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Navi Mumbai
International Airport

Ref: NMIAL/MOEF/GEN/1156

20 November 2025

To,
Regional Office (WCZ),
Integrated Regional Office (IRO)
Ministry of Environment, Forest & Climate Change (MoEFCC),
Ground Floor, East Wing, New Secretariat Building,
Civil Lines, Nagpur-440001
Email - apccfcentral-ngp-mef@gov.in

Subject: – Submission of Half Yearly Compliance Report (April 2025 - September 2025) for all the conditions stipulated in the Environmental and CRZ Clearance in respect of proposed Navi Mumbai International Airport reg.

Reference: - Environmental Clearance and CRZ Clearance for on-going project granted No. 21-60/2021-IA-III dated: November 28th, 2021.

Sir/Madam,

With reference to the above subject, it is to be informed that MoEF&CC has granted Environmental and CRZ clearance for ongoing project for establishment of Navi Mumbai International Airport (NMIA) at Panvel Tahsil, Raigad District by vide No 21-60/2021-IA-III dated November 28, 2021. and issued on December 01, 2021.

In the said Environmental and CRZ clearance at Standard condition B (VIII) Miscellaneous Sr. No. iv, it is stipulated that Project Proponent shall submit six monthly reports on the status of compliance of the stipulated EC conditions.

We are submitting herewith the half yearly Compliance Status report for the period from 1st April 2025 to 30th September 2025 for establishment of greenfield airport at Navi Mumbai.

Thanking you
Yours faithfully,
For **Navi Mumbai International Airport Pvt. Ltd.**

Charudatta Deshmukh
Joint President & Head - Planning & Design

Encl.: 1. Data Sheet.

2. Clause wise EC Compliance Report for the period of April 2025 to September 2025 with Annexures.

Copy to 1) The Vice Chairman & Managing Director, City & Industrial Development Corporation of Maharashtra Ltd. (CIDCO), CIDCO Bhavan, CBD Belapur, Navi Mumbai- 400614 for information and necessary action.

2) The Member Secretary, Maharashtra Pollution Control Board, 3rd Floor, Kalpataru Point, Sion, Mumbai – 400 022.

3) The Zonal Officer, Central Pollution Control Board, Survey no. 110, Heerbai Dhankude hall, Baner Road, Pune 411045.

4) The Chairman, Maharashtra Coastal Zone Management Authority, Room No. 217, Mantralaya (Annex Building), Mumbai – 400 032.

5) Monitoring Cell, MoEF&CC, Indira Paryavaran Bhavan, Jor Bagh Road, New Delhi – 3.

Half Yearly Compliance Report of Environmental & CRZ Clearance For Ongoing Project for Establishment of Greenfield Airport

Navi Mumbai International Airport (NMIA)

Sector- 17, Pushpak Node,
Taluka Panvel, Dist. Raigad, Maharashtra

Submitted To:
Integrated Regional Office (IRO),
Ministry of Environment, Forest & Climate Change (MoEF&CC), Nagpur

Central Pollution Control Board, Pune

Maharashtra Pollution Control Board, Mumbai

Submitted By:
Navi Mumbai International Airport Pvt. Ltd. (NMIAL)
for

Period of April 2025 to September 2025

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Monitoring the Implementation of Environmental Safeguards
Ministry of Environment, Forest & Climate Change
Regional Office (West Central Zone), Nagpur
Monitoring Report
Part – I - DATA SHEET

1st April 2025 to 30th September 2025

S. No.	Particular	Details
1.	Project type: River Valley/ Mining/ Industry/ Thermal/ Nuclear/Other (Specify)	Other- Infrastructure, Greenfield International Airport at Navi Mumbai
2.	Name of the Project Proponent	Navi Mumbai International Airport Pvt. Ltd (NMIAL)
3.	Clearance letter (s)/OM No. And Date	• Earlier EC and CRZ clearance granted to CIDCO as Nodal agency appointed by Government of Maharashtra as under: 1 EC received vide F. No. 10-53/2009-I.A.III dated. 22.11.10 valid up to 21.11.2017. 2 Extension of validity received vide F. No. 10-53/2009-IA.III dt 20.12.17 valid up to 21.11.2020. • EC transferred from CIDCO to NMIAL (Navi Mumbai International Airport Pvt. Ltd.) by MoEF&CC vide F. No. 10-53/2009-IA-III dated 17.08.2020 with same validity. • Validity extended vide S. O. No. 4254 (E) dt 27.11.20 up to 21st May 2021 for all projects due to COVID pandemic by MOEF&CC. • CRZ recommendation received from Environment & Climate Change Department, Govt. of Maharashtra vide Letter No. CRZ 2021/CR 156/TC 4 Dated – 27.09.2021. • Environmental Clearance and CRZ Clearance for on-going project granted by MOEF&CC vide No. 21-60/2021-IA-III dated: 28.11.2021 valid up to 27.11.2031.
4.	Location: a) District (s)	Raigad
	b) State (s)	Maharashtra
	c) Location	Pushpak Node, Ulwe, Taluka Panvel

S. No.	Particular	Details
	d) Latitude/Longitude	Longitude - 73° 04' 13" E Latitude - 18° 59' 40" N
5.	Address for correspondence. a) Address of the Concerned Project Chief Engineer (With Pin Code and telephone/telex/fax numbers)	Charudatta Deshmukh, Joint President & Head - Planning and Design Navi Mumbai International Airport Pvt Limited (NMIAL), Navi Mumbai International Airport Pvt Ltd, S17-C, New Project Office, Sector-17, Pushpak Node, Ulwe, Navi Mumbai, 400702 Tel: 022-68519505 Email: Charudatta.d@adani.com
6.	Salient features a) Of the project	The proposed project is for the establishment of an International Airport on a site of area 1160 Ha. The airport is designed to accommodate the aircraft (A-380 and equivalent) compatible with ICAO Standard of aerodrome 4-F. As per current EC & CRZ clearance the ultimate passenger handling capacity of the airport will be 60 MPPA and cargo capacity of 1.5 MTPA. Airport will have two parallel independent runways for simultaneous and independent operation with the provision of full-length parallel taxiways along runways. The length of runway is 3700 m x 45 m with Runway End Safety Area (RESA) of 240 m x 150 m. Central Terminal Complex (CTC) comprising of three terminal buildings catering to domestic and international passengers and ATC Tower, Cargo terminal building of domestic and international Cargo. Fuel tank Farm for Aviation Turbine Fuel (ATF) and SAF. Facilities such as Multi Level Parking, GSE storage area, ATC Tower, airport ground lighting, airport lighting, apron, GSE maintenance, hangars along with other allied facilities etc. The project activities during construction phase to be done by NMIAL are land development by cutting of Ulwe hill and filling from + 5.5m AMSL to average +8.5m AMSL.

<table>
<tr><th>S. No.</th><th>Particular</th><th>Details</th></tr>
<tr><td></td><td>b) Of the Environmental management plans</td><td>NMIAL is planned to be a resource efficient & Green airport. Environment Management Plan at construction and operations phase includes the following:
• Incorporation of LEED requirements at the design stage
• Noise and dust pollution minimization during construction phase,
• Carbon neutrality followed by Net Zero emission commitments
• Zero Sewage Discharge
• Rainwater Harvesting Ponds
• Generation and Utilization of Solar Power
• Energy Optimization
• Waste Re-cycling
• Natural Day Lighting
• Sustainable Aviation Fuel (SAF) storage & supply system
• Plantation & Landscape</td></tr>
<tr><td>7.</td><td>Breakup of the project area
a) Submergence area forest and non-forest</td><td>Not applicable</td></tr>
<tr><td></td><td>b) Others</td><td>Airside Area- 933.739 Ha.
Landside area- 226.261 Ha
Total Area – 1160 Ha
<table>
<tr><th>Land use</th><th>Area (Ha)</th></tr>
<tr><td>Airside and Landside Facilities, pavements, buildings and structures</td><td>589.661</td></tr>
<tr><td>Green /open spaces (including water bodies)</td><td>390.132</td></tr>
<tr><td>Transportation roads, parking, metro, APM systems</td><td>160.262</td></tr>
<tr><td>Utilities</td><td>19.944</td></tr>
<tr><td>Total</td><td>1160.00</td></tr>
</table>

Permission for Removal of Mangroves (Order from Hon'ble Bombay High Court) Notice of Motion No. 419 of 2011 in PIL No. 87of 2006 dated 29th Oct 2013.

Forest Clearance- 250.0635 Ha (Stage I and Stage II clearance obtained vide F. No. 8-95/2012-FC dated 17 December 2013 and 24 April 2017 respectively).</td></tr>
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S. No.	Particular	Details
	a. Total Plot Area	Total Plot Area 1160 Ha.
	b. Built - Up Area (Including Road)	Phase- I & II BUA (20MPPA)- 6,27,335.678 m^2 Total BUA Area (60 MPPA)- 14,13,069.178 m^2
	c. Green Belt Area	Phase I & II (20 MPPA) – 23,69,937.936 m^2 Final Phase (60MPPA) 39,36,817.736 m^2
8.	Breakup of the project affected population with enumeration of those losing house/dwelling units only agricultural land only. Both dwelling units and agricultural land and landless laborers/ artisans:	CIDCO completed R & R of approx. 3,113 households from 9 village gaothans located within the 1,160-hectares of airport site area. CIDCO has acquired and developed land for establishing R&R sites, which include Pushpak Nagar (R&R site) and additional 7 R&R pockets for the resettlement of villagers. CIDCO also removed all other structures from NMIA site. The rehabilitation sites were strategically planned and developed near the airport, as approved in the 2010 Environmental Clearance (EC) for the project. The R&R process was executed in accordance with the Government Resolution (GR) issued by the Government of Maharashtra (GoM) in this regard.
	a) SC, ST/Adivasis	--
	b) Others	--
9.	Financial details: a) Project cost as originally planned and subsequent revised estimates and the year of price reference:	Total cost of the development of airport consists of aeronautical and nonaeronautical activities works out for four Phases at FY 2010 prices by CIDCO Rs.9,625 Cr. Revised FY 2015 prices by CIDCO Rs 13,560 Cr. Revised FY 2019 prices by NMIAL Rs 35,538 Cr. Revised FY 2020-21: - Rs 41,302 Cr.
	b) Allocation made for environmental management plans with item wise and year wise break up.	NMIAL has allocated Rs. 291.37 Cr for EMP for Development & Operation Phase of NMIA up to final phase.
	c) Benefit cost ratio/Internal rate of return and the year of assessment	-

S. No.	Particular		Details
	d)	Whether (c) includes the cost of environmental management as shown in the above	-
	e)	Actual expenditure incurred on the project so far	a) Expenditure by CIDCO on pre-development works including land acquisition, rehabilitation and resettlement of project displaced persons and land development works Rs. 5429.82 Cr. b) Expenditure by NMIAL on planning & design, contractor advances, etc. till 30th September 2025: Rs.13,278.37 Cr.
	f)	Actual expenditure incurred on the environmental management plans so far	Rs. 17.73 Cr incurred on EMP till 30th September 2025
10.	Forest land requirement: a)	The status of approval for diversion of forest land for non-forestry use	Approval for Diversion of Forest land has been completed. Diversion of 250.0635 Ha of forest land was required for the project. • Stage-I Forest Clearance was accorded to CIDCO vide F.No.8-95/2012-FC dt. 17.12.2013. • Stage-II Forest Clearance was granted to CIDCO vide F. No. 8-95/2012-FC dt. 24.04.2017.
	b)	The status of clearing felling	Total number of non-forest trees at NMIA site to be felled was 9,492 out of which 7,234 trees were felled by CIDCO and balance 2258 trees were felled by NMIAL after completing requisite formalities of tree survey, and permission from Tree Authority as per the Tree Act, 1975.
	c)	The status of compensatory afforestation if any	Status of Compensatory Afforestation I. 37,000+ saplings have been planted under tripartite agreement between the Forest department of Maharashtra, NMIAL and an NGO at Jite village near Taluka Pen, District Raigad. II. Stage-I & Stage-II forest clearance for 250.0635 Ha land has been obtained from MoEF&CC vide letter no 8-98/212-

S. No.	Particular	Details
		FC dated 17-12-2013 and 24.04.2017 respectively. III. CIDCO has undertaken 109 Ha of compensatory mangroves plantation on NE of airport site on S. No. 27, village Kolhekhar between Jui creek and Taloja creek through the Mangrove Cell of State Forest Dept. as per the conditions stipulated in the Forest Clearance. IV. HOFF (Head of Forest Forces, Maharashtra state, Nagpur) visited site on 12th Dec 2018 and reviewed the compliance to Forest Clearance.
	d) Comments on the viability and sustainability of compensatory afforestation program in the light of actual field experience.	Plantation and protection of Mangroves over 109 ha as compensatory afforestation has been completed by Mangrove Cell on the instance of CIDCO at village Kolhekhar. Thane Forest Division has certified vide letter dated 31.10.17 that out of 1,00,000 mangrove saplings planted at above site about 92.5 % survived.
11.	The status of clear felling in non-forest areas (such as submergence area of reservoir, approach roads), if any with quantitative information	Total number of non-forest trees at NMIA site to be felled was 9492 out of which 7234 trees were felled by CIDCO and balance 2258 trees were felled by NMIAL after completing requisite formalities of tree survey, and permission from Tree Authority as per the Tree Act, 1975.
12.	Status of construction a) Date of commencement (Actual and/or planned)	April 2017 Pre-development works commenced by CIDCO.
	b) Date of completion (Actual and/or planned)	Commencement of Operation of Phase 1 & 2 (20 MPPA) shall be in December 2025
13.	Reason for the delay if the project is yet to start	Pre-development work at site commenced soon after the Forest Clearance was granted to the project. Project work could not be commenced till April 2017 pending grant of Stage II Forest Clearance for the project. Construction commenced soon after the encumbrance of free ROW on all 1160 Ha airport land was provided by CIDCO to NMIAL in June 2022.

S. No.	Particular	Details
14.	Dates of site visits	
	a) The dates on which the project was monitored by the Regional Office on previous occasions, if any	Site visit done by RO, MOEFCC on 02nd Jan 2025 for monitoring compliance of EC. Visit Report was received from Integrated Regional Office, MoEF&CC Nagpur vide Letter No. F-No.6-22-ENV /RON/ NGP/ 2010/13994 on dated 10th February 2025. NMIAL has submitted of Action taken report the Compliance of the Certified Compliance Report to IRO Nagpur office vide letter No. NMIAL/MoEF/GEN/01032 Dated 8th September 2025.

EC COMPLIANCE REPORT
(1st Apr. 2025 to 30th Sept 2025)

Introduction

Environmental Clearance (EC)and CRZ Clearance was granted to NMIA project with CIDCO as project proponent, by Ministry of Environment, Forest, and Climate Change (MoEF&CC) on November 22, 2010, and Extension of Validity to EC was granted on December 20,2017. It was valid till November 2020. The MoEF&CC had extended validity of the EC accorded to NMIA project till November 21, 2021, during pandemic period.

NMIAL received transfer of EC, which was in CIDCO's name and valid till November 21, 2021, on NMIAL's name on August 17, 2020, from MOEF & CC. Fresh EC and CRZ Clearance has been granted for on-going project for 60 million Passengers Per Annum (MPPA) & Cargo capacity 1.5 MTPA, NMIA as the project proponent by MoEF&CC granted on November 28, 2021, and issued on December 01, 2021.

Status of completed/ on-going works and approvals are given as follows:

- As on 30th September approx. 95% development works of Phase 1 & 2 (20 MPPA) were completed.
- BCAS vide letter dated 25th Sep'25 granted approval for final stage Security Vetting (partial/part operations of Phase 1 & 2).
- Aerodrome license for NMIA was granted by DGCA on 30th Sep'25.

Commencement of operations of Phase 1&2 (20 MPPA) of NMIA shall be in December 2025.

MOEF&CC's Environment and CRZ Clearance identification No.EC21A029MH183036 & file no 21-60/2021-IA-III dated November 28, 2021, and issued on December 01, 2021.

Project is under construction. Detailed pointwise compliance report pertaining to the reporting period (April–September 2025) for construction phase is given below. Compliance with operation phase conditions will be complied prior to the commissioning of the airport.

	EC & CRZ Conditions-2021	Compliance Status
A	**Specific Condition**	
i.	Conditions specified in Environmental & CRZ Clearance issued vide letter No. 10-53/2009-IA.III, dated 22.11.2010 shall be strictly complied.	**Agreed to Comply.** We will abide by the conditions specified in Environmental & CRZ Clearance issued vide letter No. 10-53/2009- IA.III Dated 22.11.2010. Status of compliance have been submitted.
ii.	PP shall submit compliance report to IRO-MoEF&CC, Nagpur for pending compliances within 6 months.	**Complied-** Six-monthly compliance reports for the respective compliance periods have already been submitted to IRO-MoEF&CC.
iii	Where construction activity is likely to cause noise nuisance to nearby residents, restrict operation hours between 7 AM to 6 PM.	**Being Complied:** Noise-generating activities like drilling are only conducted between 7 AM and 6 PM (daytime). To reduce noise and air pollution, construction vehicles have separate entry and exit points. Construction vehicles primarily stay on-site and rarely leave; separate entry and exit are provided for any vehicles that do enter or exit the site.
iv	Hazard Identification and Risk Assessment for the project shall be carried out and adequate mitigation measures shall be adopted to ensure that all safety issues are addressed. The documentation shall be reviewed periodically and shall be submitted to the regional office along with six-monthly compliance report.	**Agreed to Comply.** The safety practices at NMIAL's construction site, managed by an EPC contractor under the supervision of NMIAL's HSE team, led by the GM of Safety. Each contractor prepares an Occupational Health and Safety Emergency plan, assessing and mitigating safety hazards. Key safety tools include: - Training program

	EC & CRZ Conditions-2021	Compliance Status
		- Tool Box Talks on HSE issues - Safety committees - HSE audit -Hazard Identification and Risk Assessment (HIRA)- Accident investigation - Monthly & quarterly Safety reports DMP prepared by contractor has been submitted.
v	A detailed traffic management and traffic decongestion plan shall be drawn up to ensure that the current level of service of the roads within a 05 km radius of the project is maintained and improved upon after the implementation of the project. This plan should be based on cumulative impact of all development and increased habitation being carried out or proposed to be carried out by the project or other agencies in this 05 Kms radius of the site in different scenarios of space and time and the traffic management plan shall be duly validated and certified by the State Urban Development Department and the P.W.D./ competent authority for road augmentation and shall also have their consent to the implementation of components of the plan which involve the participation of these departments.	**Complied.** CIDCO, the nodal agency for Navi Mumbai International Airport has prepared "Detailed Traffic Management and Traffic Decongestion Plan for Navi Mumbai International Airport (NMIA)" in April 2020 which ensures that the current level of service of the roads within a 05 km radius of the project is maintained and improved upon after the implementation of the project. CIDCO has submitted final report for "Detailed Traffic Management and Traffic Decongestion Plan for Navi Mumbai International Airport (NMIA)" to MOEF vide letter No. CIDCO/GM(ENV&F)/NMIA/2020 /491 dated 14th July 2020. MMRDA also published "Updation of Comprehensive Transportation Study (TRANSFORM -2) for Mumbai Metropolitan Region" in year 2020 including Traffic decongestion plans and suggestions for Navi Mumbai International Airport at Regional and local level. Development of all transportation infrastructure required for NMIA (along with obtaining clearances and compliances for the same) is being done by CIDCO as per NOC for transfer of EC and CRZ clearance given by CIDCO to NMIAL vide letter No.

	EC & CRZ Conditions-2021	Compliance Status
		CIDCO/T&C/CT&CP/ NMIA/1317 dt 10th Feb 2020.
vi	Solar power generation capacity of 22.14 MW shall be established as proposed.	**Agreed to Comply.** NMIA is planning to install approx. 15.3 MW capacity solar power system Phase I & II (20 MPPA). In final phase of project development, the solar power generation capacity will increase to 22.14 MW.
vii	Rainwater harvesting pond of 29,747 cum capacity shall be provided as proposed. Rainwater harvesting structures shall conform of CGWA designs. Before recharging the surface run off, pre-treatment must be done to remove suspended matter, oil and grease.	**Agreed to Comply.** Design and planning of the surface drainage includes creation of RWH ponds of requisite capacity. Necessary pre-treatment like oil water separator and silt ponds are also proposed to remove suspended matter, oil and grease.
viii	A certificate from the competent authority/ agency handling municipal solid wastes should be obtained, indicating the existing civic capacities of handling and their adequacy to cater to the M.S.W generated from project.	**Agreed to Comply.** During the reporting period, development and construction works are ongoing at site. EPC contractors have appointed authorized waste handlers for MSW generated at labour camp. To handle MSW at the operational phase, in planning and design, various strategies have been incorporated to minimize waste going to the landfill site. NMIAL has received a letter from CIDCO, vide No. CIDCO/T&C/CGM(T&A)/NMIA/2024/E-887 dated June 18, 2024, wherein CIDCO has agreed to accept the MSW waste generated by NMIAL during the operation phase.
ix	Fresh water requirement from local authority shall not exceed 10.61 MLD during final operational phase. As committed, no groundwater abstraction shall be done during	**Agreed to Comply.** The project's total water demand in final phase is 21.80 MLD. of which, freshwater demand of 10.60 MLD will be sourced from CIDCO and balance 11.20 MLD will be recycled water from

	EC & CRZ Conditions-2021	Compliance Status
	construction as well as operation phase of the project.	on – site STPs. No groundwater abstraction will occur during either the construction or operational phases. The water requirement for NMIA shall be sourced from CIDCO. Water assurance letter has been received from CIDCO.
x	As proposed, wastewater shall be treated in onsite STPs of total 14.25 MLD capacity (during final phase). Treated water from the STP shall be recycled and reused for gardening, flushing etc. There shall be no discharge of treated water from the project as proposed.	**Agreed to Comply:** The project, though not yet operational, will comply with all conditions. STPs of adequate capacity have been planned for Phases 1 & 2 and treated water from these STPs will be used for flushing, gardening, and HVAC purposes, with no treated water discharged from the project.
xi	The project proponents would commission a third-party study on the implementation of conditions related to quality and quantity of recycle and reuse of treated water, efficiency of treatment systems, quality of treated water being supplied for flushing (specially the bacterial counts), comparative bacteriological studies from toilet seats using recycled treated waters and fresh waters for flushing, and quality of water being supplied through spray faucets attached to toilet seats.	**Agreed to Comply:** Since the project is yet to be operational, we assure to abide by the condition.
xii	Area for greenery shall be provided as per the details provided in the project document i.e., about 384.90 ha. will be developed as green area.	**Agreed to Comply:** Since the first phase of project is under implementation and project is yet to be operational, we assure to abide by the condition, by final phase.
xiii	PP shall explore the use of non-ozone depleting substances in air conditioning systems.	**Agreed to Comply:** Non-ODP refrigerant is specified for chillers & DX units (air conditioning system) to avoid depletion of ozone layer in environment. We assure to abide by the condition.

	EC & CRZ Conditions-2021	Compliance Status
xiv	The PP shall also provide electric charging points in the parking areas for e-vehicles.	**Agreed to Comply:** Provisions are made in NMIA Master Plan for charging points for e-vehicles in parking areas.
xv	The proposed ongoing work of Navi Mumbai International Airport should be carried out strictly as per the provisions of CRZ Notification, 2011 as amended from time to time and with a commitment of protection and conservation of coastal environment.	**Agreed to Comply:** Provisions of CRZ Notification will be strictly complied.
xvi	NMIA shall carry out the balance work without change in location, scope, area or capacity.	**Agreed to Comply:** NMIA will carry out development work without change in location, scope, area, or capacity.
xvii	No mangrove destruction is allowed to carry out balance ongoing work of the project. There shall not be violation of the Hon'ble High Court order dated 23rd October 2013 in PIL 87/2006.	**Agreed to Comply**: We undertake that no mangrove destruction will be carried out for balance ongoing work at the project, and that there will not be violation of the Hon'ble High Court order dated 23rd October 2013 in PIL 87 /2006.
xviii	Work of diversion of Ulwe and Gadhi River is completed. NMIA shall carry out studies pertaining hydraulic flow conditions, to understand the impact of diversion of Ulwe and Gadhi streams on Panvel Creek coastline, its coastal ecology and surrounding area/ settlements/ habitat/ social economic pattern. The hydraulic study shall also consider the anticipated impacts of climate change and sea level rise on proposed airport site and surrounding area. Hydraulic studies need to be carried out with an objective to anticipate the probable flooding situations in low lying areas and accordingly implement the possible mitigation measures.	**Complied:** The Ulwe river diversion work was completed in 2019 by CIDCO. In August 2024, CIDCO requested CWPRS to conduct detailed Mathematical Model studies to analyze the hydraulic flow conditions and understand the impact of diverted Ulwe streams on the Panvel creek coastline, its coastal ecology, and the surrounding areas, including settlements, habitats, and socio-economic patterns. Upon completion of this study, the final report will be submitted to MOEFCC.

	EC & CRZ Conditions-2021	Compliance Status
xix	NMIA shall regularly monitor the marine water quality of the Panvel creek during construction and post construction of the project.	**Agreed to Comply:** During construction period Marine Water quality monitoring is carried out once every three months by NMIAL through MoEF&CC recognized & NABL accredited Laboratory. Monitoring will be continued during the operation phase. Environmental monitoring reports for the reporting period are enclosed as **Annexure -2**
xx	NMIA shall ensure that all ground service vehicles will be operated on Electric or CNG. No petrol/diesel vehicles would be allowed in the Airport Premises.	**Agreed to Comply.** Since the project is yet to be operational, NMIA assures to abide by the condition subject to the availability of functionally suitable EVs approved by the authorities.
xxi	Mangrove Park shall be developed in consultation with Mangrove Cell, on site identified by the CIDCO.	**Agreed to Comply:** The villagers (of Vaghiwali village) have not vacated the village and considering the recommendation of BNHS and as per NMDP modification by Urban Development Department, GoM vide letter G.R. No.TPS /1711/2495/C.R.202/11/UD-12 dated 21st March 2012 as of now Vaghiwali Island is being protected as No Development Zone (NDZ). CIDCO is examining an alternate location for Mangrove Park based on recommendations from the Bombay Natural History Society (BNHS). The new location/site will be situated away from the flight paths of NMIA to mitigate potential bird strike risks. This land will be handed over to the Mangroves Cell for plantation, protection, and management.
xxii	NMIA to implement environment measures such as rainwater harvesting, solar lighting, efficient solid and hazardous waste	**Agreed to Comply:** Rainwater harvesting has been planned for implementation by the final phase.

	EC & CRZ Conditions-2021	Compliance Status
	management practices. NMIA shall ensure the zero liquid discharge during construction and operation of the project.	Roof top solar panels will be installed in Terminal-1. Source segregated waste management system has been planned for Phase 1 & 2 (20MPPA). Requisite energy conservation and water conservation measures will be adopted. Entire quantity of treated sewage will be recycled for various purposes within the NMIA boundary thereby ensuring Zero Liquid Discharge.
xxiii	NMIA during construction shall not disturb the coastal ecology comprising mangroves/mudflats present along the Panvel creek, present outside the northern boundary of the project site.	**Agreed to Comply:** During construction stage, all activities will remain within the boundary of 1160 Ha. NMIA ensures that no area out of NMIA premises of 1160 Ha should be disturbed due to the construction activities. Along the northern boundary of the Navi Mumbai International Airport (NMIA), the City and Industrial Development Corporation (CIDCO) has constructed a 60- meter-wide road. This road acts as a buffer zone between the NMIA's northern boundary and the Panvel Creek, including its mangroves and mudflats.
xxiv	NMIA should carry out detailed study on the impact of fishing and livelihood of people depending on local fishing and take efforts to maintain the livelihood of traditional fisher folks supposed to be affected by the project directly or indirectly.	**Agreed to Comply:** NMIA construction activities are confined within the NMIA boundary, there is no work proposed in water or at waterfront, therefore there is no direct impact of NMIA project on fishing activity in surrounding water bodies. NMIA shall comply with the condition by studying the relevant data about fishermen from 9 settlements from 8 revenue villages on the NMIA site which were resettled elsewhere by CIDCO.

	EC & CRZ Conditions-2021	Compliance Status
xxv	Green belt area (33% of total project area) of adequate width and density with local species along the periphery of the project site shall be developed so as to provide protection against particulate matter and noise	**Agreed to Comply.** Green Area of Approx. 33 % of Airport site area has been provided.
xxvi	NMIA shall set up a full-fledged in-house Environment Management Cell comprising concern experts for effective implementation of Environment Management Plan. The EM Cell shall carry out marine water quality monitoring, erosion/accretion status of the coastline along Panvel Creek, monitoring of tidal flow patterns due to diversion of Ulwe & Gadhi streams, development of mangrove park etc. and implement recommendations of the Socio-economic study as well as Disaster Management Plan.	**Agreed to Comply.** NMIA has an in-house Environment Management Cell led by the Deputy General Manager (Environment and Sustainability), reporting to the Joint President & Head of Planning and Design.
xxvii	NMIA/ CIDCO to implement. the recommendations of the report on the BNHS with respect to protection/ conservation of the biodiversity around the Airport site.	**Agreed to Comply.** CIDCO had appointed BNHS in 2018 by signing a MOU for a 10-year period (until 2028) to undertake flagging and tagging, identify bird movements and prepare management plan for active management. BNHS has submitted its Annual Report 2022-23 on" Long-Term Bird Monitoring Programme of Navi Mumbai International Airport (NMIA) Area and its Surroundings during Construction and Operational Phases" to CIDCO in 2024. In this report, based on their field study and analysis of bird flight paths BNHS has observed that "The flight pattern of birds in Thane Creek, potentially including their path intersecting with the approach path of NMIA runways 08L & 08R (for westerly take-offs/landings), has been subject to study by BNHS. According to the data visualization, it appears that aircraft taking off or landing on NMIA runways typically maintain an altitude above the observed flight elevation of birds in Thane Creek"

	EC & CRZ Conditions-2021	Compliance Status
		Further study of BNHS is in progress. BNHS submitted Mid Term Report 2018-2023 for Long-term bird monitoring programme of Navi Mumbai International Airport (NMIA) Area and its Surroundings during Construction and Operational Phases. Copy of this Report is attached as **Annexure 3.**
xxviii	The Environmental and CRZ Clearance to the project is primarily under provisions of EIA Notification, 2006 and CRZ Notification, 2011. The Project Proponent is under obligation to obtain approvals/ clearances under any other Acts/ Regulations or Statutes as applicable to the project.	**Complied:** NMIAL is obtaining all necessary approvals for the project for establishment of green field airport on 1160 Ha site. Similarly, CIDCO is obtaining separate approvals for associated infrastructure at the area surrounding the airport.
B	**Standard Conditions:**	
I	**Statutory compliance:**	
i.	The project proponent shall obtain forest clearance under the provisions of Forest (Conservation) Act, 1980, in case of the diversion of forest land for non-forest purpose involved in the project.	**Complied.** Stage-I & Stage-II forest clearance for 250.0635 Ha land has been obtained from MoEF&CC vide letter no 8-98/212-FC dated 17-12-2013 and 24.04.2017 respectively.
ii.	The project proponent shall obtain clearance from the National Board for Wildlife, if applicable.	**Complied.** Wildlife Clearance was recommended in the 29th Meeting of Standing Committee and communicated vide Minutes No. P.No.6-43/2007 WL-I dt. 1st August, 2013 of Wildlife Division of Ministry of Environment & Forest, Govt. of India.
iii	The project proponent shall prepare a Site-Specific Conservation Plan & Wildlife Management Plan and approved by the Chief Wildlife Warden. The recommendations of the approved Site-Specific Conservation Plan/ Wildlife Management Plan shall be implemented in consultation with	**Agreed to Comply.** Site Specific Conservation plan & wildlife management plan has been submitted to DCF (Wildlife) Thane on September 8, 2025 and received the comments on submitted plan from DCF

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	the State Forest Department. The implementation report shall be furnished along with the six-monthly compliance report (in case of the presence of Schedule-I species in the study area).	(Wildlife) Thane division .Preparation of updated plan is in process..
iv.	The project proponent shall obtain Consent to Establish/Operate under the provisions of Air (Prevention & Control of Pollution) Act, 1981 and the Water (Prevention & Control of Pollution) Act, 1974 from the concerned State Pollution Control Board/ Committee,	**Complied.** NMIA has been granted CTE for Phase I&II of the project for passenger capacity of 20 MPPA & 0.57MTPA Cargo by MPCB vide letter dated June 15, 2022. Copy of the CTE is attached as Annexure -1.
V.	The project proponent shall obtain the necessary permission from the Central Ground Water Authority, in case of drawl of ground water/ from the competent authority concerned in case of drawl of surface water required for the project.	**Not applicable** No ground water to be tapped during construction or operation phases. CIDCO has assured water supply for the project.
vi	Clearance from Directorate General of Civil Aviation (DGCA) and Airports Authority of India (AAI) for safety and project facilities shall be obtained.	**Agreed to Comply.** NMIAL has prepared Airport safety and security plan which are approved by DGCA, AAI, BCAS & CIDCO as per following details. 1. In-Principal Approval to NMIA Master Plan for Construction of Navi Mumbai International Greenfield Airport at Navi Mumbai by Director General of Civil Aviation (DGCA), Govt. of India vide AV.20024/40/2003-AL dt 28th August 2018. 2. In-Principal Approval to NMIA Master Plan for Construction of Navi Mumbai International Greenfield Airport at Navi Mumbai by Bureau of Civil Aviation Security (BCAS), Govt. India vide CAS-6/2018/Div-Ops-I/Navi Mumbai (E-135357) dt 28th August 2018.

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		3. Approval of Bureau of Civil Aviation Security (BCAS), Govt. of India for construction of Terminal-1 Building on NMIA vide CAS-6/2018/Div-Ops-I/Navi Mumbai (E-135357) dt 26th July 2019. 4. Approval of BCAS GoI for Security Vetting/ Security Clearance to updated Master Plan for Phase 1 & 2 (combined) of Navi Mumbai International Airport (NMIA), vide CAS(M)-2018/DIV-II/F-97 /Navi Mumbai (E-131269) dated 02/02/2023. 5. Approval of updated plan 2022 design stage security vetting for proposed airport operations and support facility building for Phase 1&2 (Combined) of Navi Mumbai International Airport (NMIA)- reg. dated 11th Aug 2023. 6. In Principal Approval of BCAS for design stage for phase I & II Master Plan & Buildings, Including Terminal 1 Updates and for three building of phase 1 & 2 of NMIA. Vide CAS(M)-/2018/DIV-II/F-97/Navi Mumbai (E- 131269) dated 27/03/2024 6. AAI has also given the Height clearance approval. 7. This greenfield airport has received NMI as its code from IATA, and VANM as its code from ICAO. 8. BCAS vide letter dated 25th Sep'25 granted approval for final stage Security Vetting (partial/part of Phase I & II Domestic Operations). 9. Aerodrome license for NMIA was granted by DGCA on 30th Sep'25
vii	A certificate of adequacy of available power from the agency supplying power to the project along with the	**Agreed to Comply:** The energy demand is estimated under the Master Plan prepared by the NMIAL and shows that cumulative peak power

	EC & CRZ Conditions-2021	Compliance Status
	load allowed for the project should be obtained.	demand will be 96 MVA which is much lower than the CEIA-2017 estimate of 190 MVA, by adhering to ECBC norms. The power supply requirement will be met through Maharashtra State Electricity Transmission Company Limited (MSETCL) Approval/NoC from MSETCL for Power Supply to NMIA vide MSETCL/CO/STU/EHV Cons/ NMIA/ NO13379 dt 27th December 2018. And SE/VC/TECH/VASHI/2023-24/02910 dt. 02 May 2024
viii	All other statutory clearances such as the approvals for storage of diesel from Chief Controller of Explosives, Fire Department, Civil Aviation Department shall be obtained, as applicable by project proponents from the respective competent authorities.	**Agreed to Comply:** Provisional Fire NOCs of all buildings of Phase 1 & 2 have been received from CIDCO Approval of PESO for NMIA Fuel Farm for Phase 1&2 Capacity of 24500 KL vide- P/WC/MH/15/6540 (P562332) dt. 23 March 2025.
I.	**Air quality monitoring and preservation:**	
i.	The project proponent shall install system to carryout Ambient Air Quality monitoring for common/criterion parameters relevant to the main pollutants released (e.g., PM_{10} and $PM_{2.5}$ in reference to PM emission, and SO_2 and NOx in reference to SO_2 and NOx emissions) within and outside the airport area at least at four locations (one within and three outside the plant area at an angle of 120 each), covering upwind and downwind directions.	**Agreed to Comply.** During the operations stage, air quality will be monitored by NMIAL's Continuous Ambient Air Quality Monitoring Station. Meanwhile, during construction, NMIAL has appointed an MOEFCC-recognized lab to conduct monthly air, noise (9 stations), and groundwater monitoring (5 locations), and quarterly marine/surface water (10 stations) and soil sampling (5 locations). Environmental monitoring reports for the reporting period are enclosed as **Annexure 2.**
ii	Diesel power generating sets proposed as source of backup power should be of enclosed type and conform to rules made under the Environment (Protection) Act, 1986.	**Agreed to Comply**: We assure MOEFCC to abide by the condition during construction & operational phases.

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	The height of stack of DG sets should be equal to the height needed for the combined capacity of all proposed DG sets. Use of low Sulphur diesel. The location of the DG sets may be decided with in consultation with State Pollution Control Board.	The DG sets will be operated only during power failure. Location of DG sets will be in utility blocks and plan showing utility block locations is submitted to MPCB at the time of grant of CTE.
iii	Soil and other construction materials should be sprayed with water prior to any loading, unloading or transfer operation so as to maintain the dusty material wet.	**Being Complied**: At present, during construction phase, water is being sprinkled on trucks carrying excavated material, as also on roads and near construction sites e.g., material handling, RMC plant etc. to suppress dust prior to loading, unloading at regular intervals.
iv	The excavation working area should be sprayed with water after operation so as to maintain the entire surface wet.	**Being Complied**: Excavation working area is sprayed with water during construction activity.
v	Excavated materials shall be handled and transported in a manner that they do not cause any problems of air pollution.	**Being Complied:** Excavated material is mostly rock and has minimal soil. However, for such movement of any soil, spraying with water is being carried out. Excavation working area is sprayed with water during construction activity.
vi	The soil/ construction materials carried by the vehicle should be covered by impervious sheeting to ensure that the dusty materials do not leak from the vehicle.	**Being Complied:** For all incoming and outgoing vehicles (carrying Soil/Loose Construction Material) from site the vehicle tops are being covered.
II.	**Water quality monitoring and preservation:**	
i	Run off from chemicals and other contaminants from aircraft maintenance and other areas within the airport shall be suitably contained and treated before disposal. A spillage and contaminant plan shall be drawn up and implemented to the satisfaction of the State Pollution Control Board.	**Agreed to Comply**: Oil water separator and silt pond are planned at all apron area to remove oil and chemicals in storm water. Storm water will be disposed of as per MPCB norms.

