is the Canadian Goose Branta canadensis, the population of which, in recent years, has increased by more than 100% in northwest Europe (Banks *et al*. 2006). Aviation organizations have noted this particular species because of its large size (2.3–7.3 kg) and tendency to fly in flocks, on traditional migration. Whilst they usually fly at altitudes below 5,000 ft, they have been encountered at altitudes up to 20,000 ft. Geese fly in V-shaped 'skeins', diagonal formations, with birds spaced about 10 to 12 ft (3 to 3.5 m) apart. Thus they must be considered as flocking birds since the same skein could strike multiple engines (CAA UK - SRG, 2002).

Although the Canadian Goose is a migratory species, in recent years a non-migratory trend has been observed, as it has adapted to urban environments (Smith *et al*. 1999). Because of the species habitat preference near standing water, it has become of primary concern for airport avifauna management in north-western Europe.

In recent decades there has been a change in the number and composition of the bird population as well as in the habitat of some bird species. Some have adjusted to the urban environment, while others have experienced a significant increase in their population. Furthermore, climatic changes have allowed new species to forage and breed in geographic areas which were not particularly suitable to them several decades ago. The ban of organochlorine pesticides has also enabled some bird species populations to increase from their low levels in the 1970s.

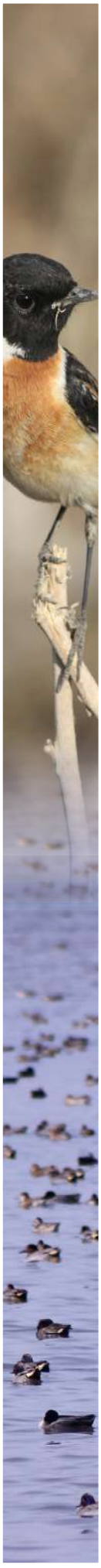
2. The Indian Perspective

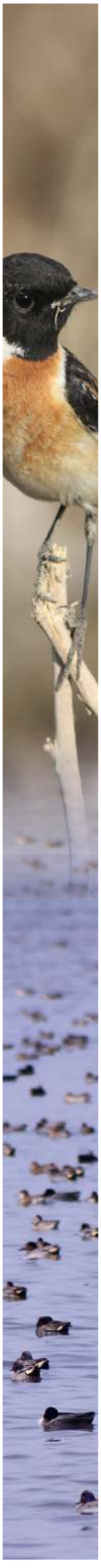
In India, a pioneering study on bird strike was carried out in 1980s by the BNHS supported by the Aeronautics R&D Board, Ministry of Defence, and Government of India. This study was carried out at Gwalior, Gorakhpur, Jodhpur, Dundigal, Tezpur, Chabua, Sirsa, Srinagar, Jammu, Kalaikunda, Hyderabad, Trivandrum, Bengaluru, Patna, Nagpur, Kolkata, Chennai, Mumbai, Delhi, Hindon, Agra, and Ambala.

It was found that about 27 species of mainly terrestrial birds are potential problem birds at Indian airports (Grubh & Ali 1984). Mainly vultures, kites, rock pigeons, lapwings, doves, myna, stone curlew, egrets, crows, sandgrouse, harriers, parakeets, and quails were the bird species found to be involved in bird strike incidencts in 1980–90 (Ali & Grubh 1989).

According to the BNHS initiative in 2006, a project entitled "Comprehensive study of Bird Hazard and remedial measures in selected airfields" was proposed and three airfields were surveyed for ecological study, i.e., Ambala, Adampur, and Srinagar, in northern India.

All the three airfields were bird strike prone, as they had large populations of problem birds such





as the Black Kite, Black-shouldered Kite, Red-wattled Lapwing, Cattle Egret, Common Myna, Jungle Myna, larks, and pipits. It was found that in Ambala and Adampur, Black Kite, Cattle Egret, and Red-wattled Lapwing are the main problem birds due to their size, behaviour, and flocking pattern, habit of flying over the runway and shoulder area. At Srinagar, in July 2001, Eurasian Collared Dove *Streptopelia decaocto* was involved in a bird strike incident. Though there are very few records of bird strike, the population of problem birds are increasing day by day and in future it will be a big menace. At Ambala and Adampur, Black Kite poses a threat from 0700 to 1200 hrs, i.e., during morning hours. Cattle Egret problem is restricted to monsoon only. Red-wattled Lapwing, being resident at airfields, cause problems almost round the year, especially at night, as they roost near the runway and any direct light on their eyes freezes them. This kind of behaviour makes them problematic mainly for the night movement of aircraft. In Srinagar, the Black-eared Kite is the main problem due to its large size and habit of soaring. According to the study in Srinagar, Black-eared Kite remains potentially active from 0900 to 1600 hrs, however movement of Barn Swallow which is another problem bird, was found restricted during cloudy weather. Other birds were seen to be active from dawn to dusk.

On all three airfields, studies revealed that low grass (grass height <10 cm) areas support a large number of sparrows and mynas, whereas high grass (grass height >10 to 15 cm) areas do not support them much. Soaring of kites was also higher over short grass area than over high grass area (Dookia 2008).

Main suggestions given: Removal of trees and shrubs, application of modern systems for garbage disposal and slaughterhouses, birdproofing of buildings, maintenance of vegetation. Modifying flight timings, levelling of infield areas, control on cattle movement near airport area (Ali & Grubh 1989).

3. Remedial Measures for avoiding Bird Hazard [Extracted from (Anon. 1988)]:

A) Ecological measures

1) Garbage dumps in vicinity of Airport: At airports all garbage, must be covered with soil. For example, in Sweden according to building law, new constructions are not allowed to be located in such a way that they interfere with earlier establishment and activities originating from them.

2) Implementation of regulation that prevent the use of land within a certain distance from any runway. For example, in Belgium zones of 150 m from the centre line of each runway and 60 m over both ends of each runway may not be used for agriculture; in case of military airport 30 m from the edge of the runways and 50 m from the edge of taxiways may not be used for agriculture.

3) Airport operational standards for Bird Hazard Control (BHC):

i. Land which is within 1200 ft of any runway centre line or runway end and within infield area shall not be used for the grazing of dairy cattle/beef/other animals.

ii. No trees shall be allowed on land within 500 ft of runway centre line as well as runway ends.

iii. For those airports where the average number of bird strikes over the previous five years is greater than five strikes a year, there shall be no agricultural leases for the use of land within 1200 ft of the runway centre line/runway ends. For example, in Czechoslovakia if airports belong to non-hunting ground, the airport authority is obliged to ask for permission to shoot animals at the airport exceptionally. In Denmark, zones of 600 m from the border of the runway may not be used for agriculture. Exceptions have been made for private land to a distance of 300 m from the border of the runway. In South Africa, within airport boundaries, the airport authorities have complete control of land usage. Outside the airport area, the relevant authorities have powers to zone land usage in accordance with proclaimed noise contours. In addition, local authorities can control the use to which land in the areas under their jurisdiction is put, in accordance with two planning principles. The civil aviation authority is thus dependent on the authorities mentioned above for influencing land use, but usually receives full co-operation from them in this respect. In Switzerland, no sheep are allowed to graze within 150–200 m on either side of runways. Grass has to be kept longer than 10–12 cm within three stripes. No natural fertilizer can be used within the confines of the airport.

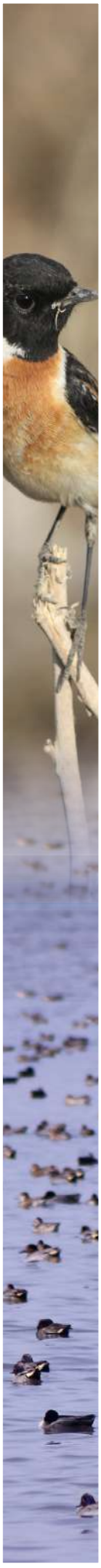
4) Sanctuaries in the vicinity of Airports: In Denmark, about 37,000 pairs of Herring Gull Larus argentatus were breeding on the island Saltholm, 5 km from the airport of Copenhagen. In 1969, the airport authorities in close co-operation with ornithologists and the department of nature conservation started an attempt to reduce the size of the colony. Every year since then, the nests in the colony have been sprayed with an emulsion of oil in water. The oil closes the pores of the eggs and the embryos are killed, but the adults continue to incubate the eggs. One effect has been that the colony produces very few young birds, and since young gulls are more likely to hit the aircraft than adults, this should cause a reduction in gull strikes in the airport. Indeed, the statistics show a much lower proportion of strikes with young Herring Gulls than with young gulls of other species. Herring Gull population was decreased to about 20,000 pairs during the first four to five years. Dead Herring Gull with chloralose tablets were used as bait for gulls.

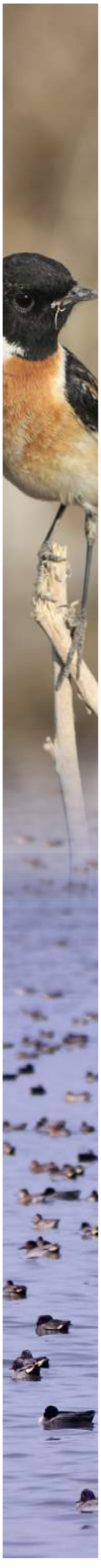
5) Length of the grass along the runways: Grass height should be kept within 15–20 cm.

B) Scaring measures

1. Distress calls/Emergency calls: These calls are taped carefully and played either via fixed station or established on mobile units.

Acoustic device: Such device reproduces the language of the birds either real or synthetic. There can be fixed real bird sounds or mobile units. In Denmark, natural sounds are used from species such as Herring Gull, Black-headed Gull, Common Gull, lapwings, starlings, rooks, and jackdaws. In Copenhagen, flocks of Oystercatchers (50–300) very frequently feed or rest on grass areas during summer or spring. When scared they usually move from one place to another within the airport, and therefore it was very difficult to remove them from the area. According to the literature,





the distress call of this species has no scaring effect. In South Africa, recorded distress calls are being used at most airports. The results are generally disappointing, as birds quickly grow accustomed to the calls, but at some airports good results have been obtained when the calls are used together with pyrotechnical scaring devices. Experiments with synthetic sounds have still to be carried out.

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 levels (80 dB) with silence period of one-minute duration between the emissions (30 seconds duration). This method, tested during four years, is effective on lapwings, gulls, and pigeons.

b. Conventional bird scaring methods are necessary together with this equipment during periods of intense bird activity. In Japan firecrackers are sometimes used when the use of gun is not available. In the erstwhile Soviet Union, engineers and students of the Riga Institute of Civil Aviation made mobile synthesizers of bird distress calls, mobile bio-acoustical devices with heightened power and different equipment on the microprocessor base. Special electro-stimulator was created by them to obtain bird distress calls.

c. Pyrotechnical Devices: These cover a wide range. They are used alone or in conjunction with other acoustical devices. The main methods are described below:

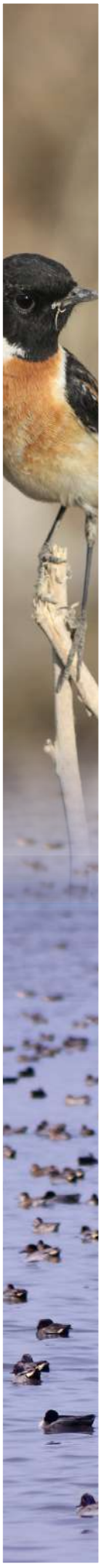
✓ Shell crackers: In India as well as other countries these are widely used at all civil airports. In Federal Republic of Germany pyroacoustic pistols with different cartridges as well as signals were used.

✓ Gas cannon: In Finland, liquid gas cannons fired automatically at regular intervals have proved cost effective at several airports. In India there is no use of gas cannon.

✓ Gun shooting: in Denmark visual scaring with shotguns is used at all military and provincial civil airports; in India it is occasionally used.

3. Visual Scaring: In Australia, vehicle mounted spotlights are used to scare away birds at night. Flashing lights have 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 in bird strikes.

Chapter VI : Results



6.1 Avifauna at various sites in 10 km radius of NMIA area

Tide timing, ongoing activities of JNPT, stone quarries, and rapid changes in habitat were found to be influencing the distribution of birds. To study congregation and movement of birds, from each block as mentioned in the study area, we selected following sites:

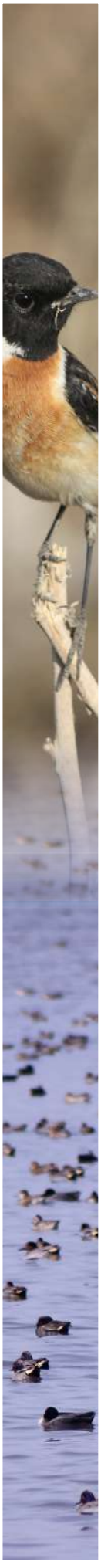
1) NMIA site: 200 Terek Sandpiper in flock of 30–40, 400 Common Redshank, 200–300 Black-tailed Godwit, and 300 Northern Shoveller were seen in Panvel and Kharghar Creek. The birds usually dispersed during low tide in nearby mudflats.

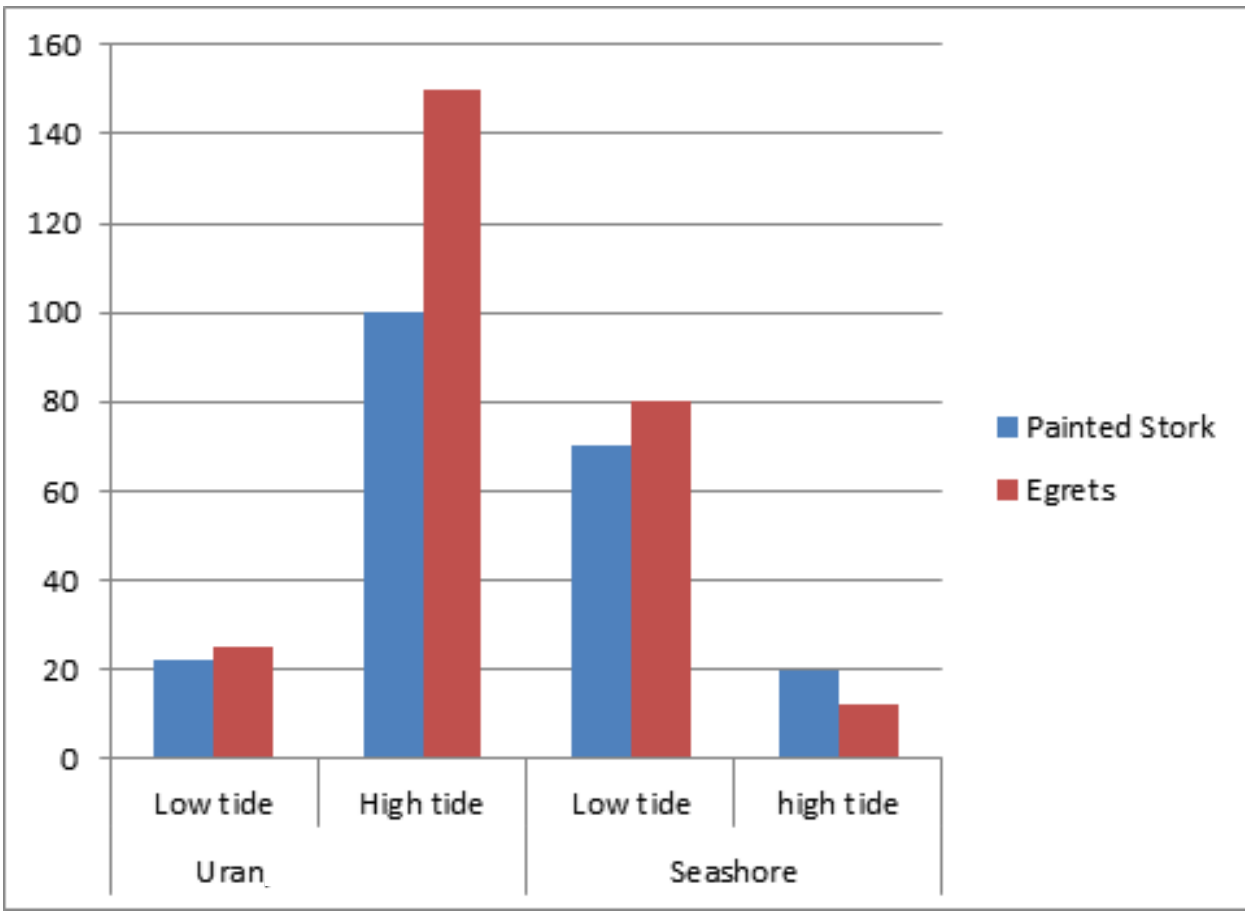
2) North-West (Behind NRI Complex): About 1,200–1,500 each of Lesser Sand Plover, Curlew Sandpiper, Little Stint, and Temminck's Stint were seen roosting in the backwaters behind NRI Complex. During low tide these birds were seen flying away from the site to different mudflats in all directions and returning during high tide.

3) North-East (Opposite Sanjivani International School): This site is located on the boundary of Kharghar and Taloja. Hundreds of cormorants, egrets, and Black-tailed Godwit were observed in waterbodies spread over one square kilometre area in front of Sanjivani International School.

4) South-East (Mosare-Patnoli-Ransai area): This block is situated in the biogeographic province of Malabar Plains region (Pande 2004), on one of the many western spurs of North Sahyadri Range. The terrain is rugged and comprised of valleys and steep hills on either side. Honey Buzzard, Crested Serpent Eagle, Short-toed Snake Eagle and Changeable Hawk Eagle were seen soaring in the area of Mosare-Patnoli-Ransai villages. Birds like Yellow-footed Green-Pigeon were also seen feeding on Ficus trees at Ransai.

5) South-West (Sonari-Belpada Lake): This site is located on the way to Uran near Jasai village, 500 m right of the toll plaza. Nearly 130–150 Eurasian Spoonbill, 150–200 Painted Stork, hundreds of egrets (Cattle Egret, Little Egret, Intermediate Egret, and Great Egret) were observed along with a few juveniles and adults in breeding plumage. Black-tailed Godwit, Temminck's Stint, Little Stint, terns, and ducks were seen in large numbers till March 2012. After the lake dried up, birds such as Painted Stork and Oriental White Ibis were found flying a couple of kilometres away to nearby areas including NMIA site. Painted Storks were observed in many areas such as Kombadbhuja, Pargaon, seashore area of Palm Beach Road, Sanjivani School, and JNPT, and were found returning to Sonari-Belpada Lake for roosting. Based on these observations, we assume that the same population of birds might be visiting all areas.





Graph 1: Movement of Painted Stork and Egrets between inland wetland and sea shore

X-axis= Number of birds, Y -axis = Study site

6) Large flocks of House Crow were seen roosting at Parsik Hills of Belapur, Mosare-Patnoli, and Tembhode.

6**.2 Distribution and movement of birds**

For study of congregation and movement of birds, from each block as mentioned in the study area, we selected the following sites shown in the map on page; 8.

A) Resident birds

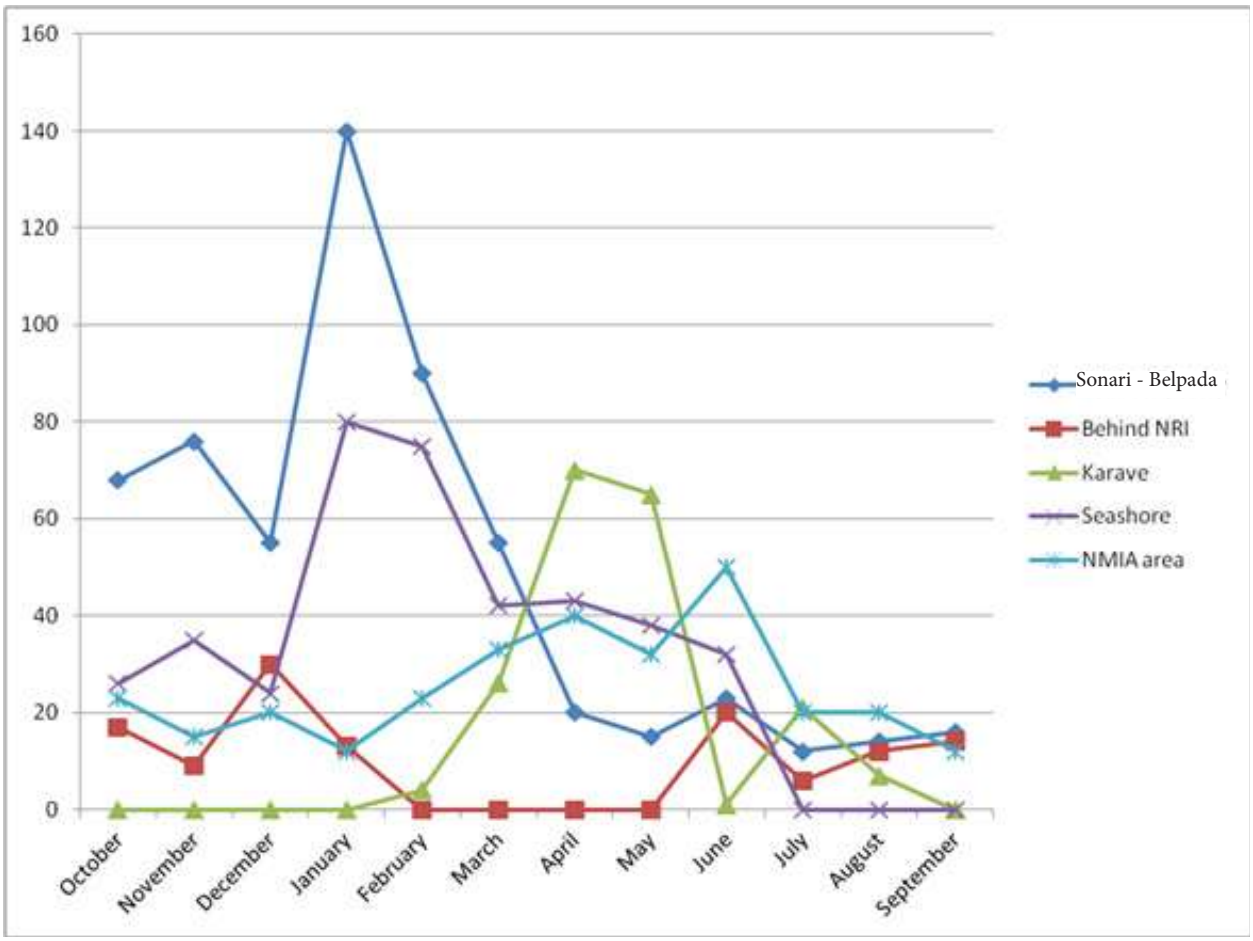
1. Storks, egrets, and ibis: Painted Stork (150–200), Eurasian Spoonbill (140–150), and Black-headed Ibis (20–25) were seen congregating at Sonari-Belpada wetland till April 2012. Juveniles of Painted Stork and Eurasian Spoonbill at Sonari-Belpada indicate the presence of a heronry nearby. Asian Openbill was seen only at Dastan Phata. In the peak of summer, wetlands of Sonari-Belpada get dried up completely, so these birds were observed moving to other areas such as Pargaon, Panvel Creek, behind NRI Complex, and Kharghar Creek during low tide and returning to Sonari-Belpada for roosting in other areas. Near about 200–300 individuals of different species of egrets were seen congregating at Sonari-Belpada wetland, and in the summer these shifted to wetlands of Palm Beach Road area.

2. Resident Ducks: After small waterbodies such as Belpada Lake and Panvel Lake dried up, Lesser

Whistling-duck congregated in large numbers in the wetland areas of NRI and TS Chanakya. 15–20 Comb Duck were observed only at Dastan Phata area. Spot-billed Duck were observed in all wetland areas.

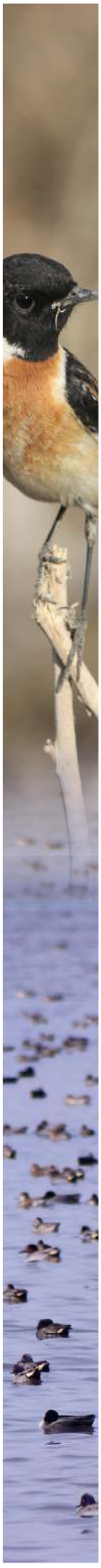
3. Cormorants: Three species of cormorants were seen in all wetland areas with congregations at DPS School (Palm Beach Road), Sanjivani School (Kharghar), and Panvel Creek.

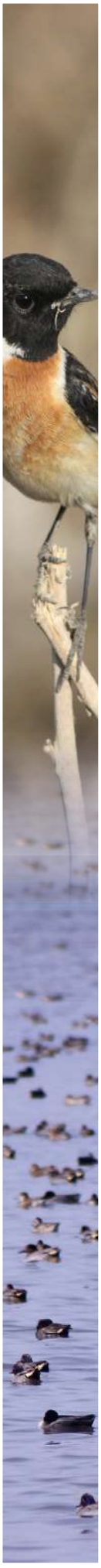
4. Forest Birds: Fourteen species of birds of prey were seen mainly in Mosare-Patnoli-Ransai forest area and at Sonari-Belpada. Belapur Pond and Dastan Phata were found to be excellent habitats for birds such as moorhens and jacanas, who prefer floating vegetation and shallow lakes. Pigeons and doves were sighted almost all over the study area, except the Yellow-footed Green-Pigeon, which was spotted only at Ransai. A dead Barn Owl, which may have been electrocuted, was found near the railway track between Kharghar and Mansarovar stations. We could sight malkohas only in the forest area of Mosare. Calls of Indian Nightjar and Savanna Nightjar were heard in the forest near Chirner road. Lesser Pied Kingfisher was seen in smaller wetlands of the villages. Birds which prefer good vegetation and forest areas, such as Indian Grey Hornbill and barbets, were seen mainly in Mosare-Patnoli region. Four roosting sites of nearly 500–1000 House Sparrow were seen between Mansarovar station and Kamothe village.



Graph 2: Distribution and seasonal movement of Egrets and Painted Stork

X-axis= Number of birds, Y axis= Months





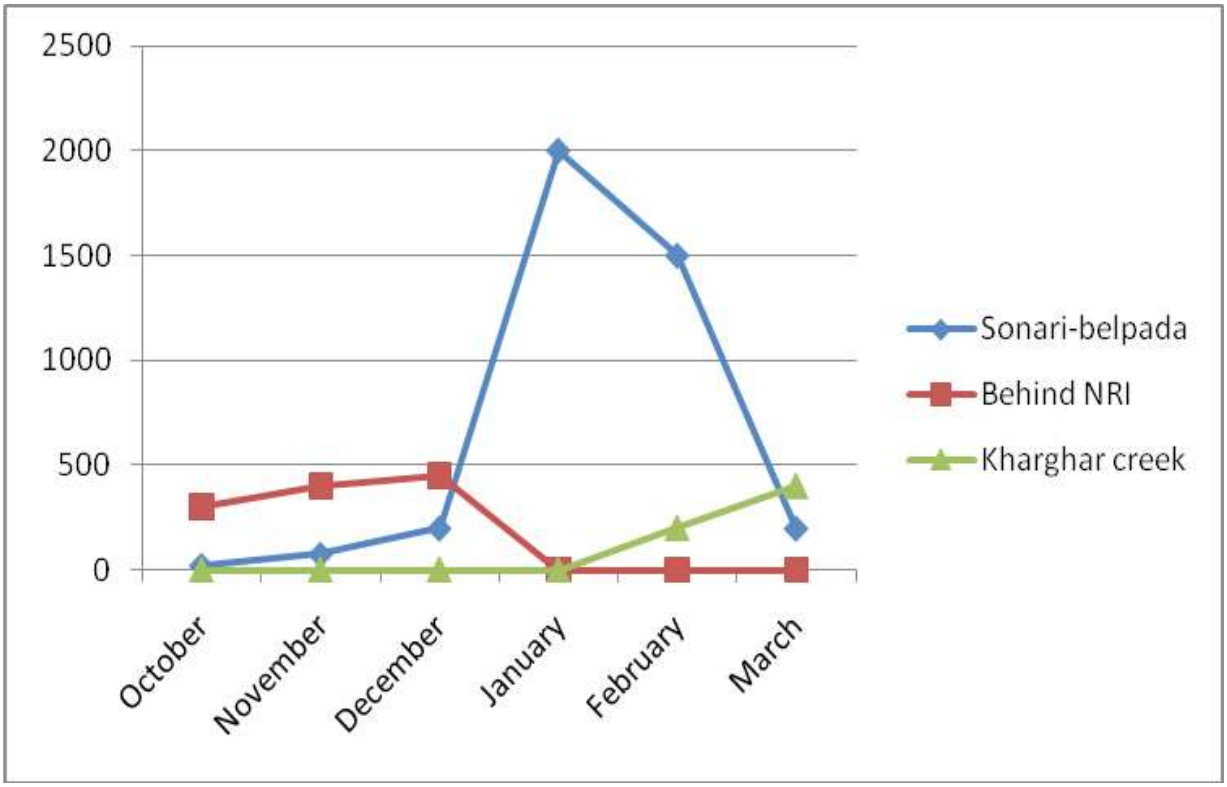
B) Migratory birds

1. Black-tailed Godwit and Marsh Sandpiper: These birds were mainly observed roosting in two wetlands, one at Sanjivani School, Kharghar, and the second at Sonari-Belpada wetland. During low tide they were seen on mudflats, seashore, and creek. After attaining breeding plumage by April end, these birds were not seen in the study area.

2. Common Redshank: Flocks of 200–300 Common Redshank were observed roosting at Kharghar Creek, and foraging in nearby wetland areas during low tide.

3. Migratory Ducks: Five species of migratory ducks were observed in the wetlands. A couple of Ruddy Shelduck were observed at Jasai and Sonari-Belpada Lakes. Groups of 150–160 Northern Pintail, 200–300 Common Teal, and 130–140 Garganey were seen at Sonari-Belpada and behind NRI Colony. More than 300 Shovellers were observed in Panvel and Kharghar Creek in January 2012.

4. Duck species: Northern Shoveller, Northern Pintail, Common Teal, and Garganey were observed mainly in Sonari-Belpada wetland and creeks of Kharghar, Panvel, and Airoli.



Graph 3: Distribution of migratory ducks

X-axis= Number of birds Y -axis= Months

5 . Gulls and terns: In winter, these birds were seen all over the wetland areas but in summer they were restricted to a few areas such as Panvel Creek and the wetlands near Palm Beach Road. They roost mainly at a wetland behind NRI Complex on Palm Beach Road and feed in creeks and along the shore.

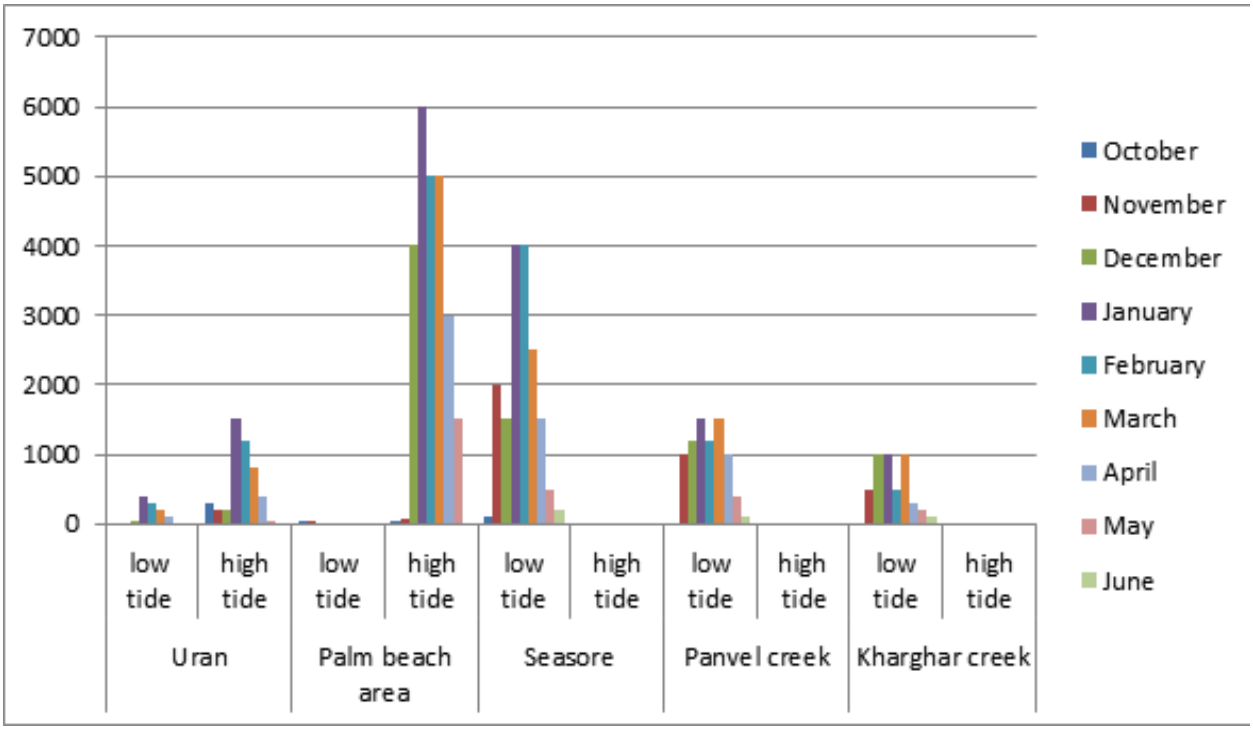
6. Lesser Sand Plover and Curlew Sandpiper: In winter, these birds were seen congregating in thousands at the wetland behind NRI Complex during high tide and feeding in all other mudflats during low tide. In late winter they were seen roosting at the wetland behind NRI Complex of Palm Beach Road and feeding at seashore along Palm Beach Road and Airoli Creek.

7. Pacific Golden Plover: In winter, these birds were observed mainly on the rocky seashore of Palm Beach Road, while in summer (May 2012), they were seen with breeding plumage at Panvel Creek.

8. Lesser Flamingo: 5,000–7,000 Lesser Flamingos were observed on large tracts of mudflats along the seashore from Palm Beach Road to Airoli Creek and were observed moving towards Trombay jetty during high tide. During summer, population of Lesser Flamingo was seen less at Sewri Mahul, one the known Flamingo areas of Mumbai and more in wetland behind TS Chanakya of Palm Beach Road area.

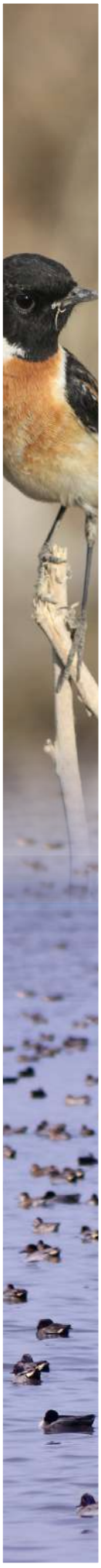
9. Blue-tailed Bee-eaters: Flock of 25-30 birds were observed roosting at Kharghar Creek.

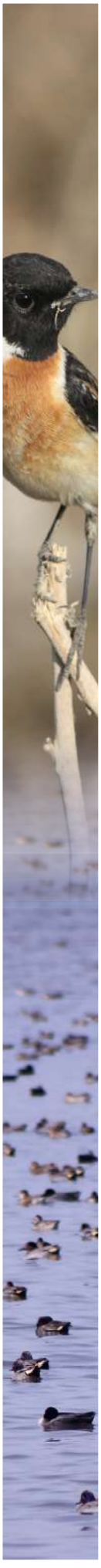
10. Harriers: Eurasian Marsh Harrier was seen in all areas, especially in marshy wetlands during winter.



Graph 4: Distribution of birds of charadriformes at different sites during high tide and low tide

X- Axis: Name of the sites, Y-Axis: Number of Birds





11. Buntings: Large flocks of more than 500–1,000 Black-headed Bunting were observed at Pargaon and Kopar area of the proposed NMIA site. These birds were using grasslands for feeding at daytime and mangroves for roosting after dark.

12. Passerines: Red-breasted Flycatcher, Black Redstart and Blue Rock-thrush were seen in open areas of Panvel and Uran.

13. Starlings: Rosy Starlings were seen mainly in the mangrovesa all over the region.

14. Wagtails: Four types of wagtail, namely Citrine, Yellow, White, and Grey were seen in all the wetlands of the study area.