	EC & CRZ Conditions-2021	Compliance Status
ii	Proper drainage systems, emergency containment in the event of a major spill during monsoon season etc. shall be provided.	**Agreed to Comply**: NMIA's stormwater drainage system is designed for a 100-year return period with a rainfall intensity of 148.1 mm/hr to handle major monsoon spills. Absorbent kits will be provided on oil dispensing vehicles during the operations phase to contain potential spills.
iii	The runoff from paved structures like Runways, Taxiways, can be routed through drains to oil separation tanks and sedimentation basins before being discharged into rainwater harvesting structures.	**Agreed to Comply**: The runoff from paved area like runways, taxiways are routed through oil water separators at various places and treated water will be discharged as per MPCB norms.
iv	Storm water drains are to be built for discharging storm water from the airfield to avoid flooding/ water logging in project area. Domestic and industrial wastewater shall not be allowed to be discharged into storm water drains.	**Agreed to Comply:** A separate stormwater drainage system is planned to prevent waterlogging on the airfield. Additionally, a dedicated sewage system will collect sewage, which will be treated using UF and RO technologies. The treated water will be reused for flushing, gardening, and HVAC purposes, with no discharge into the outfall.
v	Rainwater harvesting for roof run-off and surface run-off, as plan submitted should be implemented. Rainwater harvesting structures shall conform to CGWA designs. Before recharging the surface run off, pre-treatment must be done to remove suspended matter, oil and grease.	**Agreed to Comply**: We assure MOEFCC to abide by the condition during operational phase. Surface run-off from apron areas will pass through oil & grease separator before reaching RWH pond. Silt pond has been provided prior to outfall to settle other particulate matters.
vi	Total freshwater use shall not exceed the proposed requirement as provided in the project details. Prior permission from competent authority shall be obtained for use of fresh water.	**Agreed to Comply**: The total water demand in final phase is 21.80 MLD. Of which, freshwater demand of 10.60 MLD will be sourced from CIDCO. Water supply assurance has been obtained from Water Supply Dept. CIDCO for permanent commercial

	EC & CRZ Conditions-2021	Compliance Status
		Water Supply connection to NMIA vide CIDCO/ EE (Hetwane)/ 2025/ 218 dt 19th March 2025 .
vii	A certificate from the competent authority for discharging treated effluent/untreated effluents into the Public sewer/ disposal / drainage systems along with the final disposal point should be obtained.	**Being Complied**: Consent to Establish (CTE) for NMIA Phase I & II has been granted by the Maharashtra Pollution Control Board (MPCB) vide letters dated 15th June 2022. Copy of this approval is enclosed as Annexure-1. 100% Recycling and reuse of treated sewage water is being planned in cooling tower make-up, flushing and gardening. STP including quaternary system of RO has been proposed. Since the project is yet to be operational. We assure MOEFCC to abide by the condition
viii	A detailed drainage plan for rainwater shall be drawn up and implemented.	**Being Complied**: NMIA has prepared the detailed drainage master that was reviewed and approved by CWPRS. The same drainage master plan is being implemented.
III.	**Noise monitoring and prevention:**	
i	Noise level survey shall be carried as per the prescribed guidelines and report in this regard shall be submitted to Regional Officer of the Ministry as a part of six-monthly compliance report.	**Being Complied.** Ambient Noise monitoring is regularly carried out every month & reports in this regard submitted to regional office of the Ministry as part of six- monthly compliance report regularly. Environmental monitoring reports for the reporting period are enclosed as **Annexure 2.**
ii	Noise from vehicles, power machinery and equipment on-site should not exceed the prescribed limit. Equipment should be regularly serviced. Attention should also be	**Agreed to Comply**: We assure MOEF&CC to abide by the condition during construction & operational phases. All contractors have been asked to establish maintenance workshop at site

	EC & CRZ Conditions-2021	Compliance Status
	given to muffler maintenance and enclosure of noisy equipment's.	to ensure regular servicing of the equipment and vehicles. The existing noise monitoring reports are attached as **Annexure 2** During operation phase, low noise vehicles will be operated at the airport for GSE.
iii	Acoustic enclosures for DG sets, noise barriers for ground-run bays, ear plugs for operating personnel shall be implemented as mitigation measures for noise impact due to ground sources.	**Agreed to Comply**: We assure MOEFCC to abide by the condition. DG sets will be CPCB certified with acoustic enclosure, PPE shall be provided to the DG set operator. Wherever permissible, noise barriers will be installed for ground-run bays.
iv	During airport operation period, noise should be controlled to ensure that it does not exceed the prescribed standards. During nighttime the noise levels measured at the boundary of the building shall be restricted to the permissible levels to comply with the prevalent regulations.	**Agreed to Comply**: We assure MOEFCC to abide by the condition during airport operation period.
IV.	**Energy Conservation measures:**	
i.	Energy conservation measures like installation of LED/CFL.s/TFLs for the lighting the areas outside the building should be integral part of the project design and should be in place before project commissioning.	**Agreed to Comply**: Energy efficient light fittings have been considered in the design of lighting system. Necessary energy conservation and water conservation measures will be adopted.
V.	**Waste management:**	
i.	Soil stockpile shall be managed in such a manner that dust emission and sediment runoff are minimized. Ensure that soil stockpiles are designed with no slope greater than 2:1 (horizontal/ vertical).	**Being Complied**: We assure MOEFCC to abide by the condition during construction phase. Opportunity to conserve the stockpile is limited as most of the excavated material is used in raising plot level to 8.5 m AMSL.

	EC & CRZ Conditions-2021	Compliance Status
ii	The project activity shall conform to the fly Ash notification issued under the E P. Act of 1986.	**Being Complied**: Fly ash has been considered in the concrete mix design and is being used during construction. EPC contractors are maintaining record for use of fly ash.
iii	Solid inert waste found on construction sites consists of building rubble, demolition material, concrete; bricks, timber, plastic, glass, metals, bitumen etc. shall be reused/ recycled or disposed of as per Solid Waste Management Rules, 2016 and Construction and Demolition Waste Management Rules, 2016.	**Being Complied**: Inert material comprising of construction and demolition debris is collected and filled at a designated place within NMIA site. EPC contractors give other recyclable material such as glass, metal, cardboard, paper, etc. to a registered scrap dealer.
iv	Any wastes from construction and demolition activities related thereto shall be managed so as to strictly conform to the Construction and Demolition Waste Management Rules, 2016.	**Being complied**: Construction and demolition waste generated during development phase is being handled as per The Construction and Demolition (C&D) Waste Management Rules, 2016. We assure MOEFCC to abide by the condition during construction phase.
v	The project proponents shall implement a management plan duly approved by the State Pollution Control Board and obtain its permissions for the safe handling and disposal of:	**Agreed to Comply**: NMIAL shall prepare Waste Management Plan for operations stage and submit the same along with application for Consent to Operate to be obtained from MPCB prior to the commencement of airport operation.
	a. Trash collected in flight and disposed at the airport including segregation, collection and disposed.	**Agreed to Comply:** Trash collected from flights will be transported to NMIA's solid waste plant for segregation. Reusable and recyclable materials will be stored in a closed room for pickup by MPCB authorized vendors, while non-degradable and inert waste will be sent to CIDCO's authorized MSW landfill site.

	EC & CRZ Conditions-2021	Compliance Status
	b. Toilet wastes and sewage collected from aircrafts and disposed at the Airport.	**Agreed to Comply:** Sewage cart trucks will collect sewage from aircraft and transport it to a Triturator for primary treatment. The sewage will then be pumped to the sewage treatment plant for final treatment, with the treated sewage being used for non-potable purposes.
	c. Wastes arising out of maintenance and workshops	**Agreed to Comply:** Waste arising from maintenance and workshop will be stored at NMIA in closed room at ambient temperature and the same will be taken away by MPCB/CPCB authorized vendors.
	D. Wastes arising out of eateries and shops situated inside the airport complex.	**Agreed to Comply:** Wastes from eateries will be sent to bio-gas plant proposed at NMIA to form compost and biogas. Compost will be used as a manure to landscape area of NMIA.
	e. Hazardous and other wastes	**Agreed to Comply**: Hazardous Wastes arising from maintenance and workshop will be stored at NMIA in closed room at ambient temperature and the same will be taken away by MPCB/CPCB authorized HW vendors.
vi.	The solid wastes shall be segregated as per the norms of the Solid Waste Management Rules, 2016. Recycling of wastes such as paper, glass (produced from terminals and aircraft caterers), metal (at aircraft maintenance site), plastics (from aircrafts, terminals and offices), wood, waste oil and solvents (from maintenance and engineering operations), kitchen wastes and vegetable oils (from caterers) shall be carried out. Solid wastes shall be disposed in accordance to the Solid	**Agreed to Comply**: We assure MOEFCC to abide by the condition during construction & operational phases. Requisite area has been provided for waste collection, segregation, safe storage and compliant disposal as per Solid Waste Management Rules 2016.

	EC & CRZ Conditions-2021	Compliance Status
	Waste Management Rules, 2016 as amended.	
vii.	Used CFLs and TELs should be properly collected and disposed off/ sent for recycling as per the prevailing guidelines/rules of the regulatory authority to avoid mercury contamination.	**Agreed to Comply:** Since the project is yet to be operational, we assure to abide by the condition. Used CFL and TFLs will be collected and disposed of through MPCB authorized disposal facilities.
VI.	**Green Belt:**	
i.	Green belt shall be developed in area as provided in project details, with native tree species in accordance with Forest Department. The greenbelt shall inter alia cover the entire periphery of the Airport.	**Agreed to Comply:** Since first phase of project is under implementation and project is yet to be operational, we assure to abide by the condition by final phase. Green belt/ vegetation along periphery of the airport shall be developed at locations outside NMIA which are complying to operational safety requirement of airport. However, green area/open area amounting to 33% of NMIA site area has been planned.
ii.	Topsoil shall be separately stored and used in the development of green belt.	**Being Complied**: Topsoil is being separately stored for use in the development of green belt.
VII.	**Public hearing and Human health issues:**	
i	Construction site should be adequately barricaded before the construction begins.	**Complied:** Initially, metal sheet barricading was used, but it is now being gradually replaced with a permanent RCC boundary wall.
ii	Traffic congestion near the entry and exit points from the roads adjoining the airport shall be avoided. Parking should be fully internalized, and no public space should be utilized.	**Being Complied**: The traffic management plan by the EPC contractor is being implemented to prevent congestion on roads adjacent to NMIA. All parking, including for construction vehicles, is provided

	EC & CRZ Conditions-2021	Compliance Status
		within the NMIA premises, with no public spaces used for parking.
iii	Provision of Electro-mechanical doors for toilets meant for disabled passengers. Children nursing/feeding room to be located conveniently near arrival and departure gates.	**Agreed to Comply:** Disabled person toilets are being designed as per National Building Code, 2016. Children nursing/ feeding room being provided as per international best practice for airport passenger services.
iv	Emergency preparedness plan based on the Hazard identification and Risk Assessment (HIRA) and Disaster Management Plan shall be implemented.	**Agreed to Comply:** EPC contractors have prepared risk assessment, HIRA and disaster management plan under the terms of the EPC contract for construction phase, implementation of which is supervised by the safety team of NMIA. DMP for construction phase has been prepared by contractor has been submitted. Disaster Management Plan for operation phase is under preparation which will be completed in due course of time.
v	Provision shall be made for the housing of construction labor within the site with all necessary infrastructure and facilities such as fuel for cooking, mobile toilets, mobile STP, safe drinking water, medical health care, crèche etc. The housing may be in the form of temporary structures to be removed after the completion of the project.	**Being Complied**: EPC Contractors have made requisite provisions for labour camp at site as per this condition. All facilities have been provided to labour. We assure MOEF&CC to abide by the condition during the construction phase.
vi	Occupational health surveillance of the workers shall be done on a regular basis.	**Being Complied**: EPC Contractors have made requisite provisions for labour camp at site as per this condition. All facilities have been provided to labour. We assure MOEF&CC to abide by the condition during construction phase.
VIII.	**Miscellaneous:**	

	EC & CRZ Conditions-2021	Compliance Status
i	The project proponent shall make public the environmental clearance granted for their project along with the environmental conditions and Safeguards at their cost by prominently advertising it at least in two local newspapers of the District or State, of which one shall be in the vernacular language within seven days and in addition this shall also be displayed in the project proponent's website permanently.	**Complied:** Public was informed about the grant of EC by advertisement in newspaper Business Standard Mumbai on 10.12.2021 and Lokmat (Marathi) on 10.12.2021 and copies of Newspaper cutting were submitted with EC Compliance report July- December 2021. Copy of EC and CRZ clearance, Consent to establish are available on NMIAL web site. (https://www.nmiairport.co.in/circulars)
ii	The copies of the environmental clearance shall be submitted by the project proponent to the Heads of local bodies, Panchayats and Municipal Bodies in addition to the relevant offices of the Government who in turn must display the same for 30 days from the date of receipt.	**Complied.** Environmental clearance letters were submitted to Local Bodies, Panchayats and municipal bodies.
iii	The project proponent shall upload the status of compliance of the stipulated environment clearance conditions, including results of monitored data on their website and update the same on half-yearly basis.	**Agreed to Comply**: All EC related compliance reports filed by NMIAL are uploaded on NMIAL website and available at the link. (https://www.nmiairport.co.in/circulars)
iv	The project proponent shall submit six-monthly reports on the status of the compliance of the stipulated environmental conditions on the website of the Ministry of Environment, Forest, and Climate Change at environment clearance portal.	**Agreed to Comply**: All EC related compliance reports filed by NMIAL are uploaded on NMIAL website and available at the link (https://www.nmiairport.co.in/circulars) Also, same will get uploaded on Parivesh portal of Ministry of Environment, Forest and Climate Change for environment clearance on regular basis.

	EC & CRZ Conditions-2021	Compliance Status
v	The company shall have a well laid down environmental policy duly approved by the Board of Directors. The environmental policy should prescribe for standard operating procedures to have proper checks and balances and to bring into focus any infringements/ deviation/ violation of the environmental /forest/ wildlife norms/ conditions. The company shall have defined system of reporting infringements/ deviation/ violation of the environmental/ forest/ wildlife norms/ conditions and/or shareholder's/ stake holders. The copy of the board resolution in this regard shall be submitted to the MoEF&CC as a part of six-monthly report.	**Agreed to Comply**: NMIAL has Environmental, Social and Governance (ESG) Policy approved by the Chief Executive Officer of NMIAL in August 2023. Environmental management Plan for construction phase has been prepared which provides standard operating procedures and a system of checks and balances through continuous inspection and monitoring of environment, health & safety standards, & records of requisite data. This EMP has been circulated to all in design and construction teams. Environment Management Framework and Institutional framework of EMP. Similar EMP will be prepared at operations stage to minimize environmental impacts of operations.
vi	A separate Environmental Cell both at the project and company head quarter level, with qualified personnel shall be set up under the control of senior Executive, who will directly report to the head of the organization.	**Complied**: Separate environmental team has been deployed at both project and company headquarter.
vii	Action plan for implementing EMP and environmental conditions along with responsibility matrix of the company shall be prepared and shall be duly approved by competent authority. The year wise funds earmarked for environmental protection measures shall be kept in separate account and not to be diverted or any other purpose. Year wise progress of implementation of action plan shall be reported to the Ministry/Regional Office along with the Six-Monthly Compliance Report.	**Agreed to Comply**: Environmental management plan for construction phase and operations phase has been presented in Chapter 10 of 2021-EIA report along with the budget. The expenditure incurred on EMP implementation till 30th September 2025 is 17.73 Cr.

	EC & CRZ Conditions-2021	Compliance Status
viii	Self-environmental audit shall be conducted annually. Every three years third party environmental audit shall be carried out.	**Being Complied:** Since the project is yet to be operational, we assure to abide by the condition. NMIAL's environment team conducts inspection of all activities of EPC contractors. Independent engineer appointed by CIDCO conduct monthly review of compliance. During Airport operational phases third party environmental audit shall be conducted in every three year.
ix	The project proponent shall submit the environmental statement for each financial year in Form-V to the concerned State Pollution Control Board as prescribed under the Environment (Protection) Rules, 1986, as amended subsequently and put on the website of the company.	**Agreed to Comply:** As the project is yet to be operational, we assure to abide by the condition. The resource consumption and waste generation figures in the Consent to Establish relate to the operations stage of Phases 1 and 2 (20 MPPA). An Environmental Statement as per Form V has been prepared during the construction phase and submitted to MPCB.
x	The criteria pollutant levels namely, PM_{10}, $PM_{2.5}$, SO_2, NO_x (ambient levels) shall be monitored and displayed at a convenient location near the main gate of the company in the public domain.	**Agreed to Comply:** All EC related compliance reports are being uploaded on NMIAL website. NMIA does regularly monitors pollutants like PM_{10}, $PM_{2.5}$, SO_2, NOx through NABL approved laboratory and displays the results near the main gate of NMIA project site.
xi	The project proponent shall inform the Regional Office as well as the Ministry, the date of financial closure and final approval of the project by the concerned authorities, commencing the land development work and start of production operation by the project.	**Agreed to Comply:** Financial Closure for NMIA project Phase 1 & 2 (20 MPPA) was achieved on March 29, 2022, when State Bank of India (SBI) as a lead bank agreed to underwrite full loan amount of Rs. 12,770 Cr.
xii	The project. authorities must strictly adhere to the stipulations made by	Noted

	EC & CRZ Conditions-2021	Compliance Status
	the State Pollution Control Board and the State Government.	
xiii	The project proponent shall abide by all the commitments and recommendations made in the EIA/EMP report, commitment made during Public Hearing and also that during their presentation to the Export Appraisal Committee.	Agreed
xiv	No further expansion or modifications in the plant shall be carried out without prior approval of the Ministry of Environment, Forests and Climate Change (MoEF&CC).	Agreed
xv	Concealing factual data or submission of false/fabricated data may result in revocation of this environmental clearance and attract action under the provisions of Environment (Protection) Act, 1986.	Noted
xvi	The Ministry may revoke or suspend the clearance, if implementation of any of the above conditions is not satisfactory.	Noted
xvii	The Ministry reserves the right to stipulate additional conditions if found necessary. The Company in a time bound manner shall implement these conditions.	Noted
xviii	The Regional Office of this Ministry shall monitor compliance of the stipulated conditions. The project authorities should extend full cooperation to the officer (s) of the Regional Office by furnishing the requisite data/information/ monitoring reports.	Noted
xix	The above conditions shall be enforced, inter-alia under the provisions of the Water (Prevention & Control of Pollution) Act, 1974, the Air	Noted

	EC & CRZ Conditions-2021	Compliance Status
	(Prevention & Control of Pollution) Act, 1981, the Environment (Protection) Act, 1986, Hazardous and Other Wastes (Management and Transboundary Movement| Rules, 2016 and the Public Liability Insurance Act, 1991 along with their amendments and Rules and any other orders passed by the Hon'ble Supreme Court of India/ High Courts/NGT and any other Court of Law relating to the subject matter.	
xx	Any appeal against this EC shall lie with the National Green Tribunal. if preferred, within a period of 30 days as prescribed under Section 16 of the National Green Tribunal Act, 2010.	Noted

Compliance to conditions stipulated in Environment Clearance & CRZ Clearance No.10-53/2009-I.A. III dt. 22.11.2010 & dt 20.12.2017

Present Status of Compliance to Conditions stipulated in EC &CRZ Clearance No.10-53/2009-I.A. III dt. 22nd Nov 2010 & dt 20th Dec 2017

Sr. No		Stipulated Condition-2010	Compliance status
7.		**Specific Condition**	
I.		**Construction Phase**	
	i.	"Consent for Establishment" shall be obtained from State Pollution Control Board under Air and Water Act and a copy shall be submitted to the Ministry before start of any construction work at the site.	**Complied:** Consent to Establish (CTE) is granted to NMIA by MPCB vide letter No. Format 1.0/ CAC/UAN No. MPCB-CONSENT-0000128221/CE-2206000673 dt. 15.06.2022 for Phase I & II (20 MPPA & Cargo Capacity 0.57 MTPA) which is valid up to 05.10.2026. This document supersedes the previous CTE obtained for development of Navi Mumbai International Airport.
	ii.	CIDCO shall rehabilitate about 3000 families of 10 settlements from 7 villages falling within the airport zone as per the R & R policy of the Government of India or the Government of Maharashtra, whichever is more beneficial to the project affected persons.	**Complied:** R&R package development and implementation was in scope of CIDCO as per NOC for transfer of EC and CRZ clearance given by CIDCO to NMIAL vide letter No. CIDCO/T&C/CT&CP/ NMIA/ 1317 dated 10th Feb 2020. CIDCO has handed over 100% encumbrance free RoW of the project site of 1160 Ha to NMIAL on 10th June 2022.
	iii.	CIDCO shall obtain necessary permission from Hon'ble High Court of Bombay for cutting or damaging of mangroves and clearance under Forest Conservation Act 1980 as per the orders in respect of notice of Motion no. 417 of 2006 in PIL no. 87/2006, as required.	**Complied:** Necessary approvals / clearances have been taken by CIDCO from the MoEF&CC (stage II Forest clearance vide File No.: 8-95/2012-FC dated 24th April 2017 for diversion of 250.0635 ha area) and Permission for Removal of Mangroves over 108.607 Ha (98 Ha within site and balance in offsite area) vide Bombay High Court order dated October 29, 2013, as applicable..
	iv.	The plantation and protection of mangroves over an area of 615 ha	**Complied:**

Sr. No		Stipulated Condition-2010	Compliance status
		(245 hectares of good quality Mangroves Park shall be developed at Vaghivli on the north of the airport area + 60 hectare area located on the west side of the airport site around Moha creek and Panvel Creek + 310 hectares area on the northeast of the airport site between Gadhi River, Mankhurd Panvel Rail corridor and National Highway 4B shall be declared as No-development zone and CIDCO shall under take the development as Mangroves park/green area) would be developed and maintained in the shape of Biodiversity Mangrove Parks well before the airport project is initiated and its progress reported to the high level committee mentioned below at (xxxiii). CIDCO shall formally amend the land use in the sectioned development plan of Navi Mumbai following the due procedure under MRTP Act to achieve this objective.	The Urban Development Department, GoM has sanctioned change in Navi Mumbai Development Plan vide letter G.R.No.TPS/1711/2495/ C.R.202/11 /UD -12 dated 21st march, 2012. It was noted that work of plantation & Protection of 310 ha + 60ha + 20 ha has been completed by Mangrove Cell, State Forest department as submitted in the earlier six-monthly report. In addition, 108 ha mangrove plantation has been completed in Kolekhar village near this, NDZ has been declared as per the Forest clearance condition of compensatory mangrove plantation. Details of mangrove pockets development including compensatory mangrove plantation and development of other pockets has been submitted by CIDCO vide letter CIDCO/ GM(ENV&F)/ nmia/ 2019/038 dtd 11th September 2020.
	v.	The proposed re-coursing of tidally influenced water body outlets from Ulwe river has a large cross-sectional area at the middle with the river/creek on either end remaining unchanged with its natural course. The whole system should function as was functioning earlier without airport project. Surface runoff should not be let into the channel just because the area of cross section is large. The whole airport area will be reclaimed, and the level raised to 7m whereas the existing level all around the airport will continue to be low in its natural state. There will be flow all around due to surface runoff. This additional quantity must be collected by appropriate drainage system and let into Gadhi River and not into the re-	**Complied:** It may be noted, as per CIDCO report, as submitted to MOEFCC, that: 1. CWPRS, Pune has carried out 1D, 2D mathematical & physical Model studies based on the MoEF's approved layout plan of airport covering 1160 Ha. CIDCO has also completed designing the master drainage plan of surrounding areas by incorporating the various recommendations of CWPRS. 2. The detailed drainage plan for the airport has been prepared by the NMIAL as a part of Airport Master Plan, incorporating CWPRS recommendations and integrating with CIDCO drains plan and abiding by EC conditions. The storm Water from NMIA project area will be discharged in

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		coursing channel. The recourse channel may be able to take it but not the river or creek on either side of the channel. This aspect shall be examined by CIDCO in details to avoid the flooding of the low-lying areas besides inducting other hydrological and environmental studies.	Pavel creek and Gadhi River after settling fine particles in the silt pond proposed before outfall. 3. The Drainage Master Plan of airport is prepared for the worst conditions (highest high tide, tidal surge, maximum rainfall intensity of 148.1mm/hr and simultaneous flooding in all rivers). NMIAL had engaged CWPRS to review the internal drainage system designed for the airport area to ensure its compatibility and suitability with external Drainage Master Plan of CIDCO for surrounding areas. 4. The Master plan developed by NMIA has ensured that there will be no discharge into the Ulwe recourse channel from Airport as mandated in EC.
	vi.	The entire system shall be studied as one composite system with appropriate boundary conditions to reflect the worst conditions – minimum 100 years to be specified and compliance ensured such as - flooding, surface runoff not only from the airport but also from surrounding areas as well, normal flow, tidal flow due to tidal surge having a long return period, possible obstructions to flow, tributaries joining the main river etc. so as to take appropriate protection and remedial measures. Due to construction of recourse Channels and also due to tail end of the Gadhi & Ulwe Rivers into Panvel Creek, there is a need to prepare a Comprehensive Master Plan for Surface drainage and Flood protection, keeping in view the proposed developments. CIDCO shall	**Complied:** Main drains designed based on 148.1mm/hr for 1 in 100-year Return Period value recommended by CWPRS. Recommendations of the CWPRS report on Comprehensive Master Plan for Surface drainage and Flood protection and its compliance has been submitted to MOEFCC as a part of Comprehensive EIA report of 2021 which is being complied through the planning and design process. The earlier report was submitted to MOEFCC in 2017.

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		submit the above Master Plan to the Ministry.	
	vii.	Systemic and periodic monitoring mechanisms need to be put in place by CIDCO to assess the impact on sub-surface flow/ impact on aquifers as well as surface water bodies in different seasons. Necessary additional environmental protection measures to be adopted to address the impact of proposed development in coastal sub-subsurface flow as well as impact on aquifers.	**Complied:** NMIAL has appointed NABL & MOEFCC recognized laboratory, for the monitoring for Air & noise (9 stations) and Ground water sampling (up to 5 locations) on monthly basis. Marine/ Surface water (10 stations), & soil sampling (5 locations) on quarterly basis. Environmental analytical reports for the reporting period are attached as **Annexure 2** Since entire project is being constructed on land filled with broken rocks to an average level of 8.5 m AMSL and since ground water is not being mined for any project activity, sub-surface flow or the aquifer is not likely to be impacted.
	viii.	CIDCO shall prepare a Management Plan to handle the runoff from the airport and to ensure that runoff associated risks/ impacts such as siltation in receiving water body are avoided and are taken care within airport area during monsoons.	**Complied:** Drainage Master Plan Report of Airport and its surrounding area is prepared which includes the issue of management of runoff and associated risks during the monsoon. CWPRS studies show that siltation rates in Gadhi River and Panvel creek are low and obstructions due to such factors are considered while designing Master Drainage layout. During construction phase run off will be passed through silt traps before letting it out to Panvel Creek and Gadhi River. The Storm Water drains are designed incorporating in-line features like silting chamber and oil water separator (for surface runoff from aprons) to remove suspended matter and oils.

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	ix.	On the northern part of the airport there is a secondary channel of the Gadhi River which will be filled up for the airport runway construction. This will be replaced by a shorter channel along the northern boundary of the airport. The channel shall be designed appropriately through overall modeling study so that the channel provides tidal water to the mangrove park and moderate tidal flows under worst environmental conditions. Need for widening and deepening of Gadhi River may also be studied simultaneously, if required. The revised widths and depths of recourse channels shall be determined with modified drainage and worst rainfall/ tide conditions including appropriate factor of safety.	**Complied:** It may be noted, as per CIDCO report vide Letter CIDCO/GM(ENV&F)/NMIA/2019/938 dated 11th September 2020 available at URL: https://cidco.maharashtra.gov.in/pdf/EC_Complience/160043466783295_NMIAECComplianceStatusFinal-.pdf as submitted to MOEFCC, that: 1. The proposed North connecting channel is designed in accordance with the Model studies carried out at CWPRS, Pune as submitted by CIDCO. 2. As per CWPRS recommendations Northern Channel is planned with 75 m width. Further, studies carried out with 75 m Northern channel having bed levels of -2 m and -1 m revealed that there are no significant changes in maxima flood levels predicted with earlier studies as reported in CWPRS report. CIDCO has also submitted to MOEFCC that at present 60% area of the channel is covered by Mangroves and hence is being retained as it is. However, sufficient care is ensured that flow is not obstructed. Construction of new Channel for Gadhi River, north of NMIA Site shall be completed by CIDCO. NMIAL has requested an update from CIDCO in this regard.
	x.	The flow channels and the low -lying mangrove area which will receive water from diverted recourse/ channels should remain undisturbed. No road, embankment or any other construction shall be permitted. Any island formed due to deposition of	**Complied:** It may be noted, as per CIDCO report vide Letter CIDCO/GM(ENV&F)/NMIA/2019/938 dated 11th September 2020 available at URL: https://cidco.maharashtra.gov.in/pdf/EC_Complience/160043466783295_

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		sediment in front of Panvel creek shall be periodically removed.	NMIAECComplianceStatusFinal-.pdf, as submitted to MOEFCC, that all the flow channels in No Development Zone (615 Ha.) are kept undisturbed. CWPRS studies show that siltation rates in Gadhi River and Panvel creek are low.
	xi.	A detailed map shall be submitted by CIDCO to the Ministry with quantification of affected mangrove area with density i.e., initial proposal & modified proposal and proposed mangrove forestation with species. The work on the proposed compensatory mangrove park should commence well before the construction of the airport is undertaken. The mangrove irrigation systems and diverse species selections for all the four areas may be scientifically made. The river front development in all the areas not protected by adequate mangrove buffer along the Panvel creek and Gadhi river may be considered through studies.	**Complied:** It may be noted, as per CIDCO report vide Letter CIDCO/GM(ENV&F)/NMIA/2019/938 dated 11th September 2020 as submitted to MOEFCC, that: 1. Mumbai University has quantified the affected mangroves using Satellite Imagery for years 1995, 2000, 2005 and 2010. and qualitative analysis is done by field study to ascertain Density & Dominance of affected mangrove area. 2. The same was incorporated in the Updated EIA Report of 2011 and Comprehensive EIA Report 2017. 3. CIDCO has developed compensatory mangrove plantation over 108.67 Ha at S. No. 27, village Kolhekhar in between Jui creek and Taloja creek through the Mangrove Cell of State Forest Dept. Further, CIDCO has modified Navi Mumbai Development Plan (NMDP) to provide mangrove cover in four NDZ pockets over 616.2 Ha which was approved by GoM vide G.R. dt 12.03.12. 4. The scheme for regeneration of Mangroves is prepared through a consultant M/s. Lewis Environment Services USA. The regeneration of mangroves was done in a phased manner, in consultation with the Mangrove Cell of State Forest Dept. through FDCM in the 310 Ha of NDZ to the Northeast of airport, 60 Ha in

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			Moha Creek and 20 Ha on North of Airport. A certificate from Mangrove Cell, Forest department showing completion of Mangrove regeneration over 390 Ha and photographs have been submitted. CIDCO's position regarding development of Mangrove biodiversity park is replied in item sr. no. (iv) above.
	xii.	Whatever EIA data was submitted and presented was related to a situation for "no airport condition". The project proposal has undergone many changes in terms of converting the lagoon as Mangrove Park, shifting of non-aeronautical activities to the south etc. Updated EIA report with all the modifications and commitments given by CIDCO shall be submitted to the MoEF, MPCB and to MCZMA. This updated EIA report will serve as the preliminary baseline data. CIDCO shall submit the second report (EIA Report II) after finalization of all the facilities followed by Comprehensive EIA report prepared with approved layout of the airport, new hydrological scenario, altered topography and land use. The Comprehensive EIA report should also include ecological aspects answering quires raised by BNHS and several other points raised during the meeting. After completion of Phase I of the project, the CIDCO shall conduct the "Environmental Audit" with a reputed organization and the audit shall also include the "Validation of the conclusions drawn in the EIA Report" and to submit to MoEF, MPCB and to MCZMA and shall be uploaded on the website.	**Complied:** Updated EIA report was submitted to MoEF, MPCB and MCZMA on 21st April 2011 by CIDCO. Further, a Comprehensive EIA report incorporating the various studies / activities carried out by CIDCO post Environmental Clearance, has been prepared and submitted to MoEF, MPCB and MCZMA vide letter dtd 29th August 2017. NMIAL has submitted EIA report 2021 to MOEFCC vide letter dated 25th Oct 2021 for obtaining fresh clearance. The EIA report is uploaded on web site also & link is: (https://www.nmiairport.co.in/circulars) Environmental Audit will be conducted after commissioning of phase 1 & 2 (20MPPA) which is under implementation.

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	xiii.	The water quality of the River Gadhi, Ulwe, the Panvel Creek and the ground water is to be monitored on quarterly basis for TOC, Pb, Cd and Hg at all the locations identified in the EIA study for a period of at least 2 years from the commencement for the construction work and the quarterly reports to be submitted to Ministry of Environment and Forests Govt. of India and MPCB.	**Complied**: Marine Surface Water quality monitoring is being carried out on quarterly basis and ground water monitoring on monthly basis by NMIAL through MoEF&CC recognized Lab. Environmental analytical reports for the reporting period are attached as **Annexure 2**
	xiv.	The wastewater generated from the aircraft maintenance hangars may contain hazardous materials like lead, chromium, Sulphates, Phenolic compounds, V.O.C's etc. The surface runoff from the airport area shall also contain oils, grease, Sulphates etc, which cannot be sent directly to sewage treatment plant for the treatment. A separate treatment plant for managing the wastewater shall be specified and adopted.	**Agreed to Comply:** Since project is yet to be operational, we assure to abide by the condition. Primary treatment will be provided at hangars to remove all heavy metals and then the sewage will be discharged to STP followed with UF and RO.
	xv.	Based on the geological profile underneath the proposed airport, suitable consolidation factor shall be arrived to assess the additional noise/ vibration levels that would be produced during impact of landing & take off the air crafts simultaneously on both the runways. Further, the partially quarried hills in the vicinity will become a rebound shell for noise. CIDCO shall examine the details of noise/ vibration levels those are likely to be increased both during day and nighttime and the mitigation measures shall be installed to reduce the (noise/ vibration levels) impacts.	**Agree to Comply**: It may be noted that runway pavement has been designed taking into consideration subsoil condition, and the subgrade below pavement is not a source of noise/vibration. Any noise on landing is sourced from the aircraft undercarriage and therefore subject to aircraft attributes and undercarriage improvements by aircraft manufacturers. On take off the dominant noise is from the engines. Engine noise is being reduced progressively due to development of high-bypass engines and development of engine nacelles.
	xvi.	Standard instrument arrival and departure procedure shall be designed to minimize the noise levels	**Being complied-**

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		within the permissible limits for the area falling in the funnel near the airport on either side.	Standard instrument arrival and departure procedures are designed by Airport Authority of India (AAI) considering International Civil Aviation Organization (ICAO) standards and recommended practices.
	xvii.	Energy conservation to the extent of 20% shall be incorporated in the bidding documents including water conservation (reuse/ recycle, rainwater harvesting and water efficient fixtures) and other green building practices for various buildings proposed within the airport complex. CIDCO shall consider ECBC Guidelines 2009 to achieve the energy – efficient design.	**Being Complied:** NMIA is in process of getting LEED BD+C V4 Certification for Passenger Terminal-1 Building Preliminary energy assessment shows saving more than 20%. Energy, water conservation and green practices being implemented for Passenger Terminal Building are as per LEED guidelines and for the other buildings ECBC norms are being followed.
	xviii.	CIDCO shall prepare a detailed traffic management plan to take care of increased vehicular traffic which should also cover/ clearly delineate widening/ increasing the existing roads and associated road infrastructure approving / installation of road safety features/ pedestrian facility/ FOB / under passes etc. (that can be done by carrying out road safety audits). Measures shall be taken to prevent encroachment along/within the ROWs on connecting/ main arterial roads.	**Complied:** It may be noted, as per CIDCO report, as submitted to MOEFCC, that a detailed Connectivity Study "Regional and Local Transport Connectivity Plan for Navi Mumbai International Airport" has been carried out through international consultant M/s. Lea Associates South Asia Pvt Ltd. Based on the findings of study, CIDCO and various state Government agencies have taken up various projects for improving the connectivity through various modes, by giving emphasis to public transport.
	xix.	Necessary road (National and State Highways) and rail connectivity shall also be upgraded to handle the increased passenger and cargo traffic, in addition to metro for transition of passengers. The proposal of Hoverport shall not be taken up on the north part of the	**Complied:** It may be noted, as per CIDCO report, vide Letter CIDCO/GM(ENV&F)/NMIA/2019/938 dated 11th September 2020 as submitted to MOEFCC, the National and State Highway surrounding the airport are being upgraded for increased traffic by Mumbai JNPT Port

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		airport area as this shall damage the mangroves.	Road Company Ltd (MJPRCL) and PWD. The proposal was to widen the existing National and State Highways in the airport vicinity to 8 Lane with service roads and further to 6 Lane with service roads has been completed by MJPRCL. Widening of Sion – Panvel highway up to 10 lanes is also completed. Further, additional bridges are being constructed at the Thane Creek bridge on Sion- Panvel Highway. The Seawoods-Uran Rail link has been commissioned as part of this work. These connectivity development projects include Mumbai Trans Harbour Link (MTHL) (connecting Sewri and Navi Mumbai) is commissioned by MMRDA, expansion of Amra Marg (NH 348A -west of NMIA site) and NH4B bypass (NH 548 east of NMIA site) by MJPRCL is completed construction of North Road and road to the south of the NMIA project by CIDCO is under implementation.
	xx.	The measures should be taken to improve public transportation including dedicated road / MRTS corridors to access to Airport, may also be considered for the same. Energy Efficient dedicated rail based public transport facility; suburban/ metro train in particular, may be created between the Santa Cruz and the Navi Mumbai Airport in addition to all other links connecting various parts of Mumbai city.	**Being Complied:** It may be noted, as per CIDCO report vide Letter CIDCO/GM(ENV&F)/NMIA/2019/938 dated 11th September 2020 as submitted to MOEFCC, that CIDCO has initiated discussions with Mumbai Railway Vikas Corporation Ltd (MRVC) as well as MMRDA for planning a direct metro rail link to the airport. The Master Plan of airport envisages metro connectivity from Mumbai and Navi Mumbai to western and eastern part of airport. In continuation to above, CIDCO appointed an agency for "Preparation of Detailed Project Report (DPR) for proposed Metro Line from CSMIA-Mankhurd NMIA & (Extension of

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			CSMIA- Mankhurd Metro Line-8)," in November 2022. CIDCO is also planning to integrate Metro Line from Mankhurd to NMIA with Belapur-NMIA Line-IA (Extension of Navi Mumbai Metro Line-I Belapur-Pendhar) at Sagarsangam station. Detailed Project Report for the same is being prepared.
	xxi.	Traffic Management during construction phase should be clearly planned so that the traffic situation is not further worsened on the existing connecting roads. Installations of Noise barrier/ Green Belts should be clearly indicated in the plan (After identifying critical locations).	**Being Complied:** Construction phase traffic management plan has been prepared with entry/ exit scheme and queue length for NMIA construction vehicles. Also, necessary parking space has been created within the NMIA site so that public space is not occupied for parking of construction vehicles. During the construction phase, vehicles associated with NMIA construction activities are scheduled to operate on external roads during non-peak hours. This approach will help reduce traffic congestion and maintain the desired Level of Service on these roads. Furthermore, construction vehicles will be restricted to service roads along external routes, ensuring that through traffic remains undisturbed. Additionally, the airport boundary wall constructed will serve as an effective noise barrier for external roads.
	xxii.	To avoid accidental damage (fire, hazardous material waste handling, oil spills, wastewater disposal) in the adjacent ecologically fragile surroundings and mangrove area – a risk assessment plan and disaster management plan should be prepared and with periodic compliance of safety measures in place to avoid loss due accidental	**Agreed to Comply:** Since project is yet to be operational, we assure to abide by the condition. Risk Assessment and Disaster Management Plan shall be prepared to avoid accidental damage in the adjacent ecologically fragile surroundings and mangrove area.

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		damage that could have been otherwise avoided. Further CIDCO shall appoint a dedicated professional team/cell to handle disaster and associated risks.	Disaster Management Plan will be updated periodically. EPC contractors have prepared risk assessment and disaster management plan under the terms of the EPC contract for construction phase, implementation of which is supervised by the safety team of NMIA.
	xxiii.	In addition to the above – CIDCO shall ensure that all the risks (such as fire, hazardous material waste handling, oil spills, waste – both liquid/solid wastes) associated/ resultant risk during various stages of development (like planning, construction, operation) are managed within the airport area. In case of any unforeseen event as stated above the liability – environmental and social will rest with the developer/ CIDCO, the decision of the high-level Committee, stipulated below will be full and final for liability fixations.	**Agreed to Comply:** Since project is yet to be operational, we assure to abide by the condition. However, we assure that action will be taken as per condition (xxii) cited above.
	xxiv.	The compliance report of the monitoring committee shall be made 'public' (put online and/or also displayed for wider dissemination of compliance) at all stages (planning, construction, operation) to ensure effective monitoring and compliance of conditions.	**Agreed to Comply:** The NMIA project is periodically monitored by Hon. Chief Minister, Government of Maharashtra. Periodic review meetings and site visits are conducted by the Hon. CM and the Hon. Union Minister, Ministry of Civil Aviation, Government of India. Additionally, the Secretary, MoCA, DGCA and Chairman AAI are also regularly monitoring the NMIA project. In view of these multiple periodic project reviews, this condition may be considered as complied. Also, the environmental compliance along with the monitoring data are being uploaded to the company website.
	xxv.	Environment Management Plan or associated monitoring plan shall	**Complied**

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		ensure that mitigation measures detailed out in terms of role, responsibility, budgetary provisions, timeline for completion, frequency of monitoring and compliance etc.	Detailed Construction and Operation phase EMP and monitoring plan with budgetary allocation have been dealt with in EIA report September 2021 which was submitted to MOEF&CC. Further, we assure you to abide by the condition.
	xxvi.	In order to meet all the essential aeronautical requirements and the further airport expansions, no property development shall be undertaken within the proposed aeronautical Airport Zone area (1160 ha).	**Agreed to Comply** This condition is not relevant in current context, as NMIAL has included all future airport expansions in the Final Phase Master Plan of NMIA considering all future aeronautical requirements, up to ultimate airport capacity of 90 MPPA. CIDCO has approved NMIA Master Plan Layout Plan for this eventual capacity of NMIA.
	xxvii.	The Master plan/ Development plan of Navi Mumbai shall be revised and recasted in view of the airport development to avoid and unplanned haphazard growth around the airport. The land use should take care of bird menace including that from the Mangrove Parks.	**Complied:** It may be noted, as per CIDCO report vide Letter CIDCO/GM(ENV&F)/NMIA/2019/938 dated 11th September 2020, as submitted to MOEFCC, that: 1.The Navi Mumbai Development Plan has been revised vide Govt. Order No. TPS-1711/2495/C.R. 202/11/UD-12 vide dtd. 21st March, 2012 & copy was submitted. 2., GoM has issued notification dated 10th January, 2013, declaring the area around proposed International Airport as "Navi Mumbai Airport Influence Notified Area" (NAINA) and appointed CIDCO as the Special Planning Authority to avoid haphazard development around the airport. Copy of NAINA Notification was also submitted to R.O. MOEFCC, Nagpur. 3. BNHS is conducting decadal avifauna study in NMIA region.