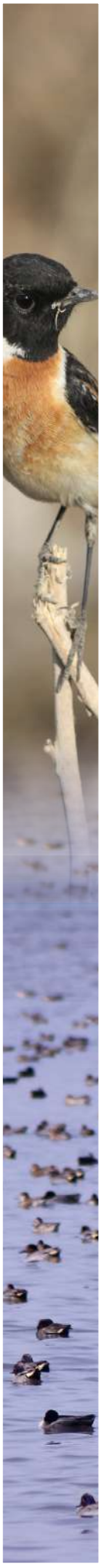
Congregation of water birds

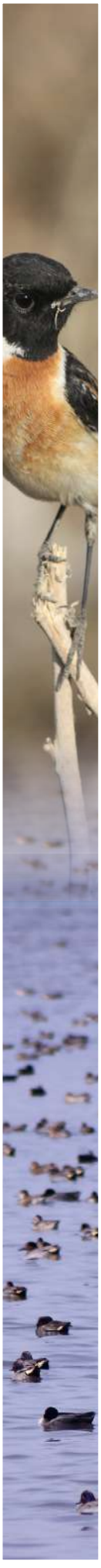
Resident Birds of Study Area

Spoonbills and Painted Storks in breeding plumages

Spot-billed Duck one of the commonly observed birds

Lesser Whislting Ducks seen usualy at smaller ponds such as Belapur pond





Black-winged Stilt along with a migratory a Common Greenshank

Openbill and Purple Swamphen usually seen in areas dominated by typha grass

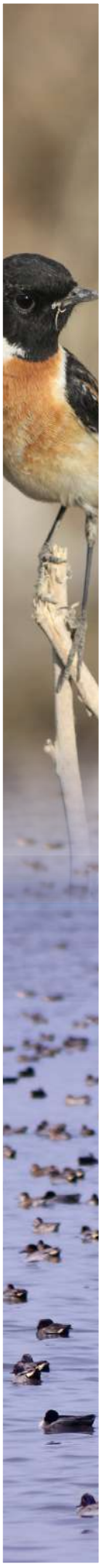
Common Moorhen

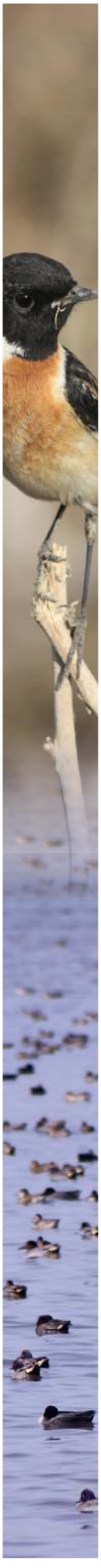
Malabar Lark

Common Iora

Spotted Dove

Indian Roller





House Sparrow

Indian Reed Warbler

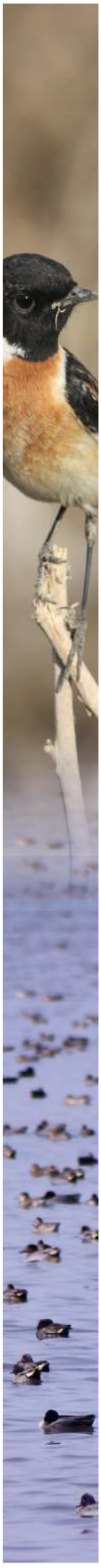
Scaly Breasted Munia

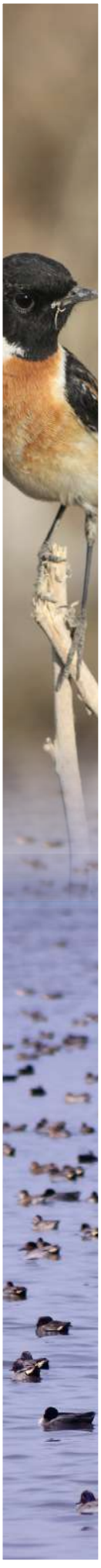
Bird Congregation

Flock of Pied Avocet

Hundreds of water birds spread across the area

Migratory Ducks





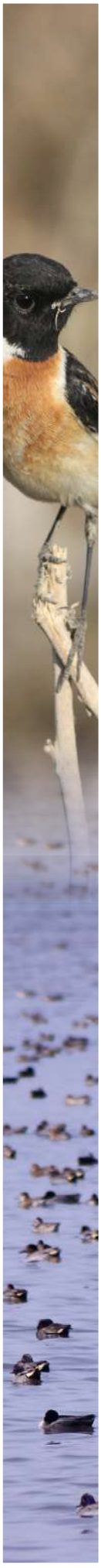
Mixed flock of Terns

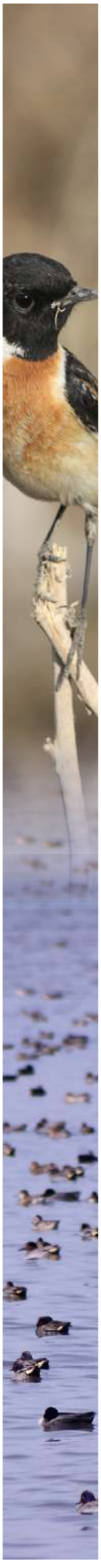
Black-tailed Godwit

Waders and flamingos can be seen feeding during low tide at airoli bridge

Waders on rocky seashore

Mixed flock of ducks





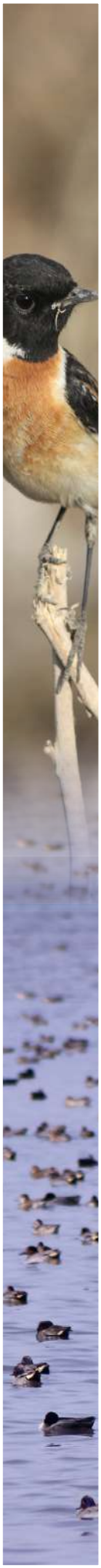
Terek Sandpiper during high tide seen perching on tree

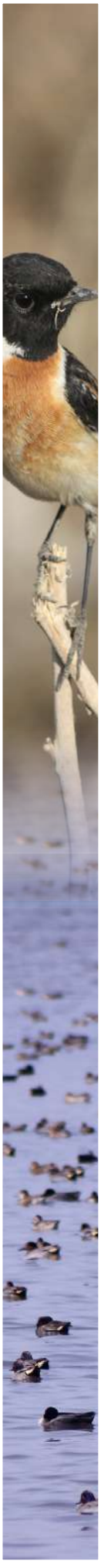
Brown-headed Gulls

Congregation of Common Redshank in Kharghar creek

Common Redshank can be observed in all over the areas during low tide

Rosy starling mainly observed in mangrove areas

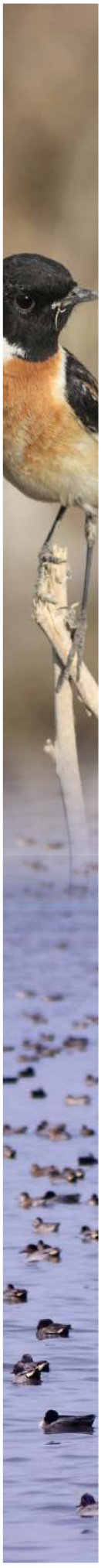




Rudy Turnstone

Eurasian Marsh Harrier

Little Ring Plover



6.3 Tide dependent bird movement at NRI site in the proposed NMIA project area.

To study tide dependent movement of birds, observations were carried out during high tide and low tide at a wetland behind NRI Complex, Palm Beach Road. This wetland was mainly used by waders and other waterbirds for roosting, and the adjoining seashore for foraging. It was also observed that birds started flying towards the seashore during low tide and eventually a few of them remained in a particular wetland, whereas during high tide birds were seen congregating at this wetland. Population and movement of gulls, terns, Painted Storks, Pied Avocet, Eurasian Curlew, and Black-tailed Godwit was seen fluctuating with the tide timing in particular sites. During high tide, the number of bird species and number of individuals in the wetland behind NRI Complex were found to be greater, which decreased towards low tide and increased at the seashore area. During low tide, the case was vice versa.

6.4 Threatened and Endemic birds of the study area

In late 1994, the following criteria for the identification and categorisation of threatened bird species were adopted by International Union for Conservation of Nature IUCN (IUCN SSC 1994) supported by BirdLife International:

Critically Endangered (CR): A taxon is Critically Endangered when it is facing an extremely high risk of extinction in the wild in the immediate future.

Endangered (EN): A taxon is Endangered when it is not Critically Endangered but is facing a very high risk of extinction in the wild in the near future.

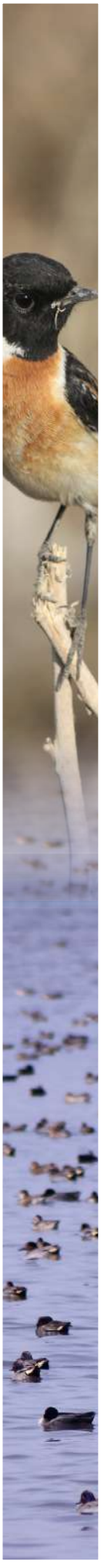
Vulnerable (VU): A taxon is Vulnerable when it is not Critically Endangered or Endangered but is facing a high risk of extinction in the wild in the medium-term future.

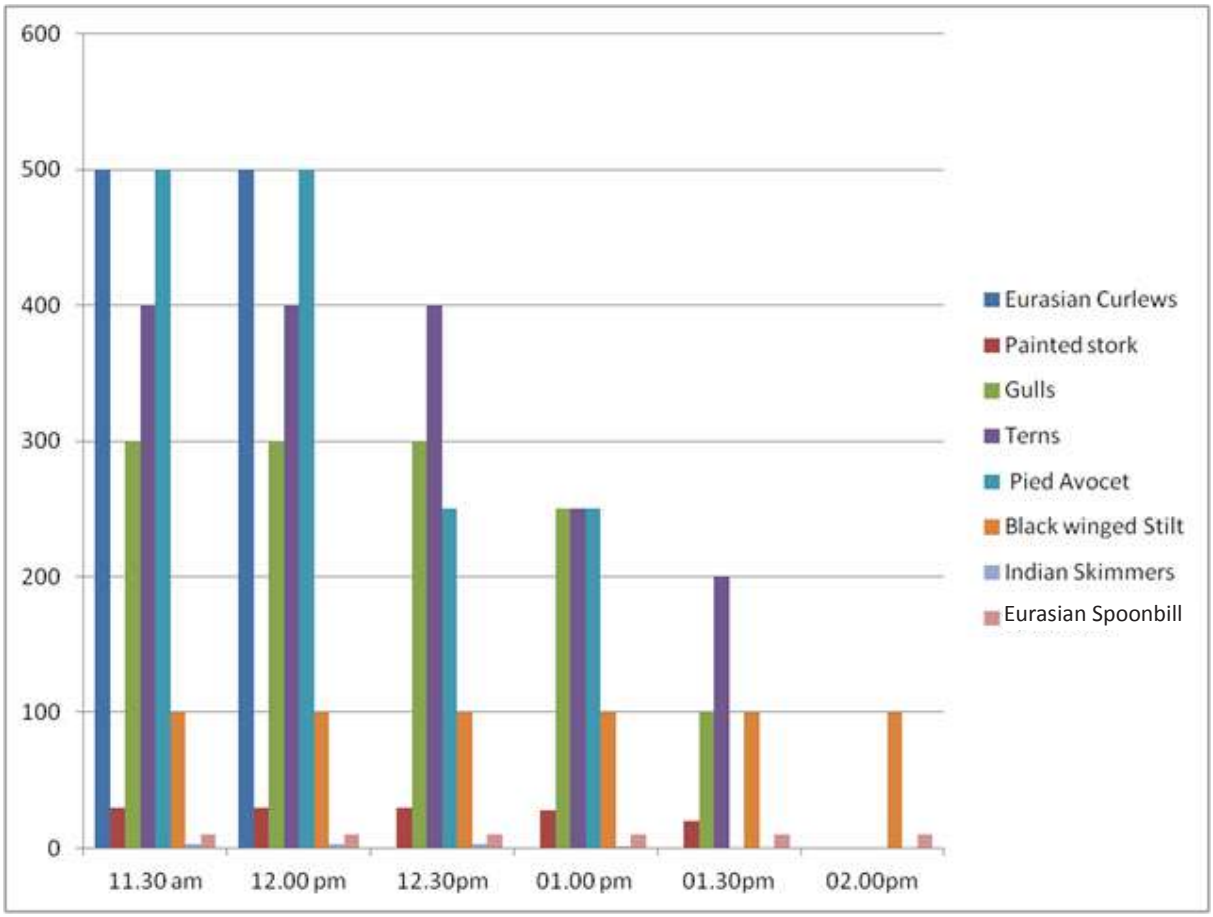
Near Threatened (NT): Taxa which do not qualify as Conservation Dependent, but which are close to qualifying as Vulnerable;

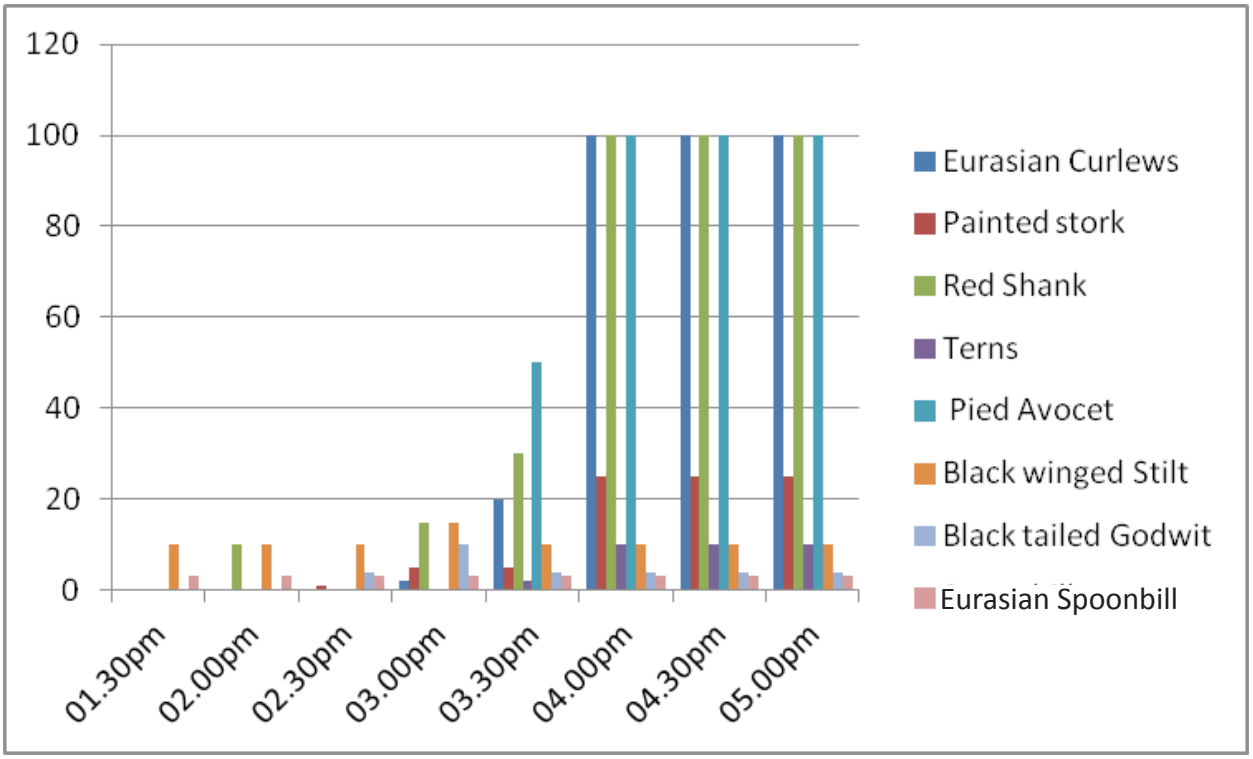
Least Concern (LC): Taxa which do not qualify as Conservation Dependent or Near Threatened.

A) Threatened birds of the study area

A flock of Painted Stork *Mycteria leucocephala* (NT) was observed roosting at Sonari-Belpada and feeding at other wetlands during winter. Black-headed Ibis *Threskiornis melanocephalus*(NT) were observed all over the creeks and mangrove areas. A flock of Black-tailed Godwit *Limosa limosa* (NT) was observed near a wetland opposite Sanjivani International School as well as at Sonari-Belpada wetland. Indian Spotted Eagle *Aquila pomarina*(VU) and Greater Spotted Eagle *Aquila clanga* (VU) was observed at Uran and Mosare areas. Indian River Tern (NT) were seen at Sonari-Belpada, Eurasian curlew Numenius arquataand three Indian Skimmer (VU) were seen behind the NRI Complex. Lesser Flemingo *Phoenicopnaias minor* (NT) were observed on mudflats of rocky sea shore.







Graph 5A and 5B: Variation in species composition and population in different time interval at wetland behind NRI complex of Palm Beach Road.

X-Axis: Time (30 min interval), Y-Axis: Number of Individuals

B) Endemic birds of India observed in study area

Indian Scimitar Babbler *Pomatorhinus (schisticeps) horsfieldii* was observed at Mosare-Patnoli area and heard calling at Chirner. Malabar Lark *Galarida malabarica* was seen almost all over. A flock of 7–8 Malabar White-headed Starling *Temenuchus blythii* was observed only in a 2 sq. km area opposite TS Chanakya, Palm Beach Road. Red Spurfowl *Galloperdix spadicea* and White-cheeked Barbet *Megalaima viridis* were seen at Chirner and Kharghar Hill.

6.5 Threats and Conservation measures

A) Threats

1. Hunting:Use of catapults for killing birds was found to be a common practice in the survey area, especially among children.

2. Modus operandi for hunting birds in large number: A long net trap is usually laid in one corner of a waterbody. Then three people flush the birds from three sides towards the net trap.

3. Trapping: Use of small noose traps to capture small birds for trading was observed. Shikra and Jungle Babbler were found trapped in a nylon net hanging on a huge tree more than 50 ft tall. The net might have been installed there for protecting crops from birds and bats by the farmers.

4. Human interference:Massive construction activities were going on in the entire Navi Mumbai region. Because of smoke from brick kilns and dust from construction sites, badly maintained roads and massive stone quarries, the visibility in the study area was found to be low in winter.

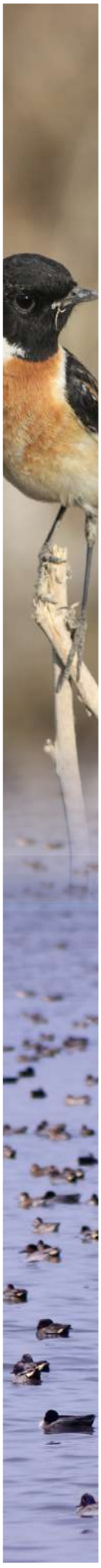
5. Rapidly changing environment: Conversion of wetlands to plain open areas by land filling for various purposes such as JNPT work in Uran has led to a change in the distribution of waterbirds. Due to non-availability of suitable waterbodies, birds have been restricted to a few areas and these sites are also under pressure of rapid changes, e.g., Funde and Sonari land fill.