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			BNHS submitted Mid Term Report 2018-2023 for Long-term bird monitoring programme of Navi Mumbai International Airport (NMIA) Area and its Surroundings during Construction and Operational Phases. Copy of this Report is attached as **Annexure 3.**
	xxviii.	All other nearby villages, if not required to be relocated should be provided with best possible infrastructure so that they compare well with the adjoining ultra-modern airport infrastructure.	**Complied:** It may be noted, as per CIDCO report vide Letter CIDCO/GM(ENV&F)/NMIA/2019/938 dated 11th September 2020, as submitted to MOEFCC, that all the nearby villages are being provided physical and social infrastructure under Gaothan expansion scheme & Grant in Aid scheme is implemented to develop social infrastructure in nearby villages for improvement of social infrastructure like water supply, sanitation, providing sewerage system, roads etc.
	xxix.	CRZ provisions shall be applicable on the tidally influenced diverted channels of Ulwe and Gadhi Rivers and CIDCO shall finalize the Airport plans accordingly.	**Agreed to Comply:** CRZ clearance has been obtained by NMIAL along with EC-2021 wherein, NMIA boundary has been clearly demarcated. All developmental activities of the project are within this boundary. CIDCO has obtained requisite CRZ clearance for off-site infrastructure such as north boundary road, bridges of eastern side, etc. wherever road component touches tidal influence area of the rivers. Master Plan was prepared for NMIA development is in strict compliance with the applicable CRZ provisions and requirement for compliance in this regard has been incorporated appropriately into the Concessionaire Agreement with NMIAL. Further, it

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			shall be monitored by Environment Cell.
	xxx.	Any cutting or filling up the airport site will create significant turbidity problem. CIDCO shall examine the impact on the marine life. The details will be put up on the website every 3 months.	**Complied:** Turbidity during pre-construction and construction period is tested and analyzed regularly through MOEF & CC recognized laboratory appointed to carry out quarterly environmental monitoring at pre-defined locations in surface waters around the airport. The quarterly monitoring of turbidity is being carried out. Environmental analytical reports for the reporting period are attached as **Annexure 2**
	xxxi.	CIDCO shall conduct the baseline survey of avian fauna before the start of construction and the details shall be put up every 3 months on the website in association with BNHS.	**Being Complied**: BNHS was appointed by CIDCO to do the Base Line Survey of Avian Fauna between 2012 to 2016. Quarterly reports of BNHS are available on CIDCO website in public domain. CIDCO has also signed a long-term MOU (ten-year period ending 2028) with BNHS. Aim of this decadal study is long term monitoring, conservation, and supervision of the terrestrial and water birds with reference to NMIA and associated regions and implementation of Bird Threat Mitigation Plan. BNHS submitted Mid Term Report 2018-2023 for Long-term bird monitoring programme of Navi Mumbai International Airport (NMIA) Area and its Surroundings during Construction and Operational Phases. Copy of this Report is attached as **Annexure 3.**
	xxxii.	The Environmental Clearance / CRZ Clearance is recommended below is only for the Navi Mumbai Airport	**Complied:** CIDCO has sought separate approvals for associated infrastructure of

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		project. CIDCO shall obtain the Environmental and CRZ clearance separately for off airport facilities and other off infrastructure projects after finalizing the locations and details as may be required under the EIA Notification 2006 and the CRZ Notification.	airport. The status of various clearances is as below: • The CRZ clearance for off-site physical infrastructure of roads, bridges and interchanges has been granted by MCZMA vide letter dated 15th February 2016 which was due for expiry in Feb 2023. Extension of 3 years up to 12 Feb 2026 has been obtained by CIDCO. • CRZ clearance for Shifting of EHVT lines has been granted by MOEF vide letter no. F.No.11-38/2016-Ia.III dated 28th August 2017. The work of shifting of EHVT lines has been completed. • Forest Clearance Stage I & II for shifting of EHVT Lines was received vide letter dt. 02.08.18; and 31.03.2022 respectively The Bombay High Court permitted CIDCO to clear Mangroves for the rerouting of EHVT lines for development of NMIA vide its Order dt. 19th December 2013 in WP no 22362 OF 2019. The work of shifting of EHVT lines has been completed.
	xxxiii.	Taking a cue from the man-made 26/11 incident arising out of external threat to our country, a strategic airport safety and security plan covering also surrounding inhabited areas of the airport shall be prepared and put in place in consultation with appropriate government departments	**Agreed to Comply:** The Bureau of Civil Aviation Security (Ministry of Civil Aviation) guidelines will be followed. Further, regular coordination with Navi Mumbai Police for Coastal security and internal risks. NMIAL has received BCAS approval for NMIA Master Plan and all projects of Phase I & II.
	xxxiv.	A high level advisory and monitoring committee which should include international experts of repute, reporting directly to the highest Airport Management Authority shall be constituted by CIDCO to plan, execute and maintain the	**Agreed to Comply:** The NMIA project is periodically monitored by Hon. Chief Minister, Government of Maharashtra. Periodic review meetings and site visits are conducted by the Hon. CM and the

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		environmental issues / recommendations mentioned above. The monitoring shall be done at various stages (planning, construction, operation) of project for compliance of conditions. Budgetary provisions shall be made to the satisfaction of this Committee. The committee meet at least once in three months and the decisions taken in the meetings shall be put up on the web site for public information.	Hon. Union Minister, Ministry of Civil Aviation, Government of India. Additionally, the Secretary, MoCA, DGCA and Chairman AAI are also regularly monitoring the NMIA project. CIDCO has engaged international consultant "AECOM Asia Company Ltd." as an Independent Engineer (IE) for monitoring and supervision of NMIA development. NMIAL has also engaged various international experts for planning, design, supervision, and operation of NMIA. Thus, conditions may be considered as complied and no separate meeting is required.
	xxxv.	Regular modeling study of air, noise shall be carried out due to the increase in traffic.	**Complied**: Air and noise modelling was carried out during EIA study. Monthly monitoring of ambient air and noise levels is being continued by NMIAL and reports are being submitted along with six monthly compliance reports **Annexure 2** Modeling study of air and noise will be carried out again after the project goes operational.
	xxxvi.	The solid waste shall be properly collected, segregated and disposed as per the provision of Solid Waste (Management and Handling) Rules, 2000.	**Being Complied**: At present, during construction phase, compliance with solid waste management has been included as a responsibility of EPC contractors. NMIAL's environment team monitors the compliance on regular basis.
	xxxvii.	Provision shall be made for the housing of construction labour within the site with all necessary infrastructure and facilities such as fuel for cooking, mobile toilets, mobile STP, safe drinking water, medical health care, crèche etc. The housing may be in the form of	**Being complied**: EPC Contractor has provided labour housing facilities as per BoCW Act and corresponding Rules and as per requirements of CA and EC.

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		temporary structures to be removed after the completion of the project.	
	xviii.	A First Aid Room will be provided in the project both during construction and operation of the project.	**Being Complied**: First aid facilities have been provided at site offices of various contractors as also in labour colony. In addition, EPC contract mandates contractor to maintain an ambulance and have tie up with local Hospitals to ensure that in case of emergency necessary medical facilities will be available. Safety team of NMIAL regularly monitors safety compliance of the contractor.
	xxix.	Disposal of muck during construction phase should not create any adverse effect on the neighboring communities and be disposed taking the necessary precautions for general safety and health aspects of people, only in approved sites with the approval of competent authority.	**Being Complied**: C&D waste is being disposed of as a filler material at a designated place within the NMIA site. No muck is taken out of NMIA site during the ongoing Phase I & II (20 MPPA) construction for disposal.
	xl.	Soil and ground water samples will be tested to ascertain that there is no threat to ground water quality by leaching of heavy metals and other toxic contaminants.	**Complied:** Soil & ground water quality monitoring during pre-development work was being carried out by CIDCO through MOEFCC recognized Lab and regular reports have been submitted to MOEFCC along with six monthly compliance reports. NMIAL has continued the monitoring for Air & noise (9 stations) and Ground water sampling (up to 5 locations) on monthly basis. Marine/ Surface water (10 stations), & soil sampling (5 locations) on quarterly basis. Environmental analytical reports for the reporting period are enclosed as **Annexure 2**
	xli.	Construction spoils, including bituminous material and other	**Being Complied**:

Sr. No		Stipulated Condition-2010	Compliance status
		hazardous materials, must not be allowed to contaminate watercourses and the dump sites for such material must be secured so that they should not leach into the ground water.	Inert construction spoils are collected and deposited at a designated area within the site as a filler material. Bituminous waste is collected given to Hot Mix Plant for recycling. No material is allowed to contaminate surface water or ground water.
	xlii.	Installation and operation of DG set shall comply with the guidelines of CPCB.	**Being complied**: DG installed on site as per complying with the CPCB guidelines.
	xliii.	The diesel generator sets to be used during construction phase should be low sulphur diesel type and should conform to Environment (Protection) Rules prescribed for air and noise emission standards.	**Being Complied**: Tender condition stipulates that the EPC contract should use DG set only in case of power failure and fuel used in DG sets should be low sulphur quality.
	xliv.	The diesel required for operating DG sets shall be stored in underground tanks and if required, clearance from Chief Controller of Explosives shall be taken.	**Being Complied**: During the operation phase, 30 KL of diesel is stored in underground tanks located near the DDS area. PESO approval for the underground storage tanks has been obtained.
	xlv.	Vehicles hired for bringing construction material to the site should be in good condition and should have a pollution check certificate and should conform to applicable air and noise emission standards and should be operated only during non-peak hours.	**Being Complied**: We assure MOEFCC that this condition is being complied. PUC certificate of each vehicle and its condition is checked by respective contractors while entering the NMIA project site for validity and emission standards.
	xlvi.	Ambient noise levels should conform to residential standards both during day and night. Incremental pollution loads on the ambient air and noise quality should be closely monitored during construction phase. Adequate measures should be made to reduce ambient air and noise level	**Being Complied:** Noise making construction activities such as drilling are being carried out only during Day time between 7 AM and 6 PM. Following measures are being taken to reduce load on Ambient Noise & Air: The noise generating activities are being carried out only

Sr. No		Stipulated Condition-2010	Compliance status
		during construction phase, so as to conform to the stipulated standards by CPCB/ MPCB.	during daytime. Separate Entry & Exit for the construction vehicles has been provided. Construction vehicles are mostly within site and do not exit project site. However, vehicles if any, entering or exiting site, for that separate exit & entry have been provided.
	xlvii.	Fly ash should be used as building material in the construction as per the provisions of Fly Ash Notification of September, 1999 and amended as on 27th August, 2003.	**Being Complied**: Fly ash has been considered in the concrete mix design and is being used during construction. EPC contractors have been asked to maintain record for use of fly ash.
	xlviii.	Ready mixed concrete must be used in building construction.	**Being complied**: Ready mixed concrete is being used in building construction.
	xlix.	Storm water control and its re-use as per CGWB and BIS standards for various applications.	**Being Complied:** Storm water drains are provided with the silt pond before discharge. At construction stage, storm water is not being reused. During operations phase, water from Rainwater Harvesting Pond will be used for landscape development. .
	l	Water demand during construction should be reduced by use of pre-mixed concrete, curing agents other best practices referred.	**Being complied**: We assure MOEFCC to abide by the condition during construction phase. Curing agents have been included in the tender specifications for all grades of concrete.
	li	Use of glass may be reduced by upto 40% to reduce the electricity consumption and load on air-	**Being Complied:** Passenger terminal building is being designed as per ASHARE standards

Sr. No		Stipulated Condition-2010	Compliance status
		conditioning. If necessary, use high quality double glass with special reflective coating in windows.	and other airport buildings have been designed in accordance with ECBC standards to make them more energy efficient.
	lii	The approval of the competent authority shall be obtained for structural safety of the buildings due to earthquake, adequacy of firefighting equipment, etc. as per National Building Code including protection measures from lightening etc.	**Being Complied**: Requisite fire NoC and structural stability certification/ approval is being obtained for buildings to be constructed in the Airport.
	liii	Regular supervision of the above and other measures for monitoring should be in place all through the construction phase, so as to avoid disturbance to the surroundings.	**Being Complied:** Various functional teams of NMIAL including Environment team continuously supervise EPC contractor's work for quality as well as compliance.
II.	**Operation Phase: -** Project is under construction, the condition pertaining to operation phase will be implemented.		
	i	Diesel power generating sets proposed as source of backup power for elevators and common area illumination during operation phase should be of enclosed type and conform to rules made under the Environment (Protection) Act, 1986. The height of stack of DG sets should be equal to the height needed for the combined capacity of all proposed DG sets. Use of low sulphur diesel. The location of the DG sets may be decided with in consultation with Maharashtra Pollution Control Board.	**Agreed to Comply**: PP has provided DG sets for the construction and operational phase. PP assured that the DG sets will be operated only during power failure. Location of DG sets will be in utility blocks and plan showing utility block locations is submitted to MPCB at the time of grant of CTE.
	ii	Noise should be controlled to ensure that it does not exceed the prescribed standards. During night time the noise levels measured at the boundary of the building shall be restricted to the permissible levels to	**Agreed to Comply**: Noted and shall be adhered during operation phase.

Sr. No		Stipulated Condition-2010	Compliance status
		comply with the prevalent regulations.	
	iii	The green belt of the adequate width and density preferably with local species along the periphery of the plot shall be raised so as to provide protection against particulates and noise.	**Agreed to Comply**: Since first phase of project is under implementation and project is yet to be operational, we assure to abide by the condition. Green belt/ vegetation along periphery of the airport shall be developed at locations outside NMIA which are in compliance to operational safety requirement of airport. However, green area/open area amounting to approx. 33% of NMIA site area has been planned.
	iv	Weep holes in the compound walls shall be provided to ensure natural drainage of rainwater in the catchment area during the monsoon period.	**Being complied**: Drainage plan of the site is such that the rainwater will get accumulated in the drains and not along compound wall.
	v	Rainwater harvesting for roof run-off and surface run- off, should be implemented. Before recharging the surface run off, pre-treatment must be done to remove suspended matter, oil and grease. The borewell for rainwater recharging should be kept at least 5 mts. above the highest ground water table.	**Being Complied:** This condition will be complied during construction stage – it is proposed to have rainwater harvesting ponds to the Northwest, southwest (Kund) and airside (total capacity 1,14,979 cum) and the harvested rainwater will be used for landscaping purpose. In addition, shallow water bodies are also planned along main airport access road which shall be as water retention tanks and landscape water bodies.
	vi	The ground water level and its quality should be monitored regularly in consultation with Central Ground Water Authority.	**Complied:** Monitoring of ground water level and its quality around the project site have been carried out by CIDCO and reports were submitted along with Six monthly compliance report to MOEFCC. NMIAL has continued monitoring for Air & noise (9 stations) and Ground water sampling (up to 5 locations) on

Sr. No		Stipulated Condition-2010	Compliance status
			monthly basis. Marine/ Surface water (10 stations), & soil sampling (5 locations) on quarterly basis. Environmental analytical reports for the reporting period are enclosed herewith as **Annexure 2**
	vii	Traffic congestion near the entry and exit points from the roads adjoining the proposed project site must be avoided. Parking should be fully internalized and no public space should be utilized.	**Agreed to Comply**: In terms of Phase I & II (20 MPPA) operational point of view, necessary parking provisions made at Central Terminal Complex (at Underground parking), Taxi Staging area, Bus Terminal, and CTC Bus Terminal.
	viii	Energy conservation measures like installation of CFLs/TFLs for the lighting the areas outside the building should be integral part of the project design and should be in place before project commissioning. Use CFLs and TFLs should be properly collected and disposed off/sent for recycling as per the prevailing guidelines/ rules of the regulatory authority to avoid mercury contamination. Use of solar panels may be done to the extent possible.	**Agreed to Comply**: Noted and shall be adhered during operation phase.
	ix	Efforts should be made to use solar energy to the maximum extent possible.	**Noted:** Shall be adhered to during Operations stage. Terminal building including all other building shall have solar PV panels installed on the roof. Additional panels will be installed along the side of runway.
III. General Conditions:			
i.		In the event of any change in the project profile a fresh reference shall be made to the Ministry of Environment and Forests.	**Agreed to Comply**: We will abide by the condition.
ii.		This Ministry reserves the right to revoke this clearance, if any, of the	**Noted.**

Sr. No	Stipulated Condition-2010	Compliance status
	conditions stipulated are not complied with to the satisfaction of this Ministry.	
iii.	This Ministry or any other competent authority may stipulate any additional conditions subsequently, if deemed necessary, for environmental protection, which shall be complied with.	**Noted.**
iv.	Full support should be extended to the officers of this Ministry's Regional Office at Bhopal and the offices of the Central and State Pollution Control Board by the project proponents during their inspection for monitoring purposes, by furnishing full details and action plans including the action taken reports in respect of mitigative measures and other environmental protection activities.	**Complied:** Full support was extended to the officers of Environment Ministry's Regional Office during visit and assured to render the same as & when required.
8	These stipulations would be enforced among others under the provisions of water (Prevention and Control of Pollution) Act, 1974 the Air (Prevention and Control of Pollution) Act 1981, the Environment (Protection) Act, 1986, the Public Liability (Insurance) Act, 1991 and Municipal Solid Wastes (Management and Handling) Rules, 2000 including the amendments and rules made thereafter.	**Noted.**
9	All other statutory clearances such as the approvals for storage of diesel from Chief Controller of Explosives, Fire Department and Civil Aviation Department from height point of view, Forest Conservation Act, 1980 and Wildlife (Protection) Act, 1972 etc. shall be obtained, as applicable by project proponents from the respective competent authorities.	**Complied:** All the necessary approvals required for the project have been obtained and copies have been submitted to I.R.O, MOEFCC, Nagpur. NMIAL shall abide by the condition.

Sr. No	Stipulated Condition-2010	Compliance status
10	The project proponent should advertise in at least two local Newspapers widely circulated in the region, one of which shall be in the vernacular language informing that the project has been accorded CRZ Clearance and copies of clearance letters are available with the State Pollution Control Board and may also be seen on the website of the Ministry of Environment and Forests at http://www.envfor.nic.in. The advertisement should be made within 10 days from the date of receipt of the Clearance letter and a copy of the same should be forwarded to the Regional office of this Ministry at Bhopal.	**Complied:** Public was informed about the grant of EC by advertisement in newspaper DNA, Mumbai on 30th Nov 2010 and Lokmat (Marathi) on 30th Nov 2010 and copies of Newspaper cutting were submitted to MOEFCC.
11	Environmental Clearance is subject to final order of the Hon'ble Supreme Court of India in the matter of Goa Foundation Vs. Union of India in Writ Petition (Civil) No.460 of 2004, if applicable to this project.	**Noted.**
12	A copy of the clearance letter shall be sent by the proponent to concerned Panchayat, Zilla Parisad / Municipal Corporation, Urban Local Body and the Local NGO, if any, from whom suggestions/ representations, if any, were received while processing the proposal. The clearance letter shall also be put on the website of the company by the proponent.	**Complied:** CIDCO had submitted status as "Complied" in the earlier compliance report.
13	The proponent shall upload the status of compliance of the stipulated EC conditions, including results of monitored data on their website and shall update the same periodically. It shall simultaneously be sent to the Regional Office of MoEF, the respective Zonal Office of CPCB and the SPCB. The criteria	**Complied:** CIDCO has been submitting six monthly compliance reports regularly. All EC related compliance reports are uploaded on the CIDCO website at the following link: https://cidco.maharashtra.gov.in/navi_mumbai_airport# under Pre-

Sr. No	Stipulated Condition-2010	Compliance status
	pollutant levels namely; SPM, RSPM, SO_2, NOx (ambient levels as well as stack emissions) or critical sectoral parameters, indicated for the project shall be monitored and displayed at a convenient location near the main gate of the company in the public domain.	Development tab as submitted by CIDCO. MoEF&CC approved Transfer of Environment & CRZ Clearance from CIDCO to NMIAL in 2020. , Since then, NMIAL has uploaded all documents pertaining to EC compliance on NMIA website at the following link. https://www.nmiairport.co.in/circulars
14	The project proponent shall also submit six monthly reports on the status of compliance of the stipulated EC conditions including results of monitored data (both in hard copies as well as by e-mail) to the respective Regional Office of MoEF, the respective Zonal Office of CPCB and the SPCB.	**Complied:** Same as mentioned above in General Condition 13.
15	The environmental statement for each financial year ending 31st March in Form-V as is mandated to be submitted by the project proponent to the concerned State Pollution Control Board as prescribed under the Environment (Protection) Rules, 1986, as amended subsequently, shall also be put on the website of the company along with the status of compliance of EC conditions and shall also be sent to the respective Regional Offices of MoEF by e-mail.	**Agreed to Comply**: Will be submitted in Operation Phase of project.

Compliance to additional conditions stipulated by MOEFCC while granting Extension of Validity for Environmental and CRZ Clearance to NMIA Project vide letter dated 20th Dec 2017.

No.	Stipulated Condition- Extension Validity for EC -2017	Compliance status
i	Certified report on sources and availability of water from the local body supplying water along with the permission received by them for the shall be submitted. This report shall specify the total annual water availability with the organization (local Body), the quantity of water already committed to other development projects, the quantity of water committed for this project and the balance water available for distribution. This should be specified separately for ground water and surface water sources and ensure that there is no impact on other uses.	**Complied:** CIDCO has submitted water Adequacy Report as a part of Compliance report for the period of Jan- June 2018 vide letter no. CIDCO/ GM (ENV & F)/NMIA/2018/184 dated 21st Sept. 2018. NMIAL has ensured that water requirement for the project is much lower (22 MLD at 60 MPPA) than that envisaged at the time of 2017 CEIA studies by CIDCO (41 MLD at 60 MPPA).
ii	Detailed traffic management and traffic decongestion plan, to ensure that the current level of service of the roads within a 5 kms radius of the project site is maintained and improved upon, shall be drawn up through an organization of repute and specializing in Transportation Planning within next 6 months. This should be based on the cumulative impact of all development and increased inhabitation being carried out by the project or other agencies in this 5 kms radius from the site under different scenarios of space and time and shall be implemented to the satisfaction of State Urban Development and Transports Departments with the consent of all the concerned implementing agencies.	**Complied:** CIDCO, the nodal agency for Navi Mumbai International Airport has prepared "Detailed Traffic Management and Traffic Decongestion Plan for Navi Mumbai International Airport (NMIA)" in April 2020 which ensure that the current level of service of the roads within a 05 km radius of the project is maintained and improved upon after the implementation of the project. CIDCO has submitted final report for "Detailed Traffic Management and Traffic Decongestion Plan for Navi Mumbai International Airport (NMIA)" to MOEF vide letter No. CIDCO/GM(ENV&F)/NMIA/2020 /491 dated 14th July 2020. As per the report, various connectivity requirements are under implementation by CIDCO along with various Authorities..
iii	Treated effluents shall also be used for irrigation and Roadside plantation after	**Agreed to Comply**: We assure to abide by the

No.	Stipulated Condition- Extension Validity for EC -2017	Compliance status
	taking due permissions from the concerned authorities/Forest department.	condition.
iv	Project proponent shall satisfactorily address all the complaints that have been received against the project and submit a compliance report to the Ministry.	**Agreed to Comply:** Compliance was submitted to MOEF vide letter No. CIDCO/ GM (ENV & F)/NMIA/2017/1017 dated 2nd November 2017. We assure to abide by the condition.
v	The extension of validity is being granted for the original proposal for which Environmental and CRZ Clearance was granted earlier. The Project proponents will not make any changes in the project nature, structure and configuration and limit themselves to activities for which the Environmental and CRZ Clearance has been given earlier.	**Agreed to Comply:** The approval of MoEF&CC for Transfer of EC from CIDCO to NMIAL has been obtained vide letter No. F. No. 10-53/2009-IA-III dated 17th August 2020. NMIAL had applied to MOEFCC for grant of fresh EC & CRZ clearance. Validity of existing EC was extended up to 21st Nov 2021 in reference to MOEFCC's Notification dated 18th Jan 2021. Fresh EC and CRZ Clearance for on-going project was granted on 28.11.2021 (No. 21-60/2021-IA-III) and issued on 1st Dec 2021.

MAHARASHTRA POLLUTION CONTROL BOARD

Tel: 24010706/24010437
Fax: 24023516
Website: http://mpcb.gov.in
Email: cac-cell@mpcb.gov.in

Kalpataru Point, 2nd and 4th floor, Opp. Cine Planet Cinema, Near Sion Circle, Sion (E), Mumbai-400022

RED/L.S.I (R23)
No:- Format1.0/CAC/UAN No.MPCB-CONSENT-0000128221/CE/2206000673

Date: 15/06/2022

To,
Navi Mumbai International Airport Pvt. Ltd.,
Villages Vadghar (Chinchpada), Kopar, Pargaon (Kohli), Pargaon-Dungi, Owale (Upper and Lower Owale + Waghivali Wada), Ulwe (Ulwe + Ganeshpuri), Targhar (Targhar + Kombadbhuje), Waghivali-Khar, Tal. Panvel, Dist. Raigad.

लोकसेवा हक्क कायदा
Right to Public Service Act
Your Service is Our Duty

Sub: Grant consent to establish for revised construction built up area, under RED category.

Ref:
1. Previous Environment & CRZ Clearance accorded vide dated 22.11.2010.
2. Previous Consent to Establish granted by Board vide dated 05.10.2021.
3. Revalidation of Environment & CRZ Clearance accorded vide dated 20.12.2017 which is transferred vide dated 17.08.2020.
4. Revalidation of Environment & CRZ Clearance accorded vide 28.11.2021
5. Minutes of 3rd CAC meeting held on 24.05.2022.

Your application No.MPCB-CONSENT-0000128221 Dated 23.12.2021

For: grant of Consent to Establish under Section 25 of the Water (Prevention & Control of Pollution) Act, 1974 & under Section 21 of the Air (Prevention & Control of Pollution) Act, 1981 and Authorization under Rule 6 of the Hazardous & Other Wastes (Management & Transboundary Movement) Rules 2016 is considered and the consent is hereby granted subject to the following terms and conditions and as detailed in the schedule I, II, III & IV annexed to this order:

1. **The consent to establish is granted for a period up to 05/10/2026**
2. **The capital investment of the project is Rs.19647 Crs. (As per undertaking submitted by pp Existing - 16250 + Expansion - 3397. Total CI - 19647)**
3. Construction of Airport of Phase-I & II with passenger capacity of 20 MPPA and cargo capacity of 0.57 MTPA., on total plot area of 1,16,00,000 Sq. Mtr., i.e. 1160 Ha & Construction BUA 6,27,335.678 Sq. mtr., for land development of Terminal Building, Terminal Hotel, Reserved housing & Apartments for staff of AAI, CISF Barracks, Control Tower ATC Building, South runway (3.7 Kms), Air Cargo Building, access roads, associated apron, taxi way, parking area, MLCP, Fuel Farm, area. Drainage system, Airport maintenance hangers, Compound wall, Security fence & Utilities such as power supply, water supply & sanitation STP, Solid waste management facility.

4. **Conditions under Water (P&CP), 1974 Act for discharge of effluent:**

Sr No	Description	Permitted (in CMD)	Standards to	Disposal Path
1.	Trade effluent	400	As per Schedule-I	The overflow of ETP outlet will be further treated in STP
2.	Domestic effluent	4210	As per Schedule-I	60% Recycle for secondary purposes & remaining on land for gardening

5. **Conditions under Air (P& CP) Act, 1981 for air emissions:**

Sr No.	Stack No.	Description of stack / source	Number of Stack	Standards to be achieved
1	S-1 to S-2	DG Set (14 x 880 KVA)- 12,320 KVA	2	As per Schedule -II

6. **Non-Hazardous Wastes:**

Sr No	Type of Waste	Quantity	UoM	Treatment	Disposal
1	Food Waste & Garbage from Terminal & PTB	7.671	Ton/D	Bio-gas plant for Bio-gas generation followed by composting facility	The waste generated from Biogas will be used as manure
2	Waste from Flight Catering Facilities	2.192	Ton/D	Bio-gas plant for Bio-gas generation followed by composting facility	The waste generated from Biogas will be used as manure
3	Cargo Handling Waste	5.000	Ton/D	Segregation	Sale to authorized vendor for further treatment & disposal
4	Waste from Aircraft Maintenance	3.557	Ton/D	Segregation	Sale to authorized vendor for further treatment & disposal
5	Waste from GSE Workshop	0.356	Ton/D	Segregation	Sale to authorized vendor for further treatment & disposal
6	STP Sludge	3.335	Ton/D	Drying	Used as manure for gardening
7	Other Solid Waste	5.750	Ton/D	Segregation	Sale to authorized vendor for further treatment & disposal

7. **Conditions under Hazardous & Other Wastes (M & T M) Rules 2016 for treatment and disposal of hazardous waste:**

Sr No	Category No./ Type	Quantity	UoM	Treatment	Disposal
1	5.1 Used or spent oil	10	Ton/Y	Recycle	Sale to authorised party
2	3.3 Sludge and filters contaminated with oil	2	Ton/Y	Incineration	CHWTSDF
3	5.2 Wastes or residues containing oil	310	Ton/D	Incineration	CHWTSDF
4	21.1 Process wastes, residues and sludges	47	Ton/Y	Recycle	CHWTSDF
5	33.1 Empty barrels /containers /liners contaminated with hazardous chemicals /wastes	5	Ton/Y	Recycle	CHWTSDF

8. **Conditions under Batteries (Management & Handling) Rules, 2001:**

Sr No	Type of Waste	Quantity	UoM	Disposal Path
1	Battery Waste	10.00	Ton/Y	Authorized Re-processer.

Specific Conditions for used Batteries:

i. The applicant shall ensure that used batteries are not disposed of in any manner other than by depositing with the authorized dealer/ manufacturer/ registered recycler/ importer/ re-conditioner or at the designated collection center.

ii. The applicant shall file half-yearly return in Form VIII to the M.P.C. Board.

iii. Bulk consumers to their user units may auction used batteries to registered recyclers only.

9. **Conditions under E-Waste Management:**

Sr No	Type of Waste	Quantity	UoM	Disposal Path
1	E-waste	25.00	Ton/Y	Authorized Re-processer.

10. **Treatment and Disposal of Biomedical Waste generated to CBMWTSDF:**

Sr.No	Category	Type of Waste	Quantity not to exceed (Kg/M)	Segregation Color coding	Treatment & Disposal
1	Yellow	a) Soiled Waste	500.00	Yellow colored non-chlorinated plastic bags or containers	CBMWTSDF

11. The Board reserves the right to review, amend, suspend, revoke this consent and the same shall be binding on the industry.

12. This consent should not be construed as exemption from obtaining necessary NOC/ permission from any other Government authorities.

13. PP shall comply with the conditions stipulated in EC/CRZ clearance & consent.

14. PP shall provided STP of adequate capacity to achieve the consented parameter BOD - 10 mg/l.

15. PP shall provide separate treatment facility for the treatment of wastewater generated from the aircraft maintenance hangers including for the contaminated surface runoff from the airport area containing oils, grease, etc.
16. The treated effluent shall be 60% recycled for secondary purposes such as toilet flushing, air conditioning, cooling tower makeup, firefighting, etc., and remaining shall be utilized on land for gardening with water metering system.
17. PP shall provide organic waste digester followed by composting facility/bio-digester followed by composting facility for the treatment of biodegradable waste.
18. PP shall carryout carbon audit & submit the report.
19. PP shall submit the plan for plastic recycling before 1st Operate.
20. PP shall submit the management plan towards the disposal of cargo waste disposal.
21. PP shall submit the plan/commitment towards adoption of E-Vehicle policy.
22. PP shall submit BG of Rs. 25.0 Lakh towards compliance of EC & consent conditions.
23. PP shall comply with revalidation of Environment Clearance conditions obtained on 28.11.2021
24. This consent is issued with the overriding effect to earlier consider isssued vide No.:- Format1.0/CAC/UAN No.0000100222/CE-2110000162 dated 05.10.2021
25. This consent is issued pursuant to the decision of the 3rd Consent Appraisal Committee Meeting held on 24.05.2022.
26. The applicant shall obtain Consent to Operate from Maharashtra Pollution Control Board before actual commencement of the Unit/Activity.

Received Consent fee of -

Sr.No	Amount(Rs.)	Transaction/DR.No.	Date	Transaction Type
1	6794000.00	MPCB-DR-9776	13/01/2022	RTGS

Copy to:

1. Regional Officer, MPCB, Raigad and Sub-Regional Officer, MPCB, Raigad I
- They are directed to ensure the compliance of the consent conditions.
2. Chief Accounts Officer, MPCB,Sion, Mumbai
3. CAC Desk - for record & updation purposes.

SCHEDULE-I

Terms & conditions for compliance of Water Pollution Control:

1. A] As per your application, you have proposed to provide ETP comprising primary treatment of capacity 400 CMD to treat the effluent generated to the tune of 400 CMD. This primary treated effluent further treated in STP of combine capacity 5500 CMD.

   B] The Applicant shall operate the effluent treatment plant (ETP) to treat the trade effluent so as to achieve the following standards prescribed by the Board or under EP Act, 1986 and Rules made there under from time to time, whichever is stringent:

Sr.No	Parameters	Limiting concentration not to exceed in mg/l, except for pH
(1)	pH	6.0 -8.5
(2)	BOD (3 days 27°C)	10
(3)	COD	50
(4)	TSS	20
(5)	Oil & Grease	10
(6)	TDS	2100
(7)	Chloride	600
(8)	Sulphate	1000

   C] The treated effluent shall be 60% recycled for secondary purposes such as toilet flushing, air conditioning, cooling tower makeup, firefighting, etc., and remaining shall be discharged on land for gardening within premise after confirming above standards. In no case, effluent shall find its way outside premises.

2. A] As per your application, you have proposed to provide 2 Nos of Sewage Treatment Plants of designed capacity 4500 CMD & 1000 CMD with SBR technology for the treatment of 4210 CMD of sewage.

   B] Industry shall comply prescribed standards & disposal path as prescribed at Sr. No. 1 B & C of schedule I.

3. The Board reserves its rights to review plans, specifications or other data relating to plant setup for the treatment of waterworks for the purification there of & the system for the disposal of sewage or trade effluent or in connection with the grant of any consent conditions. The Applicant shall obtain prior consent of the Board to take steps to establish the unit or establish any treatment and disposal system or an extension or addition thereto.

4. The industry shall ensure replacement of pollution control system or its parts after expiry of its expected life as defined by manufacturer so as to ensure the compliance of standards and safety of the operation thereof.
5. The Applicant shall comply with the provisions of the Water (Prevention & Control of Pollution) Act, 1974 and as amended, by installing water meters and other provisions as contained in the said act:

Sr. No.	Purpose for water consumed	Water consumption quantity (CMD)
1.	Industrial Cooling, spraying in mine pits or boiler feed	1972.00
2.	Domestic purpose	4880.00
3.	Processing whereby water gets polluted & pollutants are easily biodegradable	430.00
4.	Processing whereby water gets polluted & pollutants are not easily biodegradable and are toxic	0.00
5.	Gardening	0

6. The Applicant shall provide Specific Water Pollution control system as per the conditions of EP Act, 1986 and rule made there under from time to time/ Environmental Clearance/ CREP guidelines.

SCHEDULE-II

Terms & conditions for compliance of Air Pollution Control:

1. As per your application, you have proposed to provide the Air pollution control (APC) system and also to erect following stack (s) to observe the following fuel pattern:

Stack No.	Source	APC System provided/proposed	Stack Height(in mtr)	Type of Fuel	Sulphur Content(in %)	Pollutant	Standard
S-1 to S-2	DG Set (14 x 880 KVA)	Stack	6.00	HSD 135 Kg/Hr	1.0	SO2	64.8 Kg/Day

2. The Applicant shall provide Specific Air Pollution control equipments as per the conditions of EP Act, 1986 and rule made there under from time to time/ Environmental Clearance / CREP guidelines.
3. The Applicant shall obtain necessary prior permission for providing additional control equipment with necessary specifications and operation thereof or alteration or replacement/alteration well before its life come to an end or erection of new pollution control equipment.
4. The Board reserves its rights to vary all or any of the condition in the consent, if due to any technological improvement or otherwise such variation (including the change of any control equipment, other in whole or in part is necessary).

SCHEDULE-III

Details of Bank Guarantees:

Sr. No.	Consent (C2E/ C2O /C2R)	Amt of BG Imposed	Submission Period	Purpose of BG	Compliance Period	Validity Date
1	C2E	Rs. 25.0 Lakh	15 days/To be extended	Towards compliance of EC & consent conditions	31.05.2026	30.11.2026

The above Bank Guarantee(s) shall be submitted by the applicant in favour of Regional Officer at the respective Regional Office within 15 days from the date of issue of Consent.

BG Forfeiture History

Srno.	Consent (C2E/C2O/C2R)	Amount of BG imposed	Submission Period	Purpose of BG	Amount of BG Forfeiture	Reason of BG Forfeiture
NA						

BG Return details

Srno.	Consent (C2E/C2O/C2R)	BG imposed	Purpose of BG	Amount of BG Returned
NA				

SCHEDULE-IV

General Conditions:

1. Consumers or bulk consumers of electrical and electronic equipment listed in Schedule I shall ensure that e-waste generated by them is channelised through collection centre or dealer of authorised producer or dismantler or recycler or through the designated take back service provider of the producer to authorised dismantler or recycler
2. Bulk consumers of electrical and electronic equipment listed in Schedule I shall maintain records of e-waste generated by them in Form-2 and make such records available for scrutiny by the concerned State Pollution Control Board
3. Consumers or bulk consumers of electrical and electronic equipment listed in Schedule I shall ensure that such end-of-life electrical and electronic equipment are not admixed with e-waste containing radioactive material as covered under the provisions of the Atomic Energy Act, 1962 (33 of 1962) and rules made there under;
4. Bulk consumers of electrical and electronic equipment listed in Schedule I shall file annual returns in Form-3, to the concerned State Pollution Control Board on or before the 30th day of June following the financial year to which that return relates. In case of the bulk consumer with multiple offices in a State, one annual return combining information from all the offices shall be filed to the concerned State Pollution Control Board on or before the 30th day of June following the financial year to which that return relates.

5. Specific Conditions for storage, Handling and Disposal of Waste from Electrical & Electronic equipment (WEEE):
   1. **Collection of WEEE** - The applicant must provide appropriate and dedicated vehicles duly identified as per the norms for transportation of Hazardous Waste. The applicant shall obtain all the required permits for transportation of WEEE from competent authority. The applicant shall ensure the safe transport of the WEEE without any spillage during transportation.

      Storage for disassembled parts: The applicant must provide appropriate storage for disassembled spare parts from WEEE. Some spare parts (e.g. motors and compressors) will contain oil and/or other fluids. Such part must be appropriately segregated and stored in containers that are secured such that oil and other fluids cannot escape from them. These containers must be stored on an area with an area with an impermeable surface and a sealed drainage system.
   2. **Storage for other components and residues:**Other components and residues arising from the treatment of WEEE will need to be contained following their removal for disposal or recovery. Where they contain hazardous substances they should be stored on impermeable surface and in appropriate containers or bays with weatherproof covering. Containers should be clearly labelled to identify their contents and must be secured so that liquids, including rain water cannot enter them. Components should be segregated having regard to their eventual destinations and the compatibility of the component types. All batteries should be handled and stored having regard to the potential fire risk associated with team.
   3. **Balances :** WEEE Guidelines also requires that sites for handling of WEEE have “balances to measure the weight of the segregated waste’. The objective is to ensure that a record of weights can be maintained of WEEE entering a facility and components and materials leaving each site (together with their destinations). The nature of the weighing equipment should be appropriate for the type and quantity of WEEE being processed.
   4. Plastic, which cannot be recycled and is hazardous in nature, is recommended to be land filled in nearby CHWTSDF.
   5. Ferrous and nonferrous metal recycling facilities fall under the purview of existing environmental regulations for air, water, noise, land and soil pollution and generation of hazardous waste and the same should be followed.
   6. CFCS should be either reused or incinerated in common hazardous waste Incineration facilities at CHWTSDF.
   7. Waste Oil should be either reused or incinerated in common hazardous waste incineration facilities.
   8. PCB's containing capacitors shall be incinerated in common hazardous waste incineration facilities at CHWTSDF.
   9. Mercury recovery and lead recycling facilities from batteries fall under the Hazardous & Other Wastes (M & TM) Rules, 2016.
   10. Existing environmental regulations for air; water; noise, land and soil pollution and generation of hazardous waste and the same should be followed. In case Mercury or lead recovery is very low, they can be temporarily stored at e-waste recycling facility and later disposed in TSDF.
   11. The industry shall maintain records of the e-waste purchased, processed in Form-2 and shall file annual returns of its activities of previous year in Form-3 as per Rules 11(9) & 13(3)(vii) of the E-Waste(M) Rules, 2016; on or before 30th day of June of every year.
6. The Energy source for lighting purpose shall preferably be LED based

7. The PP shall harvest rainwater from roof tops of the buildings and storm water drains to recharge the ground water and utilize the same for different industrial applications within the plant
8. Conditions for D.G. Set
   a) Noise from the D.G. Set should be controlled by providing an acoustic enclosure or by treating the room acoustically.
   b) Industry should provide acoustic enclosure for control of noise. The acoustic enclosure/ acoustic treatment of the room should be designed for minimum 25 dB (A) insertion loss or for meeting the ambient noise standards, whichever is on higher side. A suitable exhaust muffler with insertion loss of 25 dB (A) shall also be provided. The measurement of insertion loss will be done at different points at 0.5 meters from acoustic enclosure/room and then average.
   c) Industry should make efforts to bring down noise level due to DG set, outside industrial premises, within ambient noise requirements by proper sitting and control measures.
   d) Installation of DG Set must be strictly in compliance with recommendations of DG Set manufacturer.
   e) A proper routine and preventive maintenance procedure for DG set should be set and followed in consultation with the DG manufacturer which would help to prevent noise levels of DG set from deteriorating with use.
   f) D.G. Set shall be operated only in case of power failure.
   g) The applicant should not cause any nuisance in the surrounding area due to operation of D.G. Set.
   h) The applicant shall comply with the notification of MoEFCC, India on Environment (Protection) second Amendment Rules vide GSR 371(E) dated 17.05.2002 and its amendments regarding noise limit for generator sets run with diesel.
9. The applicant shall maintain good housekeeping.
10. The non-hazardous solid waste arising in the factory premises, sweepings, etc. be disposed of scientifically so as not to cause any nuisance / pollution. The applicant shall take necessary permissions from civic authorities for disposal of solid waste.
11. The applicant shall not change or alter the quantity, quality, the rate of discharge, temperature or the mode of the effluent/emissions or hazardous wastes or control equipments provided for without previous written permission of the Board. The industry will not carry out any activity, for which this consent has not been granted/without prior consent of the Board.
12. The industry shall ensure that fugitive emissions from the activity are controlled so as to maintain clean and safe environment in and around the factory premises.
13. The industry shall submit quarterly statement in respect of industries obligation towards consent and pollution control compliance's duly supported with documentary evidences (format can downloaded from MPCB official site).
14. The industry shall submit official e-mail address and any change will be duly informed to the MPCB.
15. The industry shall achieve the National Ambient Air Quality standards prescribed vide Government of India, Notification No. B-29016/20/90/PCI-L dated. 18.11.2009 as amended.
16. The Board reserves its rights to review plans, specifications or other data relating to plant setup for the treatment of waterworks for the purification thereof & the system for the disposal of sewage or trade effluent or in connection with the grant of any consent conditions. The Applicant shall obtain prior consent of the Board to take steps to establish the unit or establish any treatment and disposal system or an extension or addition thereto.
17. The industry shall ensure replacement of pollution control system or its parts after expiry of its expected life as defined by manufacturer so as to ensure the compliance of standards and safety of the operation thereof.
18. The PP shall provide personal protection equipment as per norms of Factory Act

19. Industry should monitor effluent quality, stack emissions and ambient air quality monthly/quarterly.
20. Whenever due to any accident or other unforeseen act or even, such emissions occur or is apprehended to occur in excess of standards laid down, such information shall be forthwith Reported to Board, concerned Police Station, office of Directorate of Health Services, Department of Explosives, Inspectorate of Factories and Local Body. In case of failure of pollution control equipments, the production process connected to it shall be stopped.
21. The applicant shall provide an alternate electric power source sufficient to operate all pollution control facilities installed to maintain compliance with the terms and conditions of the consent. In the absence, the applicant shall stop, reduce or otherwise, control production to abide by terms and conditions of this consent.
22. The industry shall recycle/reprocess/reuse/recover Hazardous Waste as per the provision contain in the Hazardous and Other Wastes (M & TM) Rules 2016, which can be recycled /processed /reused /recovered and only waste which has to be incinerated shall go to incineration and waste which can be used for land filling and cannot be recycled/reprocessed etc. should go for that purpose, in order to reduce load on incineration and landfill site/environment.
23. An inspection book shall be opened and made available to the Board's officers during their visit to the applicant.
24. Industry shall strictly comply with the Water (P&CP) Act, 1974, Air (P&CP) Act, 1981 and Environmental Protection Act, 1986 and industry specific standard under EP Rules 1986 which are available on MPCB website (www.mpcb.gov.in).
25. Separate drainage system shall be provided for collection of trade and sewage effluents. Terminal manholes shall be provided at the end of the collection system with arrangement for measuring the flow. No effluent shall be admitted in the pipes/sewers downstream of the terminal manholes. No effluent shall find its way other than in designed and provided collection system.
26. Neither storm water nor discharge from other premises shall be allowed to mix with the effluents from the factory.
27. The industry should not cause any nuisance in surrounding area.
28. The industry shall take adequate measures for control of noise levels from its own sources within the premises so as to maintain ambient air quality standard in respect of noise to less than 75 dB (A) during day time and 70 dB (A) during night time. Day time is reckoned in between 6 a.m. and 10 p.m. and night time is reckoned between 10 p.m. and 6 a.m.
29. The industry shall create the Environmental Cell by appointing an Environmental Engineer, Chemist and Agriculture expert for looking after day to day activities related to Environment and irrigation field where treated effluent is used for irrigation.
30. The applicant shall provide ports in the chimney/(s) and facilities such as ladder, platform etc. for monitoring the air emissions and the same shall be open for inspection to/and for use of the Board's Staff. The chimney(s) vents attached to various sources of emission shall be designated by numbers such as S-1, S-2, etc. and these shall be painted/ displayed to facilitate identification.
31. The industry should comply with the Hazardous and Other Wastes (M & TM) Rules, 2016 and submit the Annual Returns as per Rule 6(5) & 20(2) of Hazardous and Other Wastes (M & TM) Rules, 2016 for the preceding year April to March in Form-IV by 30th June of every year.

32. The applicant shall install a separate meter showing the consumption of energy for operation of domestic and industrial effluent treatment plants and air pollution control system. A register showing consumption of chemicals used for treatment shall be maintained.
33. The applicant shall bring minimum 33% of the available open land under green coverage/ plantation. The applicant shall submit a yearly statement by 30th September every year on available open plot area, number of trees surviving as on 31st March of the year and number of trees planted by September end.
34. The Board reserves its rights to review plans, specifications or other data relating to plant setup for the treatment of waterworks for the purification thereof & the system for the disposal of sewage or trade effluent or in connection with the grant of any consent conditions.
35. The firm shall submit to this office, the 30th day of September every year, the Environment Statement Report for the financial year ending 31st March in the prescribed FORM-V as per the provisions of Rule 14 of the Environment (Protection) (second Amendment) Rules, 1992.
36. The Applicant shall obtain necessary prior permission for providing additional control equipment with necessary specifications and operation thereof or alteration or replacement/alteration well before its life come to an end or erection of new pollution control equipment.
37. The Board reserves its rights to vary all or any of the condition in the consent, if due to any technological improvement or otherwise such variation (including the change of any control equipment, other in whole or in part is necessary).
38. The applicant shall provide facility for collection of environmental samples and samples of trade and sewage effluents, air emissions and hazardous waste to the Board staff at the terminal or designated points and shall pay to the Board for the services rendered in this behalf.

This certificate is digitally & electronically signed.

Annexure-2

ENVIRONMENTAL COMPLIANCE MONITORING REPORT
for
Navi Mumbai International Airport (NMIA)

Sponsor:

Navi Mumbai International Airport Pvt. Ltd. (NMIAL)

Period:

April 2025 to September 2025

PREPARED BY

ADITYA ENVIRONMENTAL SERVICES PVT.LTD.
MOEFCC Recognized Laboratory under EP Act 1986
Accredited under ISO 9001: 2015 & OHSAS 18001: 2007 by ICQS
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1. INTRODUCTION

Mumbai Metropolitan Region (MMR) comprises of areas in and around Mumbai city and includes parts of Mumbai, Thane and Raigad Districts in Maharashtra. Mumbai is known as the commercial capital of India and the MMR is an industrially and technologically advanced region, which has experienced rapid growth in income and employment. The increase in trading, business and financial services demands the highest order of infrastructure. There is a need for enhancement of the available capacity of the airport, as the existing airport in Mumbai is under tremendous pressure to meet the air traffic demands of this vibrant region. Realizing this need, the Government of Maharashtra conceptualized the Navi Mumbai International Airport (NMIA) project and appointed City and Industrial Development Corporation of Maharashtra Ltd. (CIDCO) as the Nodal Agency for implementation of the project.

This project was taken up on Public Private Partnership (PPP) basis, on approval of the Government of India and the Government of Maharashtra. After an open global bidding process, CIDCO issued Letter of Award dated 25th October 2017 to Mumbai International Airport Pvt Ltd (MIAL) for development of the project.

The objective of the monitoring is to understand the Ambient Air quality, Ambient Noise quality, Ground water quality, soil and marine water quality at Navi Mumbai International Airport site and nearby villages.

The focus of compliance monitoring is to assess the reporting period environmental conditions in and around the surrounding project area to check for possible impacts on environment at an early stage so that necessary actions can be initiated. The assignment comprises monitoring of following parameters:

- Ambient Air Monitoring
- Ambient Noise Level Monitoring
- Soil
- Ground/Surface Water
- Marine Water for Biological and Physicochemical Parameters
- DG Stack Monitoring

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2. SCOPE OF MONITORING WORK

2.1 Scope of Monitoring Work as per Work Order:

The scope of monitoring work as per the Work Order are as given below:

Table 2-1: Scope of Environmental Monitoring Work as per Work Order

Sr. No.	Parameters – as per Annexure B	Location	Frequency	Samples/ Year
1.	**Ambient Air Quality:** As per NAAQS standards Published by CPCB (12 Parameters)	9	9 Stations per Month	108
2.	**Noise: Parameters: Leq Noise level -** Day time & Night time separately as per CPCB norms.	10	10 Stations per Month	120
3.	**Ground Water Quality:** As per IS 10500:2012 Revised (RA 2018)	5	5 Stations per Month	60
4.	**Soil: Parameters:** pH, Texture, EC, Na, Available N, Available K, Available Phosphorus, Sulphate, Chloride, Ca, Mg, Fe, Mn, Cu, Hg, Cd, As, Pb, Zn, Al, Ni, Co, Cr, Na	8	8 Stations (Quarterly)	32
5.	**Marine/Surface Water Quality parameters:** **Physico Chemical parameters:** PH, Temperature, Turbidity, EC, Salinity (ppt), **Chemical Parameters:** DO, BOD, Magnesium, Hardness, Alkalinity, Chloride, Sulphate, Fluoride, Sodium, Potassium, Phenol, Total phosphorus, Total Nitrogen. **Heavy Metals:** Fe, Zn, Mg, Mn, Cd, Cr, Hg, Pb **Bacteriological parameters:** Coliform Colonies (MPN). **Marine Biology:** Chlorophyll, Phaeophytin, Phytoplankton, Zooplankton, Benthos, Diversity indices	10	10 stations (Quarterly)	40
6.	**DG Set Stack Monitoring**	1	1 station (Quarterly)	4

2.2 Locations of Monitoring:

Details of monitoring stations for Ambient Air Quality, Ambient Noise, Soil, Ground Water, Marine Water- physicochemical & biological showing station locations are as given below:

Table 2-2: Details of Ambient Air Quality Monitoring Stations

Station Code	Station	Remarks
A1	Owale	Residential Village
A2	Pargaon	Receptor oriented – 400 m from proposed runway
A3	Ulwe Node	Area near highway
A4	NMIA Project Site	Within project site
A5	Kille Gaothan	Receptor oriented – on main access road
A6	L&T Site Office	Within Project site
A7	Diwale Koliwada	Receptor oriented – on main access road
A8	Jui	Eastern end of NMIA, outside project site
A9	Panvel	residential zone

Figure 2-1 Ambient Air Monitoring Locations

* Ambient Air Monitoring stations can be changed on the basis of access to villages situated within NMIA project site and other locations.

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Table 2-3: Ambient Noise Level Monitoring Stations

Sr. No.	Station Name	Category of area
N1	Owale	Residential Area
N2	Pargaon	Sensitive area (Mixed category)
N3	Ulwe Node	Sensitive Area
N4	Karanjade	Residential Area
N5	NMIA Project site	Within Airport site
N6	Kille Gaothan	Receptor oriented – on main access road
N7	L&T Site Office	Within Airport site
N8	Diwale Koliwada	Receptor oriented – on main access road
N9	Jui	Eastern end, outside project site
N10	Panvel	Residential Area (Mixed category)

Figure 2-2 Noise Level Monitoring Locations

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Table 2-4: Soil Quality Monitoring Stations

Station Code	Stations Name
S1	Chinchpada
S2	Koli
S3	Kopar
S4	Ulwe
S5	NMIA project Site
S6	Kombadbhuje
S7	Pargaon
S8	Owale

Figure 2-3 Soil Sampling Locations

* Soil Sampling locations can be changed on the basis of access to villages situated within NMIA project site and other locations.

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Table 2-5: Details of Ground and Drinking Water Quality Monitoring Stations

Station Code	Month	Station Code	Month
	April, June, August		**May, July, September**
GW1	Open well at Kille Gaothan	GW I	Dugwell at Kombadbhuje (May)
GW2	Dugwell at Ulwe	GW II	Dugwell at Owale (July, September)
GW3	Dugwell at Pargaon	GW III	Open well at Dapoli (July, September)
GW4	Open well at Jui	GW IV	Open well at Chinchpada
GW5	Open well at Panvel	DW 1	NMIA Project site (July, September)
DW 1	NMIA Project site (June)		

Figure 2-4 Ground Water and Drinking Sampling Locations

*Ground water sampling locations can be changed on the basis of access to villages situated within NMIA project site and other locations.

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Table 2-6: Details of Marine Water Quality Monitoring Stations

Station Code	Station details / Location
MW1	Extreme end of Gadhi River (upstream side)
MW2	Near Chinchpada village (2 km from MW1) in Gadhi River
MW3	Near Jui Village (1.8 from MW2) in Gadhi River
MW4	At Junction of Ulwe and Gadhi Rivers in Panvel Creek
MW5	Near Vaghivali village (2 km from MW4) in Gadhi River
MW6	Near CBD Belapur (1.5 km from MW5) in Panvel Creek
MW7	Near Vaghivali Creek Junction (800 m from MW6) in Gadhi River
MW8	Near Rathi bander in Panvel Creek
MW9	Mouth of Panvel Creek
MW10	Ulwe River near Owle Village

Figure 2-5 Marine Water Sampling Locations

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Table 2-7: Details Stack Monitoring Stations

Station Code	Station details / Location
DG 1	NMIA Project site

Figure 2-6 DG Stack monitoring Location

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2.3 Period/Time of Sampling (April 2025 to September 2025):

The sampling survey was planned to be carried out as per the schedule mentioned in Table below.

Table 2-8: Period/Time of Sampling for this Survey

Month	Parameter	Sampling Stations	Dates of Sampling	Time Period
April 2025	AAQ	A1,A2,A3	14.04.2025	24 hours
		A4, A5, A6	15.04.2025	
		A7,A8,A9	16.04.2025	
	Noise Level	N1, N2, N3, N4	14.04.2025	24 hours starting from 06:00am
		N5, N6, N7	15. 04.2025	
		N8, N9, N10	16. 04.2025	
	Ground water	GW3	15.04.2025	Grab Sample
		GW1, GW2, GW4, GW5	14.04.2025	
May 2025	AAQ	A1, A2, A3	12.05.2025	24 hours
		A4, A5, A6	13. 05.2025	
		A7, A8, A9	14. 05.2025	
	Noise Level	N1, N2, N3, N4	12. 05.2025	24 hours starting from 10:00am
		N5, N7, N7	13. 05.2025	
		N8, N9, N10	14. 05.2025	
	Ground water	GWI, GW II, GW III	12. 05.2025	Grab Sample
		GWI	13.05.2025	
	DG Set	DG 1	14.05.2025	Grab Sample
June2025	AAQ	A1, A2, A3	16.06.2025	24 hours
		A4, A5, A6	17. 06.2025	
		A7, A8, A9	18. 06.2025	
	Noise Level	N1, N2, N3, N4	16. 06.2025	24 hours starting from 10:00am
		N5, N6, N7	17. 06.2025	
		N8, N9 N10	18. 06.2025	
	Ground water	GW1, GW2, GW4, GW5	16. 06.2025	Grab Sample
		GW3	17.06.2025	
	Drinking Water	DW1	17. 06.2025	
	Soil	S4, S5, S6, S7	17.06.2025	Grab Sample
		S1, S2, S3, S8		
	Marine Water	MW1, MW2, MW3, MW4, MW10	20.06.2025	Grab Sample
		MW5, MW6, MW7, MW8, MW9	21.06.2025	
July 2025	AAQ	A1, A2, A3	14.07.2025	24 hours
		A4, A5, A6	15.07.2025	
		A7, A8, A9	16.07.2025	
	Noise Level	N1, N2 ,N3, N4	14.07.2025	24 hours starting from 06:00am
		N5, N6, N7	15.07.2025	
		N8, N9, N10	16.07.2025	
	Ground Water	GWII, GWIII	14.07.2025	Grab Sample

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Month	Parameter	Sampling Stations	Dates of Sampling	Time Period
	Drinking water	DW I	16.07.2025	
August 2025	AAQ	A1, A2, A3	11.08.2025	24 hours
		A4, A5,A6	12.08.2025	
		A7, A8, A9	13.08.2025	
	Noise Level	N1, N2, N3, N10	11.08.2025	24 hours starting from 06:00am
		N4, N5, N6,N7	12.08.2025	
		N8, N9,	13.08.2025	
	DG Set Noise	DG 1	12.08.2025	
	Ground Water	GW1, GW2, GW3	11.08.2025	Grab Sample
		GW4, GW5	13.08.2025	
	DG Set	DG 1	13.08.2025	Grab Sample
September 2025	AAQ	A1, A2, A3	15.09.2025	24 hours
		A4, A5, A6	16.09.2025	
		A7, A8, A9	17.09.2025	
	Noise Level	N1, N2, N3,	15.09.2025	24 hours starting from 06:00am
		N5, N6	16.09.2025	
		N4, N7, N8, N9, N10	17.09.2025	
	Ground Water	GWII, GWIII	15.092025	Grab Sample
	Drinking water	DW1	16.09.2025	
	Soil	S1, S2, S4, S8	16.09.2025	Grabe Sample
		S3, S5, S6, S7	17.09.2025	
	Marine Water	MW4,MW5, MW6, MW7, MW8, MW9	18.09.2025	Grab sample
		MW1, MW2, MW3, MW10	20.09.2025	

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3. METHODOLOGY ADOPTED FOR ENVIRONMENTAL MONITORING

3.1 AMBIENT AIR QUALITY

3.1.1 Reconnaissance Survey:

Reconnaissance survey in study area (10 km around proposed airport site) shows that sources of air pollution include the following:

- Airport land development work and predevelopment work
- Heavy traffic along Amara Marg, NH4/4B and Uran / JNPT Road
- Construction activity in Ulwe node and nearby areas
- Industries in Panvel (private), MIDC Taloja (6 km NE of site) & MIDC TTC (4 km N of site)
- Burning of poor-quality fuels in villages to the south of proposed site (Airport)

In order to arrest the deterioration in air quality, Govt. of India has enacted Air (Prevention and Control of Pollution) Act in 1981. The responsibility has been further emphasized under the Environment (Protection) Act, 1986. The National Ambient Air Quality Standards (NAAQS) have been published by CPCB in November 2009 giving methods for measurement.

3.1.2 Methodology for Ambient Air Quality Monitoring:

To monitor Air Pollutants in Ambient air following method of analysis adopted.

Table 3-1 Technique and Methods Adopted for Analysis of AAQ Parameters

S N	Parameter	Technique	Method of Analysis
1.	PM_{10}	Respirable Dust Sampler (Gravimetric Method)	IS 5182 (Part 23) RA2022
2.	$PM_{2.5}$	Fine Respirable Dust (Gravimetric Method)	IS 5182 (Part 24) RA2024
3.	SO_2	Modified West and Gaeke Method	IS 5182 (Part 2/Sec 1) 2023
4.	NO_X	Jacob & Hochheiser Method	IS 5182 (Part 6) RA2022
5.	NH_3	Indophenol Blue method	IS 5182 (part 25) RA 2023
6.	CO	Gas Chromatography Method	IS 5182 (part 10) RA2019
7.	Ozone	Spectrophotometric method	IS 5182 (part 09) RA2019
8.	Benzene[C_6H_6]	Gas Chromatography	IS 5182 (part 11) RA2022
9.	Benzopyrene	Solvent extraction followed by GC	IS 5182 (part 12) 2019
10.	Lead	ICPOES after sampling EPM filter Paper	CPCB Manual Volume I: 2013
11.	Arsenic [As]		APHA Air method 822-3rdEd
12.	Nickel [Ni]		CPCB Manual Volume I: 2013

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Figure 3-1 Ambient Air Quality Monitoring

3.1.3 Selection of air sampling location

Selection of representative location is very important. The following precautions have been taken while installing AAQM stations:

- It is away from source & other interferences
- Samplers are installed at free flowing well mixed area (3 m) above ground level
- Only Calibrated Air Samplers are used
- The samples are transported to the laboratory at the earliest for further analysis
- Gaseous samples were preserved in cold box before taking them to laboratory

3.2 AMBIENT NOISE LEVEL

3.2.1 Reconnaissance Survey:

Reconnaissance survey in study area (10 km around proposed airport site) shows that sources of air pollution include the following:

- Airport land development work and predevelopment works
- Heavy traffic along Amara Marg, NH4/4B and Uran / JNPT Road
- Construction activity in Ulwe node and nearby areas
- Industries in Panvel (private), MIDC Taloja (6km NE of site) & MIDC TTC (4 km N of site)

Noise pollution in urban areas is now being recognized as a major environmental issue around the world. With increasing awareness of the adverse impacts of noise on human health, more and more people are becoming less tolerant to environmental noise. The objective of this exercise is to assess the baseline status within study area and to compare the noise levels with Ambient Noise Standards as prescribed under Environmental Protection Act, 1986.

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3.2.2 Methodology for Sample Collection

Center C-390 Sound level Meter with data logger

Integrated Sound Level Meter C390 was used for undertaking the surveys and installed on tripods at the selected locations over a 24-hour period. This Meter is then taken to the laboratory where the data collected is downloaded onto PC using specialized software. Noise is measured in decibel (dB) and 'A' weighting is used for this entire monitoring since in this method of frequency weighting, the signal generated reproduces the way the human ear responds to a range of acoustic frequencies. Leq: The equivalent continuous Sound Pressure Level for a particular duration. The Day-Night Equivalent Sound Level refers to average sound exposure over a 24- hour period. Leq day & night values are calculated from hourly Leq values, with the Leq values for the nighttime increased by 10 dB to reflect the greater disturbance potential from nighttime noises.

Figure 3-2 Ambient Noise level Monitoring

3.3 Soil

The purpose of soil testing is to identify contamination of soil due to land development works and the soil fertility from a viewpoint of use for landscape development.

3.3.1 Reconnaissance Survey:

The southern side of the study area is rural in character and large tracts are being cultivated as paddy fields. Soil is also seen plentifully at the bottom of hills where it supports large vegetation. However, the northern portion of study area is mostly urban in character since it has seen largescale development being part of Navi Mumbai.

3.3.2 Methodology of Sample Collection:

Soil samples are collected after removing top two inches – which may contain high amount of organic carbon and humus. The soil area and volume could be a large field, a small garden, or simply the root zone of a single tree or shrub. The most difficult step in soil testing is accurately representing the desired area of soil. When the sampling area is determined, a sufficient number of soil cores taken to acquire a representative sample. This is generally 10 to 20 cores. The depth of sample for surface soils was taken from 0 to 6 inches or as deep as the primary tillage.

Soil samples collected from proposed project stations by using stainless steel soil sampling probe, packed in labeled polythene bags & send for analyze the physicochemical characteristics. The sample so collected is then made representative by coning- quartering and then stored in plastic bags, sealed and then sent to laboratory for analysis.

Figure 3-3 Soil Sample Collection

3.4 GROUND WATER SAMPLING

3.4.1 Reconnaissance Survey:

Villages to the south of the airport site use ground water from open/bore well for drinking and other domestic purposes. Ground water gets contaminated due to bad sanitary habits such as washing of utensils, cattle and bathing and location of septic tanks near the open wells.

3.4.2 Methodology of Sampling:

Ground water samples are collected by using containers and the sampling container is rinsed before using them for storing water samples. Ground water samples are stored in two separate containers for Physicochemical & Microbiological analysis and preservatives added as recommended by Standard Methods APHA, stored in cold storage box and transferred to the laboratory for further analysis.

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Figure 3-4 Ground Water Sampling

3.5 MARINE WATER, SEDIMENTS & PLANKTON SAMPLING EQUIPMENTS

3.5 1 Reconnaissance Survey:

The site for the project is located in four different micro water sheds – viz Panvel creek, Gadhi river, Kasardi river, Ulwe river. The study area represents complex hydrodynamic systems. The Ulwe river flows down through the mountains (to the south) towards the centre of project site and has been diverted/retrained as part of the project. The Gadhi River flows from the East to the West and is partly retrained towards the northern part of the site. The river Gadhi receives sewage from Panvel town and nearby areas. Both the rivers drain into the Panvel creek flowing adjacent to the North of site which drains into the Arabian sea to the west. The Panvel creek also receives treated effluents from CETP at MIDC Taloja and sewage from NMMC STPs in Nerul.

3.5.2 Methodology of Sampling:

3.5.2.1 Niskin Bottle - Marine Water Sampler

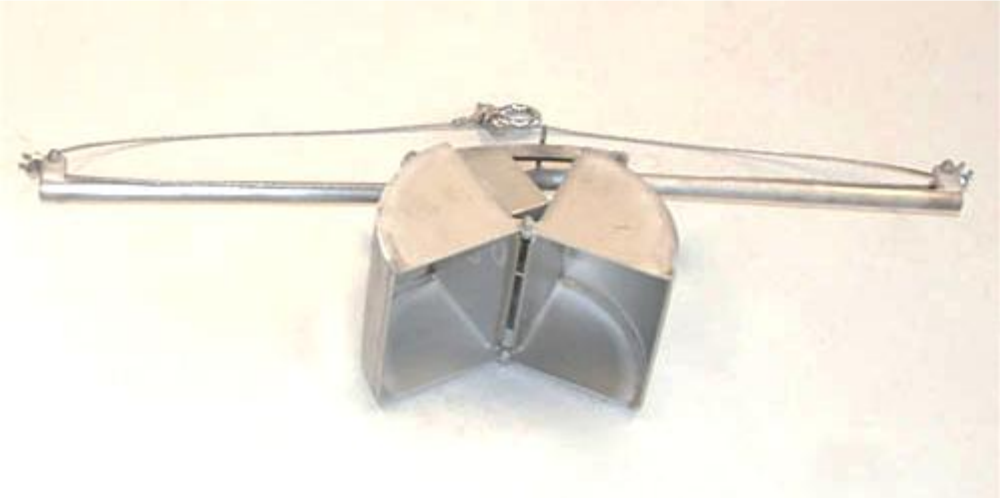
This Water Sampler is used to collect samples at various water depths and can operate at any depth on a cable or line with a messenger.

3.5.2.2 Plankton Net - Biological Samples

This plankton net operates a cable or lined by hand or behind a boat, it can be towed vertically or horizontally. Nets comes in varieties of size (Mesh no 00 equal an aperture of 0.30 inches)

3.5.2.3 Grab Sampler - For Marine Sediments

Sediment grab operates at any depth on a cable or line by free fall (without a messenger). It is extremely heavy and can take samples of the hardest rocky ocean bottoms.



Grab Sampler

3.5.2.4 Selection of Stations, Preservation and Transportation of Samples:

Marine water samples were collected from sampling locations in Gadhi river, Ulwe river and Panvel creek at the locations indicated by NMIAL – in all, 10 samples were collected from 10 sampling locations for physicochemical and biological samples (Stations 1 to 4 are in Gadhi River & Station 5 & 8 are Panvel creek while station 9 Mouth of Panvel creek and Station 10 in Ulwe river. A good amount of mangrove vegetation was noted on either side of stream 2, 3, 4 and 7. Sampling locations were approached by boats (wherever possible) and collection done irrespective of tide. Sampling was done only for surface water. The samples were preserved and taken to the laboratory using a vehicle on the same day.

3.6 Laboratory Credentials

Sampling and analysis were done by the laboratory of Aditya Environmental Services Pvt Ltd located at Plot P-1, MIDC Commercial plots, Mohopada, Tal Panvel, Dist. Raigad.

- Environmental Laboratory is recognized by Ministry of Environment & Forest (MoEFCC), Govt. of India under Environment (Protection) Act, 1986.
- Laboratory is also certified ISO 9001:2015 and OHSAS 18001:2007.
- Laboratory is accredited under ISO/IEC 17025:2005 (vide Certificate No. TC-7085) for water, wastewater and soil parameters.
- Environmental sampling conducted by our experienced, qualified environmental staff & Analysis and reporting by approved Government Analyst.
- Instruments used for sampling are from reputed manufacturers & are regularly calibrated.
- Chemicals used are Analytical Reagent grade and from reputed manufacturer.
- Analytical Instrumentation used in the laboratory is regularly calibrated.
- Laboratory has a regular program of Preventive & Annual Maintenance for all critical equipment.
- Ground Water, Soil Analysis - using APHA, BIS, ASTM & CPCB standards Methods for water Analysis.
- Standard Methods Adopted in the laboratory are those prescribed by APHA, BIS, ASTM & CPCB for water, waste & marine water analysis using methods as per NIO (National Institute of Oceanography) Manual.
- Laboratory has CRMs (Certified Reference Material) for heavy metals from reputed manufacturers for heavy metals and Standard Sea water which we use for analysis.
- Laboratory is regularly participating in Proficiency testing with reputed Organizations like Central Pollution Control Board (CPCB), Goa State Pollution Control Board and others as also Intra laboratory QC testing to check performance of our chemists.
- Overall approach & methodology is with Annexure IA Scope of the work & the Best practices as per prevailing norms of Central Pollution Board /Ministry of Environment & Forest etc. /Internationally adopted practices.

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4. COMPILATION OF DATA & INFERENCE

4.1 Ambient air quality monitoring report

4.1.1 AAQM Data

Ambient Air Quality was monitored at various locations for relevant parameters as per NAAQS standards published by CPCB in November 2009. Data is compiled and presented below:

Table 4-1: Ambient Air Quality monitoring at various stations during April 2025

Sampling Locations	Owale Village	Pargaon	Ulwe Node	NMIA Project Site	Kille Gavthan	L&T Office	Diwale Koliwada	Panvel	Jui Village	Limit #	Unit
Sampling Date	**14.04.2025**			**15.04.2025**			**16.04.2025**				
SO_2	29.9	26.8	33.0	29.9	23.7	27.8	24.7	30.9	27.8	80*	µg/m³
NO_X	42.2	35.3	45.7	39.4	39.4	41.5	38.8	43.6	40.8	80*	µg/m³
PM_{10}	87.2	80.6	92.6	89.5	82.3	81.4	84.7	93.4	90.5	100*	µg/m³
$PM_{2.5}$	38.7	29.1	35.4	26.6	28.7	30.4	31.6	36.2	32.9	60*	µg/m³
Ozone (O_3)	20.6	18.2	18.5	21.4	17.4	19.4	18.2	22.0	19.4	180**	µg/m³
Lead (Pb)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	1***	µg/m³
CO	0.65	0.62	0.68	0.74	0.59	0.79	0.71	0.78	0.70	4**	mg/m³
Benzene (C_6H_6)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	8***	µg/m³
Benzopyrene	BDL (DL-0.5)	BDL (DL-0.5)	BDL(DL-0.5)	BDL(DL-0.5)	BDL(DL-0.5)	BDL(DL-0.5)	BDL (DL-0.5)	BDL (DL-0.5)	BDL(DL-0.5)	1***	ng/m³
Arsenic (As)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	8***	ng/m³
Nickel (Ni)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	20***	ng/m³
NH_3	26.0	24.1	28.3	26.0	23.0	22.6	22.6	27.5	25.3	400*	µg/m³

BDL–Below Detectable Limit (Note # Limits as per National Ambient Air Quality Standards NAAQS,2009)

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[*] 24 hour monitoring value; [**] 1 hour monitoring value; [***] Annual monitoring value

Results

Particulate Matter (PM_{10}): Maximum value of PM_{10} is observed at Panvel (AAQ-9) as 93.4 µg /m³ with minimum value observed at Pargoan (AAQ-2) as 80.6 µg /m³ in April 2025.

Particulate Matter ($PM_{2.5}$): Maximum value of $PM_{2.5}$ is observed at Panvel (AAQ-9) as 36.2 µg /m³ with minimum value observed at NMIA Project office (AAQ-4) as 26.6 µg /m³ in April 2025

Sulphur Dioxide (SO_2): Maximum value of SO_2 is observed at Ulwe Node (AAQ-3) as 33.0µg /m³ with minimum value observed at Kille Gavthan (AAQ-5) as 23.7 µg /m³ in April 2025

Oxides of Nitrogen (NO_X): Maximum value of NO_2 is observed at Ulwe Node (AAQ-3) as 45.7 µg /m³ with minimum value observed at Pargoan (AAQ-2) as 35.3 µg /m³ in April 2025

Carbon Monoxide (CO): Maximum value for CO is observed at L&T Site office (AAQ-6) as 0.79 mg/m³ with minimum value observed at Kille Gavthan (AAQ-5) as 0.59 mg/m³ in April 2025

Ozone (O_3): Maximum value for O_3 is observed at Panvel (AAQ-9) as 22.0 µg /m³ with minimum value observed at Kille Gavthan (AAQ-5) as 17.4 µg /m³ in April 2025.

Ammonia (NH_3): Maximum value for NH_3 is observed at Ulwe Node (AAQ-3) as 28.3 µg /m³ with minimum value observed at L&T site office (AAQ-5) as 22.6 µg /m³ in April 2025.

All above parameters are observed to be following permissible limits as per NAAQ Standards in April 2025. Also, parameters such as Lead (Pb), Arsenic (As), Nickel (Ni), Benzo(a)Pyrene (BaP) and Benzene (C_6H_6) were found to be within the prescribed limits in April 2025.

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Table 4-2: Ambient Air Quality monitoring at various stations during May 2025

Sampling Locations	Owale	Pargaon High School	Ulwe Node	NMIA Project site	Kill Gavthan	L & T Site Office	Diwale Koliwada	Panvel	Jui Village	Limit #	Unit
Sampling Date	**12.05.2025**			**13.05.2025**			**14.05.2025**				
SO_2	25.8	22.7	29.9	25.8	23.7	27.8	26.8	28.9	24.7	80*	µg/m³
NO_X	38.4	30.4	41.0	40.4	34.4	43.0	42.2	40.4	37.7	80*	µg/m³
PM_{10}	84.7	82.6	87.5	83.7	79.0	90.3	81.2	91.6	86.4	100*	µg/m³
$PM_{2.5}$	38.7	30.4	35.8	29.1	24.5	36.6	25.4	34.5	31.2	60*	µg/m³
Ozone (O_3)	19.7	17.1	16.8	18.8	15.6	20.3	18.5	20.0	16.2	180**	µg/m³
Lead (Pb)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	1***	µg/m³
CO	0.59	0.66	0.62	0.72	0.51	0.68	0.68	0.7	0.59	4**	mg/m³
Benzene (C_6H_6)	BDL (DL-0.2)	BDL (DL-0.2)	BDL (DL-0.2)	BDL (DL-0.2)	BDL(DL-0.2)	BDL (DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	8***	µg/m³
Benzopyrene	BDL (DL-0.5)	BDL (DL-0.5)	BDL (DL-0.5)	BDL (DL-0.5)	BDL (DL-0.5)	BDL(DL-0.5)	BDL(DL-0.5)	BDL(DL-0.5)	BDL(DL-0.5)	1***	ng/m³
Arsenic (As)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	8***	ng/m³
Nickel (Ni)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	20***	ng/m³
NH_3	23.7	22.0	27.1	27.1	21.6	24.3	25.0	26.7	23.3	400*	µg/m³

BDL–Below Detectable Limit (Note # Limits as per National Ambient Air Quality Standards NAAQS,2009)
[*] 24 hour monitoring value; [**] 1 hour monitoring value; [***] Annual monitoring value

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Results:

Particulate Matter (PM_{10}): Maximum value of PM_{10} is observed at Panvel (AAQ-9) as 91.6 µg /m³ with minimum value observed at Kille Gavthan (AAQ-5) as 79.0 µg /m³ in May 2025.

Particulate Matter ($PM_{2.5}$): Maximum value of $PM_{2.5}$ is observed at Owale (AAQ-1) as 38.7 µg /m³ with minimum value observed at Kille Gavthan (AAQ-5) as 24.5 µg /m³ in May 2025.

Sulphur Dioxide (SO_2): Maximum value of SO_2 is observed at Ulwe node (AAQ-3) as 29.9 µg /m³ with minimum value observed at Pargaon (AAQ-2) as 22.7 µg /m³ in May 2025.

Oxides of Nitrogen (NO_X): Maximum value of NO_2 is observed at L&T Site Office (AAQ-6) as 43.0 µg /m³ with minimum value observed at Pargaon (AAQ-2) as 30.4µg /m³ in May 2025.

Carbon Monoxide (CO): Maximum value for CO is observed at NMIA Project office (AAQ-4) as 0.72 mg/m³ with minimum value observed at Kille Gavthan (AAQ-5) as 0.51mg/m³ in May 2025.

Ozone (O_3): Maximum value for O_3 is observed at L&T Site Office (AAQ-6) as 20.3 µg /m³ with minimum value observed at Kille Gavthan (AAQ-5) as 15.6 µg /m³ in May 2025.

Ammonia (NH_3): Maximum value for NH_3 is observed at Ulwe Node (AAQ-3) & NMIA Project office (AAQ-4) as 27.1 µg /m³ with minimum value observed at Kille Gavthan (AAQ-5) as 21.6 µg /m³ in May 2025.

All above parameters are observed to be following permissible limits as per NAAQ Standards in May 2025. Also, parameters such as Lead (Pb), Arsenic (As), Nickel (Ni), Benzo(a)Pyrene (BaP) and Benzene (C_6H_6) were found to be within the prescribed limits in May 2025.