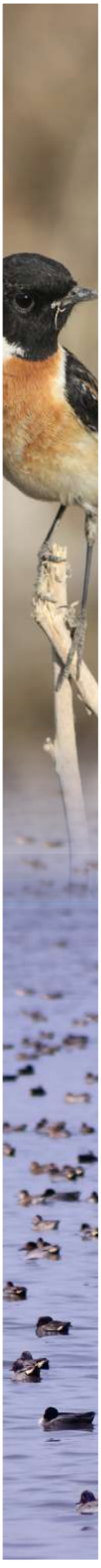
6. Burning of forests for fuel wood removal.

7. Disturbance to waterbirds by stray dogs: It was observed many times that stray dogs chase the waterbirds in the wetland areas of Sonari-Belpada and Palm Beach Road.

8. Spreading of garbage, especially plastic bags, in the natural habitat of the birds.

9. Land filling: This was observed commonly at wetland areas of Jasai, Sonari-Belpada, and Palm Beach Road, among others, after decrease of water level in summer.





Area after landflling opposite to Nava Sheva Police Station

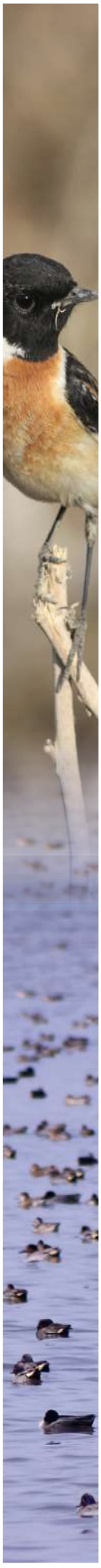
Habiatat change from wetland to shrubland

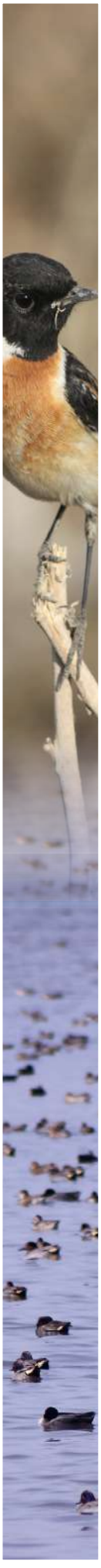
Tall grassess in monsoon

Development of road

Laying of pipeline

Lake behind NRI complex of Palm Beach Road during high water levels with no birds





Continuos change in land use

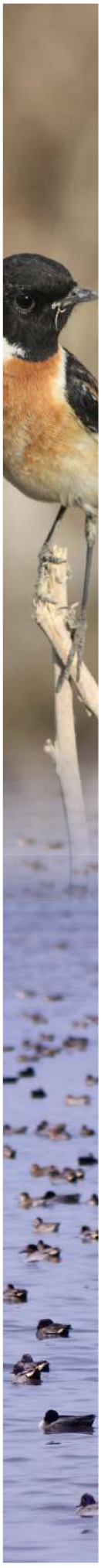
Belapada-Sonari lake completely dry in Summer

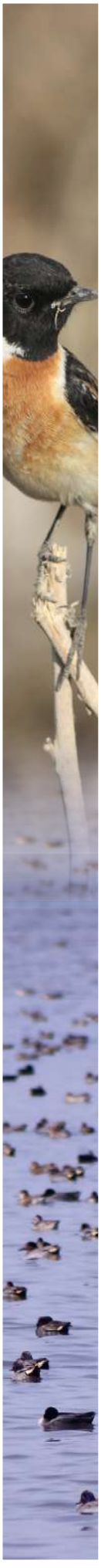
Increasing number of brick clins

Lake in late winter

Water level of the water bodies are controlled by local people

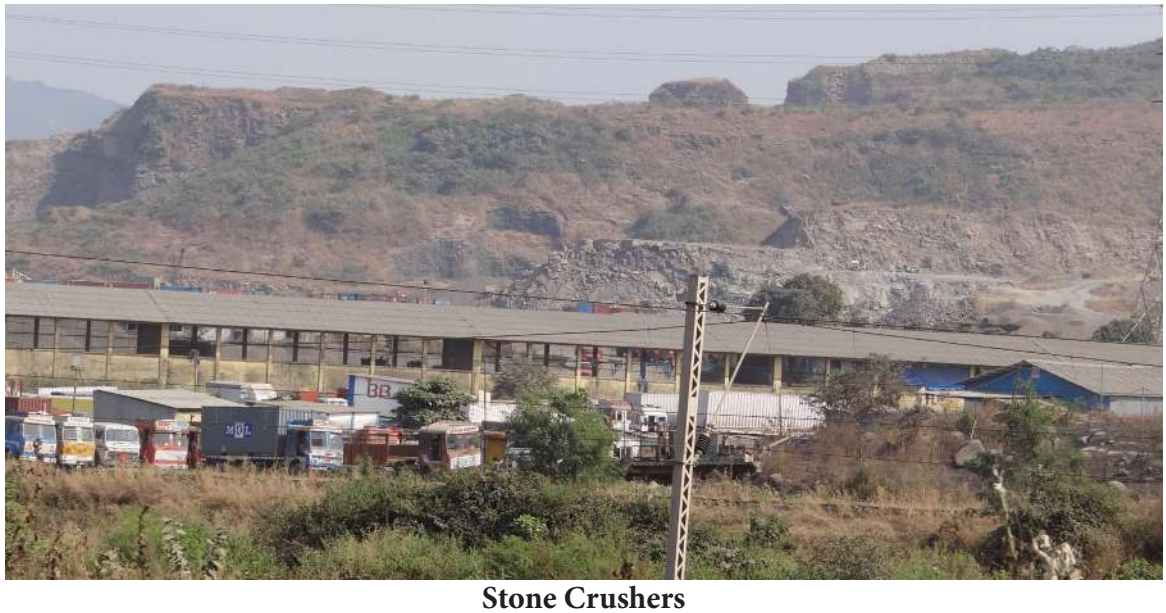
Stone Quarry





Shikra trapped in a Nylon net used at orchards to protect the fruits from frugivorous animals

New Brick Clin

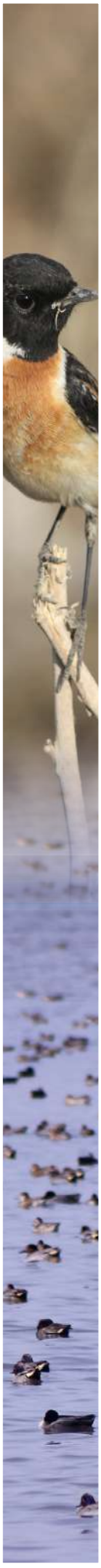


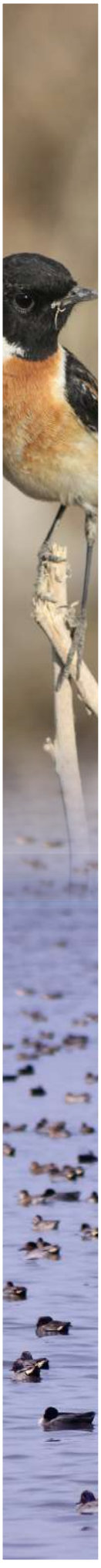
Stone Crushers

Removal of entire hill

Construction of roads through salt pans and mangroves

Though the mangroves are recognised as protected forest people are found unaware about it.





Garbage dumping

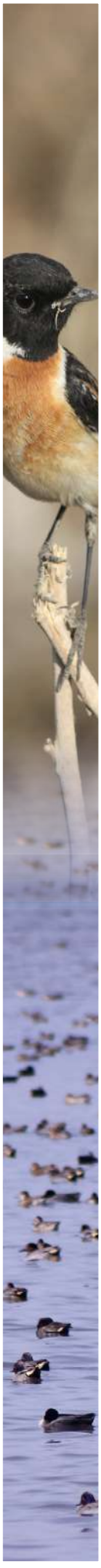
The small hillock after forest fire

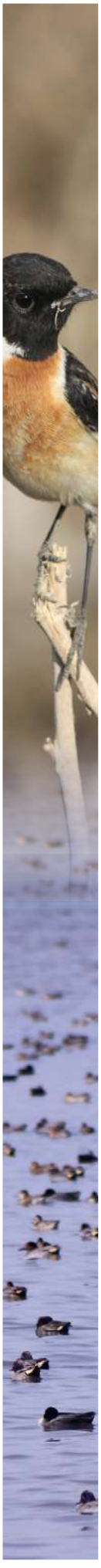
Stone crushers

Burning garbage near natural habitats

Electrocution of birds

Roadkill of a Jackal





Hunting by catapults

Heavy vehicular traffic of containers

Land filling

B) Conservation measures to be taken

1) Strict implementation of Wildlife Protection Act to stop hunting and trapping.

2) Nylon nets hanging on trees in forest patches should be removed and disposed of.

3) The extent and spread of stone quarries and construction work should be strictly regulated and this work should be minimized in winter.

4) Some sites should be protected for conservation of habitat in this rapidly developing region, especially roosting sites at Sonari-Belpada and Palm Beach Road wetlands.

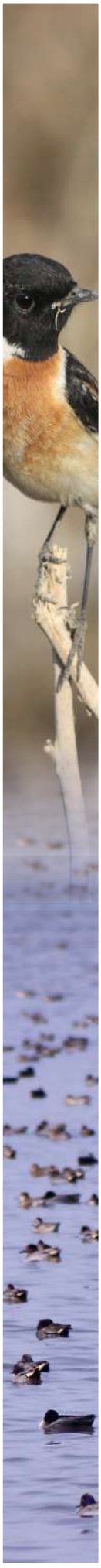
5) Development of a system for proper disposal of garbage, especially plastic waste.

6) Control on stray dogs, especially in winter at the sites used by the waterbirds for congregation.

7) Land filling activities should be regulated strictly, especially at important bird sites such as wetlands of Sonari-Belpada and Palm Beach Road.

Future Work

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 important for the protection of birds as well as human life. It is the need of the hour to monitor the area scientifically on a long-term basis with focused study on bird occupancy and movement in the study area.



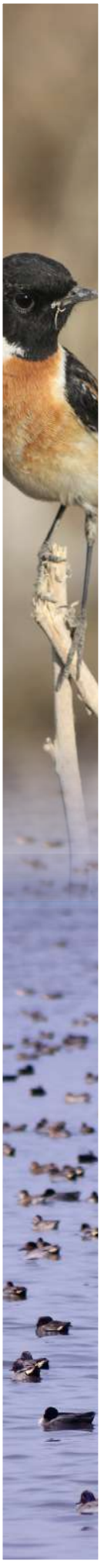


Table 1: GPS locations of the sites visited

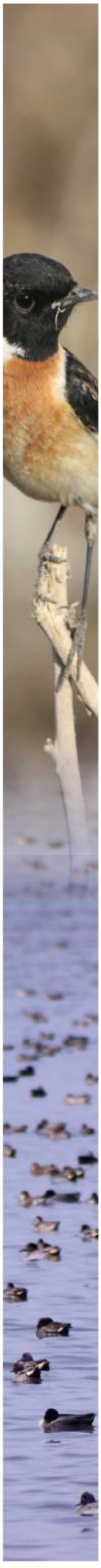
Sr. No.	Name	Position	Altitude
1.	Ajivali	N18 57.628 E73 08.848	31 m
2.	Sonari-Belpada	N18 55.424 E73 00.127	57 m
3.	Chiple	N19 00.393 E73 09.161	17 m
4.	Chirner road	N18 56.473 E73 02.486	52 m
5.	Dahirghate	N18 52.942 E73 04.478	86 m
6.	Dighade	N18 54.306 E73 02.695	4 m
7.	Dighati	N18 49.719 E73 03.161	38 m
8.	Diwale	N19 00.791 E73 02.274	63 m
9.	Dongari	N18 53.761 E72 57.479	16 m
10.	DPS, Palm Beach Road	N19 00.478 E73 01.265	2 m
11.	Dastan Phata	N18 57.484 E73 00.608	15 m
12.	Jasai	N18 56.594 E73 01.679	6 m
13.	Kalamboli Bridge	N18 59.564 E73 05.762	26 m
14.	Kalhe	N18 52.572 E73 05.758	16 m
15.	Karnala	N18 53.607 E73 06.748	53 m
16.	Kewale	N19 01.468 E73 09.783	35 m
17.	Kopar	N18 59.119 E73 04.989	39 m
18.	Lonivali	N18 58.860 E73 11.410	48 m
19.	Mansarovar-Kamothe	N19 01.127 E73 04.804	0 m
20.	Mosare	N18 57.334 E73 04.419	46 m
21.	Nanoshi	N18 56.341 E73 05.027	23 m
22.	Nere	N19 00.867 E73 10.248	26 m
23.	Nerul	N19 01.092 E73 01.708	7 m
24.	Nhava	N18 57.805 E72 59.108	15 m
25.	NRI Complex, Sea Woods	N19 00.497 E73 00.694	2 m
26.	Palaspe	N18 57.528 E73 07.852	24 m
27.	Pali	N18 59.428 E73 10.885	45 m
28.	Pargon	N18 58.795 E73 04.052	3 m
29.	Patnoli	N18 55.834 E73 04.980	20 m
30.	Ransai	N18 53.727 E73 05.136	34 m
31.	Ransaidam	N18 53.608 E73 04.146	36 m
32.	Sanpada, Palm Beach Road	N19 01.502 E73 00.426	0 m
33.	Shedung	N18 57.252 E73 10.306	43 m
34.	Tembhode	N19 01.308 E73 07.391	17 m
35.	TS Chanakya	N19 00.844 E73 00.482	0 m
36.	Ulvenode	N18 58.765 E73 01.274	5 m

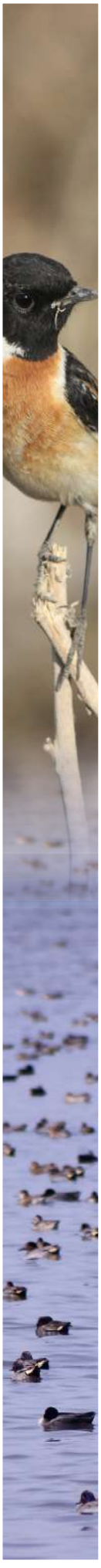
Table 2: Threatened birds found in the study area

Sr. no.	Name of bird	Area	Habitat	No. of birds	Activity
1.	Painted Stork *Mycteria leucocephala* (NT)	Sonari-Belpada NRI Lake All wetlands	W W/GS	150 40	Roosting Foraging
2.	Black-headed Ibis *Threskiornis aetheopica* (NT)	All areas	W, MC	2-5	Feeding
3.	Black-tailed Godwit *Limosa limosa* (NT)	Near Sanjivani School (Kharghar) Sonari-Belpada All wetlands	W W	200 150	Roosting Roosting Foraging
4.	Indian Spotted Eagle *Aquila clanga* (VU)	Sonari-Belpada Mosare	W F	1 1	Foraging
5.	Indian Skimmer *Rynchops albicollis* (VU)	NRI Lake	W	3	Roosting
6.	Indian River Tern (NT) *Sterna aurentia*	Sonari-Belpada	W	10 -12	Roosting
7.	*Lesser Flamingo Phoeniconaias minor*	Wetlands and seashore areas of Palm Beach Road, Airoli Creek	MD	5000-6000	Feeding
8.	*Eurasian Curlew Numenius arquata*	Wetlands of Palm Beach Road	W	300-400	Roosting
9.	*Greater Spotted Eagle Aquila clanga*	Sonari-Belpada, Mo-sare	W	2-3	Soaring

Table 3: Family wise bird species count (N=52

Sr. No.	Family	No. of species	Sr. No.	Family	No. of species
1.	Podicipedidae	1	27.	Apodidae	2
2.	Phalacrocoracidae	3	28.	Alcedinidae	4
3.	Ardeidae	11	29.	Meropidae	2
4.	Ciconiidae	4	30.	Coraciidae	1
5.	Threskiornithidae	3	31.	Upupidae	1
6.	Phoenicopteridae	2	32.	Bucerotidae	1
7.	Anatidae	9	33.	Capitonidae	3
8.	Accipitridae	16	34.	Picidae	1





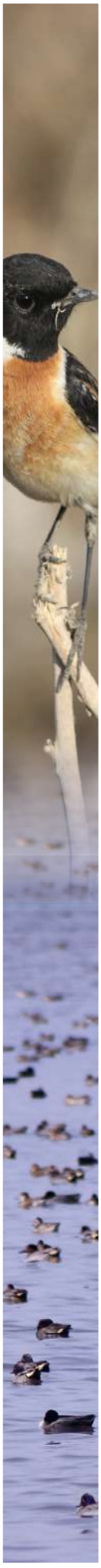
9.	Falconidae	1	35.	Pittidae	1
10.	Pandionidae	1	36.	Alaudidae	3
11.	Phasianidae	4	37.	Hirundinidae	2
12.	Turnicidae	2	38.	Motacillidae	7
13.	Gruidae	1	39.	Campephagidae	4
14.	Rallidae	7	40.	Pycnonotidae	3
15.	Jacanidae	2	41.	Irenidae	2
16.	Charadriidae	7	42.	Laniidae	3
17.	Scolopacidae	17	43.	Muscicapidae	27
18.	Recurvirostridae	2	44.	Paridae	1
19.	Laridae	9	45.	Nectariniidae	4
20.	Rynchopidae	1	46.	Emberizidae	2
21.	Columbidae	5	47.	Estrildidae	5
22.	Psittacidae	2	48.	Passeridae	4
23.	Cuculidae	5	49.	Sturnidae	7
24.	Tytonidae	1	50.	Oriolidae	2
25.	Strigidae	2	51.	Dicruridae	3
26.	Caprimulgidae	2	52.	Corvidae	3

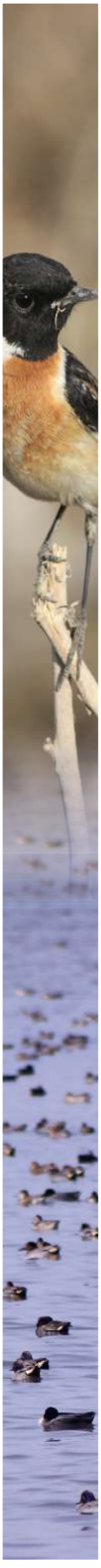
I) **Estimated maximum population of congregatory birds and their flock movement observed in various sites of the study area during survey period**

Our study was focussed on population and flock movement of congregating birds, raptors and birds observed within proposed airport area.