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Table 4-3: Ambient Air Quality monitoring at various stations during June 2025

Sampling Locations	Owale Village	Pargaon	Ulwe Node	NMIA Project site	Kille Gaothan	L & T Site Office	Diwale Koliwada	Panvel	Jui	Limit #	Unit
Sampling Date	**16.06.2025**			**17. 06.2025**			**18.06.2025**				
SO_2	17.5	20.6	19.6	23.7	22.7	21.6	18.5	19.6	17.5	80*	µg/m³
NO_X	29.4	31.6	34.6	38.2	33.1	35.3	32.4	30.1	26.5	80*	µg/m³
PM_{10}	57.8	66.3	61.2	69.5	67.3	71.4	54.0	59.1	53.6	100*	µg/m³
$PM_{2.5}$	20.4	21.6	22.5	25.8	26.2	24.1	21.2	23.3	19.5	60*	µg/m³
Ozone (O_3)	12.7	13.6	14.2	16.2	17.1	15.3	12.4	13.3	11.9	180**	µg/m³
Lead (Pb)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	1***	µg/m³
CO	0.44	0.49	0.52	0.59	0.47	0.55	0.43	0.50	0.56	4**	mg/m³
Benzene (C_6H_6)	BDL (DL-0.2)	BDL (DL-0.2)	BDL (DL-0.2)	BDL (DL-0.2)	BDL (DL-0.2)	BDL (DL-0.2)	BDL (DL-0.2)	BDL (DL-0.2)	BDL (DL-0.2)	8***	µg/m³
Benzopyrene	BDL (DL-0.5)	BDL (DL-0.5)	BDL (DL-0.5)	BDL (DL-0.5)	BDL (DL-0.5)	BDL (DL-0.5)	BDL (DL-0.5)	BDL (DL-0.5)	BDL (DL-0.5)	1***	ng/m³
Arsenic (As)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	8***	ng/m³
Nickel (Ni)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	20***	ng/m³
NH_3	21.2	18.2	24.6	22.0	23.7	20.7	19.5	21.6	20.7	400*	µg/m³

BDL–Below Detectable Limit (Note # Limits as per National Ambient Air Quality Standards NAAQS,2009)
[*] 24 hour monitoring value; [**] 1 hour monitoring value; [***] Annual monitoring value

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Results:

Particulate Matter (PM_{10}): Maximum value of PM_{10} is observed at L&T Site Office (AAQ-6) as 71.4 µg /m^3 with minimum value observed at Jui (AAQ-8) as 53.6 µg /m^3 in June 2025.

Particulate Matter ($PM_{2.5}$): Maximum value of $PM_{2.5}$ is observed at Kille Gavthan (AAQ-5) as 26.2 µg /m^3 with minimum value observed at Jui (AAQ-8) as 19.5 µg /m^3 in June 2025.

Sulphur Dioxide (SO_2): Maximum value of SO_2 is observed at NMIA Project Office (AAQ-4) as 23.7 µg /m^3 with minimum value observed at Owale (AAQ-1) & Jui (AAQ-8) as 17.5 µg /m^3 in June 2025.

Oxides of Nitrogen (NO_X): Maximum value of NO_2 is observed at NMIA Project Office (AAQ-4) as 38.2 µg /m^3 with minimum value observed at Jui (AAQ-8) as 26.5 µg /m^3 in June 2025.

Carbon Monoxide (CO): Maximum value for CO is observed at NMIA Project office (AAQ-4) as 0.59 mg/m^3 with minimum value observed at Diwale Koliwada (AAQ-7) as 0.43mg/m^3 in June 2025.

Ozone (O_3): Maximum value for O_3 is observed at Kille Gavthan (AAQ-5) as 17.1 µg /m^3 with minimum value observed at Jui (AAQ-8) as 11.9 µg /m^3 in June 2025.

Ammonia (NH_3): Maximum value for NH_3 is observed at Ulwe Node (AAQ-3) as 24.6 µg /m^3 with minimum value observed at Pargaon (AAQ-2) as 18.2 µg /m^3 in June 2025.

All above parameters are observed to be following permissible limits as per NAAQ Standards in June 2025.

Also, parameters such as Lead (Pb), Arsenic (As), Nickel (Ni), Benzo(a)Pyrene (BaP) and Benzene (C_6H_6) were found to be within the prescribed limits in June 2025.

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Table 4-4: Ambient Air Quality monitoring at various stations during July 2025

Sampling Locations	Owale Village	Pargaon	Ulwe Node	NMIA project site	Kille Gaothan	L & T Site office	Diwale Koliwada	Panvel	Jui	Limit #	Unit
Sampling Date	**14.07.2025**			**15. 07.2025**			**16. 07.2025**				
SO_2	19.4	17.4	16.3	14.3	14.3	18.4	16.3	15.3	13.3	80*	µg/m³
NO_X	30.1	26.5	25.7	26.5	26.5	31.6	29.4	26.5	25.7	80*	µg/m³
PM_{10}	55.7	51.4	46.2	56.9	56.9	69.4	57.8	58.4	46.8	100*	µg/m³
$PM_{2.5}$	17.0	19.5	15.8	16.2	16.2	26.2	24.5	18.7	24.5	60*	µg/m³
Ozone (O_3)	12.0	10.6	13.1	10.9	10.9	13.6	11.4	11.7	12.2	180**	µg/m³
Lead (Pb)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	1***	µg/m³
CO	0.41	0.45	0.48	0.43	0.43	0.54	0.45	0.47	0.51	4**	mg/m³
Benzene (C_6H_6)	BDL (DL-0.2)	BDL (DL-0.2)	BDL (DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL (DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	8***	µg/m³
Benzopyrene	BDL (DL-0.5)	BDL (DL-0.5)	BDL (DL-0.5)	BDL(DL-0.5)	BDL(DL-0.5)	BDL(DL-0.5)	BDL (DL-0.5)	BDL (DL-0.5)	BDL(DL-0.5)	1***	ng/m³
Arsenic (As)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	8***	ng/m³
Nickel (Ni)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	20***	ng/m³
NH_3	20.3	21.5	23.1	18.3	18.3	19.1	20.3	17.9	18.7	400*	µg/m³

BDL–Below Detectable Limit (Note # Limits as per National Ambient Air Quality Standards NAAQS,2009)

[*] 24 hour monitoring value; [**] 1 hour monitoring value; [***] Annual monitoring value

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Checked By:
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Results

Particulate Matter (PM_{10}): Maximum value of PM_{10} is observed at L&T site office (AAQ-6) as 69.4 µg /m³ with minimum value observed at Ulwe Node (AAQ-3) as 46.2 µg /m³ in July 2025.

Particulate Matter ($PM_{2.5}$): Maximum value of $PM_{2.5}$ is observed at L&T site office (AAQ-6) as 26.2 µg /m³ with minimum value observed at Ulwe Node (AAQ-3) as 15.8 µg /m³ in July 2025.

Sulphur Dioxide (SO_2): Maximum value of SO_2 is observed at Owale (AAQ-1) as 19.4µg /m³ with minimum value observed at Jui (AAQ-9) as 13.3 µg /m³ in July 2025.

Oxides of Nitrogen (NO_X): Maximum value of SO_2 is observed at L&T site office (AAQ-6) as 31.6 µg /m³ with minimum value observed at Ulwe Node (AAQ-3) & Jui (AAQ-9) as 25.7µg /m³ in July 2025.

Carbon Monoxide (CO): Maximum value for CO is observed at L&T site office (AAQ-6) as 0.54 mg/m³ with minimum value observed at Owale (AAQ-1) as 0.41mg/m³ in July 2025.

Ozone (O_3): Maximum value for O_3 is observed at L&T site office (AAQ-6) as 13.6 µg /m³ with minimum value observed at Pargoan (AAQ-2) as 10.3 µg /m³ in July 2025.

Ammonia (NH_3): Maximum value for NH_3 is observed at Ulwe Node (AAQ-3) as 23.1 µg /m³ with minimum value observed at Panvel (AAQ-9) as 17.9 µg /m³ in July 2025.

All above parameters are observed to be following permissible limits as per NAAQ Standards in July 2025.

Also, parameters such as Lead (Pb), Arsenic (As), Nickel (Ni), Benzo(a)Pyrene (BaP) and Benzene (C_6H_6) were found to be within the prescribed limits in July 2025.

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.Table 4-5: Ambient Air Quality monitoring at various stations during August 2025

Sampling Locations	Owale Village	Pargaon	Ulwe Node	NMIA Project site	Kille Gaothan	L & T Site Office	Diwale Koliwada	Panvel	Jui	Limit #	Unit
Sampling Date	**11. 08. 2025**			**12. 08. 2025**			**13.08.2025**				
SO_2	19.4	16.3	21.5	20.4	13.3	17.4	13.3	15.3	17.4	80*	µg/m³
NO_X	32.4	26.5	34.6	33.1	21.3	29.4	24.3	28.7	29.4	80*	µg/m³
PM_{10}	46.6	54.7	57.4	61.3	46.3	54.6	49	47.1	55.3	100*	µg/m³
$PM_{2.5}$	18.3	22	20.4	23.7	12.5	19.1	15.4	13.7	19.5	60*	µg/m³
Ozone (O_3)	11.1	14.2	15.2	16.3	11.7	15.2	10.9	12.5	13.1	180**	µg/m³
Lead (Pb)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	1***	µg/m³
CO	0.43	0.51	0.56	0.68	0.4	0.61	0.41	0.45	0.53	4**	mg/m³
Benzene (C_6H_6)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	8***	µg/m³
Benzopyrene	BDL (DL-0.5)	BDL(DL-0.5)	BDL(DL-0.5)	BDL(DL-0.5)	BDL(DL-0.5)	BDL(DL-0.5)	BDL(DL-0.5)	BDL(DL-0.5)	BDL (DL-0.5)	1***	ng/m³
Arsenic (As)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	8***	ng/m³
Nickel (Ni)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	20***	ng/m³
NH_3	21.5	24.3	26.3	25.9	21.1	23.9	22.3	20.7	25.1	400*	µg/m³

BDL–Below Detectable Limit (Note # Limits as per National Ambient Air Quality Standards NAAQS,2009)

[*] 24 hour monitoring value; [**] 1 hour monitoring value; [***] Annual monitoring value

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Results:

Particulate Matter (PM_{10}): Maximum value of PM_{10} is observed at NMIA Project Site (AAQ-4) as 61.30 µg /m³ with minimum value observed at Kille Gavthan (AAQ-5) as 46.30 µg /m³ in August 2025.

Particulate Matter ($PM_{2.5}$): Maximum value of $PM_{2.5}$ is observed at NMIA Project Site (AAQ-4) as 23.70 µg /m³ with minimum value observed at Kille Gavthan (AAQ-5) as 12.50 µg /m³ in August 2025.

Sulphur Dioxide (SO_2): Maximum value of SO_2 is observed at Ulwe node (AAQ-3) as 21.50µg /m³ with minimum value observed at Kille Gavthan (AAQ-5) as 13.30 µg /m³ in August 2025.

Oxides of Nitrogen (NO_X): Maximum value of SO_2 is observed at Ulwe node (AAQ-3) as 34.60 µg /m³ with minimum value observed at Kille Gavthan (AAQ-5) as 21.30µg /m³ in August 2025.

Carbon Monoxide (CO): Maximum value for CO is observed at NMIA Project Site (AAQ-4) as 0.68 mg/m³ with minimum value observed at Kille Gavthan (AAQ-5) as 0.40 mg/m³ in August 2025.

Ozone (O_3): Maximum value for O_3 is observed at NMIA Project Site (AAQ-4) as 16.30 µg /m³ with minimum value observed at Diwale Koliwada (AAQ-7) as 10.90 µg /m³ in August 2025.

Ammonia (NH_3): Maximum value for NH_3 is observed at Ulwe Node (AAQ-3) as 26.30 µg /m³ with minimum value observed at Panvel (AAQ-9) as 20.70 µg /m³ in August 2025.

All above parameters are observed to be following permissible limits as per NAAQ Standards in August 2025.

Also, parameters such as Lead (Pb), Arsenic (As), Nickel (Ni), Benzo(a)Pyrene (BaP) and Benzene (C_6H_6) were found to be within the prescribed limits in August 2025.

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Table 4-6: Ambient Air Quality monitoring at various stations during September 2025

Sampling Locations	Owale Village	Pargaon	Ulwe Node	NMIA Project site	Kille Gavthan	L & T Site Office	Diwale Koliwada	Panvel	Jui	Limit #	Unit
Sampling Date	**15.09.2025**			**16.09.2025**			**17.09.2025**				
SO_2	16.3	12.3	18.4	17.4	14.3	15.3	13.3	19.4	16.3	80*	µg/m³
NO_X	25.0	22.8	28.7	31.6	24.3	26.5	23.5	29.4	25.7	80*	µg/m³
PM_{10}	41.5	49.3	50.1	56.5	51.2	47.7	55.6	58.4	53.3	100*	µg/m³
$PM_{2.5}$	16.2	15.8	18.7	20.4	14.5	17.5	18.8	21.6	11.6	60*	µg/m³
Ozone (O_3)	11.7	10.6	24.8	12.2	13.6	10.9	11.4	14.2	12.0	180**	µg/m³
Lead (Pb)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	1*	µg/m³
CO	0.42	0.48	0.43	0.60	0.42	0.55	0.45	0.49	0.50	4**	mg/m³
Benzene (C_6H_6)	BDL (DL-0.2)	BDL (DL-0.2)	BDL (DL-0.2)	BDL (DL-0.2)	BDL (DL-0.2)	BDL (DL-0.2)	BDL (DL-0.2)	BDL (DL-0.2)	BDL(DL-0.2)	5***	µg/m³
Benzopyrene	BDL (DL-0.5)	BDL (DL-0.5)	BDL (DL-0.5)	BDL (DL-0.5)	BDL (DL-0.5)	BDL (DL-0.5)	BDL (DL-0.5)	BDL (DL-0.5)	BDL(DL-0.5)	1***	ng/m³
Arsenic (As)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	6***	ng/m³
Nickel (Ni)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	BDL(DL-0.2)	20***	ng/m³
NH_3	23.8	21.9	24.8	25.8	23.3	22.9	21.4	24.3	22.4	400*	µg/m³

BDL–Below Detectable Limit (Note # Limits as per National Ambient Air Quality Standards NAAQS,2009)

[*] 24 hour monitoring value; [**] 1 hour monitoring value; [***] Annual monitoring value

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Results:

Particulate Matter (PM_{10}): Maximum value of PM_{10} is observed at Panvel (AAQ-9) as 58.4 µg /m³ with minimum value observed at Owale (AAQ-1) as 41.5 µg /m³ in September 2025.

Particulate Matter ($PM_{2.5}$): Maximum value of $PM_{2.5}$ is observed at Panvel (AAQ-9) as 21.6 µg /m³ with minimum value observed at Jui (AAQ-8) as 11.6 µg /m³ in September 2025.

Sulphur Dioxide (SO_2): Maximum value of SO_2 is observed at Panvel (AAQ-9) as 19.4 µg /m³ with minimum value observed at Paragon (AAQ-2) as 12.3 µg /m³ in September 2025.

Oxides of Nitrogen (NO_X): Maximum value of NO_2 is observed at NMIA Project Office (AAQ-4) as 31.6 µg /m³ with minimum value observed at Paragon (AAQ-2) as 22.8 µg /m³ in September 2025.

Carbon Monoxide (CO): Maximum value for CO is observed at NMIA Project office (AAQ-4) as 0.60 mg/m³ with minimum value observed at Owale (AAQ-1) & Kille Gavthan (AAQ-5) as 0.42 mg/m³ in September 2025.

Ozone (O_3): Maximum value for O_3 is observed at Ulwe node (AAQ-3) as 24.8 µg /m³ with minimum value observed at Pargaon (AAQ-2) as 10.6 µg /m³ in September 2025.

Ammonia (NH_3): Maximum value for NH_3 is observed at NMIA Project office (AAQ-4) as 25.8 µg /m³ with minimum value observed at Diwale Koliwada (AAQ-7) as 21.4 µg/m³ in September 2025

All above parameters are observed to be following permissible limits as per NAAQ Standards in September 2025.

Also, parameters such as Lead (Pb), Arsenic (As), Nickel (Ni), Benzo(a)Pyrene (BaP) and Benzene (C_6H_6) were found to be within the prescribed limits in September 2025.

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4.1.2 Inference of AAQM Data

The concentration of Particulate Matter – 10 µ (PM_{10}) was observed in range of 41.5 – 93.4 µg/m^3 and level of Particulate Matter - 2.5 µ (PM 2.5) were noted ranged from 11.6 to 38.7 µg/m^3. PM10 and PM 2.5 are under limits as per NAAQ Standards. Gaseous pollutants - Nitrogen Oxide, Sulfur Dioxide, Carbon Monoxide, Ozone and Ammonia are under NAAQS norms during collection period during April 2025 to September 2025 (Refer Tables 4.1 to 4.6 above) Lead, Benzene (C_6H_6), Benzopyrene, Arsenic, Nickel were found below detectable level.

4.2 AMBIENT NOISE LEVEL MONITORING REPORT

4.2.1 Noise Level Data

Ambient Noise level was monitored over 24 hours' duration for Day and Nighttime as per Schedule - II of Environmental Protection Act 1986 for Industrial, Commercial, Residential and Sensitive Area (Refer Table 2.3).

Results of analysis are compiled below:

Table 4-7: Ambient Noise Level monitoring during April 2025 –*September* 2025

Stn Code	Sampling Location	Sampling Date	Observed Value (Leq) (dB(A))						Limiting Standard (Leq) as per EP Act Schedule II. dB(A)	
			Day Time			Nighttime				
			Max	Min	Avg	Max	Min	Avg	Day Time	Nighttime
N1	Owale	14.04.2025	56.3	48.2	54.2	43.3	42.1	43.3	55	45
N2	Pargaon		56.6	45.6	52.3	48.7	41.9	44.2	55	45
N3	Ulwe Node		66.5	51.0	53.7	44.7	42.5	43.8	55	45
N5	Karanjade	15.04.2025	56.7	45.1	51.9	45.4	42.1	44.0	55	45
N6	NMIA Project Site		57.0	52.9	54.9	54.8	52.1	53.9	75	70
N7	Kille Gavthan		58.2	51.9	54.8	45.3	42.1	43.5	55	45
N4	L&T Site Office		57.3	53.5	55.0	54.6	53.8	54.1	75	70
N8	Diwale Koliwada	16.04.2025	57.3	45.2	52.7	47.3	42.9	44.4	55	45
N9	Jui		63.3	44.3	51.2	45.3	43.4	43.5	55	45
N10	Panvel		59.8	46.6	52.1	45.4	42.9	44.0	55	45
N1	Owale	12.05.2025	54.1	47.1	51.6	43.7	41.5	41.3	55	45
N2	Pargaon		57.2	51.4	53.5	43.7	41.5	42.3	55	45
N3	Ulwe Node		56.6	44.1	53.1	45.2	41.2	42.5	55	45
N4	Karanjade		54.7	45.5	53.1	44.2	42.0	43.1	55	45
N5	NMIA Project Site	13.05.2025	61.4	53.3	56.6	55.3	52.7	53.6	75	70
N6	Kille Gavthan		55.1	43.5	51.0	45.5	41.5	43.2	55	45
N7	L&T Site Office		57.6	54.6	56.3	54.3	52.9	53.4	75	70
N8	Diwale Koliwada	14.05.2025	56	44.6	51.3	45.8	38.2	41.2	55	45

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Environmental Consultant **Aditya Environmental Services Pvt. Ltd.**

Stn Code	Sampling Location	Sampling Date	Observed Value (Leq) (dB(A))						Limiting Standard (Leq) as per EP Act Schedule II. dB(A)	
			Day Time			Nighttime				
			Max	Min	Avg	Max	Min	Avg	Day Time	Nighttime
N9	Jui		59.1	43.1	53.4	43.2	41.3	42.1	55	45
N10	Panvel		56.1	46.5	52.5	44.3	40.7	42.2	55	45
N1	Owale	16.06.2025	55.3	47.1	51.7	42.9	40.1	41.0	55	45
N2	Pargaon		57.2	51.5	53.7	42.5	41	41.9	55	45
N3	Ulwe Node		56.6	44.5	53.3	44.1	41.2	42.2	55	45
N4	Karanjade		54.9	45.2	53.3	44.1	41.3	43.0	55	45
N4	NMIA Project Site	17. 06.2025	59.7	53.4	56.3	54.8	52	53.3	75	70
N5	Kille Gavthan		55.1	43.5	50.7	45.2	41.5	42.8	55	45
N6	L&T Site Office		57.5	54.2	56.1	54	52.4	53.1	75	70
N8	Diwale Koliwada	18. 06.2025	55.4	44.6	51.1	44.8	38.8	41.6	55	45
N9	Jui		59.1	43.2	53.6	43.4	41.3	42.4	55	45
N10	Panvel		56.1	46.1	52.3	43.5	40.7	41.8	55	45
N1	Owale	14.07.2025	55.3	48.1	51.4	42.9	40.1	40.5	55	45
N2	Pargaon		55.6	52.1	53.2	42.5	41.9	41.3	55	45
N3	Ulwe Node		57.5	44.1	52.9	45.5	41.2	41.3	55	45
N4	Karanjade		54.8	45.8	52.8	44.2	42.0	41.5	55	45
N5	NMIA Project Site	15.07.2025	62.4	53.3	56.4	55.5	52.9	52.8	75	70
N6	Kille Gavthan		56.1	43.9	50.4	45.9	41.6	41.9	55	45
N7	L&T Site Office		58.9	55.5	55.9	54.3	52.9	52.7	75	70
N8	Diwale Koliwada	16.07.2025	56.0	43.3	51.6	46.4	38.2	42.6	55	45
N9	Jui		59.1	43.1	53.3	43.5	41.6	40.8	55	45
N10	Panvel		56.1	46.5	51.9	44.9	40.9	41.5	55	45
N1	Owale	11.08.2025	53.1	49.1	51.6	42.9	40.1	41.1	55	45
N2	Pargaon		5.4	52.1	53.6	42.6	40.1	41.5	55	45
N3	Ulwe Node		55.2	51.4	52.7	44.5	40.1	41.5	55	45
N4	Karanjade		54.9	46.9	52.5	44.8	41.8	43.1	55	45
N5	NMIA Project Site	12.08.2025	59.4	53.4	56.6	54.5	52.1	53.3	75	70
N6	Kille Gavthan		56.1	43.9	51.7	43.9	42.2	42.9	55	45
N7	L&T Site Office		57.2	53.3	55.2	54.1	51.2	52.2	75	70
N8	Diwale Koliwada	13.08.2025	57.9	43.3	51.0	44.9	38.6	42.0	55	45
N9	Jui		59.5	43.1	53.1	42.5	40.1	41.6	55	45
N10	Panvel		55.4	45.5	52.8	44.1	40.3	42.3	55	45
N1	Owale	15.09.2025	56.1	48.9	53.3	44.7	41.2	42.4	55	45
N2	Pargaon		56.8	51.8	54.2	45.9	41.8	43.2	55	45

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Stn Code	Sampling Location	Sampling Date	Observed Value (Leq) (dB(A))						Limiting Standard (Leq) as per EP Act Schedule II. dB(A)	
			Day Time			Nighttime				
			Max	Min	Avg	Max	Min	Avg	Day Time	Nighttime
N3	Ulwe Node		55.4	51.9	53.9	47.6	40.5	42.5	55	45
N4	Karanjade		55.9	51.9	54.0	44.8	41.5	42.2	55	45
N5	NMIA Project site		61.2	52.9	55.9	53.6	50.4	51.8	75	70
N6	Kille Gaothan	16.09.2025	56.1	46.9	52.1	44.5	40.2	42.1	55	45
N7	L&T Site Office		63.5	53.2	56.6	53.4	50.3	52.1	75	70
N8	Diwale Koliwada		56.3	44.6	51.8	43.2	40.6	41.9	55	45
N9	Jui	17.09.2025	56.9	49.6	54.5	44.2	40.9	42.5	55	45
N10	Panvel		56.7	46.9	53.0	46.2	41.2	42.7	55	45

4.2.2 Inference of Noise Data

During daytime, the average Noise level was observed in the range of 50.4- 56.6 dB(A) & Nighttime levels were observed at 40.5 – 54.1 dB(A) during sampling period. Following observations are made about average Noise levels in the monitoring carried out in different months:

- In April 2025 average Noise level during daytime and night time is under the Limit of Standard (Leq) as per EP Act Schedule II.
- In May 2025 average Noise level during daytime and night time is under the Limit of Standard (Leq) as per EP Act Schedule II.
- In June 2025 average Noise level during daytime and night time is under the Limit of Standard (Leq) as per EP Act Schedule II.
- In July 2025 average Noise level during daytime and nighttime were under the Limit of Standard (Leq) as per EP Act Schedule II.
- In August 2025 average Noise level during daytime and nighttime were under the Limit of Standard (Leq) as per EP Act Schedule II.
- In September 2025 average Noise level during night time and nighttime noise level were under the Limit of Standard (Leq) as per EP Act Schedule II.

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4.3 SOIL QUALITY MONITORING REPORT

4.3.1 Soil Analysis Data (April 2025 and September 2025)

Data on soil analysis is compiled and presented below for the sampling period:

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Table 4-8: Soil analysis of various stations in study area during June 2025

Sr. No.	Locations		Chinchpada	Koli	Kopar	Ulwe	NMIA Project site	Kombadbhuje	Pargaon	Owale	Unit
	Sampling Date		17.06.2025								
1.	pH		7.52	7.10	6.88	8.10	7.71	8.62	7.44	8.09	--
2.	Texture	Coarse sand	20	22	19	16	19	18	17	21	%
3.	Texture	Clay	32	35	36	36	41	38	32	34	%
		Silt	25	24	24	16	16	20	25	16	%
		Fine Sand	23	19	21	32	24	24	26	29	%
4.	Conductivity		337.2	240.2	98.7	344.7	215.5	627.5	370.5	306.9	µS/cm
5.	Organic Carbon		0.41	0.84	0.68	0.36	0.54	0.42	0.30	0.34	%
6.	Available Nitrogen		0.010	0.0119	0.0117	0.014	0.0110	0.0106	0.016	0.012	%
7.	Available Phosphorus		46	80	52	66	28	82	68	59	kg/ha
8.	Available Potassium		60	60	60	60	60	70	60	60	kg/ha
9.	Chloride		29	35	28	18	32	29	21	28	mg/kg
10.	Sulphate as SO_4		36	26	20	21	30	32	20.0	26	mg/kg
11.	Calcium as Ca		48.1	21.5	34.5	36.9	26	36	44.7	32.7	meq/l
12.	Magnesium as Mg		16.9	8.6	12	12.4	12	17	12.3	10.2	meq/l
13.	Sodium as Na		50	50	50	50	50	70	50	50	kg/ha
14.	Manganese as Mn		0.06	1.18	< 0.2	1.16	2.04	2.00	1.15	1.89	mg/kg

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Sr. No.	Locations	Chinchpada	Koli	Kopar	Ulwe	NMIA Project site	Kombadbhuje	Pargaon	Owale	Unit
	Sampling Date	**17.06.2025**								
15.	Copper as Cu	1.08	0.05	0.37	1.00	1.00	1.04	0.98	1.10	mg/kg
16.	Cadmium as Cd	0.21	0.07	0.48	0.16	0.11	0.18	0.21	0.21	mg/kg
17.	Cobalt as Co	< 0.2	0.34	1.32	< 0.02	0.19	0.21	0.25	0.18	mg/kg
18.	Zinc as Zn	1.12	1.26	1.37	4.10	2.21	2.30	2.92	2.24	mg/kg
19.	Nickel as Ni	0.04	1.61	2.19	0.79	1.10	1.20	0.06	1.04	mg/kg
20.	Aluminium as Al	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	mg/kg
21.	Arsenic as As	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	<0.02	mg/kg
22.	Mercury as Hg	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	<0.02	mg/kg
23.	Chromium as Cr	2.19	0.18	2.54	3.09	2.18	2.31	1.72	2.19	mg/kg
24.	Iron as Fe	4.29	3.87	4.74	4.41	3.11	3.24	3.34	3.00	mg/kg
25.	Lead as Pb	0.14	0.10	0.06	0.15	0.06	0.08	0.13	0.07	mg/kg

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4.3.2 Soil Data Inference during June 2025:

It has been observed that the pH of the soil ranged from 6.88 to 8.62 indicating that the soils are Acidic to Alkaline in nature. The soil in the study area is mostly clay. The observed electrical conductivity ranged from 98.7 to 627.5 µS/cm.

The nitrogen concentrations are in the range of 0.010 % to 0.016%. The phosphorous concentrations are in the range of 28 kg/ha to 82 kg/ha indicating that soils have less to more than sufficient quantities of phosphorus. The very less phosphorus recorded at NIMA project site; medium at Chinchpada; on an average sufficient at Kopar and Owale; Sufficient at Owale, Pargaon and Koli; and more than sufficient Phosphorus at Kombadbhuje.

The potassium concentrations range between 60 kg/ha to 70 kg/ha, which indicate that the soils have very less quantity of potassium at all sampling locations.

Source: Standard soil classification as per Handbook of Agriculture, Indian Council of Agricultural Research.

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Table 4-9: Soil analysis of various stations in study area during September 2025

Sr. No.	Locations		Chinchpada	Koli	Kopar	Ulwe	NMIA Project site	Kombadbhuje	Pargaon	Owale	Unit
	Sampling Date		16.09.2025 To 17.09.2025								
1.	pH		7.06	7.71	6.52	8.05	7.56	8.11	8.07	8.39	--
2.	Texture	Coarse sand	18	18	14	20	21	18	14	18	%
		Clay	38	35	39	37	39	38	40	37	
		Silt	24	27	19	22	19	21	20	19	
		Fine Sand	20	20	28	21	21	23	26	26	
3.	Conductivity		465.54	373.7	57.7	295.6	288.6	546.4	206.6	297.7	µS/cm
4.	Organic Carbon		0.46	0.88	0.69	0.42	0.46	0.50	0.38	0.24	%
5.	Available Nitrogen		0.012	0.0119	0.0118	0.017	0.012	0.011	0.017	0.011	%
6.	Available Phosphorus		62	81	71	70	62	70	77	83	kg/ha
7.	Available Potassium		70	60	70	60	70	70	60	70	kg/ha
8.	Chloride		24	26	22	20	24.2	27	15	21.7	mg/kg
9.	Sulphate as SO_4		27	21	18	21.3	21.9	24	17	20.4	mg/kg
10.	Calcium as Ca		45.3	18.3	32.2	38.5	24.2	38.3	39.1	37	meq/l
11.	Magnesium as Mg		17.1	7.8	12.6	13.2	13.4	11.4	16.6	9.1	meq/l
12.	Sodium as Na		60	50	60	50	50	60	50	60	kg/ha

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Checked By:
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Sr. No.	Locations	Chinchpada	Koli	Kopar	Ulwe	NMIA Project site	Kombadbhuje	Pargaon	Owale	Unit
	Sampling Date	**16.09.2025 To 17.09.2025**								
13.	Manganese as Mn	0.08	1.08	< 0.2	13.2	2.08	11.4	16.6	1.28	mg/kg
14.	Copper as Cu	1.02	0.08	0.28	1.00	1.04	1.06	0.88	1.12	mg/kg
15.	Cadmium as Cd	0.24	0.06	0.42	0.20	0.12	0.22	0.22	0.28	mg/kg
16.	Cobalt as Co	< 0.02	0.38	1.22	< 0.02	0.16	0.28	0.24	0.10	mg/kg
17.	Zinc as Zn	1.24	1.28	1.58	3.88	2.24	2.18	2.12	2.22	mg/kg
18.	Nickel as Ni	0.08	1.42	1.59	0.80	1.08	1.24	0.04	1.04	mg/kg
19.	Aluminium as Al	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	mg/kg
20.	Arsenic as As	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	<0.02	mg/kg
21.	Mercury as Hg	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	<0.02	mg/kg
22.	Chromium as Cr	2.04	0.22	1.84	2.99	2.22	2.24	1.62	2.11	mg/kg
23.	Iron as Fe	3.26	3.07	3.44	3.88	2.88	3.12	2.34	3.12	mg/kg
24.	Lead as Pb	0.18	0.12	0.10	0.18	0.08	0.18	0.14	0.05	mg/kg

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4.3.3 Soil Data Inference during September 2025:

It has been observed that the pH of the soil ranged from 6.52 to 8.39 indicating that the soils are Moderately acidic to alkaline nature of soil. The soil in the study area is mostly clay. The electrical conductivity was observed to be in the range of 57.7 to 546.4 µS/cm.

The nitrogen concentrations are in the range of 0.011% to 0.017%. The phosphorous concentrations are in the range of 62 kg/ha to 83 kg/ha. The phosphorus concentration is sufficient at Kopar, Ulwe, Kombadbhuje and Pargaon; on an average sufficient at Chinchpada and NMIA project site and more than sufficient at Koli & Owale.

The potassium concentrations range between 60 kg/ha to 70 kg/ha, which indicates that the soils have very less quantity of potassium.

Source: Standard soil classification as per Handbook of Agriculture, Indian Council of Agricultural Research.

4.4 GROUND WATER QUALITY ANALYSIS REPORT

4.4.1 GW Analysis Data during April 2025

Ground water samples were collected in April 2025.

Table 4-10: Ground water analysis at various stations during April 2025

Sr. No.	Sampling Locations	Kille Gaothan	Ulwe	Pargaon	Jui	Panvel
	Sampling month	14.04.2025		15.04.2025	14.04.2025	
1.	Colour, Hazen	<5.0	<5.0	<5.0	<5.0	<5.0
2.	pH@ 25°C	7.2	7.2	7.3	8.1	8.0
3.	Turbidity, NTU	<1.0	<1.0	<1.0	<1.0	<1.0
4.	TDS, mg/l	850	300	390	280	260
5.	NH3(as N), mg/l	< 0.56	< 0.56	< 0.56	< 0.56	< 0.56
6.	Boron, mg/l	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
7.	Calcium as Ca, mg/l	48	40	45	36	33.6
8.	Chlorides, mg/l	250	55	72	52	48
9.	Fluoride, mg/l	0.38	0.32	0.34	0.38	0.32
10.	Free Res Cl_2, mg/l	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
11.	Iron, mg/l	0.034	0.038	0.04	0.04	0.032
12.	Magnesium as Mg, g/l	75.3	14.6	31.6	21.4	14.6
13.	Sulphate, mg/l	170	42	60	41	25
14.	Alkalinity, mg/l	214	174	220	180	176
15.	Hardness, mg/l	430	160	230	178	144
16.	Odour	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
17.	Aluminum, mg/l	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
18.	Detergents, mg/l	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04
19.	Arsenic As, mg/l	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
20.	Barium, mg/l	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
21.	Copper, mg/l	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
22.	Manganese, mg/l	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
23.	Chromium as Cr, mg/l	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
24.	Zinc, mg/l	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
25.	Nitrate, mg/l	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
26.	Selenium, mg/l	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
27.	Lead, mg/l	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
28.	Molybdenum, mg/l	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
29.	Nickel, mg/l	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
30.	Cadmium as Cd, mg/l	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003
31.	Phenolic comp. mg/l	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
32.	Sulphide as S^{2-} mg/l	< 0.02	< 0.05	< 0.05	< 0.05	< 0.05

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Sr. No.	Sampling Locations	Kille Gaothan	Ulwe	Pargaon	Jui	Panvel
	Sampling month	**14.04.2025**		**15.04.2025**	**14.04.2025**	
33.	Mercury as Hg, mg/l	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
34.	Chloramines, mg/l	<2.0	<2.0	<2.0	<2.0	<2.0
35.	Silver as Ag, mg/l	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
36.	Cyanide as Cn, mg/l	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
37.	PAH, mg/l	<0.025	<0.025	<0.025	<0.025	<0.025
38.	Trihalomethanes, mg/l					
a	Bromoform	<0.01	<0.01	<0.01	<0.01	<0.01
b	Dichlorobromomethane	<0.01	<0.01	<0.01	<0.01	<0.01
c	Bromodichloromethane	<0.01	<0.01	<0.01	<0.01	<0.01
d	Chloroform	<0.01	<0.01	<0.01	<0.01	<0.01
39.	Alachlor, µg/l	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
40.	Atrazine, µg/l	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
41.	Aldrin, µg/l	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
42.	Alpha HCH, µg/l	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
43.	Beta HCH, µg/l	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
44.	Butachlor, µg/l	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
45.	Chlorpyriphos, µg/l	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
46.	Delta HCH, µg/l	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
47.	DDT, µg/l	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
48.	Endosulphan, µg/l	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
49.	Ethion, , µg/l	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
50.	Lindane, , µg/l	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
51.	Malathion, , µg/l	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
52.	Methyl parathion, , µg/l	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
53.	Monocrotophos , µg/l	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
54.	Phorate, µg/l	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
	Microbiology					
55.	Coliform (MPN/100 ml)	>1600	>1600	>1600	>1600	>1600
56.	E. Coli/100 ml	Present	Present	Present	Present	Present

4.4.2 GW Analysis Inference:

The analysis results indicate the pH range of 7.2 to 8.1 and is observed to be within the desirable limit of 6.5 to 8.5, beyond this range water will affect the mucous membrane and/or water supply system. The total hardness is in the range of 144 to 430 mg/l and is observed to be within the permissible limit of 600 mg/l at all locations. The total hardness beyond the permissible limit causes encrustation in water supply structure and adverse effects on domestic use. The iron concentration is found to be in the range of 0.032 to 0.040 mg/l for all the five samples and is observed to be within the acceptable limit of 1.0 mg/l at all locations. Beyond the desirable limit taste/appearance are affected, has adverse effect on domestic uses and water supply structures, and promotes iron bacteria.

The chlorides concentration is in the range of 48 mg/l to 250 mg/l and is observed to be within the acceptable limit of 250 mg/l at all five locations. Beyond this limit, taste, corrosion and palatability are affected. The fluoride concentration ranged from 0.32 to 0.38 mg/l, observed at all locations to be within the acceptable limit of 1.5 mg/l and permissible limit of 1.5 mg/l at all locations, high fluoride may cause fluorosis. The TDS are in the range of 260 to 850 mg/l, and is observed within the permissible limit of 500 mg/l at all four locations and slightly higher at Kille Gaothan (i.e. 850 mg/l) & are also within the permissible limit of 2000 mg/l.

The ground water samples collected from five locations and are analyzed for physical, chemical and biological parameters. The chemical and physical characteristics of the analyzed ground water samples show that the samples are potable as per IS 10500-RA2018. The biological characteristics of the analyzed ground water samples show that the samples are not potable as per IS 10500-RA2018.

4.4.3 GW Analysis Data during May 2025

Ground water samples were collected in May 2025. Access was not available to predefined locations; hence sampling was done at nearby and other locations within the study area. The Chinchpada well was demolished as it falls within the alignment of road.

Table 4-11: Ground water analysis at various stations during May 2025

Sr. No.	Sampling Locations	Kombadbhuje	Owale	Dapoli
	Sampling month	**13.05.2025**		**12.05.2025**
1.	Colour, Hazen	< 5.0	<5.0	<5.0
2.	pH@ 25°C	6.9	6.8	7.3
3.	Turbidity, NTU	<1.0	<1.0	<1.0
4.	TDS, mg/l	280	380	420
5.	NH3(as N), mg/l	< 0.56	< 0.56	< 0.56
6.	Boron, mg/l	< 0.05	< 0.05	< 0.05
7.	Calcium as Ca, mg/l	38	52.8	65.6
8.	Chlorides, mg/l	42	58	62
9.	Fluoride, mg/l	0.32	0.34	0.36
10.	Free Res Cl_2, mg/l	< 0.2	< 0.2	< 0.2
11.	Iron, mg/l	0.034	0.032	0.036
12.	Magnesium as Mg, g/l	21.9	28.6	23.8
13.	Sulphate, mg/l	71	65	85
14.	Alkalinity, mg/l	130	246	256
15.	Hardness, mg/l	180	250	262
16.	Odour	Agreeable	Agreeable	Agreeable

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Sr. No.	Sampling Locations	Kombadbhuje	Owale	Dapoli
	Sampling month	13.05.2025		12.05.2025
17.	Aluminum, mg/l	< 0.01	< 0.01	< 0.01
18.	Detergents, mg/l	< 0.04	< 0.04	< 0.04
19.	Arsenic As, mg/l	< 0.01	< 0.01	< 0.01
20.	Barium, mg/l	< 0.01	< 0.01	< 0.01
21.	Copper, mg/l	< 0.01	< 0.01	< 0.01
22.	Manganese, mg/l	< 0.01	< 0.01	< 0.01
23.	Chromium as Cr, mg/l	< 0.01	< 0.01	< 0.01
24.	Zinc, mg/l	< 0.01	< 0.01	< 0.01
25.	Nitrate, mg/l	< 0.5	< 0.5	< 0.5
26.	Selenium, mg/l	< 0.01	< 0.01	< 0.01
27.	Lead, mg/l	< 0.01	< 0.01	< 0.01
28.	Molybdenum, mg/l	< 0.01	< 0.01	< 0.01
29.	Nickel, mg/l	< 0.01	< 0.01	< 0.01
30.	Cadmium as Cd, mg/l	< 0.003	< 0.003	< 0.003
31.	Phenolic comp. mg/l	< 0.001	< 0.001	< 0.001
32.	Sulphide as S^{2-} mg/l	< 0.02	< 0.05	< 0.05
33.	Mercury as Hg, mg/l	< 0.001	< 0.001	< 0.001
34.	Chloramines, mg/l	<2.0	<2.0	<2.0
35.	Silver as Ag, mg/l	< 0.01	< 0.1	< 0.1
36.	Cyanide as Cn, mg/l	< 0.05	< 0.05	< 0.05
37.	PAH, mg/l	<0.0001	<0.0001	<0.0001
38.	Trihalomethanes, mg/l			
a	Bromoform	<0.01	<0.01	<0.01
b	Dichlorobromomethane	<0.01	<0.01	<0.01
c	Bromodichloromethane	<0.01	<0.01	<0.01
d	Chloroform	<0.01	<0.01	<0.01
39.	Alachlor, µg/l	< 1.0	< 1.0	< 1.0
40.	Atrazine, µg/l	< 1.0	< 1.0	< 1.0
41.	Aldrin, µg/l	< 1.0	< 1.0	< 1.0
42.	Alpha HCH, µg/l	< 1.0	< 1.0	< 1.0
43.	Beta HCH, µg/l	< 1.0	< 1.0	< 1.0
44.	Butachlor, µg/l	< 1.0	< 1.0	< 1.0
45.	Chlorpyriphos, µg/l	< 1.0	< 1.0	< 1.0
46.	Delta HCH, , µg/l	< 1.0	< 1.0	< 1.0
47.	DDT, µg/l	< 1.0	< 1.0	< 1.0
48.	Endosulphan, , µg/l	< 1.0	< 1.0	< 1.0
49.	Ethion, , µg/l	< 1.0	< 1.0	< 1.0
50.	Lindane, , µg/l	< 1.0	< 1.0	< 1.0
51.	Malathion, , µg/l	< 1.0	< 1.0	< 1.0

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Sr. No.	Sampling Locations	Kombadbhuje	Owale	Dapoli
	Sampling month	**13.05.2025**		**12.05.2025**
52.	Methyl parathion, , µg/l	< 1.0	< 1.0	< 1.0
53.	Monocrotophos , µg/l	< 1.0	< 1.0	< 1.0
54.	Phorate, µg/l	< 1.0	< 1.0	< 1.0
55.	Coliform (MPN/100 ml)	>1600	>1600	>1600
56.	E. Coli/100 ml	Present	Present	Present

4.4.4 GW Analysis Inference:

The analysis results indicate the pH range of 6.8 to 7.3 and is observed to be within the desirable limit of 6.5 to 8.5, beyond this range water will affect the mucous membrane and/or water supply system. The total hardness is in the range of 180 to 262 mg/l and is observed within the permissible limit of 600 mg/l at all three locations. The total hardness beyond the permissible limit causes encrustation in water supply structure and adverse effects on domestic use. The iron concentration is found in the range of 0.032 to 0.036 mg/l and is observed to be within the acceptable limit of 1.0 mg/l at all locations. Beyond the desirable limit taste/appearance are affected, has adverse effect on domestic uses and water supply structures, and promotes iron bacteria. The chlorides concentration is in the range of 42mg/l to 62 mg/l and is observed within the acceptable limit of 250 mg/l at all four locations. Beyond this limit, taste, corrosion and palatability are affected. The fluoride concentration observed ranged from 0.32 to 0.36 mg/l, within the Acceptable and permissible limit of 1.0 mg/l and 1.5 mg/l respectively at all locations, high fluoride may cause fluorosis. The TDS are in the range of 280 to 420 mg/l and is observed within the desirable limit of 500 mg/l. The ground water samples are collected from all locations and are analyzed for physical, chemical and biological parameters. The chemical and physical characteristics of the analyzed ground water samples show that the samples are potable as per IS 10500-RA2018. The biological characteristics of the analyzed ground water samples show that the samples are not potable as per IS 10500- RA2018.

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4.4.5 GW Analysis Data during June 2025

Ground water samples were collected in June2025.

Table 4-12: Ground water analysis at various stations during June2025

Sr. No.	Sampling Locations	Kille Gaothan	Ulwe	Pargaon	Jui	Panvel
	Sampling month	**16.06.2025**		**17.06.2025**	**16.06.2025**	
1.	Colour, Hazen	5.0	<5.0	<5.0	<5.0	<5.0
2.	pH@ 25°C	6.9	7.0	6.8	7.0	7.1
3.	Turbidity, NTU	<1.0	<1.0	<1.0	<1.0	<1.0
4.	TDS, mg/l	600	220	440	430	250
5.	NH3(as N), mg/l	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
6.	Boron, mg/l	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
7.	Calcium as Ca, mg/l	69.6	24	86.4	36.8	44.8
8.	Chlorides, mg/l	268	40	54	38	44
9.	Fluoride, mg/l	0.38	0.32	0.32	0.38	0.32
10.	Free Res Cl_2, mg/l	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
11.	Iron, mg/l	0.04	0.038	0.038	0.036	0.032
12.	Magnesium as Mg, g/l	29	7.3	11.2	27.7	6.3
13.	Sulphate, mg/l	60	28	102	80	52
14.	Alkalinity, mg/l	96	122	218	282	140
15.	Hardness, mg/l	296	90	262	206	138
16.	Odour	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
17.	Aluminum, mg/l	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
18.	Detergents, mg/l	<0.04	< 0.04	< 0.04	< 0.04	< 0.04
19.	Arsenic As, mg/l	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
20.	Barium, mg/l	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
21.	Copper, mg/l	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
22.	Manganese, mg/l	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
23.	Chromium as Cr, mg/l	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
24.	Zinc, mg/l	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
25.	Nitrate, mg/l	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
26.	Selenium, mg/l	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
27.	Lead, mg/l	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
28.	Molybdenum, mg/l	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
29.	Nickel, mg/l	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
30.	Cadmium as Cd, mg/l	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003
31.	Phenolic comp. mg/l	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
32.	Sulphide as S^{2-} mg/l	< 0.02	< 0.05	< 0.05	< 0.05	< 0.05
33.	Mercury as Hg, mg/l	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001

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Sr. No.	Sampling Locations	Kille Gaothan	Ulwe	Pargaon	Jui	Panvel
	Sampling month	16.06.2025		17.06.2025		16.06.2025
34.	Chloramines, mg/l	<2.0	<2.0	<2.0	<2.0	<2.0
35.	Silver as Ag, mg/l	< 0.01	< 0.1	< 0.1	< 0.1	< 0.1
36.	Cyanide as Cn, mg/l	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
37.	PAH, mg/l	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
38.	Trihalomethanes, mg/l					
a	Bromoform	<0.01	<0.01	<0.01	<0.01	<0.01
b	Dichlorobromomethane	<0.01	<0.01	<0.01	<0.01	<0.01
c	Bromodichloromethane	<0.01	<0.01	<0.01	<0.01	<0.01
d	Chloroform	<0.01	<0.01	<0.01	<0.01	<0.01
39.	Alachlor, µg/l	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
40.	Atrazine, µg/l	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
41.	Aldrin, µg/l	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
42.	Alpha HCH, µg/l	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
43.	Beta HCH, µg/l	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
44.	Butachlor, µg/l	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
45.	Chlorpyriphos, µg/l	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
46.	Delta HCH, , µg/l	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
47.	DDT, µg/l	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
48.	Endosulphan, , µg/l	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
49.	Ethion, , µg/l	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
50.	Lindane, , µg/l	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
51.	Malathion, , µg/l	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
52.	Methyl parathion, , µg/l	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
53.	Monocrotophos , µg/l	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
54.	Phorate, µg/l	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
	Microbiology					
55.	Coliform (MPN/100 ml)	>1600	>1600	>1600	>1600	>1600
56.	E. Coli/100 ml	Present	Present	Present	Present	Present

4.4.6 GW Analysis Inference:

The analysis results indicate the pH range of 6.8 to 7.0 and is observed within the desirable limit of 6.5 to 8.5, beyond this range water will affect the mucous membrane and/or water supply system. The total hardness is in the range of 90 to 296 mg/l and is observed within the permissible limit of

600 mg/l at all locations. The total hardness beyond the permissible limit causes encrustation in water supply structure and adverse effects on domestic use. The iron concentration is found in the range of 0.032 to 0.040 mg/l for all samples and is observed to be within the acceptable limit of 1.0 mg/l at all locations. Beyond the desirable limit taste/appearance are affected, has adverse effect on domestic uses and water supply structures, and promotes iron bacteria.

The chlorides concentration is in the range of 38 mg/l to 268 mg/l and is observed within the acceptable limit of 250 mg/l at all 4 locations except at Kille Gavthan (268 mg/l) which is under permissible limit. Beyond this limit, taste, corrosion and palatability are affected. The fluoride concentration is in the range of 0.32 to 0.38 mg/l and is observed within the acceptable and permissible limit of 1.0 mg/l and 1.5 mg/l respectively at all locations, high fluoride may cause fluorosis. The TDS are in the range of 220 to 600 mg/l, and is observed within the desirable limit of 500 mg/l except at Kille Gavthan (600 ml/l), which is under permissible limit of 2000 mg/l.

The ground water samples collected from five locations and are analyzed for physical, chemical and biological parameters. The chemical and physical characteristics of the analyzed ground water samples show that the samples are potable as per IS 10500-RA2018. The biological characteristics of the analyzed ground water samples show that the samples are not potable as per IS 10500-RA2018.

4.4.7 GW Analysis Data during July 2025

Ground water samples were collected in July 2025. Due to ongoing airport construction, the access to Kombadbhuje was not possible and Chinchpada Well had been demolished. Therefore, sampling could be carried out only at Owale and Dapoli.

Table 4-13: Ground water analysis at various stations during July 2025

Sr. No.	Sampling Locations	Owale	Dapoli
	Sampling month	14.07.2025	
1.	Colour, Hazen	< 5.0	5.0
2.	pH@ 25°C	7.0	6.9
3.	Turbidity, NTU	<1.0	<1.0
4.	TDS, mg/l	470	610
5.	NH3(as N), mg/l	< 0.2	< 0.2
6.	Boron, mg/l	< 0.05	< 0.05
7.	Calcium as Ca, mg/l	50.4	44.8
8.	Chlorides, mg/l	65	75
9.	Fluoride, mg/l	0.32	0.38
10.	Free Res Cl_2, mg/l	< 0.2	< 0.2
11.	Iron, mg/l	0.034	0.04
12.	Magnesium as Mg, g/l	32	41.8
13.	Sulphate, mg/l	96	165

Sr. No.	Sampling Locations	Owale	Dapoli
	Sampling month	**14.07.2025**	
14.	Alkalinity, mg/l	250	292
15.	Hardness, mg/l	258	284
16.	Odour	Agreeable	Agreeable
17.	Aluminum, mg/l	< 0.01	< 0.01
18.	Detergents, mg/l	< 0.04	< 0.04
19.	Arsenic As, mg/l	< 0.01	< 0.01
20.	Barium, mg/l	< 0.01	< 0.01
21.	Copper, mg/l	< 0.01	< 0.01
22.	Manganese, mg/l	< 0.01	< 0.01
23.	Chromium as Cr, mg/l	< 0.01	< 0.01
24.	Zinc, mg/l	< 0.01	< 0.01
25.	Nitrate, mg/l	< 0.5	< 0.5
26.	Selenium, mg/l	< 0.01	< 0.01
27.	Lead, mg/l	< 0.01	< 0.01
28.	Molybdenum, mg/l	< 0.01	< 0.01
29.	Nickel, mg/l	< 0.01	< 0.01
30.	Cadmium as Cd, mg/l	< 0.003	< 0.003
31.	Phenolic comp. mg/l	< 0.001	< 0.001
32.	Sulphide as S^{2-} mg/l	< 0.02	< 0.05
33.	Mercury as Hg, mg/l	< 0.001	< 0.001
34.	Chloramines, mg/l	<2.0	<2.0
35.	Silver as Ag, mg/l	< 0.01	< 0.1
36.	Cyanide as Cn, mg/l	< 0.05	< 0.05
37.	PAH, mg/l	<0.025	<0.025
38.	Trihalomethanes, mg/l		
a	Bromoform	<0.01	<0.01
b	Dichlorobromomethane	<0.01	<0.01
c	Bromodichloromethane	<0.01	<0.01
d	Chloroform	<0.01	<0.01
39.	Alachlor, µg/l	< 0.5	< 0.5
40.	Atrazine, µg/l	< 0.5	< 0.5
41.	Aldrin, µg/l	< 0.01	< 0.01
42.	Alpha HCH, µg/l	< 0.01	< 0.01
43.	Beta HCH, µg/l	< 0.01	< 0.01
44.	Butachlor, µg/l	< 5.0	< 5.0
45.	Chlorpyriphos, µg/l	< 0.05	< 0.05
46.	Delta HCH, , µg/l	< 0.01	< 0.01
47.	DDT, µg/l	< 0.01	< 0.01

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Sr. No.	Sampling Locations	Owale	Dapoli
	Sampling month	**14.07.2025**	
48.	Endosulphan, , µg/l	< 0.01	< 0.01
49.	Ethion, , µg/l	< 0.05	< 0.05
50.	Lindane, , µg/l	< 0.01	< 0.01
51.	Malathion, , µg/l	< 0.05	< 0.05
52.	Methyl parathion, , µg/l	< 0.01	< 0.01
53.	Monocrotophos , µg/l	< 0.5	< 0.5
54.	Phorate, µg/l	< 0.5	< 0.5
55.	Coliform (MPN/100 ml)	>1600	>1600
56.	E. Coli/100 ml	Present	Present

4.4.8 GW Analysis Inference:

The analysis results indicate the pH range of 6.9 to 7.0 and is observed within the desirable limit of 6.5 to 8.5, beyond this range will affect the mucous membrane and/or water supply system. The total hardness is in the range of 258 to 284 mg/l and is observed within the permissible limit of 600 mg/l at all 2 locations. The total hardness beyond the permissible limit causes encrustation in water supply structure and adverse effects on domestic use. The iron concentration is found to be in the range of 0.034 to 0.04 mg/l and is observed to be within the acceptable limit of 1.0 mg/l at all locations. Beyond the desirable limit taste/appearance are affected, it has adverse effect on domestic uses and water supply structures and promotes iron bacteria.

The chlorides concentration is in the range of 65 to 75 mg/l and is observed within the acceptable limit of 250 mg/l at all locations. Beyond this limit, taste, corrosion and palatability are affected. The fluoride concentration is 0.32 to 0.38 mg/l and is observed within the acceptable and permissible limit of 1.0 mg/l and 1.5 mg/l respectively at all locations, high fluoride may cause fluorosis. The TDS are in the range of 470 to 610 mg/l. The Owale is observed within the acceptable limit of 500 mg/l and Dapoli is observed within the permissible limit of 2000 mg/l.

The ground water samples collected from all locations and are analyzed for physical, chemical and biological parameters. The chemical and physical characteristics of the analyzed ground water samples show that the samples are potable as per IS 10500-RA2018. The biological characteristics of the analyzed ground water samples show that the samples are not potable as per IS 10500-RA2018.

4.4. 9 GW Analysis Data during August 2025

Ground water samples were collected in August 2025.

Table 4-14: Ground water analysis at various stations during August 2025

Sr. No.	Sampling Locations	Kille Gaothan	Ulwe	Pargaon	Jui	Panvel
	Sampling month	**11.08.2025**			**13.08.2025**	
1.	Colour, Hazen	5.0	5.0	< 5.0	5.0	< 5.0
2.	pH@ 25°C	6.9	7	6.8	6.8	6.9
3.	Turbidity, NTU	<1.0	<1.0	<1.0	<1.0	<1.0
4.	TDS, mg/l	960	260	500	300	490
5.	NH3(as N), mg/l	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
6.	Boron, mg/l	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
7.	Calcium as Ca, mg/l	68	24	69.6	36	32
8.	Chlorides, mg/l	510	45	39	55	80
9.	Fluoride, mg/l	0.38	0.34	0.32	0.34	0.32
10.	Free Res Cl_2, mg/l	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
11.	Iron, mg/l	0.04	0.034	0.038	0.04	0.03
12.	Magnesium as Mg, g/l	97.2	9.72	16	8.3	36.5
13.	Sulphate, mg/l	76	64	222	70	94
14.	Alkalinity, mg/l	138	92	206	116	260
15.	Hardness, mg/l	550	100	240	124	230
16.	Odour	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
17.	Aluminum, mg/l	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
18.	Detergents, mg/l	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04
19.	Arsenic As, mg/l	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
20.	Barium, mg/l	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
21.	Copper, mg/l	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
22.	Manganese, mg/l	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
23.	Chromium as Cr, mg/l	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
24.	Zinc, mg/l	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
25.	Nitrate, mg/l	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
26.	Selenium, mg/l	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
27.	Lead, mg/l	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
28.	Molybdenum, mg/l	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
29.	Nickel, mg/l	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
30.	Cadmium as Cd, mg/l	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003
31.	Phenolic comp. mg/l	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
32.	Sulphide as S^{2-} mg/l	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
33.	Mercury as Hg, mg/l	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
34.	Chloramines, mg/l	<2.0	<2.0	<2.0	<2.0	<2.0
35.	Silver as Ag, mg/l	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
36.	Cyanide as Cn, mg/l	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
37.	PAH, mg/l	<0.025	<0.025	<0.025	<0.025	<0.025
38.	Trihalomethane, mg/l					
a	Bromoform	<0.01	<0.01	<0.01	<0.01	<0.01

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Sr. No.	Sampling Locations	Kille Gaothan	Ulwe	Pargaon	Jui	Panvel
	Sampling month	**11.08.2025**			**13.08.2025**	
b	Dichlorobromomethane	<0.01	<0.01	<0.01	<0.01	<0.01
c	Bromodichloromethane	<0.01	<0.01	<0.01	<0.01	<0.01
d	Chloroform	<0.01	<0.01	<0.01	<0.01	<0.01
39.	Alachlor, µg/l	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
40.	Atrazine, µg/l	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
41.	Aldrin, µg/l	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
42.	Alpha HCH, µg/l	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
43.	Beta HCH, µg/l	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
44.	Butachlor, µg/l	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
45.	Chlorpyriphos, µg/l	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
46.	Delta HCH, , µg/l	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
47.	DDT, µg/l	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
48.	Endosulphan, , µg/l	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
49.	Ethion, , µg/l	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
50.	Lindane, , µg/l	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
51.	Malathion, , µg/l	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
52.	Methyl parathion, , µg/l	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
53.	Monocrotophos , µg/l	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
54.	Phorate, µg/l	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
	Microbiology					
55.	Coliform (MPN/100 ml)	>1600	>1600	>1600	>1600	>1600
56.	E. Coli/100 ml	Present	Present	Present	Present	Present

4.4.10 GW Analysis Inference:

The analysis results indicate the pH range of 6.8 to 7.0 and is observed within the desirable limit of 6.5 to 8.5, beyond this range water will affect the mucous membrane and/or water supply system. The total hardness is in the range of 100 to 550 mg/l and is observed within the acceptable and permissible limit of 200 mg/l and 600 mg/l respectively at all locations. The total hardness beyond the permissible limit causes encrustation in water supply structure and adverse effects on domestic use. The iron concentration is found to be in the range of 0.030 to 0.040 mg/l and is observed to be within the acceptable limit of 1.0 mg/l at all locations. Beyond the acceptable limit taste/appearance are affected, it has adverse effect on domestic uses and water supply structures, and promotes iron bacteria.

The chlorides concentration is in the range of 39 mg/l to 510 mg/l and is observed within the acceptable limit of 250 mg/l at all 4 locations, except at Kille Gavthan (600 mg/l) which is under permissible of 2000 mg/l. Beyond this limit, taste, corrosion and palatability are affected. The fluoride concentration is 0.32 to 0.38 mg/l and is observed to be within the acceptable limit of 1.0 mg/l at all locations, high fluoride may cause fluorosis. The TDS are in the range of 260 to 960 mg/l and is observed within the acceptable limit of 500 mg/l at 4locations and higher at Kille Gaothan within the permissible limit of 2000 mg/l.

The ground water samples collected from all locations and are analyzed for physical, chemical and biological parameters. The chemical and physical characteristics of the analyzed ground water samples show that the samples are potable as per IS 10500-RA2018. The biological characteristics of the analyzed ground water samples show that the samples are not potable as per IS 10500-RA2018.

4.4. 11 GW Analysis Data during September 2025

Ground water samples were collected in September 2025.

Table 4-15: Ground water analysis at various stations during September 2025

Sr. No.	Sampling Locations	Owale	Dapoli
	Sampling month	15.09.2025	
1.	Colour, Hazen	< 5.0	5.0
2.	pH@ 25°C	6.8	7.0
3.	Turbidity, NTU	<1.0	<1.0
4.	TDS, mg/l	310	360
5.	NH3(as N), mg/l	< 0.2	< 0.2
6.	Boron, mg/l	< 0.05	< 0.05
7.	Calcium as Ca, mg/l	30.4	32
8.	Chlorides, mg/l	48	60
9.	Fluoride, mg/l	0.32	0.34
10.	Free Res Cl_2, mg/l	0.4	0.4
11.	Iron, mg/l	0.038	0.034
12.	Magnesium as Mg, g/l	37.4	41.3
13.	Sulphate, mg/l	70	65
14.	Alkalinity, mg/l	210	260
15.	Hardness, mg/l	230	250
16.	Odour	Agreeable	Agreeable
17.	Aluminum, mg/l	< 0.01	< 0.01
18.	Detergents, mg/l	<0.04	< 0.04
19.	Arsenic As, mg/l	< 0.01	< 0.01
20.	Barium, mg/l	< 0.01	< 0.01
21.	Copper, mg/l	< 0.01	< 0.01
22.	Manganese, mg/l	< 0.01	< 0.01
23.	Chromium as Cr, mg/l	< 0.01	< 0.01
24.	Zinc, mg/l	< 0.01	< 0.01
25.	Nitrate, mg/l	< 0.5	< 0.5
26.	Selenium, mg/l	< 0.01	< 0.01
27.	Lead, mg/l	< 0.01	< 0.01
28.	Molybdenum, mg/l	< 0.01	< 0.01
29.	Nickel, mg/l	< 0.01	< 0.01
30.	Cadmium as Cd, mg/l	< 0.003	< 0.003
31.	Phenolic comp. mg/l	< 0.001	< 0.001
32.	Sulphide as S^{2-} mg/l	< 0.02	< 0.05
33.	Mercury as Hg, mg/l	< 0.001	< 0.001

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Sr. No.	Sampling Locations	Owale	Dapoli
	Sampling month	**15.09.2025**	
34.	Chloramines, mg/l	<2.0	<2.0
35.	Silver as Ag, mg/l	< 0.01	< 0.1
36.	Cyanide as Cn, mg/l	< 0.05	< 0.05
37.	PAH, mg/l	<0.0001	<0.0001
38.	Trihalomethanes, mg/l		
a	Bromoform	<0.01	<0.01
b	Dichlorobromomethane	<0.01	<0.01
c	Bromodichloromethane	<0.01	<0.01
d	Chloroform	<0.01	<0.01
39.	Alachlor, µg/l	< 1.0	< 1.0
40.	Atrazine, µg/l	< 1.0	< 1.0
41.	Aldrin, µg/l	< 1.0	< 1.0
42.	Alpha HCH, µg/l	< 1.0	< 1.0
43.	Beta HCH, µg/l	< 1.0	< 1.0
44.	Butachlor, µg/l	< 1.0	< 1.0
45.	Chlorpyriphos, µg/l	< 1.0	< 1.0
46.	Delta HCH, , µg/l	< 1.0	< 1.0
47.	DDT, µg/l	< 1.0	< 1.0
48.	Endosulphan, , µg/l	< 1.0	< 1.0
49.	Ethion, , µg/l	< 1.0	< 1.0
50.	Lindane, , µg/l	< 1.0	< 1.0
51.	Malathion, , µg/l	< 1.0	< 1.0
52.	Methyl parathion, , µg/l	< 1.0	< 1.0
53.	Monocrotophos , µg/l	< 1.0	< 1.0
54.	Phorate, µg/l	< 1.0	< 1.0
55.	Coliform (MPN/100 ml)	>1600	>1600
56.	E. Coli/100 ml	Present	Present

4.4.12 GW Analysis Inference:

The analysis results indicate the pH range of 6.8 to 7.0 and is observed within the desirable limit of 6.5 to 8.5, beyond this range water will affect the mucous membrane and/or water supply system. The total hardness is in the range of 230 to 250 mg/l and is observed within the permissible limit of 600 mg/l at all four locations. The total hardness beyond the permissible limit causes encrustation in water supply structure and adverse effects on domestic use. The iron concentration is found to be in the range of 0.034 to 0.038 mg/l and is observed within the acceptable limit of 1.0 mg/l at all locations. Beyond the desirable limit taste/appearance are affected, it has adverse effect on domestic uses and water supply structures and promotes iron bacteria.

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The chlorides concentration is in the range of 48 mg/l to 60 mg/l and is observed to be within the acceptable limit of 250 mg/l at all locations. Beyond this limit, taste, corrosion and palatability are affected. The fluoride concentration is 0.32 to 0.34 mg/l and is observed within the acceptable limit of 1.0 mg/l at all locations, high fluoride may cause fluorosis. The TDS are in the range of 310 to 360 mg/l and is observed within the desirable limit of 500 mg/l at all locations.

The ground water samples collected from four locations and are analyzed for physical, chemical and biological parameters. The chemical and physical characteristics of the analyzed ground water samples show that the samples are potable as per IS 10500-RA2018. The biological characteristics of the analyzed ground water samples show that the samples are not potable as per IS 10500-RA2018.

4.5 DRINKING WATER QUALITY ANALYSIS REPORT

NMIA project site was selected for analysis of drinking water during June 2025, July 2025 and September 2025.

Table 4-16: Drinking water analysis during June 2025, July 2025 and September 2025

Sr. No.	Sampling Locations	NMIA Project site	NMIA Project site	NMIA Project site
	Sampling month	**17.06.2025**	**16.07.2025**	**16.09.2025**
1.	Colour, Hazen	<5.0	< 5.0	5.0
2.	pH@ 25°C	7.1	6.8	7.4
3.	Turbidity, NTU	<1.0	<1.0	<1.0
4.	TDS, mg/l	90	80	70
5.	NH3(as N), mg/l	< 0.2	< 0.2	< 0.2
6.	Boron, mg/l	< 0.05	< 0.05	< 0.05
7.	Calcium as Ca, mg/l	14.4	12	11.2
8.	Chlorides, mg/l	16	18	10
9.	Fluoride, mg/l	0.34	0.32	0.38
10.	Free Res Cl_2, mg/l	0.3	< 0.2	0.4
11.	Iron, mg/l	0.03	0.03	0.04
12.	Magnesium as Mg, g/l	1.9	6.3	3.9
13.	Sulphate, mg/l	7.1	6.6	7.8
14.	Alkalinity, mg/l	58	48	58
15.	Hardness, mg/l	44	56	44
16.	Odour	Agreeable	Agreeable	Agreeable
17.	Aluminum, mg/l	< 0.01	< 0.01	< 0.01
18.	Detergents, mg/l	< 0.04	< 0.04	< 0.04
19.	Arsenic As, mg/l	< 0.01	< 0.01	< 0.01
20.	Barium, mg/l	< 0.01	< 0.01	< 0.01

Sr. No.	Sampling Locations	NMIA Project site	NMIA Project site	NMIA Project site
	Sampling month	17.06.2025	16.07.2025	16.09.2025
21.	Copper, mg/l	< 0.01	< 0.01	< 0.01
22.	Manganese, mg/l	< 0.01	< 0.01	< 0.01
23.	Chromium as Cr, mg/l	< 0.01	< 0.01	< 0.01
24.	Zinc, mg/l	< 0.01	< 0.01	< 0.01
25.	Nitrate, mg/l	< 0.5	< 0.5	< 0.01
26.	Selenium, mg/l	< 0.01	< 0.01	< 0.5
27.	Lead, mg/l	< 0.01	< 0.01	< 0.01
28.	Molybdenum, mg/l	< 0.01	< 0.01	< 0.01
29.	Nickel, mg/l	< 0.01	< 0.01	< 0.01
30.	Cadmium as Cd, mg/l	< 0.003	< 0.003	< 0.01
31.	Phenolic comp. mg/l	< 0.001	< 0.001	< 0.003
32.	Sulphide as S^{2-} mg/l	< 0.05	< 0.05	< 0.001
33.	Mercury as Hg, mg/l	< 0.001	< 0.001	< 0.05
34.	Chloramines, mg/l	<2.0	<2.0	< 0.001
35.	Silver as Ag, mg/l	< 0.1	< 0.05	<0.5
36.	Cyanide as Cn, mg/l	< 0.05	< 0.5	< 0.1
37.	PAH, mg/l	< 0.0001	<0.025	< 0.0001
38.	Trihalomethanes, mg/l			
a	Bromoform	<0.01	<0.01	<0.01
b	Dichlorobromomethane	<0.01	<0.01	<0.01
c	Bromodichloromethane	<0.01	<0.01	<0.01
d	Chloroform	<0.01	<0.01	<0.01
39.	Alachlor, μg/l	< 1.0	< 0.5	< 1.0
40.	Atrazine, μg/l	< 1.0	< 0.5	< 1.0
41.	Aldrin, μg/l	< 1.0	< 0.01	< 1.0
42.	Alpha HCH, μg/l	< 1.0	< 0.01	< 1.0
43.	Beta HCH, μg/l	< 1.0	< 0.01	< 1.0
44.	Butachlor, μg/l	< 1.0	< 5.0	< 1.0
45.	Chlorpyriphos, μg/l	< 1.0	< 0.05	< 1.0
46.	Delta HCH, , μg/l	< 1.0	< 0.01	< 1.0
47.	DDT, μg/l	< 1.0	< 0.01	< 1.0
48.	Endosulphan, , μg/l	< 1.0	< 0.01	< 1.0
49.	Ethion, , μg/l	< 1.0	< 0.05	< 1.0
50.	Lindane, , μg/l	< 1.0	< 0.01	< 1.0
51.	Malathion, , μg/l	< 1.0	< 0.05	< 1.0
52.	Methyl parathion, , μg/l	< 1.0	< 0.01	< 1.0
53.	Monocrotophos , μg/l	< 1.0	< 0.5	< 1.0

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Sr. No.	Sampling Locations	NMIA Project site	NMIA Project site	NMIA Project site
	Sampling month	**17.06.2025**	**16.07.2025**	**16.09.2025**
54.	Phorate, µg/l	< 1.0	< 0.5	< 1.0
Microbiology				
55.	Coliform (MPN/100 ml)	Absent	Absent	Absent
56.	E. Coli/100 ml	Absent	Absent	Absent

4.5.1 Drinking Water Analysis Inference:

The analysis results indicate the pH range of 6.8 to 7.4 and is observed within the desirable limit of 6.5 to 8.5, beyond this range water will affect the mucous membrane and/or water supply system. The total hardness is in the range of 44 to 56 mg/l and is observed within the permissible limit of 600 mg/l. The total hardness beyond the permissible limit causes encrustation in water supply structure and adverse effects on domestic use. The iron concentration is found 0.03 to 0.04 mg/l and is observed within the acceptable limit of 1.0 mg/l. Beyond the desirable limit taste/appearance are affected, has adverse effect on domestic uses and water supply structures, and promotes iron bacteria.

The chlorides concentration is in the range of 10 mg/l to 16 mg/l and is observed to be within the acceptable limit of 250 mg/l. Beyond this limit, taste, corrosion and palatability are affected. The fluoride concentration is 0.32 to 0.38 mg/l and is observed within the acceptable limit of 1.0 mg/l at all locations, high fluoride may cause fluorosis. The value of TDS is observed from 70 to 90 mg/l and is observed within the desirable limit of 500 mg/l at all locations and are also within the permissible limit of 2000 mg/l. The Drinking water samples were collected from two locations and analyzed for physical, chemical and biological parameters. Which shows that the samples are potable as per IS 10500-RA2018.

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4.6 QUARTERLY MARINE WATER QUALITY ANALYSIS REPORT DURING June 2025

Surface Marine water samples were collected for different Physiochemical and Biological parameters from 10 stations on 20th and 21st June 2025. The analysis part is mentioned in subsequent sections below.

Figure 4-1 Collection of Marine Water and sediment samples during June 2025

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4.6.1 Analytical Data - Physicochemical Parameters during June 2025

Table 4-17: Marine water physicochemical analysis at various stations during June 2025

Sr. No.	Parameter	MW 1	MW 2	MW 3	MW 4	MW 5	MW 6	MW7	MW 8	MW9	MW 10	Unit
		S	S	S	S	S	S	S	S	S	S	
1.	pH	7.0	7.0	7.0	7.4	7.3	7.3	7.05	7.4	7.3	7.0	--
2.	Temperature	28	27	27	27	27	27	27	27	26	27	°C
3.	Turbidity	1.4	1.4	1.4	1.6	1.3	1.4	2.0	2.1	2.8	1.4	NTU
4.	Conductivity	220	320	450	638	750	700	1250	1.7	4.5	580	mS/Cm
5.	Salinity	4.2	2.6	0.2	2.8	4.0	22.2	22.8	22.2	26.4	28.8	ppt
6.	Iron as Fe,	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	mg/l
7.	Magnesium as Mg	9.7	18	14.6	6.8	48	18	9.2	30	210	16.5	mg/l
8.	Manganese as Mn	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	mg/l
9.	Fluoride	0.32	0.30	1.8	0.32	0.32	0.36	0.32	0.42	0.84	0.32	mg/l
10.	Sulphate	420	140	48	250	550	590	420	550	600	108	mg/l
11.	Phenolic compound	18	16	24	18	28	16	14	12	6.0	28	µg/l
12.	Alkalinity	86	86	92	76	82	92	90	96	196	160	mg/l
13.	Hardness as CaCO3	98	108	122	72	112	154	120	234	650	192	mg/l
14.	Zinc as Zn	<0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	mg/l
15.	Cadmium as Cd	< 0.01	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	mg/l
16.	BOD	1.3	1.2	1.8	1.2	1.0	1.6	1.2	1.1	1.2	1.0	mg/l
17.	Chloride	1120	1160	1233	1100	50	1180	1120	1200	1830	2020	mg/l
18.	DO	2.0	2.1	2.1	2.0	1.8	1.8	2.0	1.8	1.6	1.8	mg/l
19.	Total Nitrogen as N	4.1	4.2	2.6	3.2	4.0	3.2	3.2	3.1	3.2	3.4	µmol/l
20.	Phosphorus as P	1.4	1.1	1.4	1.0	1.6	0.84	0.85	0.94	0.8	1.4	µmol/l
21.	Sodium as Na	80	154	150	142	140	139	135	138	138	100	mg/l
22.	Potassium as K	20	100	80	102	102	104	100	102	108	100	mg/l
23.	Lead as Pb	< 0.01	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	mg/l
24.	Mercury as Hg	<0.001	< 0.001	< 0.001	< 0.001	< 0.001	<0.001	<0.001	<0.001	<0.001	<0.001	mg/l
25.	Chromium as Cr	<0.01	< 0.01	< 0.01	<0.01	< 0.01	<0.01	<0.01	<0.01	<0.01	<0.01	mg/l

4.6.2 Inference - Physicochemical Parameters during June 2025

The pH value ranged from 7.0 to 7.4 at surface represents Acidic nature of water. Salinity was low form MW1 to MW5 due to influx of fresh water and in increasing trends in creek waters during collection Period of sampling as proceedings from Gadhi river to Panvel creek.

Dissolved Oxygen level was observed low at MW9 during collection of time due to seasonal variation. BOD value suggests the presence of organic matter present in water body which comes as domestic sewage discharge from surrounding areas (villages, STPs of NMMC in Nerul) and effluents from CETP at MIDC Taloja.

The concentration of Magnesium was high at MW9 and Iron were low at all stations (Refer Table 4.17).

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4.6.3 Analytical Data - Biological Parameters during June 2025

Biological parameters viz. Phytopigments, Phytoplankton, Zooplankton, Benthos and Microbiology were analyzed, and compiled data is presented below:

Table 4-18: Marine Water biological analysis of stations (MW1 to MW5) during June 2025

Parameter	MW 1	MW 2	MW3	MW4	MW5
	S	S	S	S	S
Phytoplankton					
Chlorophyll (mg/m^3)	1.23	0.98	55.65	0.53	1.07
Pheophytin (mg/m^3)	0.64	0.14	1.41	0.53	3.20
Population (nox10^3/L)	19.2	12	36	22.4	60
Total Genera (No)	12	7	14	15	18
Major Genera	*Navicula (29.2%) Nitzschia (20.8%), Leptocylindrus (12.5%), Thalassiosira (4.2%)*	*Navicula (33.3%), Nitzschia (20.0%) Euglena (13.3%), Cyclotella (13.3%)*	*Nitzschia (31.1%), Skeletonema (24.4%), Navicula (11.1%) Thalassiosira (6.7%)*	*Skeletonema (28.6%), Navicula (14.3%) Nitzschia (7.1%), Pleurosigma (7.1%)*	*Skeletonema (48.0 %) Anabaena (13.3%), Navicula (6.7%), Pseudonitzschia (6.7%)*
Diversity Index	2.14	1.77	2.09	2.39	1.96
Zooplankton					
Population (no 10^3/100m^3)	1	1	2	2	1
Total Group (No)	1	1	1	4	4
Major Groups	*Copepods (100%),*	*Copepods (100%)*	*Cladocera (100%)*	*Copepods (71.76%), Cladocera (27.78%) Decapod (0.35%), Ostracod (0.12%)*	*Copepods (69.65%), Cladocera (27.36%), Decapod (2.86%), Polychaete (0.12%)*
Biomass (ml/100m^3)	16.7	16.7	16.7	0.2	0.2
Diversity Index	0.00	0.00	0.00	0.62	0.72
Macrobenthos					
Population (no x 10^2/m^2)	278	434	35	139	2066
Total Group (No)	1	1	1	1	1
Major Groups	*Polychaete (100%)*	*Polychaete (100%)*	*Polychaete (50%) Crab (50%)*	*Polychaete (100%)*	*Polychaete (100%)*
Biomass (gm/m^2)	2.03	7.47	0.45	0.40	30.81
Diversity Index	0.00	0.00	0.69	0.00	0.00
Microbiology					
Total Coliform (MPN/100 ml)	>1600	>1600	>1600	>1600	>1600

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Table 4-19: Marine Water biological analysis of stations (MW6 to MW10) during June 2025

Parameter	MW 6	MW 7	MW8	MW9	MW10
	S	S	S	S	S
Phytoplankton					
Chlorophyll (mg/m^3)	1.92	1.60	2.14	2.67	1.07
Pheophytin (mg/m^3)	3.96	1.39	1.60	1.44	0.80
Population ($nox10^4/L$)	52.8	48	72.8	156	18.4
Total Genera (No)	15	12	13	13	9
Major Genera	*Nitzschia (37.9%), Skeletonema (15.2%), Anabaena (15.2%), Thalassiosira (10.6%)*	*Nitzschia (38.3%), Skeletonema (35.0%) Navicula (10.0%) Thalassiosira (3.3%)*	*Skeletonema (56.04%), Nitzschia (8.79%) Navicula (8.79%) Scenedesmus (8.79%)*	*Skeletonema (85.6%), Nitzschia (5.6%), Cyclotella (2.1%) Pleurosigma (1.0%)*	*Navicula (21.7%), Thalassiosira (17.4%) Scenedesmus (17.4%), Nitzschia (13.0%)*
Diversity Index	2.0	1.62	1.63	0.70	2.02
Zooplankton					
Population (no x $10^3/100m^3$)	1.43	5	3	2	2
Total Group (No)	5	3	3	4	1
Major Groups	*Copepods (78.90%), Cladocera (17.93%), Decapod Larvae (2.93%), Fish Larvae (%)*	*Copepods (77.6%), Cladocera (17.85%) Decapod larvae (4.5%)*	*Copepods (79.77%) Cladocera (14.65%), Decapoda larvae (5.57%)*	*Copepods (78.4%), Cladocera (19.9%), Decapoda (11.3%), Fish Egg (0.4%)*	*Copepods (100%)*
Biomass ($ml/100m^3$)	0.1	5.4	0.3	0.1	16.7
Diversity Index	0.61	0.64	0.62	0.59	0.00
Macrobenthos					
Population (no x $10^2/m^2$)	764	2257	1198	122	35
Total Group (No)	1	1	2	1	1
Major Groups	*Polychaete (100%)*	*Polychaete (100%)*	*Polychaete (81.16%), Bivalve (18.84%)*	*Polychaete (100%)*	Polychaete (100%)
Biomass (gm/m^2)	12.14	29.53	158.16	8.47	0.31
Diversity Index	0.00	0.00	0.48	0.00	0.00
Microbiology					
Total Coliform (MPN/100 ml)	>1600	>1600	>1600	>1600	>1600

4.6.4 Inferences - Biological Parameters during June 2025

4.6.4.1 Phytoplankton

In June 2025, Chlorophyll ranged from 0.53 to 55.65 mg/m^3 and pheophytin ranged 0.14 to 3.96 mg/m^3; at surface water of all 10 stations. **Figure 4.2** below shows graphical representation of phytopigments in different stations.