Sr. No.	Common / Scientific name	R/M	Estimated count of congregating birds	Seasonal movement
	Family Phalacrocoracidae			
1.	Little Cormorant *Phalacrocorax niger*	R	400 -500	In summer congregated in Panvel Creek else found in all wetland areas
2.	Great Cormorant *Phalacrocorax carbo*	R	200-300	In summer congregated in Panvel Creek else found in all wetland areas
3.	Indian Cormorant or Indian Shag *Phalacrocorax fuscicollis*	R	800-1000	In summer congregated in Panvel Creek else found in all wetland areas
	Family – Ardeidae			
4.	Eastern Cattle Egret *Bubulcus coromandus*	R	400-500	All over
5.	Intermediate Egret *Egretta intermedia*	R	100-200	Mainly observed at Sonari-Belpada Lake and spread in peak summer and monsoon

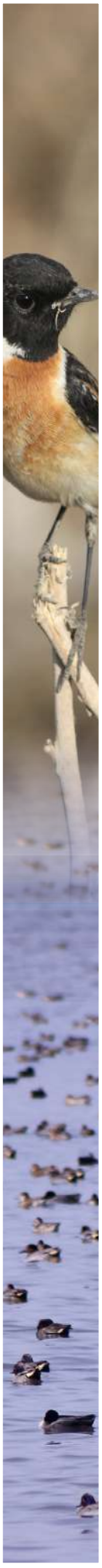
6.	Great Egret *Egretta alba*	R	50-100	Mainly observed at Sonari-Belpada Lake and spread in peak summer and monsoon
7.	Little Egret *Egretta garzetta*	R	200-300	All over in group of 5-6 birds
8.	Grey Heron *Ardea cinerea*	R	50-100	Mainly observed at Sonari-Belpada Lake and spread in peak summer and monsoon
9.	Indian Pond Heron *Ardeola grayii*	R	300-400	All over
10.	Purple Heron *Ardea purpurea*	R	50-60	Mangrove areas single individual
11.	Western Reef Egret *Egretta gularis*	M	30-40	All wetlands mainly single individual
12.	Black-crowned Night-heron *Nycticorax nycticorax*	R	20-30	Mangrove areas 2-3 individuals
	Family Ciconiidae			
13.	Painted Stork *Mycteria leucocephala*	R	150-200	Mainly observed at Sonari-Belpada Lake and spread in peak summer and monsoon
14.	Asian Openbill *Anastomus oscitans*	R	30-40	Mainly observed at Jasai wetland, move in peak summer and monsoon
15.	Woolly-necked Stork *Ciconia episcopus*	R	20-30	All areas
	Family Threskiornithidae			
16.	Oriental White Ibis *Threskiornis melanocephalus*	R	20-25	Flock of 5-6 birds in mangrove
17.	Eurasian Spoonbill *Platalea leucorodia*	R	140-150	Mainly at Sonari-Belpada, moves to Palm Beach Road areas in summer
18.	Glossy ibis *Plegadis falcinellus*	M	20-30	All fresh water wetlands
	Family Phoenicopteridae			
19.	*Lesser Flamingo* *Phoeniconaias minor*	M	5000-6000	Wetlands and seashore areas of Palm Beach Road, Airoli Creek
	Family Anatidae			
20.	*Purple Swamphen* *Porphyrio porphyrio*	M	25-30	Sonari-Belpada, Jasai Lake observed only during November to February
21.	Northern Pintail *Anas acuta*	M	50-60	Sonari-Belpada Lake in December-February

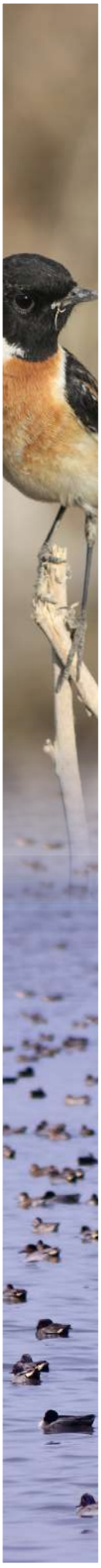




22.	*Common Teal* *Anas crecca*	M	60-70	Wetland behind NRI Complex and Sonari-Belpada Lake in December-February
23.	Spot-billed Duck *Anas poecilorhyncha*	R	70-80	All wetland areas
24.	Garganey Anas querquedula	M	30-40	Wetland behind NRI Complex and Sonari-Belpada Lake in December-March
25.	Northern Shoveler *Anas clypeata*	M	300-400	Kharghar Creek, NRI Complex in December to February
26.	*Comb Duck* *Sarkidiornis melanotos*	R	15-20	Observed only at Jasai Lake
27.	Lesser Whistling-duck *Dendrocygna javanica*	R	250-300	Largest congregation in summer at wetlands of Palm Beach Road and post summer at Sonari-Belpada Lake
28.	*Cotton Teal* *Nettapus coromandelianus*	R	40-50	Belapur pond and JNPT area
	Family Accipitridae			
29.	Black Kite *Milvus migrans*	R	100-125	Near Sonari-Belpada Lake
	Family Pandionidae			
30.	Osprey *Pandion haliaetus*	R	5-6	Nesting at Sonari-Belpada and movement to other areas
	Family Rallidae			
31.	Purple Swamphen *Porphyrio porphyrio*	R	20-25	Jasai, Sonari-Belpada
32.	Common Moorhen *Gallinula chloropus*	R	30-40	Jasai, JNPT, Belpaur Pond
33.	Eurasian Coot *Fulica atra*	R	150-160	Uran
	Family Jacanidae			
34.	Bronze-winged Jacana *Metopidius indicus*	R	40-50	Uran, Belapur Pond
35.	Pheasant-tailed jacana *Hydrophasianus chirurgus*	R	30-40	Uran, Belpaur pond
	Family Charadriidae			
36.	Red-wattled Lapwing *Vanellus indicus*	R	60-70	All areas
37.	Lesser Sand Plover *Charadrius mongolus*	M	2000-2200	Mainly Palm Beach Road and other areas for feeding
38.	Greater Sand Plover *Charadrius leschenaultia*	M	1000-1200	Mainly Palm Beach Road and other areas for feeding
39.	Little Ringed Plover *Charadrius dubius*	R	30-40	Mainly Sea shore of Palm Beach Road for feeding and NRI Lake for roosting

40.	Pacific Golden Plover *Pluvialis fulva*	M	50-60	Panvel Creek, Rocky seashore of Palm Beach Road
41.	Grey Plover *Pluvialis squatarola*		25-30	Sonari-Belpada, Palm Beach Road wetlands
	Family Scolopacidae			
42.	Common Redshank *Tringa tetanus*	M	250-300	Roost at Kharghar Creek and feed in all other wetland areas
43.	Terek Sandpiper *Xenus cinereus*	M	200-250	Kharghar and Panvel Creeks
44.	Marsh Sandpiper *Tringa stagnatilis*	M	20-25	Sonari-Belpada, Uran
45.	Black-tailed Godwit *Limosa limosa*	M	400-500	Near Sanjivani School (Kharghar), Jaskhar, Sonari-Belpada
46.	Eurasian Curlew *Numenius arquata*	M	300-400	Wetlands of Palm Beach Road
47.	Ruddy Turnstone *Arenaria interpres*	M	20-25	Rocky seashore of Palm Beach Road
48.	Temminck's Stint *Calidris temminckii*	M	1000-1200	Mainly Palm Beach Road and other areas for feeding
49.	Little Stint *Calidris minuta*	M	200-300	Mainly Palm Beach Road and other areas for feeding
50.	Curlew Sandpiper *Calidris ferruginea*	M	1500-1600	Mainly Palm Beach Road and other areas for feeding
51.	Ruff *Philomachus pugnax*	M	100-120	Jasai, Sonari-Belpada
52.	Dunlin *Calidris alpina*	M	10-12	Rocky seashore of Palm Beach Road
53.	Whimbrel *Numenius phaeopus*	M	1	Sonari-Belpada
	Family Recurvirostridae			
54.	Black-winged Stilt *Himantopus himantopus*	R	200-250	All wetland areas
55.	Pied Avocet *Recurvirostra avosetta*	M	600-700	NRI, Jasai
	Family Laridae			
56.	Gull-billed Tern *Gelochelidon nilotica*	M	100-150	All wetland areas, mainly at wetlands of Palm Beach Road
57.	Caspian Tern *Sterna caspia*	M	40-50	All wetland areas, mainly at wetlands of Palm Beach Road
58.	Saunders's Tern *Sterna saundersi*	M	10-12	All wetland areas, mainly at wetlands of Palm Beach Road

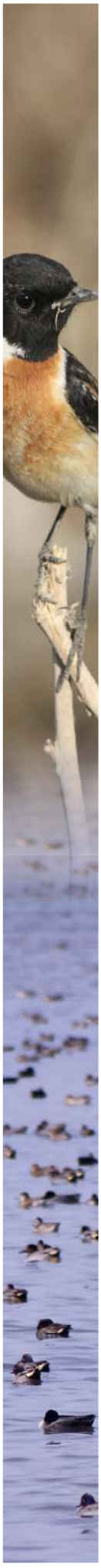


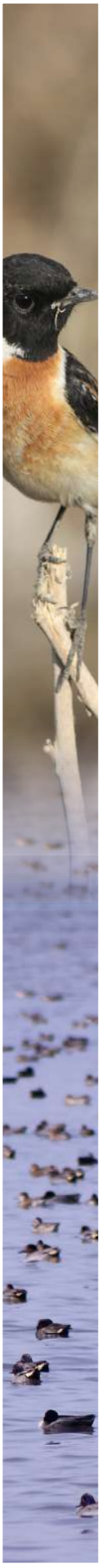


59.	Whiskered Tern *Chlidonias hybridus*	M	200-250	Jasai
60.	River Tern *Sterna aurantia (NT)*	M	20-25	Sonari-Belpada
61.	White-cheeked Tern *Sterna repressa*	M	25-30	Jasai
62.	Brown-headed Gull *Larus brunnicephalus*	M	300-350	All wetland areas, mainly at wetlands of Palm beach road
63.	Black-headed Gull *Larus ridibundus*	M	200-250	All wetland areas, mainly at wetlands of Palm beach road
	Family Columbidae			
64.	Rock Pigeon *Columba livia*	R	600-700	All human habitations
	Family Rynchopidae			
65.	Indian Skimmer *Rynchops albicollis*	R	3	NRI area
	Family Meropidae			
66.	Blue-tailed Bee-eater *Merops philippinus*	R	25-30	Kharghar creek
	Family Hirundinidae			
67.	Wire-tailed Swallow *Hirundo smithii*	R	60-70	NMIA area
68.	Barn Swallow *Hirundo rustica*	R	60-70	NMIA area
69.	Clamorous Reed-warbler or Indian Great Reed-warbler *Acrocephalus [strentoreus] bruniscens*	R	200-250	All mangrove areas
	Family Emberizidae			
70.	Red-headed Bunting *Emberiza bruniceps*	M	1000	Pargaon, NMIA site
71.	Black-headed Bunting *Emberiza melanocephala*	M	500	Pargaon, NMIA site
	Family Estrildidae			
72.	Red Avadavat *Amandava amandava*	R	140-150	Kharghar creek, Sonari-Belpada,
73.	Scaly-breasted Munia *Lonchura punctulata*	R	60-70	Kharghar creek, Palm beach road
	Family Sturnidae			
74.	Rosy Starling *Sturnus roseus*	M	700-1000	Kharghar Creek, DPS School,

Annexure I: List of birds observed during surveys carried out in 10km radius area of NMIA

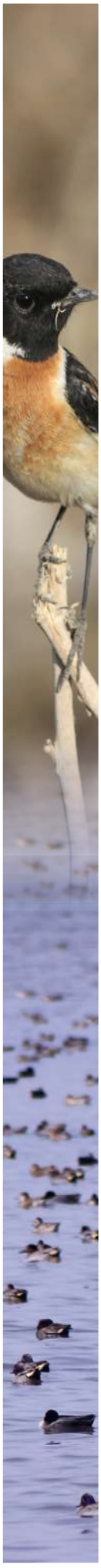
Sr. no.	Common and scientific names of the birds	Habi-tat	WPA schedule	IUCN status	R/M	Sites
	Family Podicipedidae					
1.	Little Grebe *Tachybaptus ruficollis*	W	IV	LC	R	Dastan Phata, DPS Lake, Belapur pond
	Family Phalacrocoracidae					
2.	Little Cormorant *Phalacrocorax niger*	W	IV	LC	R	All wetland areas
3.	Great Cormorant *Phalacrocorax carbo*	W	IV	LC	R	Ulve
4.	Indian Cormorant or Indian Shag *Phalacrocorax fuscicollis*	W	IV	LC	R	All wetland areas
	Family Ardeidae					
5.	Eastern Cattle Egret *Bubulcus coromandus*	W/P	IV	LC	R	All wetland areas
6.	Intermediate Egret *Egretta intermedia*	W/P	IV	LC	R	All wetland areas
7.	Great Egret *Egretta alba*	W	IV	LC	R	All wetland areas
8.	Little Egret *Egretta garzetta*	W/P/C	IV	LC	R	All wetland areas
9.	Grey Heron *Ardea cinerea*	W/C	IV	LC	R	All wetland areas
10.	Indian Pond Heron *Ardeola grayii*	W	IV	LC	R	All wetland areas
11.	Purple Heron *Ardea purpurea*	W/C	IV	LC	R	All wetland areas
12.	Western Reef Egret *Egretta gularis*	W / MD	IV	LC	M	Dastan Phata, Nere, Sonari-Belpada
13.	Black-crowned Night-heron *Nycticorax nycticorax*	W	IV	LC	R	Kharghar creek, Panvel creek
14.	Striated Heron *Butorides striatus*	W	IV	LC	R	Uran
15.	Chestnut Bittern *Ixobrychus cinnamomeus*	W	IV	LC	R	Panvel Lake

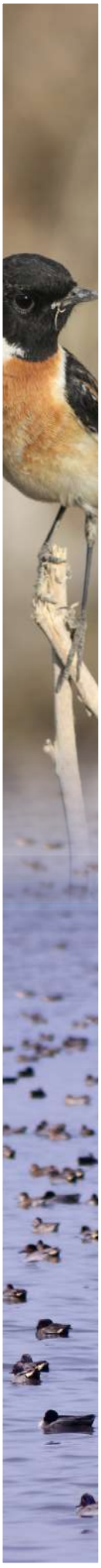




	Family Ciconiidae					
16.	Painted Stork *Mycteria leucocephala*	W	IV	NT	R	Sonari-Belpada, Kopar, wetlands at Palm Beach Road
17.	Asian Openbill *Anastomus oscitans*	W	IV	LC	R	Dastan Phata,
18.	Woolly-necked Stork *Ciconia episcopus*	W	IV	LC	R	Dastan Phata, Mosare
19.	Black Stork *Ciconia nigra*	W	IV	LC	M	Ransai dam
	Family Threskiornithidae					
20.	Oriental White Ibis *Threskiornis melanocephalus*	W/C	IV	NT	R	All wetlands and mangroves
21.	Eurasian Spoonbill *Platalea leucorodia*	W	I	LC	R	Jasai, Sanjivani Sch, Sonari-Belpada
22.	Glossy Ibis *Plegadis falcinellus*	W	IV	LC	M	Karal
	Family Phoenicopteridae					
23.	Greater Flamingo *Phoenicopterus major*	W	I	LC	M	Sonari-Belpada, NRI
24.	Lesser Flamingo *Phoeniconaias minor*	W	I	NT	M	Wetlands and Seashore of Palm Beach Road
	Family Anatidae					
25.	Ruddy Shelduck *Tadorna ferruginea*	W	IV	LC	M	Jasai, Sanjivani School, Sonari-Belpada
26.	Northern Pintail *Anas acuta*	W	IV	LC	M	Sonari-Belpada
27.	Common Teal *Anas crecca*	W	IV	LC	M	Sonari-Belpada
28.	Spot-billed Duck *Anas poecilorhyncha*	W/C	IV	LC	R	All
29.	Garganey *Anas querquedula*	W	IV	LC	M	Sonari-Belpada
30.	Northern Shoveler *Anas clypeata*	W/C	IV	LC	M	Kharghar Creek

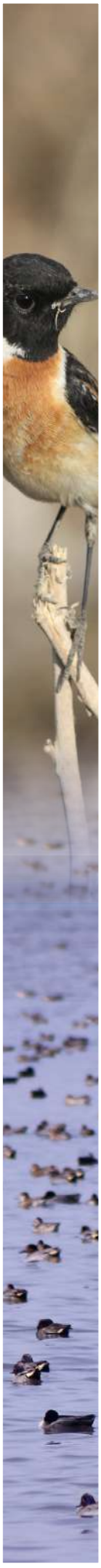
31.	Comb Duck *Sarkidiornis melanotos*	W	IV	LC	R	Dastan Phata
32.	Lesser Whistling-duck *Dendrocygna javanica*	W	IV	LC	R	Dastan Phata, Belapur pond, Sonari-Belpada, Palm Beach Road
33.	Cotton Teal *Nettapus coromandelianus*	W	IV	LC	R	Dastan Phata, Belapur pond
	Family Accipitridae					
34.	Black-shouldered Kite *Elanus caeruleus*	All	I	LC	R	All areas
35.	Black Kite *Milvus migrans*	All	I	LC	R	All areas
36.	Brahminy Kite *Haliastur indus*	W/P	I	LC	R	Sonari-Belpada, Dastan Phata
37.	Black-eared Kite *Milvus milvus lineatus*	W	I	LC	M	Sonari-Belpada
38.	Shikra *Accipiter badius*	All	I	LC	R	All areas
39.	White-eyed Buzzard *Butastur teesa*	F	I	LC	R	Jasai
40.	Oriental Honeybuzzard *Pernis ptylorhynchus*	F	I	LC	R	Mosare
41.	Common Buzzard *Buteo buteo*	F	I	LC	R	Ransai, Chirner
42.	Long-legged Buzzard *Buteo rufinus*	F	I	LC	R	Mosare
43.	Western Marsh Harrier *Circus aeruginosus*	W	I	LC	M	All areas
44.	Crested Serpent-eagle *Spilornis cheela*	F	I	LC	R	Ransai, Mosare
45.	Changeable Hawk Eagle *Nisaetus cirrhatus*	F	I	LC	R	Ransai
46.	Short-toed Snake-eagle *Circaetus gallicus*	GS	I	LC	R	Chirner road
47.	Booted Eagle *Hieraaetus pennatus*	F	I	LC	M	Mosare