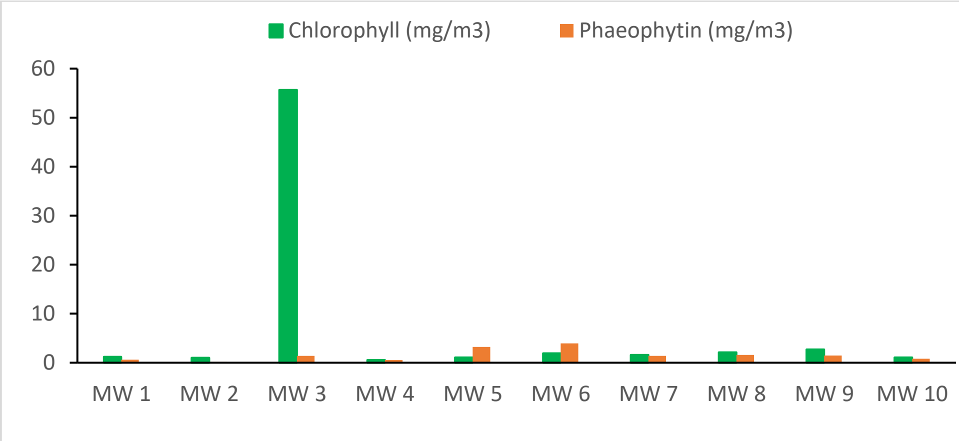

Figure 4-2: Representation of phytopigments for June 2025

Phytoplankton population density ranges from 12-156 x 10^3/l at surface water of all 10 stations. Highest phytoplankton population at surface water of MW9 may be due to influx of domestic water from surrounding villages; total generic groups ranges from 7-18 nos. at surface water of all 10 stations. Maximum generic diversity 18 no. is observed at surface water of Station MW5 and lowest at MW2 respectively during June 2025 (Refer Table 4.18 and 4.19).

Navicula, Nitzschia, Thalassiosira, Skeletonema and Pleurosigma are most common ones, followed by rest of observed genera like *Pleurosigma, Cyclotella* and *Leptocylindrus*. The other freshwater phytoplankton genera found are *Scenedesmus, Anabaena, Closterium, Phacus and Pediastrum* in Gadhi river (MW1) and Ulwe river (MW10) respectively. Graphical representations of phytoplankton population and total genera is represented in **Figure 4.3**.

The graph below shows the population of phytoplankton is more at MW2; and less at station MW10, which represents there is discharge of sewage and domestic waste. The phytoplankton trend with respect to total number of genera is high at Station MW5. Some of the major genera seen were photographed and shown in **Figure 4.4.**

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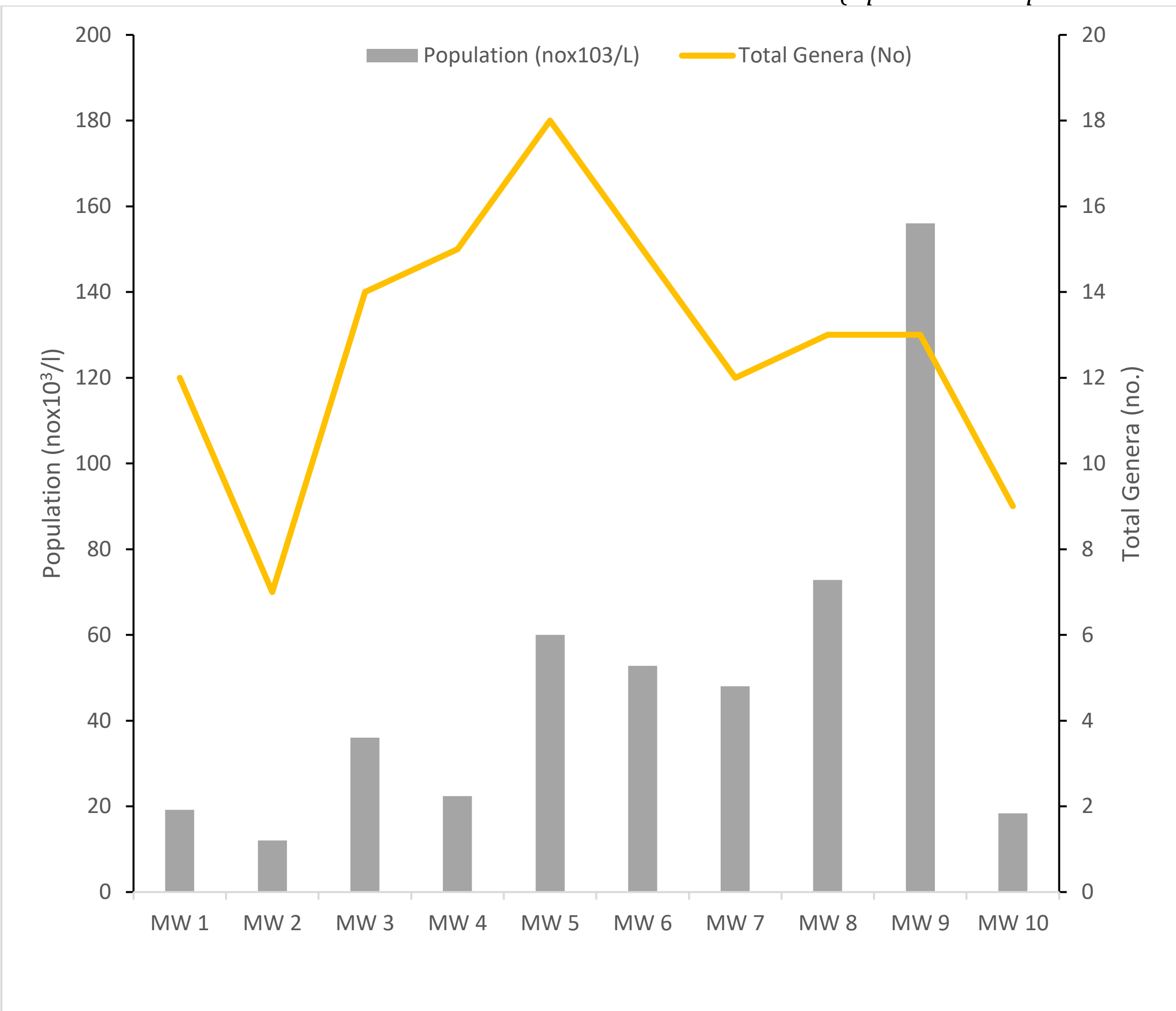

Figure 4-3: Representation of phytoplankton population & Total genera June 2025

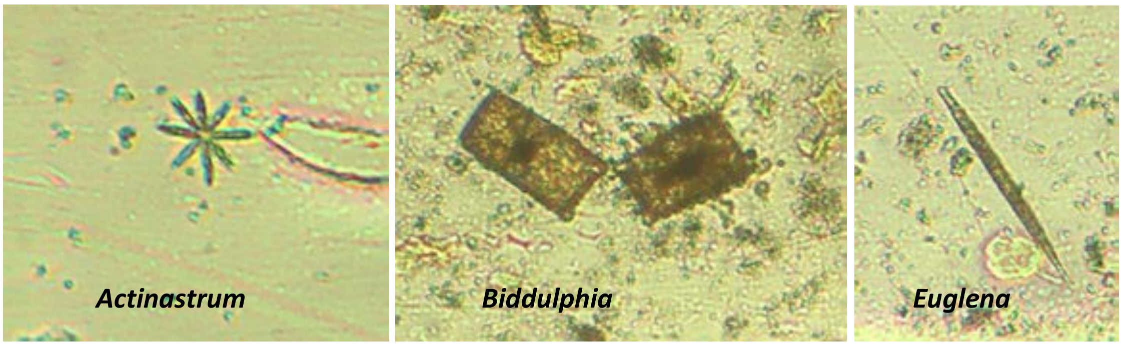

Figure 4-4: Phytoplankton found in samples for June 2025

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4.5.4.2 Zooplankton

In June 2025, the zooplankton biomass ranged from 0.1 to 16.7 ml/100 m^3 with population density of 1 to 5 x 10^3/100 m^3 while having faunal groups ranging from 1-5 nos. The zooplankton was noted with a good population and group diversity. Copepods, Cladocera, Decapods and Polychaetes were common groups observed, **Figure 4.5** represents zooplankton standing stock graphically and **Figure 4.6** represents photos of peculiar zooplankton genera. The graph below represents that standing stock reported from all stations; MW1, MW2 and MW5 shows lowest population respectively as compared to MW7 with highest population; and MW6 shows lowest biomass and MW10 shows highest biomass, respectively.

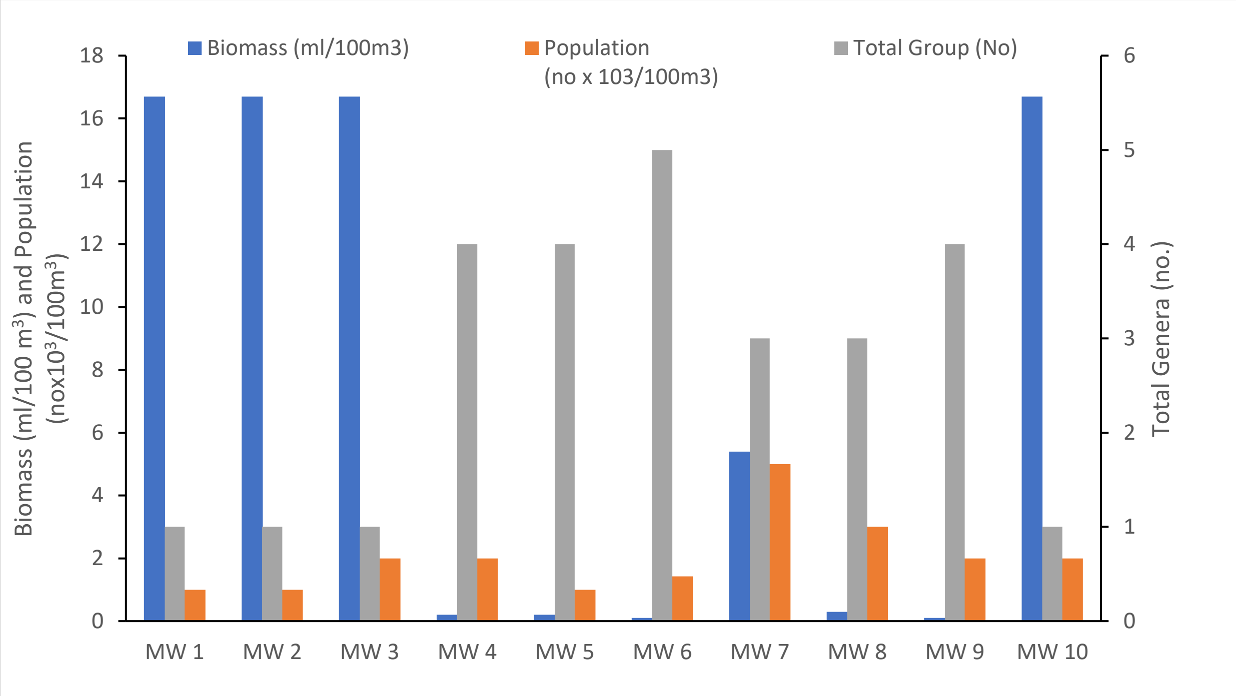

Figure 4-5: Representation of Zooplankton Biomass, Population & Total group for June 2025

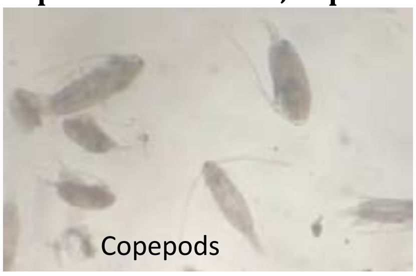

Figure 4-6 Zooplankton found in samples for June 2025

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4.6.4.3 Macrofauna

In June 2025, macro-benthic biomass ranged from 2.21 to 54.61 gm/ m^2 with population ranging from 208 to 4213 (no x $10^2/m^2$). Total group 1 to 2 was observed. Low biomass noted at MW4 and high biomass at MW3. Low population was noted at MW2 and high population observed at MW7. The faunal group found were majorly Polychaete. **Figure 4.7** shows the % composition of benthic organisms for study period. Figure 4.8 shows peculiar organisms found.

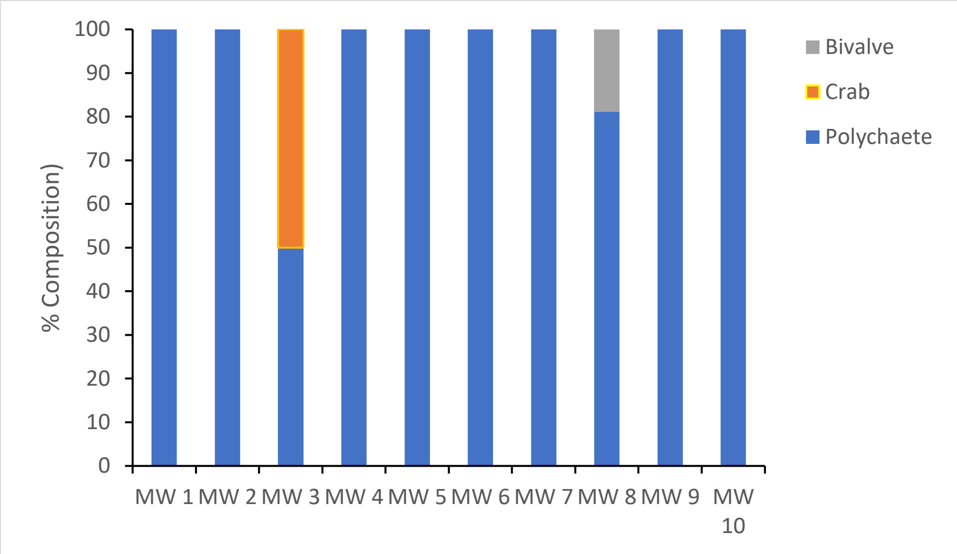

Figure 4-7 % Composition of Benthic organisms for June 2025

Polychaetes

Figure 4-8 Benthic organism Found in samples for June 2025

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4.6.4.5 Microbiology

Coliform microbes were present at all stations in surface level. No specific trend was observed.

4.7 QUARTERLY MARINE WATER QUALITY ANALYSIS REPORT DURING September 2025

Surface Marine water samples were collected for different Physiochemical and Biological parameters for 10 stations on 18th and 20th September 2025. The analysis part is mentioned in subsequent sections below.

Figure 4-9 Collection of Marine Water samples during September 2025

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4.7.1 Analytical Data - Physicochemical Parameters during September 2025

Table 4-20: Marine water physicochemical analysis at various stations during September 2025

Sr. No.	Parameter	MW 1	MW 2	MW 3	MW 4	MW 5	MW 6	MW 7	MW 8	MW9	MW 10	Unit
		S	S	S	S	S	S	S	S	S	S	
1.	pH	7.0	7.1	7.1	6.9	6.9	6.9	7.0	7.1	7.1	7.2	--
2.	Temperature	26	29	29	27	26	26	26	27	26	26	°C
3.	Turbidity	1.1	1.1	1.1	1.8	1.6	1.3	1.5	1.4	1.8	1.2	NTU
4.	Conductivity	305	272	427	8690	14200	18330	15930	27500	32022	703	mS/Cm
5.	Salinity,	2.4	2.2	2.0	2.8	3.0	3.4	3.2	3.8	4.2	2.8	ppt
6.	Iron as Fe,	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	mg/l
7.	Magnesium as Mg	8.2	5.8	10.2	170.1	320.7	359.6	359.6	651.2	777.6	7.2	mg/l
8.	Manganese as Mn	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	<0.01	<0.01	<0.01	<0.01	<0.01	mg/l
9.	Fluoride	0.320	0.32	0.3	0.36	0.34	0.36	0.32	0.36	0.32	0.30	mg/l
10.	Sulphate	3.5	3.4	9.9	507.6	356.4	93.96	1139.4	2311.2	2046.6	28.94	mg/l
11.	Phenolic compound	14	10	8.0	12	14	12	14	14	10	10	µg/l
12.	Alkalinity	48	56	56	118	66	86	88	96	86	94	mg/l
13.	Hardness as CaCO3	74	78	86	1040	1800	2200	3480	3480	3800	134	mg/l
14.	Zinc as Zn	< 0.01	<0.01	< 0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	mg/l
15.	Cadmium as Cd	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	<0.01	mg/l
16.	BOD	1.0	0.8	1.2	1.0	1.2	1.2	1.0	0.5	1.0	1.6	mg/l
17.	Chloride	28	36	202	3200	5200	7200	5700	11500	13200	110	mg/l
18.	DO	1.7	1.2	2.2	1.8	2.0	2.1	1.8	1.0	1.7	2.1	mg/l
19.	Total Nitrogen as N	1.4	1.4	2.0	2.9	2.8	3.4	3.5	3.0	2.6	1.8	µmol/l
20.	Phosphorus as P	1.1	0.8	0.84	1.4	1.1	1.4	1.2	0.88	1.1	0.84	µmol/l
21.	Sodium as Na	84	150	148	140	144	132	130	140	130	138	mg/l
22.	Potassium as K	24	102	82	100	98	102	98	102	100	98	mg/l
23.	Lead as Pb	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	mg/l
24.	Mercury as Hg	<0.001	< 0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	mg/l
25.	Chromium as Cr	<0.01	<0.01	<0.01	<0.01	< 0.01	<0.01	<0.01	<0.01	<0.01	<0.01	mg/l

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4.7.2 Inference - Physicochemical Parameters during September 2025

The pH value ranged from 6.9to 7.2 at surface, which shows basic neutral to alkaline nature of water. The salinity was observed low at station MW4 to MW6 due to influx of fresh water during collection Period of sampling.

Dissolved Oxygen level was observed low during collection of time due to seasonal variation at all locations. BOD value suggests the presence of organic matter in the water body which comes as domestic sewage discharge from surrounding areas (villages, STPs of NMMC in Nerul) and effluents from CETP at MIDC Taloja.

The concentration of Magnesium was low at MW1, MW2 & MW10, and Iron was low at all stations (Refer Table 4.20).

4.7.3 Analytical Data - Biological Parameters during September 2025

Biological parameters viz. Phytoplankton, Zooplankton, Benthos and Microbiology were analyzed, and compiled data is presented below:

Table 4-21: Marine Water biological analysis of stations (MW1 to MW5) during September 2025

Parameter	MW 1	MW 2	MW 3	MW 4	MW 5
	S	S	S	S	S
Phytoplankton					
Chlorophyll (mg/m^3)	2.67	1.07	0.53	1.07	3.21
Pheophytin (mg/m^3)	3.31	6.04	2.08	0.69	33.84
Population ($nox10^3/L$)	18.4	20.0	10.4	28.8	108
Total Genera (No)	10	13	9	11	11
Major Genera	*Skeletonema (34.8%), Navicula (17.4%) Nitzschia (13.0%), Peridinium (8.7%)*	*Leptocylindrus (28.0%), Navicula (16.0%), Nitzschia (16.0%) Thalassiosira (4.0%)*	*Nitzschia (23.1%), Anabaena (23.1%), Navicula (7.7%) Closterium (7.7%)*	*Munieria (44.4%), Anabaena (11.1%) Thalassiosira (11.1%), Oscillatoria (8.3%)*	*Skeletonema (85.19 %), Bacteriastrum (5.93%), Spirulina (2.22%), Oscillatoria (1.48%)*
Diversity Index	1.97	2.23	2.06	1.87	0.71
Zooplankton					
Population (no x $10^3/100m^3$)	2	1	1	0.2	1
Total Group (No)	1	1	1	3	3
Major Groups	Copepods (100%)	Copepods (100%)	Copepods (100%)	Copepods (63.6%), Cladocera (29.5%) Decapod (7.0%)	Copepods (70.43%), Decapod (16.45%), Cladocera (13.11%)
Biomass ($ml/100m^3$)	16.7	16.7	8.3	0.2	0.3
Diversity Index	0.0	0.0	0.00	0.83	0.81
Macrobenthos					
Population (no x $10^2/m^2$)	69	347	486	3212	139

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Parameter	MW 1	MW 2	MW 3	MW 4	MW 5
	S	S	S	S	S
Total Group (No)	1	1	1	1	1
Major Groups	Polychaete (100%)	Polychaete (100%)	Polychaete (100%)	Polychaete (100%)	Polychaete (100%)
Biomass (gm/m²)	0.09	0.77	3.55	16.2	0.47
Diversity Index	0.00	0.00	0.00	0.00	0.00
Microbiology					
Total Coliform (MPN/100 ml)	>1600	>1600	>1600	>1600	>1600

Table 4-22: Marine Water biological analysis of stations (MW6 to MW10) during September 2025

Parameter	MW 6	MW 7	MW 8	MW 9	MW 10
	S	S	S	S	S
Phytoplankton					
Chlorophyll (mg/m³)	4.81	1.60	8.02	10.16	2.14
Pheophytin (mg/m³)	3.96	2.14	1.71	10.05	0.11
Population (nox10³/L)	308	24	790.4	1335.2	36.8
Total Genera (No)	12	9	10	11	16
Major Genera	*Skeletonema (94.8%), Bacteriastrum (2.3%), Nitzschia (0.5%), Closterium (0.3%)*	*Skeletonema (73.3%), Thalassiosira (3.3%), Pleurosigma (3.3%) , Spirulina (3.3%)*	*Skeletonema (96.7%), Thalassiosira (0.9%) Nitzschia (0.8%) Chaetoceros (0.7%)*	*Skeletonema (97.6%), Thalassiosira (1.7%), Pseudonitzschia (0.2%) Guinardia (0.1%)*	*Navicula (32.6%), Rhizosolenia (21.7%) Euglena (10.9%), Gyrosigma (4.3%)*
Diversity Index	0.30	1.13	0.21	0.14	2.18
Zooplankton					
Population (no x 0³/100m³)	7	24.89	22	16	Nil
Total Group (No)	7	4	5	5	Nil
Major Groups	Copepods (94.95%), Decapod Larvae (3.39%) Cladocera (1.12%), Medusa (0.26%)	Copepods (99.82%), Decapod larvae (0.12%), Gastropods (0.04%), Chaetognath (0.03%)	Copepods (99.84%) Decapoda larvae (0.07%) Gastropods (0.04%), Chaetognath (0.03%)	Copepods (99.60%), Gastropod (0.22%), Decapoda (0.13%), Chaetognath (0.03%)	Nil
Biomass (ml/100m³)	1.1	1.8	1.6	0.9	Nil
Diversity Index	0.25	0.01	0.01	0.03	Nil
Macrobenthos					
Population (no /m²)	35	1580	590	382	Nil
Total Group (No	1	2	4	1	Nil
Major Groups	Polychaete (100 %)	Polychaete (98.90%) Crab (1.10%)	Polychaete (76.47%), Amphipod (14.71%) Prawns (5.88%), Bivalve (2.94%)	Polychaete (100%)	Nil
Biomass (gm/m²)	0.07	116.9	8.44	0.36	Nil

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Parameter	MW 6	MW 7	MW 8	MW 9	MW 10
	S	S	S	S	S
Diversity Index	0.00	0.06	0.76	0.00	Nil
Microbiology					
Total Coliform (MPN/100 ml)	>1600	>1600	>1600	>1600	>1600

4.7.3 Inferences - Biological Parameters during September 2025

4.7.3.1 Phytoplankton

In September 2025, Chlorophyll ranged from 0.53 to 10.16 mg/m^3 and pheophytin ranged 0.11 to 38.34 mg/m^3 at surface water of all 10 stations. The **Figure 4.10** below shows graphical representation of phytopigments at different stations.

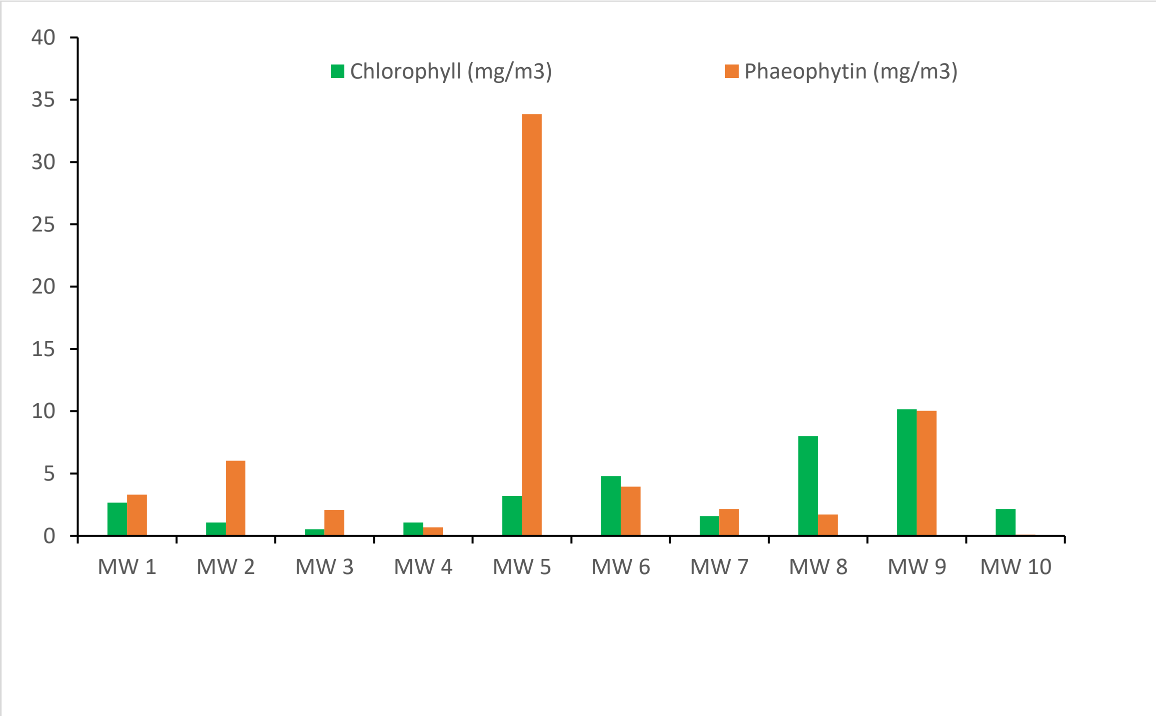

Figure 4-10: Representation of phytopigments for September 2025

The phytoplankton population ranged from 10.4 to 1335.2 (no x 10^3/l) with highest population noted at Station MW9 and Lowest at Station MW3. Total generic groups range from 9-16 nos. at surface water of all 10 stations. Maximum generic diversity 16 no. is observed at surface water of Station MW10 during September 2025 (Refer Table 4.21 and 4.22).

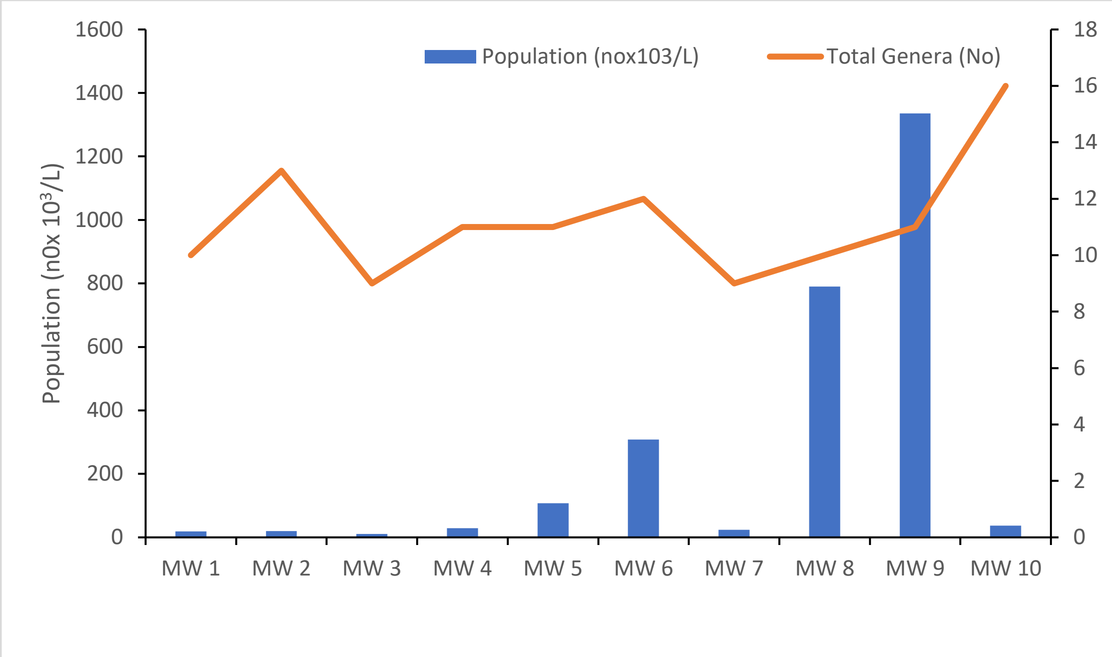

Figure 4-11: Representation of phytoplankton population & Total genera September 2025

Skeletonema, Navicula, Nitzschia and Thalassiosira are most common ones, followed by rest of observed genera like *Pleurosigma, Navicula, Gyrosigma and Oscillatora*. The other freshwater phytoplankton genera found are *Scenedesmus*, Phacus, *Agmenellum and Pediastrum* in Gadhi River (MW1) and Ulwe river (MW10) respectively. Graphical representations of phytoplankton population and total genera are represented in **Figure 4.11**, graph below shows the population of phytoplankton is maximum at MW9; and less at station MW3. The phytoplankton trend with respect to the total number of genera is high at Station MW10 and low at station MW3 & MW7 respectively. Some of the major genera seen were photographed and shown in **Figure 4.12**.

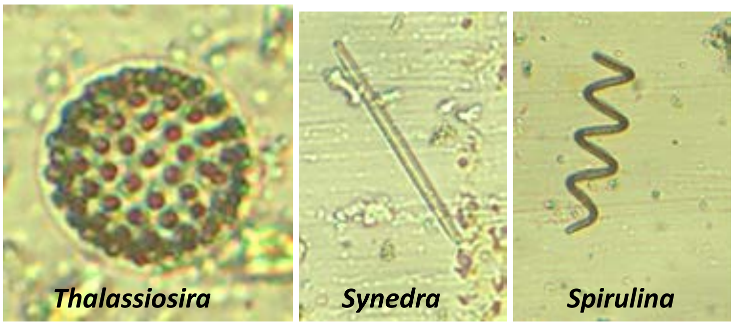

Figure 4-12: Phytoplankton found in samples for September 2025

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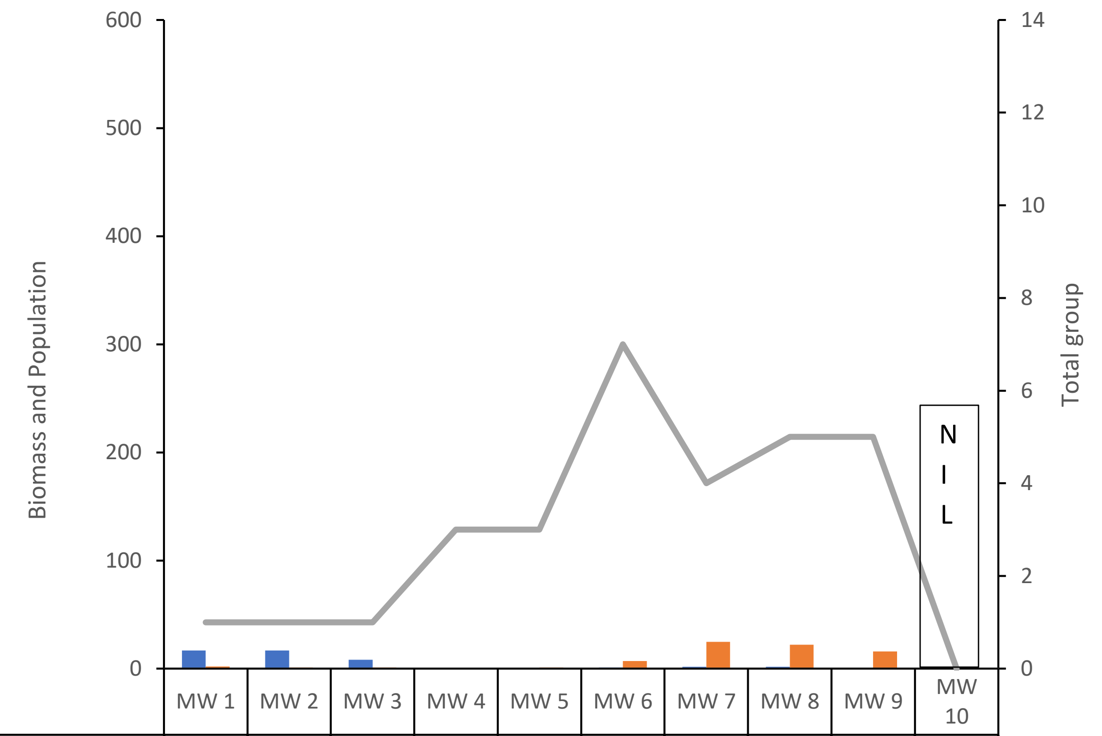
4.7.3.2 Zooplankton

In September 2025, the zooplankton biomass ranged from 0.2 to 16.7 ml/100 m^3 with population density of 0.2 to 24.89x $10^3/100m^3$ while having faunal group ranging from 1-7 nos. The zooplankton was noted with good population and group diversity. Copepods, Decapods, Cladocera & Gastropods were common groups observed, **Figure 4.13** represents zooplankton standing stock graphically and **Figure 4.14** represents photos of peculiar zooplankton found in marine water body.

The graph below represents that the average standing stock reported from all stations; Station MW4 has lowest population as compared to Station MW7 with highest population; and Station MW4 show lowest biomass and Station MW1 and MW2 shows the highest biomass, respectively.



	MW 1	MW 2	MW 3	MW 4	MW 5	MW 6	MW 7	MW 8	MW 9	MW 10
Biomass (ml/100m3)	16.7	16.7	8.3	0.2	0.3	1.1	1.8	1.6	0.9	0
Population (no x 103/100m3)	2	1	1	0.2	1	7	24.89	22	16	0
Total Group (No)	1	1	1	3	3	7	4	5	5	0

Figure 4-13: Representations of Zooplankton Biomass, Population & Total group for September 2025

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Figure 4-14: Zooplankton found in samples for September 2025

4.7.3.3 Macrofauna

In September 2025, macro-benthic biomass ranged from 0.07 to 116.9 gm/ m^2 with population ranging from 35 to 3212 /m^2. The total group ranges from 1 to 4. The lowest biomass was noted at MW5 and high biomass at MW7. The lowest population was noted at MW6 and high population observed at MW4. The faunal group found were majorly Polychaetes. The % composition and peculiar Benthic organism are shown in **Figure 4.15** and **4.16** respectively.

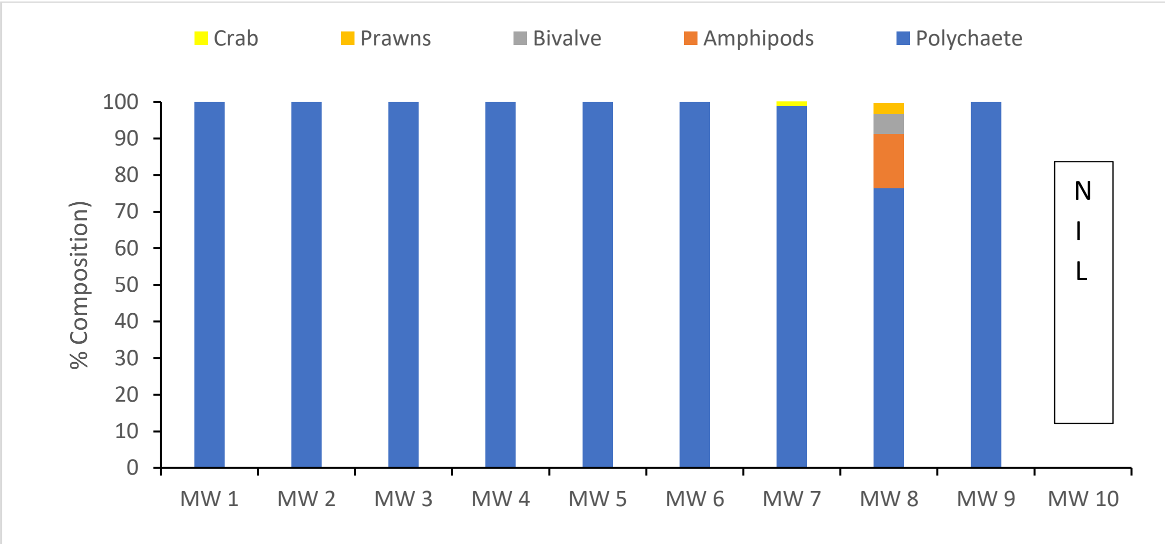
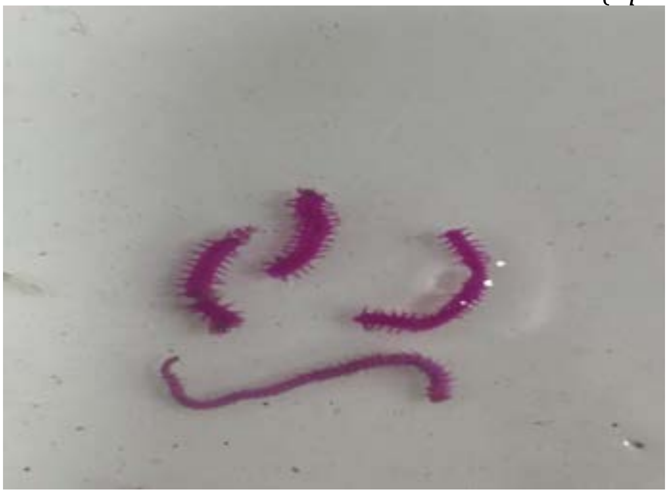


Figure 4-15: % composition of Benthic organisms for September 2025



Polychaete

Figure 4-16: Benthic organism found in samples for September 2025

4.7.3.5 Microbiology

Coliform microbes were present at all stations in surface level. No specific trend was observed.

4.8 DG SET Monitoring

4.8.1 Stack Monitoring

The stack monitoring was done at NMIA project Site. The table below represents results of Gaseous emission for the months of May 2025 and August 2025.

Table 4-23 Stack Monitoring of DG Set

Sampling Locations	DG 1		MPCB Limit	Unit
Sampling Date	**14.05.2025**	**12.08.2025**		
Gas Temperature	131	125	-	(°C)
Gas Velocity	11.8	8.5	-	(m/s)
Gas Flow Rate	612	446	-	(Nm^3/hr.)
Particulate Matter	39.5	33.8	150	(mg/Nm^3)
Sulphur Dioxide	30.8	28.3		(mg/Nm^3)
Sulphur Dioxide	0.45	0.30	-	(Kg/Day)
Oxides of Nitrogen	44.2	41.5	-	(mg/Nm^3)
NMHC	23.5	11.9	-	(mg/Nm^3)

Figure 4-17 DG Stack Sampling

The monitoring undertaken indicates the stack Air Quality Values for Particulate matter is under limit set by MPCB.