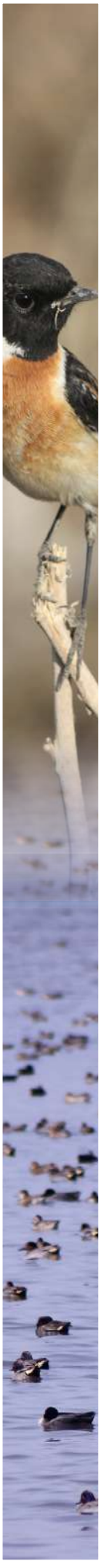




48.	Greater Spotted Eagle *Aquila clanga*	F	I	LC	M	Sonari-Belpada, Mosare
49.	Indian Spotted Eagle *Aquila pomarina*		I	VU	R	Sonari-Belpada
	Family Falconidae	V	I	LC	R	
50.	Common Kestrel *Falco tinnunculus*	GS	IV	LC	R	Chirner road
	Family Pandionidae					
51.	Osprey *Pandion haliaetus*	W/C	I	LC	R	Kharghar Creek, Sonari-Belpada
	Family Phasianidae					
52.	Red Spurfowl *Galloperdix spadicea*	F	-	LC	R	Kharghar hills
53.	Jungle Bush-quail *Perdicula asiatica*	F	-	LC	R	Ransai, Chirner Road
54.	Indian Peafowl *Pavo cristatus*	F	1	LC	R	Nere
55.	Rain Quail *Coturnix coromandelica*	P	-	LC	R	Chirner
	Family Turnicidae					
56.	Barred Buttonquail *Turnix suscitator*	P	-	LC	R	Chirner
57.	Yellow-legged buttonquail *Turnix tanki*	P	-	LC	R	Chirner
	Family Gruidae					
58.	Demoiselle Crane *Grus virgo*	W		LC	M	Belpada
	Family Rallidae					
59.	White-breasted Waterhen *Amaurornis phoenicurus*	W/C	IV	LC	R	Dastan Phata, Pargaon
60.	Purple Swamphen *Porphyrio porphyrio*	W	IV	LC	R	Dastan Phata, Pargaon
61.	Common Moorhen *Gallinula chloropus*	W	IV	LC	R	Belapur pond, Dastan Phata
62.	Eurasian Coot *Fulica atra*	W	IV	LC	R	Belapur pond, Dastan Phata

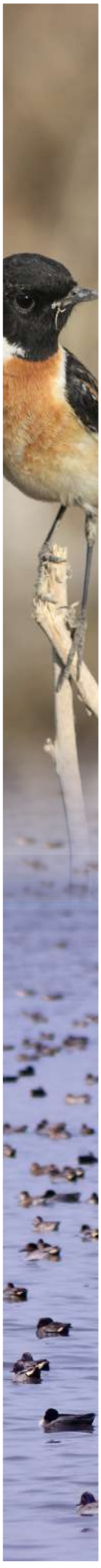
63.	Slaty-breasted Rail *Gallirallus striatus*	W/C	IV	LC	R	Kharghar Creek, Panvel Creek
64.	Ruddy-breasted Crake *Porzana fusca*	W/C	IV	LC	R	Kharghar Creek, Panvel Creek
65.	Brown Crake *Porzana akool*	W/C	IV	LC	R	Chirner, Uran
	Family Jacanidae					
66.	Bronze-winged Jacana *Metopidius indicus*	W	IV	LC	R	Belapur Pond, Dastan Phata
67.	Pheasant-tailed jacana *Hydrophasianus chirurgus*	W	IV	LC	R	Belapur pond, Dastan Phata
	Family Charadriidae					
68.	Red-wattled Lapwing *Vanellus indicus*	ALL	IV	LC	R	All areas
69.	Lesser Sand Plover *Charadrius mongolus*	W / MD	IV	LC	M	All Mudflats in study area
70.	Greater Sand Plover *Charadrius leschenaulti*	W / MD	IV	LC	M	Behind NRI Complex
71.	Little Ringed Plover *Charadrius dubius*	W / MD	IV	LC	R	All wetlands
72.	Pacific Golden Plover *Pluvialis fulva*	W / MD	IV	LC	M	Behind TS Chanakya, Panvel Creek
73.	Kentish Plover *Charadrius alexandrinus*	W / MD	IV	LC	M	All wetlands
74.	Grey Plover *Pluvialis squatarola*	W / MD	IV	LC	M	Sonari-Belpada, wetlands of Palm Beach Road area
	Family Scolopacidae					
75.	Common Snipe *Gallinago gallinago*	W	IV	LC	R	Sonari-Belpada, Dastan Phata
76.	Common Redshank *Tringa totanus*	W / MC	IV	LC	M	All (congregation at Kharghar Creek)
77.	Wood Sandpiper *Tringa glareola*	W / MC	IV	LC	M	All wetlands
78.	Common Sandpiper *Tringa hypoleucos*	W / MC		LC	R	All wetlands

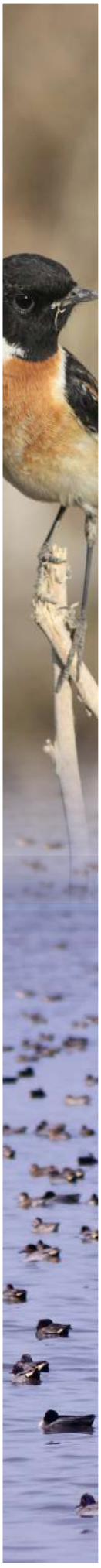




79.	Common Greenshank *Tringa nebularia*	W/RS	IV	LC	M	Seashore of Palm Beach Road, Sonari-Belpada
80.	Terek Sandpiper *Xenus cinereus*	W / MC	IV	LC	M	Kharghar Creek, Kopar
81.	Green Sandpiper *Tringa ochropus*	W / MC	IV	LC	M	Sonari-Belpada
82.	Marsh Sandpiper *Tringa stagnatilis*	W		LC	M	All wetlands (more at Belpada)
83.	Black-tailed Godwit *Limosa limosa*	W	IV	LC	M	Sonari-Belpada, Sanjivani School
84.	Eurasian Curlew *Numenius arquata*	W	IV	LC	M	Behind NRI complex
85.	Ruddy Turnstone *Arenaria interpres*	RS	IV	LC	M	Behind TS Chanakya,
86.	Temminck's Stint *Calidris temminckii*	W		LC	M	All (Large congregation behind NRI Complex)
87.	Little Stint *Calidris minuta*	W	IV	LC	M	All wetland areas
88.	Curlew Sandpiper *Calidris ferruginea*	W	IV	LC	M	Sonari-Belpada, Dastan Phata, Sanjivani school (congregation of 2000 birds behind NRI Complex)
89.	Ruff *Philomachus pugnax*	W	IV	LC	M	Sonari-Belpada, Dastan Phata
90.	Dunlin *Calidris alpina*	W	IV	LC	M	Seashore of Palm Beach Road
91.	Whimbrel *Numenius phaeopus*	W	IV	LC		Sonari-Belpada
	Family Recurvirostridae					
92.	Black-winged Stilt *Himantopus himantopus*	W	IV	LC	R	All wetland areas
93.	Pied Avocet *Recurvirostra avosetta*	W	IV	LC	M	Jasai, NRI area
	Family Laridae					
94.	Gull-billed Tern *Gelochelidon nilotica*	W	IV	LC	M	All wetland areas

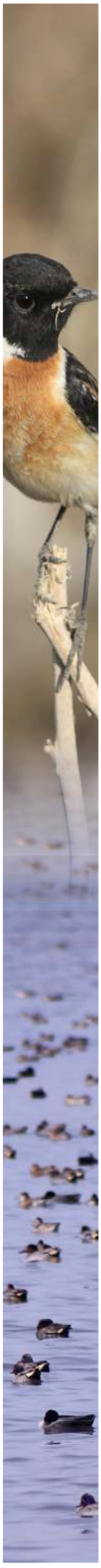
95.	Caspian Tern *Sterna caspia*	W/C	IV	LC	M	Wetlands of Kamothe, Panvel, Palm Beach Road
96.	Saunders's Tern *Sterna saundersi*	W/C	IV	LC	M	Wetlands of Palm Beach Road
97.	Whiskered Tern *Chlidonias hybridus*	W/C	IV	LC	M	Wetlands of Palm Beach Road, Panvel Creek
98.	River Tern *Sterna aurantia*	W/C	IV	LC	M	Wetlands of Sonari-Belpada, Palm Beach Road, Panvel Creek
99.	White-cheeked Tern *Sterna repressa*	W	IV	LC	M	Jasai
100.	Brown-headed Gull *Larus brunnicephalus*	W	IV	LC	M	All wetland areas (more than 200 at DPS lake)
101.	Black-headed Gull *Larus ridibundus*	W	IV	LC	M	All wetland areas
102.	Heuglins Gull *Larus heuglini*	W	IV	LC	M	Airoli
	Family Rynchopidae					
103.	*Indian Skimmer* *Rynchops albicollis* (VU)	W	IV	VU	R	NRI area
	Family Columbidae					
104.	Rock Pigeon *Columba livia*	A l l / NH		LC	R	All areas
105.	Yellow-footed Green-pigeon *Treron phoenicoptera*	F	IV	LC	R	Ransai
106.	Little Brown Dove *Streptopelia senegalensis*	All	IV	LC	R	All areas
107.	Eurasian Collared Dove *Streptopelia decaocto*	GS	IV	LC	R	Uran
108.	Spotted Dove *Streptopelia chinensis*	All	IV	LC	R	All areas
	Family Psittacidae					
109.	Rose-ringed Parakeet *Psittacula krameri*	All	IV	LC	R	All areas
110.	Plum-headed Parakeet *Psittacula cyanocephala*	F	IV	LC	R	Ransai
	Family Cuculidae					

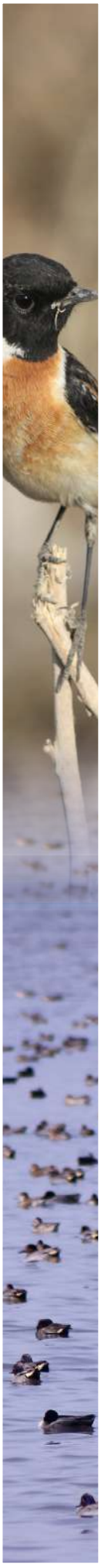




111.	Asian Koel *Eudynamys scolopaceus*	All	IV	LC	R	All areas
112.	Greater Coucal (Southern Coucal) *Centropus sinensis*	All	IV	LC	R	All areas
113.	Common Hawk Cuckoo *Hierococcyx varius*	All	IV	LC	R	Mosare, Ransai
114.	Blue-faced Malkoha *Phaenicophaeus viridirostris*	All	IV	LC	R	Mosare
115.	Sirkeer Malkoha *Phaenicophaeus leschenaulti*	All	IV	LC	R	Mosare
	Family Tytonidae					
116.	Common Barn-Owl *Tyto alba*	NH	IV	LC	R	Kharghar
	Family Strigidae					
117.	Spotted Owlet *Athene brama*	F/NH	IV	LC	R	Mosare, Ransai
118.	Indian Eagle-Owl *Bubo bengalensis*	NH	IV	LC	R	Jasai
	Family Caprimulgidae					
119.	Indian Little Nightjar *Caprimulgus asiaticus*	A/GS	IV	LC	R	Ransai
120.	Indian Jungle Nightjar *Caprimulgus indicus*	F	IV	LC	R	Ransai
	Family Apodidae					
121.	Little or House Swift *Apus affinis*	NH		LC	R	All areas
122.	Asian Palm-Swift *Cypsiurus balasiensis*	F/NH		LC	R	All areas
	Family Alcedinidae					
123.	Lesser Pied Kingfisher *Ceryle rudis*	W	IV	LC	R	Kopar
124.	White-breasted Kingfisher *Halcyon smyrnensis*	All	IV	LC	R	All areas
125.	Common Kingfisher *Alcedo atthis*	W	IV	LC	R	All areas

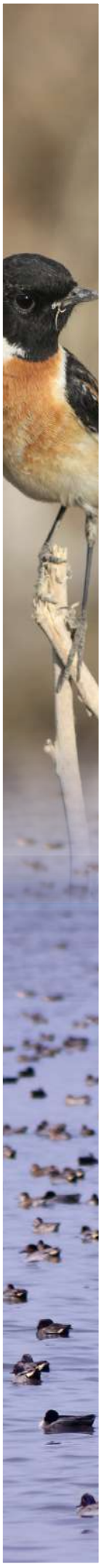
126.	Black-capped Kingfisher *Halcyon pileata*	W/F	IV	LC	R	Ransai
	Family Meropidae					
127.	Little Green Bee-eater *Merops orientalis*	All		LC	R	All areas
128.	Blue-tailed Bee-eater *Merops philippinus*	F/MC		LC	R	Kharghar Creek, Mosare
	Family Coraciidae					
129.	Indian Roller *Coracias benghalensis*	All	IV	LC	R	All areas
	Family Upupidae					
130.	Common Hoopoe *Upupa epops*	M C / GS		LC	M	All areas
	Family Bucerotidae					
131.	Indian Grey Hornbill *Ocyceros birostris*	F	I	LC	R	Mosare, Ransai
	Family Capitonidae					
132.	Coppersmith Barbet *Megalaima haemacephala*	F	IV	LC	R	Mosare, Ransai
133.	Brown-headed Barbet *Megalaima zeylonica*	F	IV	LC	R	Mosare, Ransai
134.	White-cheeked Barbet *Megalaima viridis*	F	IV	LC	R	Patnoli, Chirner
	Family Pittidae					
135.	Indian Pitta *Pitta brachyura*	F	IV	LC	R	Mosare
	Family Picidae					
136.	Eurasian Wryneck *Jynx torquilla*	F	IV	LC	R	Mosare
137.	Rufous Woodpecker *Celeus brachyurus*	F	IV	LC	R	Patnoli, Chirner
138.	Yellow-fronted Pied Woodpecker *Dendrocopos mahrattensis*	F	IV	LC	R	Mosare, Nere
	Family Alaudidae					
139.	Ashy -crowned Sparrow-lark *Eremopterix griseus*	GS	IV	LC	R	Uran

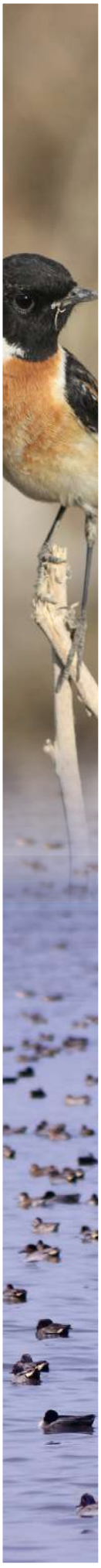




140.	Rufous-tailed Finch-Lark *Ammomanes phoenicura*	All	IV	LC	R	All areas
141.	Malabar Lark *Galerida malabarica*	ALL	IV	LC	R	All areas
	Family Motacillidae					
142.	Citrine Wagtail *Motacila citreola*	W/M	IV	LC	M	All areas
143.	Yellow Wagtail *Motacilla flava*	W/M	IV	LC	M	All areas
144.	Grey Wagtail *Motacilla cinerea*	W	IV	LC	M	All areas
145.	White Wagtail *Motacilla alba*	W	IV	LC	M	All areas
146.	Large Pied Wagtail *Motacia maderaspatensis*	W	IV	LC	R	All areas
147.	Tree Pipit *Anthus trivialis*	P/GS	IV	LC	M	All areas
148.	Paddyfield Pipit *Anthus rufulus*	ALL	IV	LC	R	All areas
	Family Hirundinidae					
149.	Wire-tailed Swallow *Hirundo smithii*	All		LC	R	All areas
150.	Barn Swallow *Hirundo rustica*	W		LC	R	All areas
	Family Campephagidae					
151.	Common Woodshrike *Tephrodornis pondiceria-nus*	F	IV	LC	R	Mosare
152.	Large Cuckooshrike *Coracina macei*	F	IV	LC	R	Patnoli
153.	Small Minivet *Pericrocotus cinnamome-us*	F	IV	LC	R	Mosare
154.	Scarlet Minivet *Pericrocotus flammeus*	F	IV	LC	R	Ransai
	Family Irenidae					
155.	Common Iora *Aegithina tiphia*	F	IV	LC	R	Ransai
156.	Gold-fronted Chloropsis *Chloropsis aurifrons*	F	IV	LC	R	Ransai, Mosare

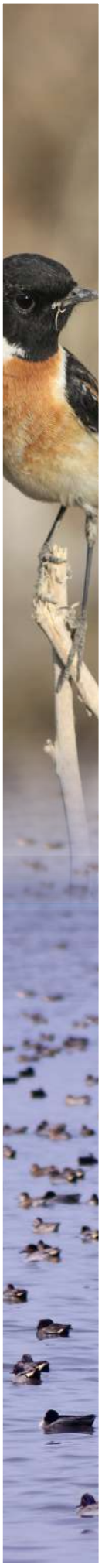
	Family Pycnonotidae					
157.	Red-vented Bulbul *Pycnonotus cafer*	All	IV	LC	R	All areas
158.	Red-whiskered Bulbul *Pycnonotus jocosus*	F/MC	IV	LC	R	All areas
	Family Laniidae					
159.	Bay-backed Shrike *Lanius vittatus*	All		LC	R	All areas
160.	Long-tailed Shrike *Lanius schach*	All		LC	R	All areas
161.	Southern Grey Shrike *Lanius meridionalis*	GS		LC	R	Chirner road
	Family Muscicapidae					
162.	Orange-headed Thrush *Zoothera citrina*	F	IV	LC	R	Ransai
163.	Jungle Babbler *Turdoides striatus*	F	IV	LC	R	Ransai, Mosare, Patnoli
164.	Tawny-bellied Babbler *Turdoides hyperythra*	F	IV	LC	R	Mosare, Patnoli
165.	Yellow-eyed Babbler *Chrysomma sinense*	F	IV	LC	R	Chirner
166.	Indian Scimitar-babbler *Pomatorhinus [schisticeps] horsfieldii*	F	IV	LC	R	Chirner, Mosare
167.	Puff-throated Babbler *Pellorneum ruficeps*	F	IV	LC	R	Mosare, Patnoli
168.	Brown-cheeked Fulvetta *Alcippe poioicephala*	F	IV	LC	R	Ransai
169.	Black Redstart *Phoenicurus ochruros*	GS	IV	LC	M	Mosare
170.	Malabar Whistling-thrush *Myophonus horsfieldi*	F	IV	LC	M	Ransai
171.	Oriental Magpie-robin *Copsychus saularis*	All	IV	LC	R	All areas
172.	Common Stonechat *Saxicola torquatus*	All	IV	LC	M	All areas
173.	Pied Bushchat *Saxicola caprata*	All	IV	LC	R	Uran

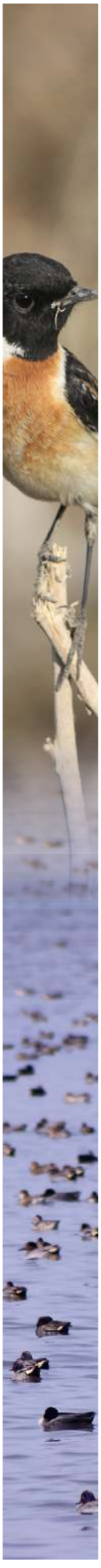




174.	Isabelline Wheatear *Oenanthe isabellina*	GS	IV	LC	M	T S Chanakya
175.	Indian Black Robin *Saxicoloides fulicatus*	All	IV	LC	R	All areas
176.	White-rumped Shama *Copsychus saularis*	F	IV	LC	R	Ransai
177.	Bluethroat *Luscinia svecica*	MC	IV	LC	M	Sonari-Belpada, Kharghar creek, Pargaon
178.	Blue Rockthrush *Monticola solitarius*	GS	IV	LC	M	Uran
179.	Zitting Cisticola *Cisticola juncidis*	MC	IV	LC	R	Kopar
180.	Plain Prinia *Prinia inornata*	All	IV	LC	R	All areas
181.	Ashy Prinia *Prinia socialis*	All	IV	LC	R	All areas
182.	Grey-breasted Prinia *Prinia hodgsonii*	All	IV	LC	R	Mosare
183.	Clamorous Reed-warbler or Indian Great Reed-warbler *Acrocephalus [strentoreus] bruniscens*	MS	IV	LC	M	All creeks and mangrove areas
184.	Common Tailorbird *Orthotomus sutorius*	All		LC	R	All areas
185.	Lesser Whitethroat *Sylvia curruca*	GS	IV	LC	M	Uran
186.	Red-breasted Flycatcher *Ficedula parva*	GS/F	IV	LC	M	Nere
187.	Asian Brown Flycatcher *Muscicapa dauurica*	MC	IV	LC	M	Kopar
188.	White-browed Fantail-flycatcher *Rhipidura albicollis*	MC	IV	LC	M	Khargahr Creek
189.	Grey Headed Canary Flycatcher *Culicicapa ceylonensis*	F	IV	LC		Ransai
	Family Paridae					
190.	Great Tit *Parus major*	NH	IV	LC	R	Uran

	Family Nectariniidae					
191.	Purple Sunbird *Cinnyris asiatica*	All	IV	LC	R	Uran
192.	Purple-rumped Sunbird *Leptocoma zeylonica*	GS	IV	LC	R	Uran
193.	Small Sunbird *Leptocoma minima*	F			R	Ransai
194.	Vigors's Sunbird *Aethopyga vigorsii*	F			R	Ransai
	Family Emberizidae					
195.	Red-headed Bunting *Emberiza bruniceps*	GS	IV	LC	M	Paragaon
196.	Black-headed Bunting *Emberiza melanocephala*	GS	IV	LC	M	Paragaon, Kharghar Creek
	Family Estrildidae					
197.	Indian Silverbill *Euodice malabarica*	P	IV	LC	R	All areas
198.	Red Avadavat *Amandava amandava*	W / MC	IV	LC	R	Sonari-Belpada, TS Chanakya
199.	Black-headed Munia *Lonchura malacca*	MC	IV	LC	R	Kharghar Creek, TS Chanakya
200.	Scaly-breasted Munia *Lonchura punctulata*	MC/F	IV	LC	R	Kharghar Creek, TS Chanakya, Mosare
201.	White-rumped Munia *Lonchura striata*	F	IV	LC	R	Mosare
	Family Passeridae					
202.	House Sparrow *Passer domesticus*	All	IV	LC	R	All areas
203.	Baya Weaver *Ploceus philippinus*	All	IV	LC	R	All areas
204.	Black-breasted Weaver *Ploceus benghalensis*	All	IV	LC	R	All areas
205.	Yellow-throated Sparrow *Petronia xanthocollis*	F/GS	IV	LC	R	Uran, Mosare
	Family – Sturnidae					
206.	Rosy Starling *Sturnus roseus*	All	IV	LC	M	Sonari-Belpada, Nhava, Kharghar Creek, Pargaon, Kopar





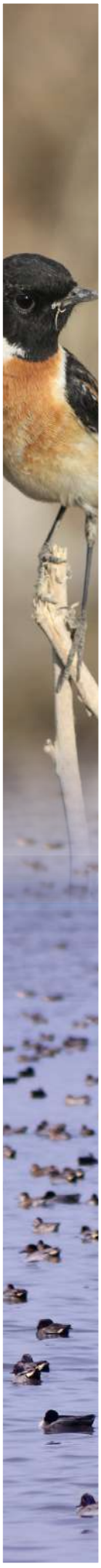
207.	Brahminy Starling *Temenuchus pagodarum*	GS	IV	LC	R	Uran
208.	Grey-headed Starling *Temenuchus malabarica*	GS	IV	LC	R	Behind TS Chanakya
209.	Malabar White-headed Starling *Temenuchus blythii*	GS	IV	LC	R	Behind TS Chanakya
210.	Asian Pied Starling *Gracupica contra*	GS	IV	LC	R	All areas
211.	Common Myna *Acridotheres tristis*	All	IV	LC	R	All areas
212.	Jungle Myna *Acridotheres fuscus*	All	IV	LC	R	Mosare
	Family Oriolidae					
213.	Eurasian Golden Oriole *Oriolus oriolus*	All	IV	LC	R	All areas
214.	Black-hooded Oriole *Oriolus xanthornus*	F	IV	LC	R	Ransai
	Family Dicruridae					
215.	Black Drongo *Dicrurus macrocercus*	All	IV	LC	R	All areas
216.	Ashy Drongo *Dicrurus leucophaeus*	F	IV	LC	R	Ransai
217.	White-bellied Drongo *Dicrurus caerulescens*	F	IV	LC	R	Ransai, Patnoli
	Family Corvidae					
218.	House Crow *Corvus splendens*	NH	V	LC	R	All areas
219.	Jungle Crow *Corvus macrorhynchos*	All	IV	LC	R	All areas
220.	Rufous Treepie *Dendrocitta vagabunda*	F	IV	LC	R	Mosare

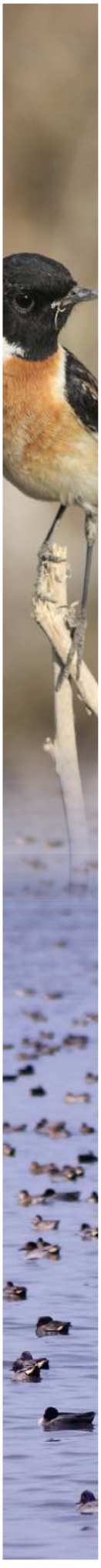
Raptors of Study Area

Osprey

Indian Spotted Eagle

Greater Spotted Eagle





Brahminy Kite chased by crows

Long legged Buzzard

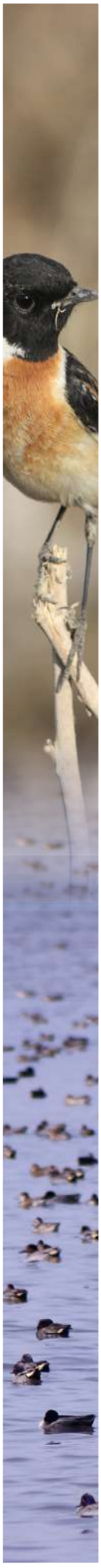
Crested Serpent Eagle

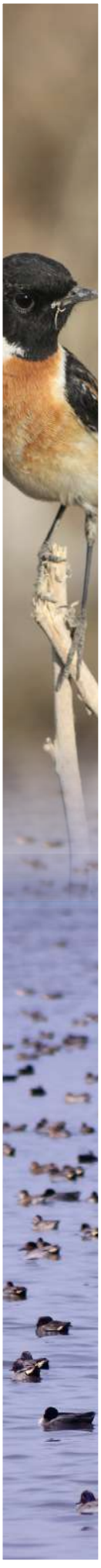
Birds in Flight

Birds in flight at dawn

Flock of Painted Stork in flight

Water birds in flight





Waders in flight

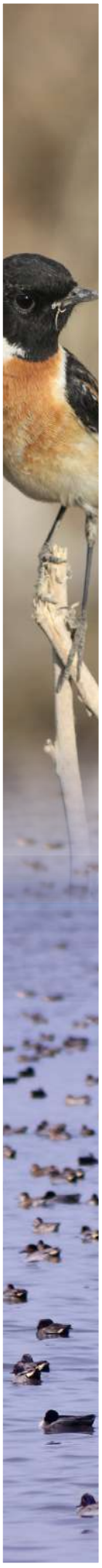
Congregation of birds

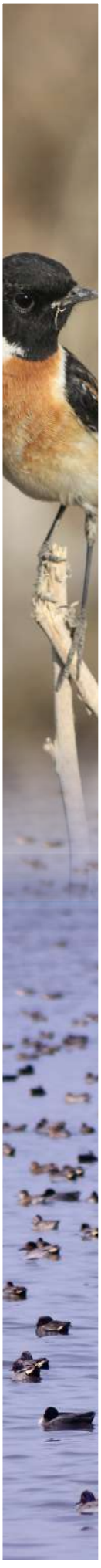
Large flock of Brown-headed Gull

Hundreds of Cormorants and Indian Shags fly from creek areas

House Crows flying to roosting site

Black-tailed Godwit in flight





Flock of Pied Avocet in Flight

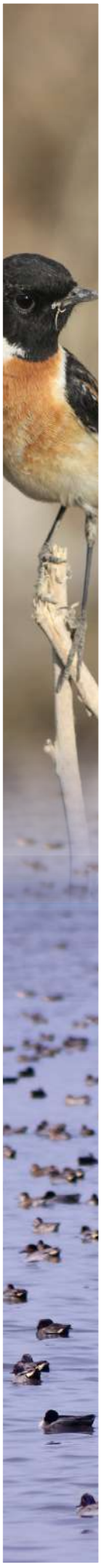
Sandplovers and Curlew Sandpipers in breeding plumage

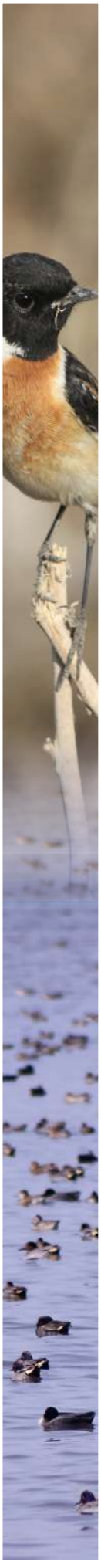
Spoonbills and Painted Stork

Waders at jaskhar

Eurasian Curlew

Mixed group of water birds at NRI area





Painted Storks in mangroves

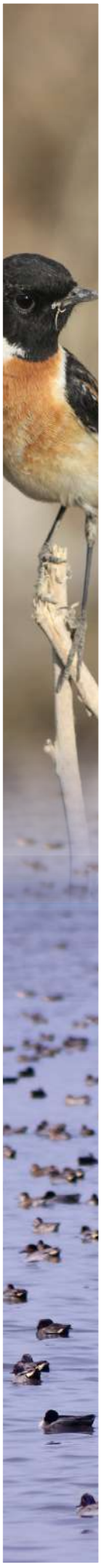
Baya Weavers

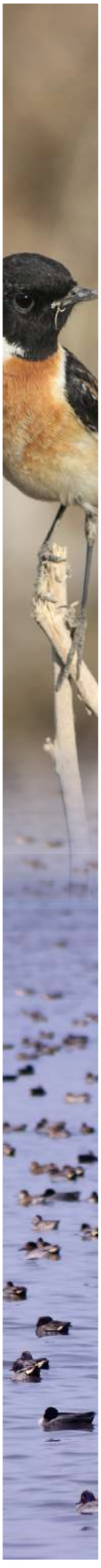
Congregation of Lesser Whsitling Ducks

Flamingos and Redshank in July

Waders in April

Common Snipe





Indian Skimmer in large flock of other water birds

Painted Storks

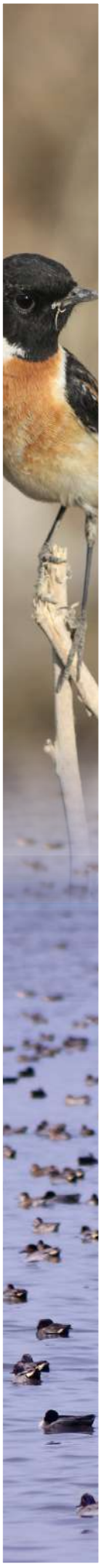
Malabar White-headed Starling

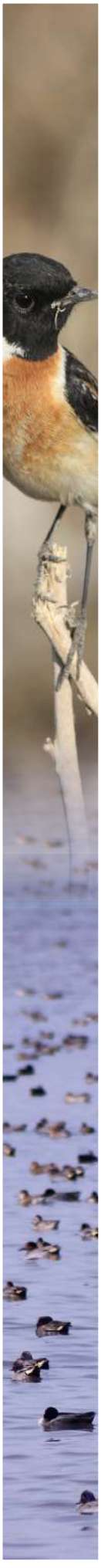
Acknowledgement

We are grateful to Ministry of Environment and Forests (MoEF), Government of India for recommending BNHS to carry out this study. We thank Mr. Soma Vijaykumar, C.G.M (Transport & Airport) and Nagendra Madiwal, Assistant Transportation Engineer (ATE), Transportation & Communication (T&C), CIDCO, Navi Mumbai for their continuous support to run the project activity.

We would also like to debt our gratitude towards Mr. Atul Sathe, Manager, Communications and Ms. Divya Warrier, Scientist-In-Charge, ENVIS Centre, BNHS for their involvement in field surveys. We are also thankful to Mr. Vikas Pisal, Driver cum Field Assistant, BNHS for assisting in the field work.

Without the support, patience and help of many people from the BNHS this task would not have completed. We owe a particular debt of gratitude to the entire staff of the BNHS, for providing infrastructure and resources.





References:

Abdulali, H. (1939): The sun as a mortality factor among young birds. J. Bombay Nat. Hist. Soc. 41: 433-434.

Abdulali, H. and N. Sethna (1982): Black-eared Kite [Milvus migrans lineatus (Gray)] near Bombay. J. Bombay Nat. Hist. Soc. 79: 411.

Abdulali, H. and R. Grubh (1966): Extension of range of Ixobrychus minutus minutus (Linnaeus) - an addition to the avifauna of the Bombay area. J. Bombay Nat. Hist. Soc. 63: 198.

Abdulali, H. and R. Grubh (1982): Pinkfooted Shearwater [Procellaria carneipes (Gould)] in India. J. Bombay Nat. Hist. Soc. 79: 666–667.

Abdulali, H. and S. Ali (1953): The Pied Myna and Bank Myna as birds of Bombay and Salsette. J. Bombay Nat. Hist. Soc. 51: 736–737.

Abdulali, H. and S. Ali (1940): Additional notes on the birds of Bombay and Salsette. J. Bombay Nat. Hist. Soc. 42: 191–197.

Abdulali, H. (1931): Eleven Koel's eggs in a crow's brood. J. Bombay Nat. Hist. Soc. 35: 458.

Abdulali, H. (1934): Note on the White-cheeked Bulbul (Molpastes leucogenys) in Salsette, Bombay. J. Bombay Nat. Hist. Soc. 37: 221.

Abdulali, H. (1935): Occurrence of the Grey-fronted Green Pigeon (Dendrophasia pompadora affinis Jerdon) in the Kolaba district. J. Bombay Nat. Hist. Soc. 37: 955

Abdulali, H. (1940): Swifts and terns at Vengurla rocks. J. Bombay Nat. Hist. Soc. 41: 661–665.

Abdulali, H. (1941): The Great Black Woodpecker in the neighbourhood of Bombay. J. Bombay Nat. Hist. Soc. 42: 933–934.

Abdulali, H. (1942): The terns and edible-nest swifts at Vengurla, west coast, India. J. Bombay Nat. Hist. Soc. 43: 446–451.

Abdulali, H. (1943): Local movements of the Painted Partridge (Francolinus pictus Jard. and Selby) around Bombay. J. Bombay Nat. Hist. Soc. 43: 658–660.

Abdulali, H. (1945): Notes on Indian birds - a correction. J. Bombay Nat. Hist. Soc. 45: 244.

Abdulali, H. (1948): Wilson's Petrel in India. J. Bombay Nat. Hist. Soc. 47: 550.

Abdulali, H. (1950a): On the Blue-tailed Bee-eater (Merops superciliosus javanicus Horsf.) in Bombay. J. Bombay Nat. Hist. Soc. 49: 307.

Abdulali, H. (1950b): Occurrence of the White-winged Black Tern [Chlidonias leucopterus (Temm.) in Bombay. J. Bombay Nat. Hist. Soc. 49: 310–311.

Abdulali, H. (1951): Extension of breeding range of the Stilt (Himantopus h. himantopus) and some notes on its habits and plumages. J. Bombay Nat. Hist. Soc. 49: 789–791.

Abdulali, H. (1952a): An unrecorded feature of spurfowl (Galloperdix). J. Bombay Nat. Hist. Soc. 50: 661–662.

Abdulali, H. (1952b): The Whitetailed Lapwing (Chettusia leucura) near Bombay. J. Bombay Nat. Hist. Soc. 50: 947.

Abdulali, H. (1954): Cuculus canorus bakeri in Bombay. J. Bombay Nat. Hist. Soc. 52: 210.

Abdulali, H. (1957): The Grey Junglefowl in Salsette. J. Bombay Nat. Hist. Soc. 54: 946.

Abdulali, H. (1958): Occurrence of the Large Whistling Teal Dendrocygna bicolor (Vieillot) in Bombay. J. Bombay Nat. Hist. Soc. 55: 358–359.

Abdulali, H. (1960): Occurrence of the Least Frigate Bird [Fregata ariel (G.R. Gray)] in Bombay. J. Bombay Nat. Hist. Soc. 57: 668–669.

Abdulali, H. (1962): The Small Indian Swallow Plover, Glareola lactea Temminck, near Bombay. J. Bombay Nat. Hist. Soc. 59: 948.

Abdulali, H. (1963): Occurrence of the Large Whiterumped Swift [Apus pacificus leuconyx (Blyth)] in Bombay. J. Bombay Nat. Hist. Soc. 60: 731–732.

Abdulali, H. (1964): Some notes on the Painted Partridge [Francolinus pictus (Jardine and Selby)] around Bombay. J. Bombay Nat. Hist. Soc. 61: 446–449.

Abdulali, H. (1965a): Some notes on the Painted Partridge [Francolinus pictus (Jardine and Selby)] around Bombay: a correction. J. Bombay Nat. Hist. Soc. 62: 152.

Abdulali, H. (1965b): On the occurrence of Finsch's Starling (Sturnus vulgaris poltaratskyi Finsch), near Bombay. J. Bombay Nat. Hist. Soc. 62: 161.

Abdulali, H. (1965c): Notes on Indian Birds 8 - Occurrence of the Blackheaded Munia [Lonchura m. malacca (Linn.)] near Bombay. J. Bombay Nat. Hist. Soc. 62: 599–600.

Abdulali, H. (1967a): On the occurrence of Black-necked Stork [Xenorhynchus asiaticus (Latham)] in the Bombay Konkan. J. Bombay Nat. Hist. Soc. 64: 367.

Abdulali, H. (1967b): Unusual method of fishing by Little Egret Egretta garzetta Linnaeus. J. Bombay Nat. Hist. Soc. 64: 557–558.

Abdulali, H. (1970): On the occurrence of Swinhoe's Snipe, Capella megala (Swinhoe) near Bombay, and a note on its identification. J. Bombay Nat. Hist. Soc. 67: 108–109.

Abdulali, H. (1972): Some bird notes by W. F. Sinclair. J. Bombay Nat. Hist. Soc. 69: 422–424.

Abdulali, H. (1974): On the occurrence of the Common Grey Hornbill Tockus birostris (Scopoli) near Bombay. J. Bombay Nat. Hist. Soc. 71: 147.

Abdulali, H. (1979): The nesting of Tickell's Flycatcher in Bombay. J. Bombay Nat. Hist. Soc. 76: 159–161.

Abdulali, H. (1980): Sparrow 'helping' nesting bulbuls. J. Bombay Nat. Hist. Soc. 77 : 513.

Abdulali, H. (1981a): Checklist of the birds of Borivli National Park with notes on their status. BNHS, Bombay, 10 pp.

Abdulali, H. (1981b): Checklist of the birds of Maharashtra with notes on their status around Bombay BNHS, Bombay, 16 pp.

Abdulali, H. (1983): Pigeons (Columba livia) nesting on the ground - some more bird notes from the Vengurla rocks. J. Bombay Nat. Hist. Soc. 80: 215–217. Abdulali, H. (1985): On the juvenile plumage of female Chrysocolaptes festivus (Boddaert) and other nesting notes near Bombay. J. Bombay Nat. Hist. Soc. 82: 202–203.

Abdulali, H. (1986): Borivli – on the edge of Bombay. Oriental Bird Club Bulletin 4: 12–13.

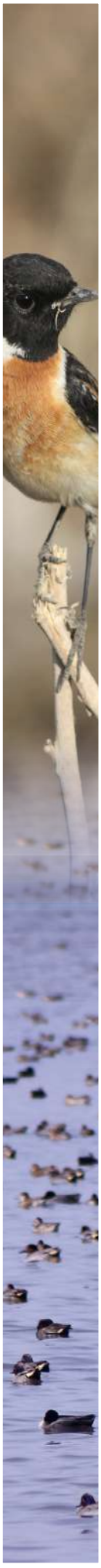
Aitken, E.H. (1947): The Common Birds of Bombay. Biotech Books, Delhi: 195 pp.

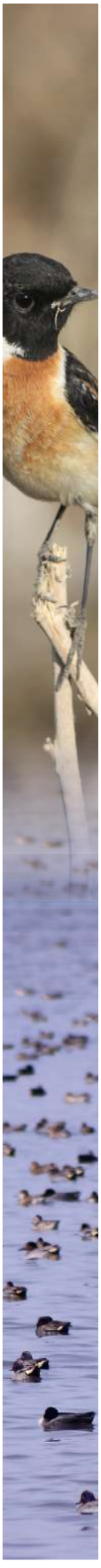
Akhtar, A. (1977): Sandpipers at a suburban marsh. Newsletter for Birdwatchers 17 (10): 11.

Ali, B. (2006): Sewree Birds. Indian Birds 2 (6): 166–168.

Ali, S. and H. Abdulali (1937): The birds of Bombay and Salsette, Part 2. J. Bombay Nat. Hist. Soc. 39 (3): 520–530.

Ali, S. and H. Abdulali (1937): The birds of Bombay and Salsette, Part 3. J. Bombay Nat. Hist. Soc. 39 (4): 679–688.





Ali, S. and H. Abdulali (1941): The birds of Bombay and Salsette. Prince of Wales Museum, Bombay.

Ali, S. and R.B. Grubh (1989): Ecological study of bird hazards of Indian aerodromes. Phase II. BNHS. 111 pp.

Ali, S. and S.D. Ripley (1987): Compact edition of Handbook of the Birds of India and Pakistan Bombay: Oxford University Press.

Ali, S. (1974): Jungle Babblers at Pali Hills, Bandra, Bombay 400 050. Newsletter for Birdwatchers 14 (11): 5–6.

Anon. (1988): The Green Booklet – Some measure used in different countries for reduction of bird strike around airports. Prepared by Bird Strike Committee, 3rd edn. 75 pp.

Anon. (1906): The protection of wild birds in the Bombay Presidency. J. Bombay Nat. Hist. Soc. 17 : 231.

Anon. (1981): From my diary, Andheri, Bombay. Newsletter for Birdwatchers 21 (6): 2.

Banks, A.N., M.P. Collier, G.E. Austin, R.D. Hearn and A.J. Musgrove (2006): Waterbirds in the UK 2004/05: the Wetland Bird Survey, UK.

Bethell, L. (1912): Grey Quail (Coturnix communis) at sea. J. Bombay Nat. Hist. Soc. 22: 200.

Bibby, C.J., N.D. Burgess, D.A. Hill, S.H. Mustoe and S. Lambton (2000): Bird Census Techniques, 2nd Edn. American Press, London.

BirdLife International: http://www.birdlife.org/datazone/species/search

Bombay Gazetteer, Govt. Central Press. 113 pp.

Butler, E.A. (1880): Birds of the southern portion of the Bombay Presidency.

CAA UK (2008), CAP 772: Birdstrike Risk Management for Aerodromes, UK.

CAA UK-SRG (2002): Large Flocking Birds: An International Conflict Between Conservation and Air Safety, UK.

Champion, H.G. and S.K. Seth (1968): The forest types of India. Natraj Publishers, Dehradun.

Chandran, P. (1966): Unusual mating behaviour of the crow. Newsletter for Birdwatchers 6 (10): 7.

Clearly, E.C., S.E. Wright and R.A. Dolbeer (1997): Wildlife strikes to civil aircraft in the United States 1992–1996. Report DOT/FAA/AS/97-3.30 pp.

Conover, M.R., W.C. Pitt, K.K. Kessler, T.J. Dubow and W.A. Sanborn (1995): Review of data on human injuries, illness and economic losses caused by wildlife in the United States. Wildl. Soc. Bull. 23: 407–414.

Creado, W. (1969): The Indian Three-toed Kingfisher (Ceyx erythacus). Newsletter for Bird watchers 9 (12): 2–3.

Dalal, P.A. (1936): Crow assemblies. J. Bombay Nat. Hist. Soc. 39: 173–174.

Dekker, A. (1994): Airfield bird counts, a management tool in the prevention of on-airfield Bird strikes. 22nd Meeting Bird Strike Committee Europe, Vienna 1994, Working Paper 57.

Dolbeer, R. (2004): Height distribution of birds recorded by collisions with civil aircraft, Wildlife Damage Management, Internet Centre for USDA National Wildlife Research Centre, University of Nebraska, USA.

Dolbeer, R.A. and P. Eschenfelder (2002): Population increases of large birds, airworthiness standards, and high-speed flight; a precarious combination. 273–281 pp. in Proceedings of

the 55th International Air Safety Seminar (Flight Safety Foundation), Dublin, Ireland.

Dookia, S. (2008): Comprehensive study of Bird Hazard and Remedial measures in Ten Airfields; Preliminary Report. 60 pp.

Durinck, J.; H. Skov, F.P. Jensen, and S. Phil; (1994). Important Marine Areas for Wintering Birds in the Baltic Sea. EU DG XI research contractno.224/90-09-01, Ornis Consult Report, Copenhagen.

Eds. (2002): A BNHS review of the avifaunal list of Wildlife (Protection) Act, 1972. BUCEROS 7 (3): 56.

Ellison, B. C. (1923): Notes on the habits of a young Hornbill. J. Bombay Nat. Hist. Soc. 29: 280–281.

Eschenfelder, P (2005): High speed flight at low altitudes: Hazard to commercial aviation? Bird strike Committee USA/Canada, Vancouver, 2005.

Feare, C. and A. Craig (1999): Starlings and Mynas. Princeton University Press, New Jersey.

Furness, R.W., and J.J.D. Greenwood (eds.) (1993). Birds as Monitors for Environmental Change. Chapman and Hall, London.

Goenka, D. (1986): Lack of traffic sense amongst Indian Rollers. Bombay - Goa Road. J. Bombay Nat. Hist. Soc. 83: 665.

Grimmett, R., C. Inskipp and T. Inskipp (1998): Birds of the Indian Subcontinent. Oxford University Press, Oxford. Second Edition. 528 pp.

Grubh, R. and S. Ali (1984): Potential problem birds at Indian Aerodromes. Bombay Natural History Society. 59 pp.

Howe, M.A., P.H. Geissler, and B.A. Harrington; (1989). Population trends of North American shorebirds based on the International Shorebird Survey. Biological Conservation49,185-199.

Islam, M.Z. and A.R. Rahmani (2004): Important Bird Areas in India: Priority sites for conservation. Indian Bird Conservation Network (IBCN), Bombay Natural History Society (BNHS) and BirdLife International, UK. 706–707 pp. GIVE CORRECT CITATION RSPB?? It has been given as recommended in the book

Kannan, P. (1966): Ornithophily: a preliminary study of the reciprocal association between flower birds and bird flower as observed in and around Bombay. M.Sc. Thesis, University of Mumbai.

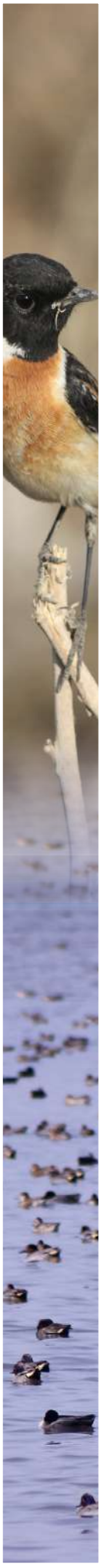
Linnell, M. A., M.R. Conover and T.J. Ohashi (1999): Biases in bird strike statistics based on pilot reports. J. Wildlife Manage. 63: 997–1003.

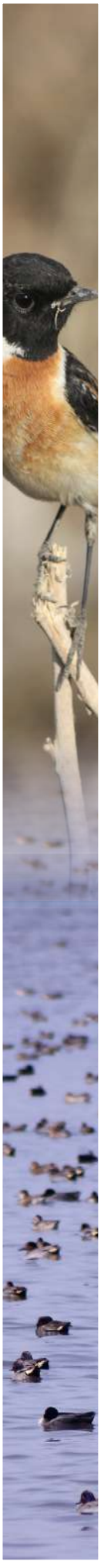
Lykos, V., H. Jerrentrup, P. Dora and E. Anastasios (2005): Assessment and Integrated Risk Man agement of Collisions Aircraft to Birds at International Civil Aerodrome of Kavala (N.E. Greece). IBSC27/WP VIII-2 Athens: 23–27.

Manakadan, R. and A. Pittie (2001): Standardised common and scientific names of the birds of the Indian Subcontinent. Buceros (ENVIS News¬letter) 6(1): i–ix, 1–37.

Manakadan, R., J.C. Daniel and N. Bhopale (2011): Birds of the Indian Subcontinent – a field guide. BNHS-OUP. 409 pp.

Maragakis, I. (2009): Bird population trends and their impact on Aviation safety 1999–2008. Eu ropean Aviation Safety Agency, Safety Analysis and Research Department.





Mathews, D.N., R. Palat and M. Mahesh Kumar (2003): Review of bird strike reports sent to BNHS, India during 1997–2000. International Bird Strike Committee, Warsaw, IBSC26/ WP-SA7. 13 pp.

Milsom, T.P. and N. Horton (1995): Bird strike. An assessment of the hazard on UK civil aero dromes 1976–1990. Central Science Laboratory, Sand Hutton, York, United Kingdom.

Monga, S. (2003): Birds of Mumbai. India Book House Pvt. Ltd. 75 pp.

Navarro, A. (1964): Round the clock vigil at a Coral Tree. Newsletter for Birdwatchers 4 (4): 2–4.

Nicholls, D. and J. Bell (2005): An Assessment of Bird Strike Risk at National Level IBSC27/WP VI-1: 2.

Nilakanta, S.V. (1964): Ringed birds. Newsletter for Birdwatchers 4 (12): 12.

Palkhiwalla, B.A. (1968): Parakeets: flights to roosts. Newsletter for Birdwatchers 8 (12): 12.

Pande, P. and N. Pathak (2005): National Parks (NP) and Wildlife Sanctuaries (WLS) of Maha rashtra, Vol. I & II. Published by BNHS and sponsored by Ministry of Environment and Forests, Government of India, New Delhi.

Prater, S.H. (1922): Notes on two young Indian Hornbills. J. Bombay Nat. Hist. Soc. 28: 550–552.

Piersma, T. and Y. Ntiamoa-Baidu; (1995). Waterbird Ecology and the management of coastal wetlands in Ghana. Netherlands Institute for Sea Research, Texel.

Raman, L. (2004): Karnala Bird Sanctuary. Sanctuary Asia 24 (3): 73.

Rao, V.U.S. (1965): Strange feeding habit of the Little Green Bittern. Newsletter for Birdwatchers 5 (2): 6–7.

Rassmusen, P.C. and Anderton, J.C. (2005). Birds of South Asia - The Ripley Guide. 2 vols. Smith sonian Institution and Lynx Edicions, Washington, D.C. and Barcelona.

Rosalind, L. and R.B. Grubh (1987): Microscopic identification of feathers aiding Bird Hazard Prevention Programme in India. J. Bombay Nat. Hist. Soc. 84: 429–431.

Sarkar, S. (2007): Shore Birds (Waders) of the Mumbai region. BUCEROS 12 (3): 5

Satheesan, S. M., P. Rao and H. Datye (1991): Biometrics and food of some harriers. Pavo 28: 75–76.

Serrao, J.S. (1971): Black Drongo (Dicrurus adsimilis) fishing. Newsletter for Birdwatchers 11 (7): 10.

Serrao, J.S. (1973): Adult birds' concern for young of other birds. Newsletter for Birdwatchers 13 (12): 9–10.

Serrao, J.S. (1993): Scavenging by Cattle Egret. Newsletter for Birdwatchers 33: 55–56.

Skov, H., J.Durinck, M.F. Leopold and M.L. Tasker, (1995). Important Bird Areas for Seabirds in the North Sea. Birdlife International, Cambridge.

Smith, A. E., S. R. Craven and P. D. Curtis(1999): Managing Canada Geese in urban environen-

ments. A publication of Cornell Cooperative Extension, the University of Wisconsin, The Jack H.

Berryman Institute, Utah State University, and The Wildlife Society, Wildlife Damage Management Working Group. 43 pp.

Soman, P.W. (1963): Pittas and crows. Newsletter for Birdwatchers 3 (12): 9.

Sowrirajan, T.V. (1994): Are there Flamingos in Sewri? Hornbill (1): 2–7.

Thorpe, J. (1996): Fatalities and Destroyed Civil Aircraft Due to Birds Strikes 1912–1995, The International Bird Strike Committee's 23rd Conference, 13–17 May, London, 18 pp.

Thrope, J. (1997): The implications of recent serious bird strike accidents and multiple engine ingestions. Bird Strike Committee, Boston, MA. 11 pp.

Tucker, G. M. and M.F. Heath, (1994). Birds in Europe: their Conservation Status. BirdLife International, Cambridge.

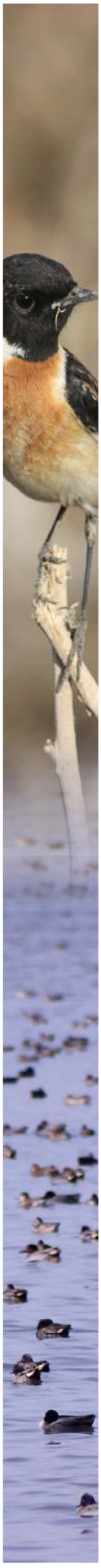
Tyabji, A. (1964): Pugnacious behaviour of breeding White-browed Fantail Flycatcher (Cumballa Hills, Bombay). Newsletter for Birdwatchers 4 (4): 10.

Vaylure, S., Y. Pednekar, P. Choghale, N. Chaturvedi, I. Kehimkar, G. Jathar, V. Giri, N. Perira, H. Tripathi, V. Chapke and I. Joseph (2008): Biodiversity survey of Navi Mumbai Nature Park, BNHS. 106 pp.

Verma, A., S. Balachandran, N. Chaturvedi and V. Patil (2004): A preliminary report on the biodiversity of Mahul Creek, Mumbai, India with special reference to avifauna. Zoo's Print 19 (9): 1599–1695.

Web resources: http://www.birdlife.org/

Woodward, T. (2007): Sewri bay, Thane Creek, Mumbai, India. Birding Asia 7: 61–64.



Eurasian Wryneck