4.8.2 Noise monitoring

The Noise generated from DG Set was monitored at NMIA project Site. The tables below represent results of noise generated for the months of May 2025 and August 2025.

Table 4-24 Noise Quality of DG Set

Reading from 0.5 m away from DG Set				
Direction	DG 1			
	14.05.2025		**12.08.2025**	
	Door Closed	**Door Opened**	**Door Closed**	**Door Closed**
East	73.7	98.9	73.9	99.8
West	73.9	99.7	72.9	99.9
South	74.0	98.9	73.5	98.8
North	73.5	99.7	74.2	99.5
Avg.	73.8	99.3	73.6	99.5
Difference	25.5		25.9	

Figure 4-18 Noise monitoring for DG Set

The monitoring undertaken indicates the DG Noise Quality value for insertion loss is within consent limit.

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Long-Term Bird Monitoring Programme of Navi Mumbai International Airport (NMIA) Area and its Surroundings during Construction and Operational Phases

Mid Term Report 2018-2023

Submitted to

The City and Industrial Development Corporationof Maharashtra (CIDCO) Ltd.

Submitted by

Bombay Natural History Society (BNHS)

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2025

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Layout and Design: V. Gopi Naidu

Note: The findings are a summary of annual observations only. The final analysis will only be per- formed after completion of the project tenure.

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Table : List of Abbreviations	
BASH	Bird Aircraft Strike Hazard
BNHS	Bombay Natural History Society
CIDCO	City and Industrial Development Corporation of Maharashtra Ltd.
GIS	Geographic Information System
GPS	Global Positioning System
LULC	Land Use Land Cover
MoEFCC	Ministry of Environment, Forest and Climate Change
NMIA	Navi Mumbai International Airport
PCS	Point Count Station
R	Resident
M	Migrant

Team Information	
Position	**Name**
Principal Investigator	Rahul Khot
JRF	Sarbasis Dutta
Driver	Ashok Pisal

Chapter 1 - Progress Report and Current Status

1.1 The brief from NMIA proposal and background:

BNHS took the offer made by CIDCO of conducting five years pre-construction phase study (2012-2015) on the ecology of the birds in and around the proposed airport site. This study was primarily focused on shorebirds, most of which are migratory because of their exceptional flight abilities and massive abundance, which was a real concern for aviation. BNHS conducted a pilot study in order to determine sites for long-term monitoring of birds at Navi Mumbai and shortlisted eleven sites based on their locations, habitat, bird species diversity and abundance of which eight were wetlands – Training Ship Chanakya (TSC), Non-residential Indian (NRI) Complex, Delhi Public School (DPS), Kharghar Creek, Kalundre River, Sonari-Belpada, Dastan Phata Jasai, Uran and three were forested areas i.e., Karnala Bird Sanctuary, Chinar, and Mosare.

The study indicated the local movement of birds is driven by tide height and water depth in high-tide roosting sites (inland wetlands) which highlighted the importance of these wetlands in the conservation and management of the birds in these areas. Apart from observational examination we also conducted ringing studies and satellite monitoring around Mumbai for investigating the migratory ecology of shorebirds, resident birds, birds of prey, and birds of Karnala Bird Sanctuary. Mumbai has been identified as one of the important areas in the Central Asian Flyways, which plays a vital role in maintaining the fragile group of wader population wintering in India. (Balachandran *et al.*).

Impacts of construction and post-construction phases of the airport on birds needs to be investigated. In addition to this, while looking at the key site for migratory birds (if any) ringing studies coupled with cutting-edge techniques such as stable isotope and population genetics will be used for increasing our understanding the migratory ecology of birds for their effective conservation and management.

The long-term objectives of this study include: A) Assessing the impact of construction and post-construction activities on birds through changes in their behaviour before, during, and after construction and examining spatial and temporal (within and between years) patterns in population and communities' dynamics of the birds and factor affecting it in addition to construction activities. B) Monitoring the movement of waders and land birds between the roosting and foraging sites and identifying species-wise flock composition and preferential habitats C) To determine the carrying capacity of existing wetlands in terms of biomass/current population of bird's as well as the Benthic composition of wetlands in the study area and to explore migration pattern and population dynamics of migratory birds in Mumbai and Navi Mumbai. D) To standardize the stable isotopes method for analyzing regional and global scale population movement and feeding ecology of migratory and resident birds in Mumbai. E) To develop a genetic library for precise identification of bird hazard cases and to standardize the DNA barcoding techniques for accurate identification of the birds involved in aircraft strikes. F) To explore the possibility of bird strike events in Navi Mumbai aerodromes to formulate a conservation and management plan for NMIA. G) To provide the measures to reduce the risk of bird strikes. H) To suggest a practical solution to reduce the impact of developmental activities on birds and their long-term conservation.

1.2 The executive summary of 1st and 2nd NMIA annual reports:

The Navi Mumbai region with its diverse habitat types such as mangroves, mudflats, creeks, grasslands, and agricultural fields amongst others is home to various bird species. To assess the impacts of the upcoming Navi Mumbai International Airport (NMIA) on the avian fauna in the region BNHS started pilot surveys in a 10km radius around the Airport. We stratified the study area based on habitat. Grid sampling was carried out habitat wise and point count surveys were undertaken in the grids. Along with data on bird species, other covariates, both physical and environmental were noted down. The data thus obtained was used to understand the diversity of birds in the various habitat types and the influence of these habitats on bird ecology. The diversity of birds was found to be highest in mangroves and mudflats**.** The abundance of house crows was highest in agricultural areas, rock doves were highest in urban, red-vented bulbul in green spaces, oriental magpie-robin in degraded areas, and little cormorant in mangroves. Post the pilot surveys we intend to start the first phase of surveys which will aim at understanding the occupancy and density of birds in the area and the factors that impact them.

After completing our pilot survey, we started our seasonal intensive surveys on birds and their habitat covariates. Grid sampling was carried out habitat-wise, and fixed-radius point count surveys were undertaken in the grids. Along with the data on bird species, other covariates, both physical and habitat, were noted down. We also surveyed wetlands in the study area and noted the water bird species and their abundance. In addition to this, we carried out a pilot survey in Panvel Creek to determine the species present and to fix a methodology for creek surveys. The species richness was highest in green spaces in post monsoon season while in the winter season it was highest in mangroves and mudflats. We computed the average abundance of bird species across the different habitat types in both survey seasons. We found the average abundance of Rock Dove (*Columba livia)* to be highest across all habitat types except green spaces and at the airport site in the post-monsoon survey. In the winter survey, the average abundance of Lesser Flamingo *Phoeniconaias minor* was highest compared to other species. Amongst the synanthropic species, the abundance of Rock Dove was the highest. We also used diversity indices to determine the character of a community. The various indices calculated to decipher the community structure include Pielou’s Evenness Index-to determine species evenness, Shannon-Wiener, and Simpson’s Dominance Index to determine richness and abundance patterns, and Bray-Curtis Dissimilarity Index to measure distance between habitat types depending on their composition.

1.3 Executive Summary of the 3rd and 4th NMIA annual report:

After the initial two consecutive year of intensive bird sampling in the NMIA construction site and its 10 km surroundings, the 3rd and 4th Annual Report brought a better understanding of bird communities and their associated habitat types. The main objectives of the study included a) the habitat- wise seasonal patterns in the bird species richness and abundance of the terrestrial and water bird species in the 10 km radius in and around the NMIA site. b) Data collection on garbage dumps and meat shops in the various habitats and also the associations of bird species in them. We had also extended our study area beyond 10km radius based on the presence of potential habitats like Morbe Dam, Gadeshwar Dam, Hetanwe Dam, and Pen Grasslands. We observed a total of 229 species from the study area and we recorded 80 species from the NMIA airport construction site. Additionally, we have updated the checklist of birds present in garbage dumps and meat shops mentioned in our previous annual report.

1.4 Executive Summary of the 5th NMIA annual report:

After four consecutive year of intensive bird sampling in and around NMIA site, this report brings a more rigorous and comprehensive ideas of bird communities and their associated habitat types. The main objectives of the current study included 1) Continuation of habitat-wise seasonal patterns in the bird species richness and abundance of the bird species in the 10km radius around the NMIA site. 2) Observations on the bird species and their season-wise abundance accounted in the NMIA construction site and its adjacent creek and mangrove habitat. 3) Checklist of overall bird diversity along their family classification and IUCN status in the study area. 4) Data collection on meat shops in the various habitats and also the associations of bird species in them. 5) Study on water bird species presence and abundance in all the selected wetlands of our study area. We have also analyzed the species richness of birds in all the habitat types where we observed Mangrove habitat has the highest species richness whereas Urban habitat has the lowest species richness across all the seasons. We have also analyzed and presented the ten ‘most represented’ species based on their higher abundance for all the habitat types including NMIA site. Same analysis has been performed for the monthly surveys in the studied wetlands and Belapur-Panvel Creek area. Till now, we have observed a total of 231 species from the study area although the species recorded from the NMIA airport construction site has decreased from 80 to 60 species. Additionally, we have updated the checklist of birds present in relevant meat shops locations along with bird association in the study points.

1.5 Way Forward:

More intensive sampling will be performed season-wise and monthly on terrestrial and water birds respectively to understand their changing patterns based on species abundance and richness. We will also try to understand the changes in Land Use-Land Cover (LULC) for the last eleven years to understand the alteration of habitat types and the shaping of bird community structure in these habitats.

Chapter 2 - Land Use - Land Cover (LULC) Classification at QGIS

The main habitat types are urban areas, agriculture, degraded habitats, green spaces, mangroves, mudlflats, salt pans creek and inland water-bodies. The land use/land cover classification of NMIA (Navi Mumbai International Airport) was carried out using Sentinel – 2 satellite data and reference with Bhuvan Thematic services, base map and Google Earth then digitized given area. An imagery of 10 m resolution obtained from this dataset was digitized in ArcGIS (Version 10.7) by identifying the spectral features of different land use types.

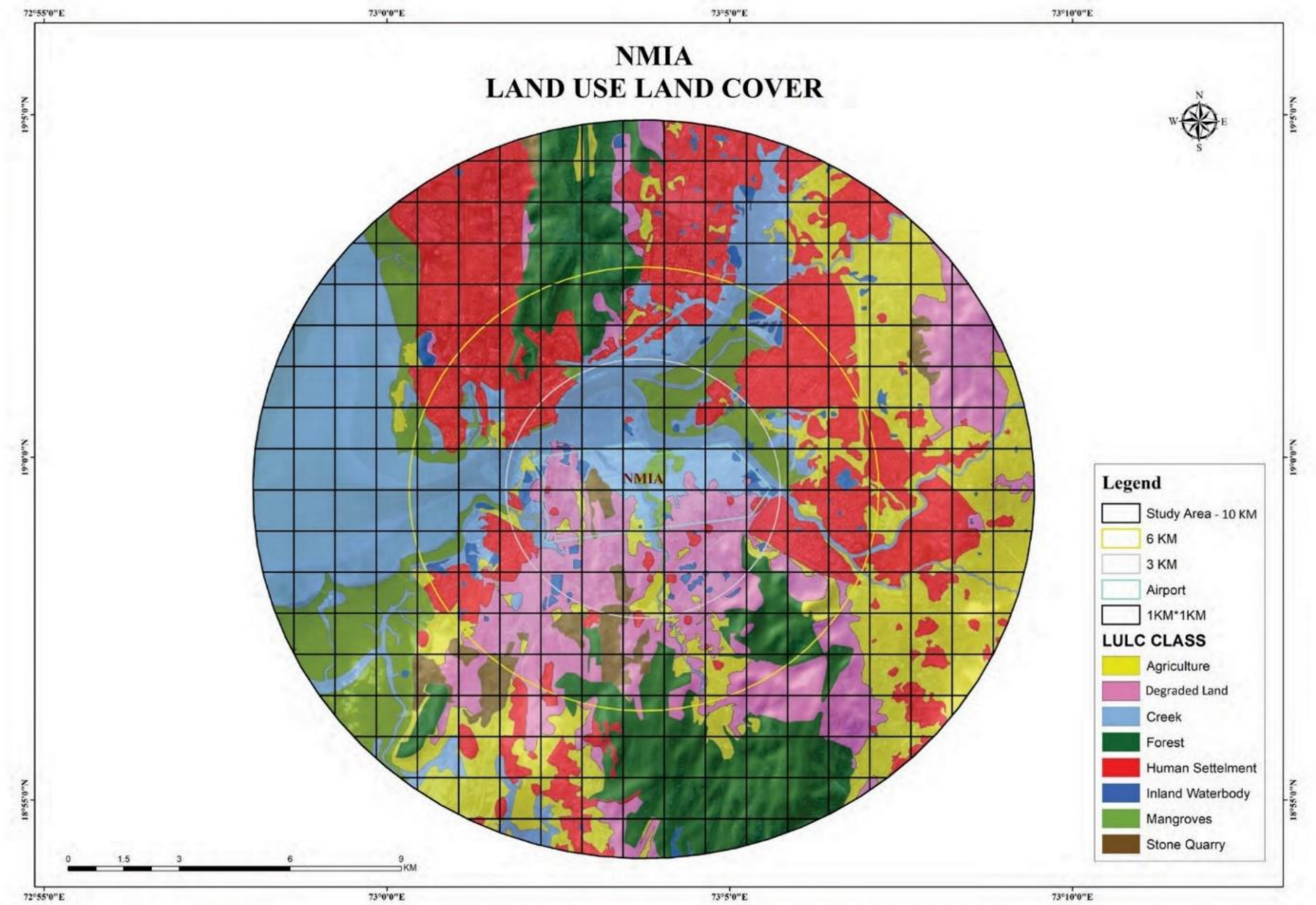

Figure 1: Land Use- Land Cover Classified Map showing all the habitat types at NMIA and surroundings

Table 2.1: The percentage and description of each habitat type

Habitat Type	Percentage of Habitat Type in Study Area	Habitat description considering all the microhabitat types
Human Settlements	23.68	Urban settlements, associated rural areas and peri-urban areas.
Inland Water bodies	1.40	Lakes, ponds, dams and wetlands, both perennial and annual bodies as well as natural and artificial bodies.
Creek	20.50	An inlet that flows into the land from the sea. Our study area covered a part of the Thane creek, the Panvel creek and its smaller inlets.
Agricultural Area	17.31	Agricultural fields under cultivation and fallow lands.
Mangrove	7.24	Trees or shrubs that largely belong to the genus Avicennea. Mangroves have special root systems that help them to adapt to the dynamic creek ecosystem, especially the changing water levels and the brackish waters.
Degraded Habitat	16.66	Habitats that have been altered extensively from their original state. Such habitats included small patchy growth of scrubs and grasses, stone quarries and land that has been altered for infrastructural projects.
Green spaces	13.21	Secondary growth forests, continuous scrublands and grasslands. Patches of moist deciduous forest and scrub forest were also included in this category.

Chapter 3- Terrestrial Bird Survey

Study Sites

The study was conducted in parts of Navi Mumbai and Raigad districts in Western Maharashtra, India. The upcoming Navi Mumbai International Airport (NMIA) is being constructed at Ulwe-Kopar- Panvel in Maharashtra and the study area covers a 314 sq.km with the NMIA airport at its center. The study area stretches to the north with the area of Turbhe as its northern border, and the Mosare Forest Range marks the southern border. The Thane Creek marks the western border, and the village of Nere in Raigad District marks the eastern border. Additionally, we have extended our study site considering the potential habitat types in some areas of Raigad District like Pen grasslands, Hetawane Dam area, Vashi Sagar Vihar area, andTaloja area.

The study area is a heterogeneous landscape with varied habitat types as mentioned: 1) Mangrove mudlflats, salt pans, 2) Green Space/Fores, 3) Urban Areas, 4) Agriculture, 5) Creek and Inland Water bodies, 6) Degraded Habitats.

The study area experiences four distinct seasons: Summer (March–May), Monsoon (June–September), Post Monsoon (October-December), Winter (January-March starting). The temperature in this region ranges from a minimum of 17° C to a maximum of 34° C. The average maximum rainfall received by the region is 3000mm. The region experiences high humidity throughout the year.

Methodology

A thorough and systematic literature review is consistently been carried out which helped us to advance the methodology for the present study and also effectively plan for implementing methods for our new objectives.

Post Monsoon Survey 2021, Winter Survey 2021-2022, Summer Survey 2022 could be performed in various sampling points. The entire area was divided into 1km X 1km grids through stratified random sampling. We carried out the fixed-radius point count methodology at each of the three PCS (Point count Stations) in the grid. To carry out bird point count, we recorded birds in a 100-m radius from the selected point. Each point count was conducted for ten minutes. In the ten minutes time frame, all the birds that were seen or heard were noted down, and their numbers were also recorded. An ocular estimate of the distance of the birds from the observation point was noted.

Other site covariates such as temperature, wind speed, visibility, noise and cloud cover were recorded. The locality and time of the survey were also noted. The birds were identified by referring to Ali & Ripley 1983, Grimmett et al. 1998 and Rasmussen & Anderton 2012. Fly in, fly out and fly away birds are also taken into consideration while doing our regular surveys.

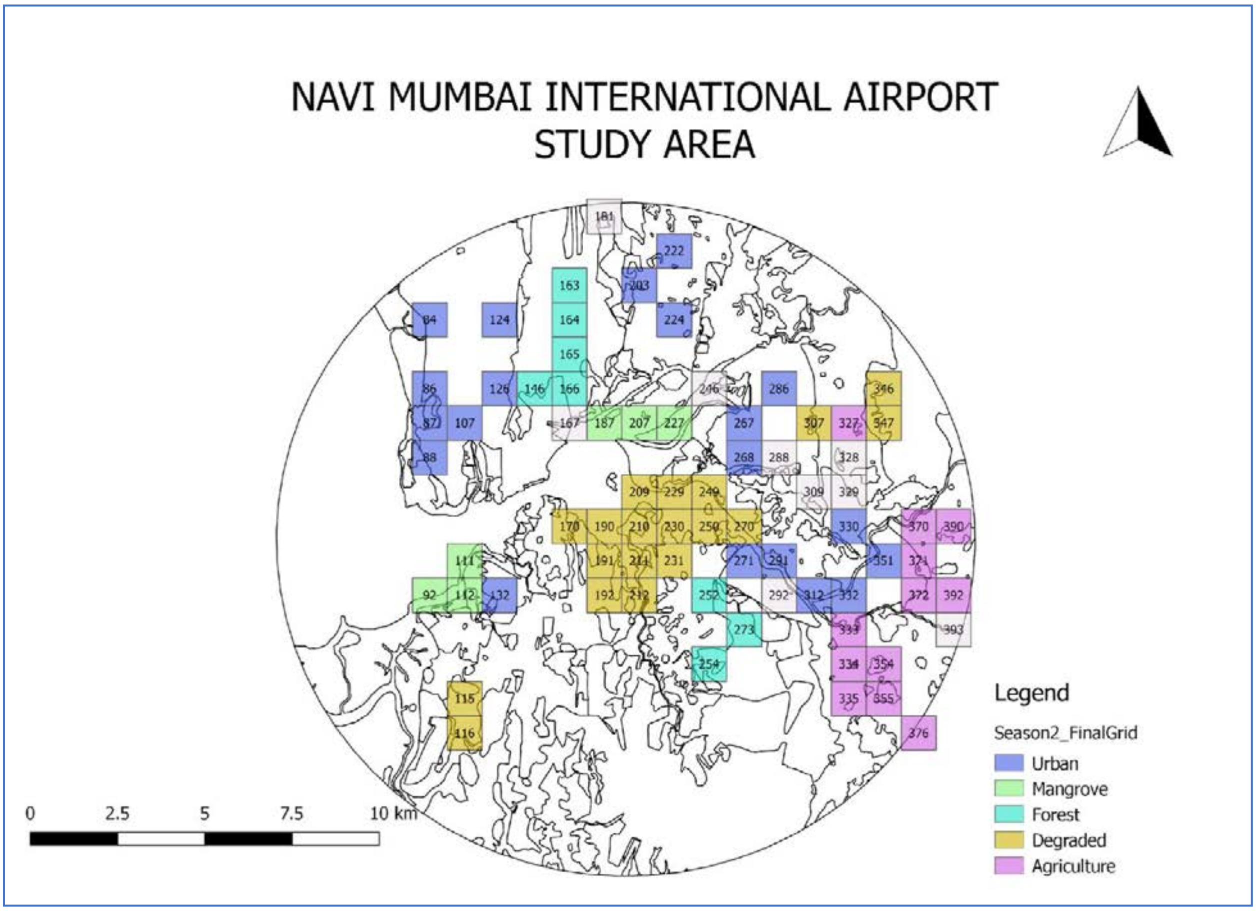

Figure 2 : Grid-wise habitat classification for the Fixed-radius Point Count survey

Methodology for Habitat Assessment in the study area

In our present study, at each point count station, a circular plot was demarcated with a radius of around 20m for the habitat assessment.

For each plot, various parameters were recorded to understand the ground cover and anthropogenic influences. Four transacts were taken from the central point in cardinal directions, that is, north, south, east and west, at ten-meter and twenty-meter intervals, a scale of one meter was laid, and at every 25 cm, the ground cover was recorded.

It is especially essential to understand the factors affecting the occurrence of birds in urban habitats in order to maintain or even increase the diversity of birds in these fragments. Several other studies also indicate that at moderate levels of urbanization, species density and richness peaked and decreased respectively as urbanization increased (Blair 2004). To assess the human impact in our study area, we planned our methodology to include various potential anthropogenic indicators affecting the bird diversity and abundance.

Tree cutting & Lopping: The number of vertically cut trunks in a particular tree was counted to understand the extent of tree cutting (Brack 2003). The number of longitudinally cut stems were also counted along with branches and tree stumps to assess the degree of lopping. Tree stumps were also counted.

Presence of Fire: Periodic burning of grasslands and scrublands are very common anthropogenic stressors in some habitat types in our study area like degraded lands and forested patches. From conversations with local people, we learnt that this is mostly done by tribal communities and farmers to increase the fertility of the soil which helps to make the particular area suitable for farming. Signs of fire were noted at the survey sites. We intend to interact with local people to get more explicit narratives about the fire history of the area.

Signs of Domestic Intervention: As domestic intervention is considered to be primary anthropogenic stress in a particular area, we assessed this parameter grid-wise in our study area, also taking into consideration the number of hoof marks, and dung cakes along with the number of dogs, cats, and cattle.

Percentage of Invasive Species: A significant process of success of invasive species is mainly dependent on the extent of disturbance in the recipient ecosystem (Tamburello *et al.* 2014). If disturbance, either biotic or abiotic, is prevalent in an ecosystem, it can promote invasion by increasing the availability of limited resources (space, light, and nutrients) and by reducing competition with natives (Tamburello *et al.* 2014). At each PCS, we considered a 20m circular plot within which we estimated the percentage of invasive weeds through the ocular method. Percentage of invasive species at a given plot can broadly help us to determine the condition of soil texture, which can indicate the extent of habitat fragmentation.

Human Trails/Pathways: In each grid of our study area, specifically in forested and mangrove patches, we considered the presence of human trails whenever encountered and also noted down the human activities around, whenever relevant.

Canopy Cover: Canopy is one of the chief determinants of microhabitat. It affects the plant growth and survival, hence determining the nature of vegetation and wildlife habitat. There are various techniques invented to measure the canopy cover (Jennings *et al.* 1999). Canopy cover is the area of ground covered by the vertical projection of the canopy. In our study area, after selecting random grids, we measured canopy cover in four cardinal directions in each point using spherical densitometer.

Urban Indicators: With the increasing number of human populations in an area, the need for buildings and infrastructure, traffic-related air pollution, noise pollution, and artificial light at night, has also been increased (Isaksson 2018). Thus, human population size is a relatively good indicator of city-level impact on birds (Isaksson 2018). In each grid, after selecting random points, we measured some relevant parameters in a 20-metre radius:

- Number of market places
- Number of meat shops
- Number of grocery shops

- Number of garbage dumps
- Type and number of urban structures: kutcha, one storey, two storeys, multi-storied
- Number of vehicles passing per minute
- Number of slaughter houses

3.1 Terrestrial Bird Survey:

Species Richness across habitats

During the terrestrial bird survey, the entire study area which includes NMIA and its 10km surrounding area, was divided into different kind of habitats. Bird species richness and abundance largely varied from one habitat type to another. To address the proper scientific explanation, understanding of correlation between bird species richness and its habitat covariates was most important.

Species Diversity

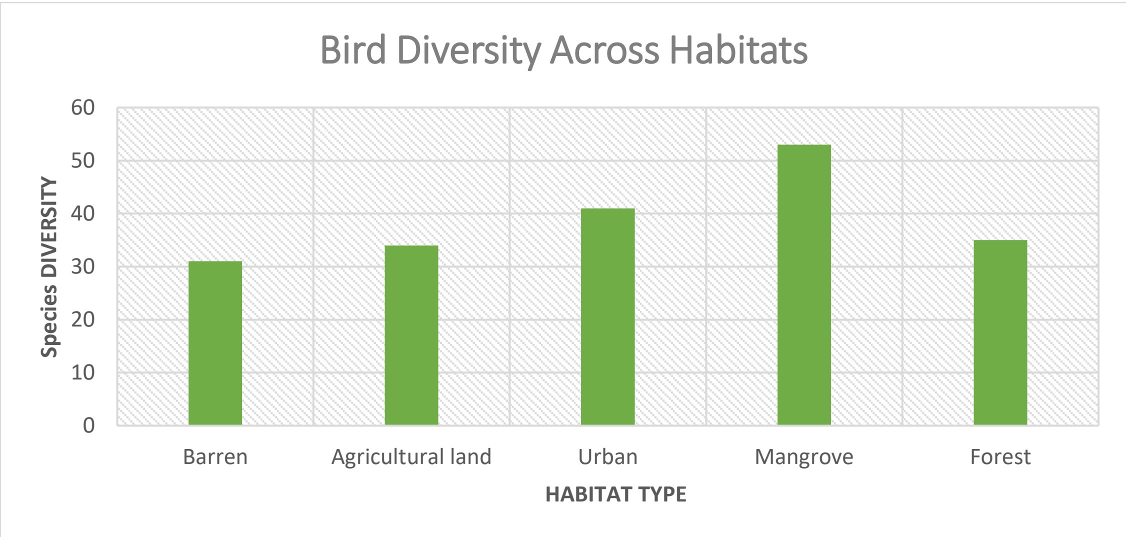

Figure 3.1: Bird diversity across habitats

The diversity of bird species across different habitat types was found. From Figure 3.1 it can be seen that the highest diversity was observed in mangroves, mudlflats, and salt pans. followed by urban areas. In forested areas & agricultural fields, the species richness was less but the species abundance was high. In barren lands, due to high level of disturbance & habitat destruction, the bird diversity was lower compared to the other habitats.

Species Abundance

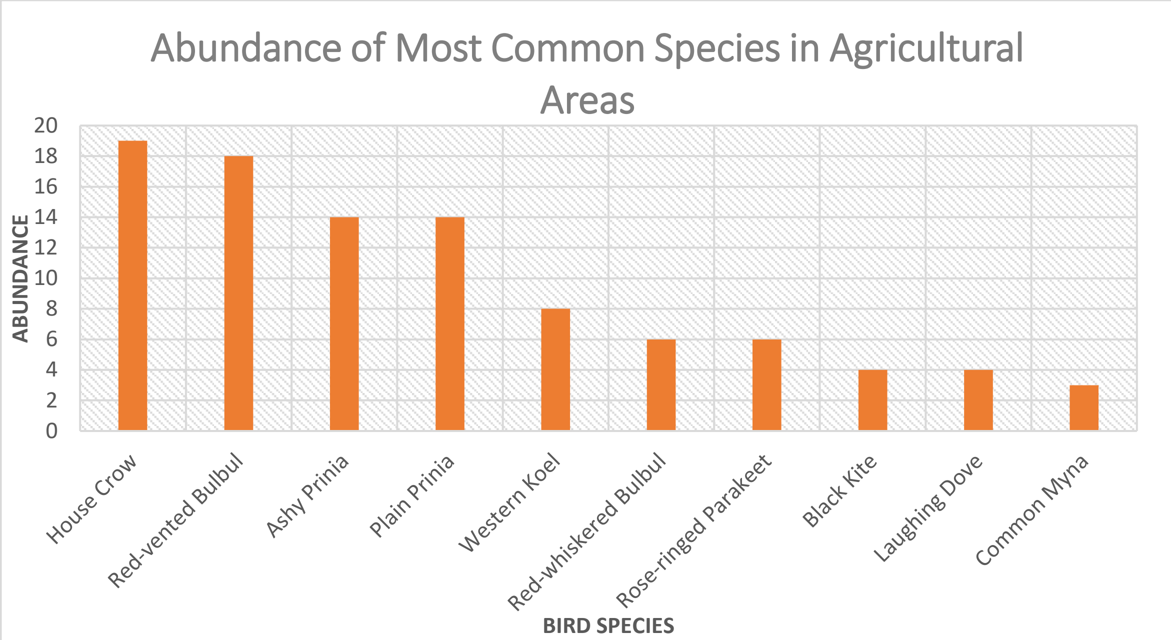

Figure 3.2 Abundance of Common species in agricultural areas

Based on abundance, the highest total number of individuals of different bird species in agricultural areas (Figure 3.2) were analysed. The highest recorded abundance was that of House crow (*Corvus splendens)*, followed by Red-vented Bulbul (*Pycnonotus cafer)* and then Ashy Prinia (*Prinia socialis*). Ashy Prinia and Plain Prinia (*Prinia inornata*) were mostly found in thickets of different grass species and weeds intermingled in agricultural land.

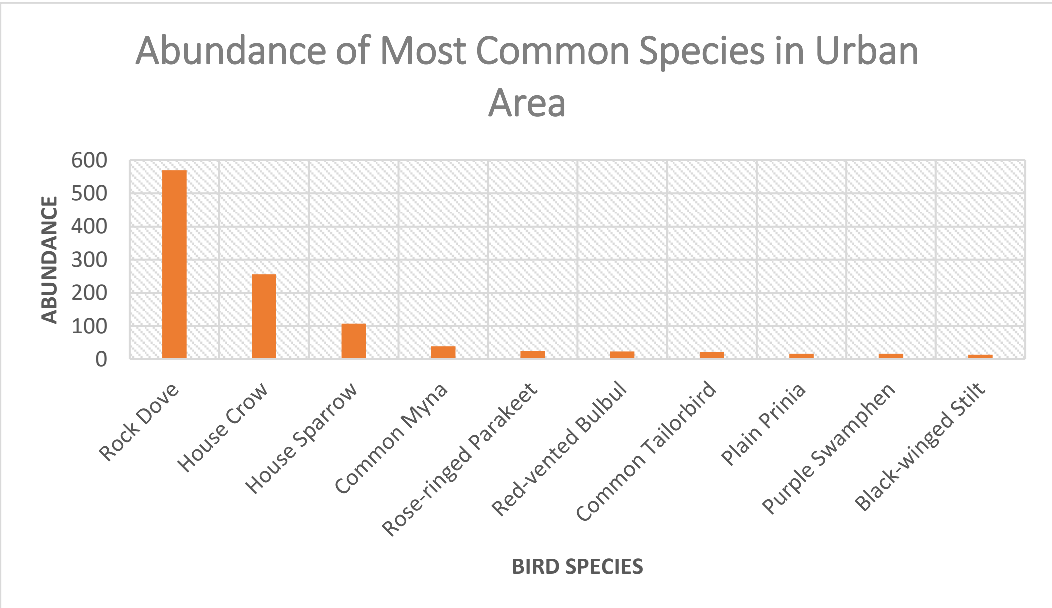

Figure 3.3 Abundance of common species in urban area

In urban areas (Figure 3.3), the highest abundance was that of Rock dove (*Columba livia*) followed by House Crow and House Sparrow (*Passer domesticus*) but surprisingly in the existing small waterbodies inside urban areas, few fascinating migratory and resident water birds has been found which include Purple Swamphen (*Porphyrio porphyrio*), Common Moorhen (*Gallinula chloropus*) , Little Grebe (*Tachybaptus ruficollis*), Bronze-winged Jacana (*Metopidius indicus*) and Pheasant-tailed Jacana (*Hydrophasianus chirurgus*) etc.

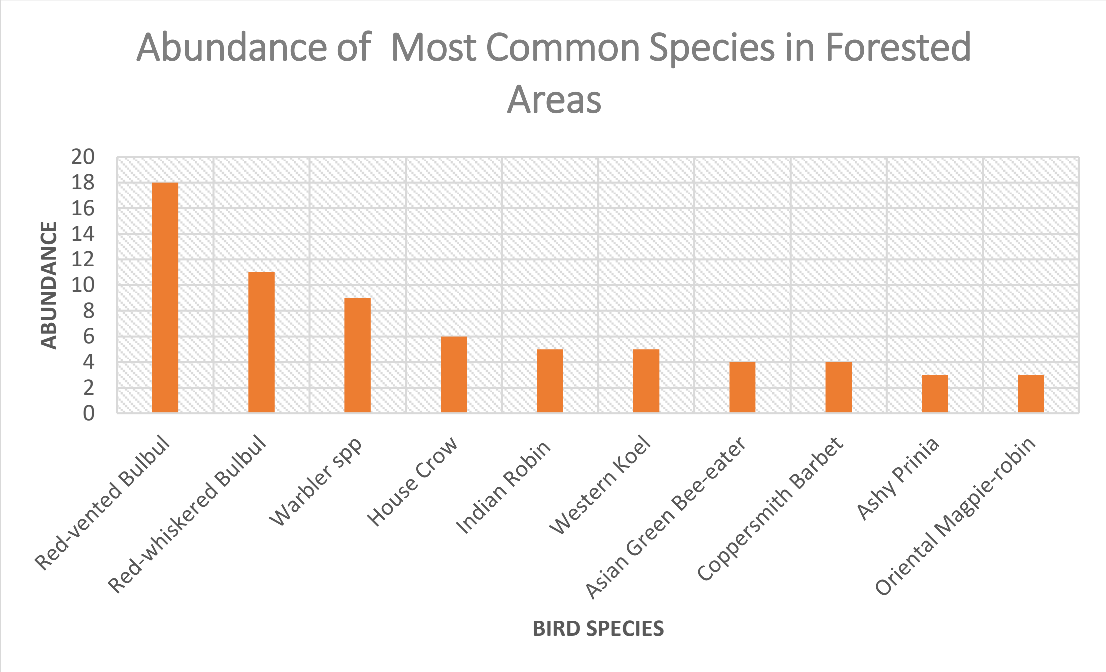

Figure 3.4 Abundance of common species in forested area

In forested areas (Figure 3.4), species abundance of birds is more due to comparatively higher level of habitat integrity and less disturbance. The abundance of Red-vented bulbuls and Red-whiskered bulbul (*Pycnonotus cafer*) was highest.

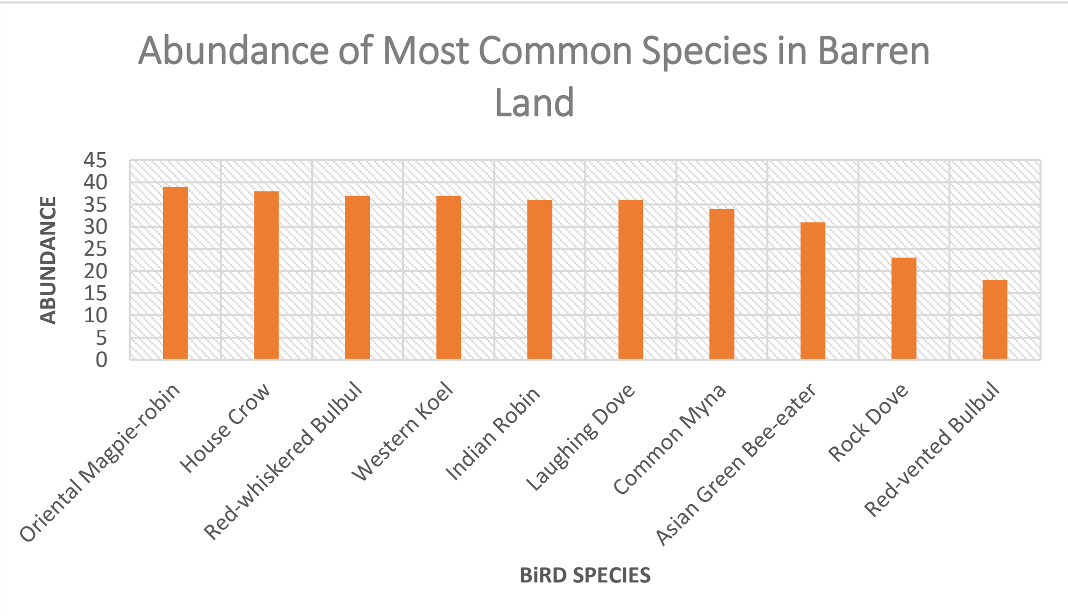

Figure 3.5 Abundance of common species in barren land

Barren lands are formed mostly as a result of habitat fragmentation or seasonal variation. As the habitat characteristics in Barren lands are highly dynamic, the bird species composition also changes accordingly. From Figure 3.5 it can be seen that Oriental magpie-robin (*Copsychus saularis*) had the highest abundance in barren land. The next highest abundance was that of House crow and Red-whiskered bulbul.

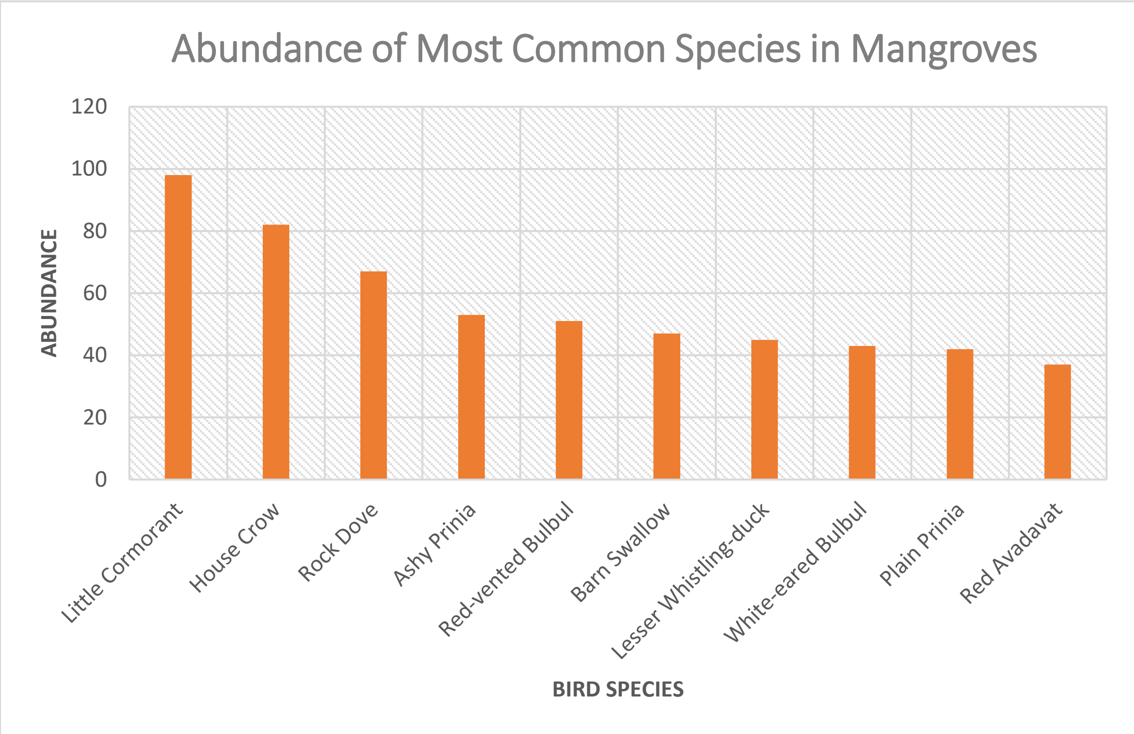

Figure 3.6 Abundance of common species in Mangroves

Mangroves mudlflats, and salt pans are the integral part in our study area as it supports a large number of both terrestrial and water bird species. In mangroves (Figure 3.6), Little Cormorants had the highest abundance followed by House Crow and Rock Dove. The abundance of Lesser Whistling Duck (*Dendrocygna javanica*), White-eared Bulbul (*Pycnonotus leucotis*) and Red avadavat (*Amandava amandava*) are also substantial in the study area.

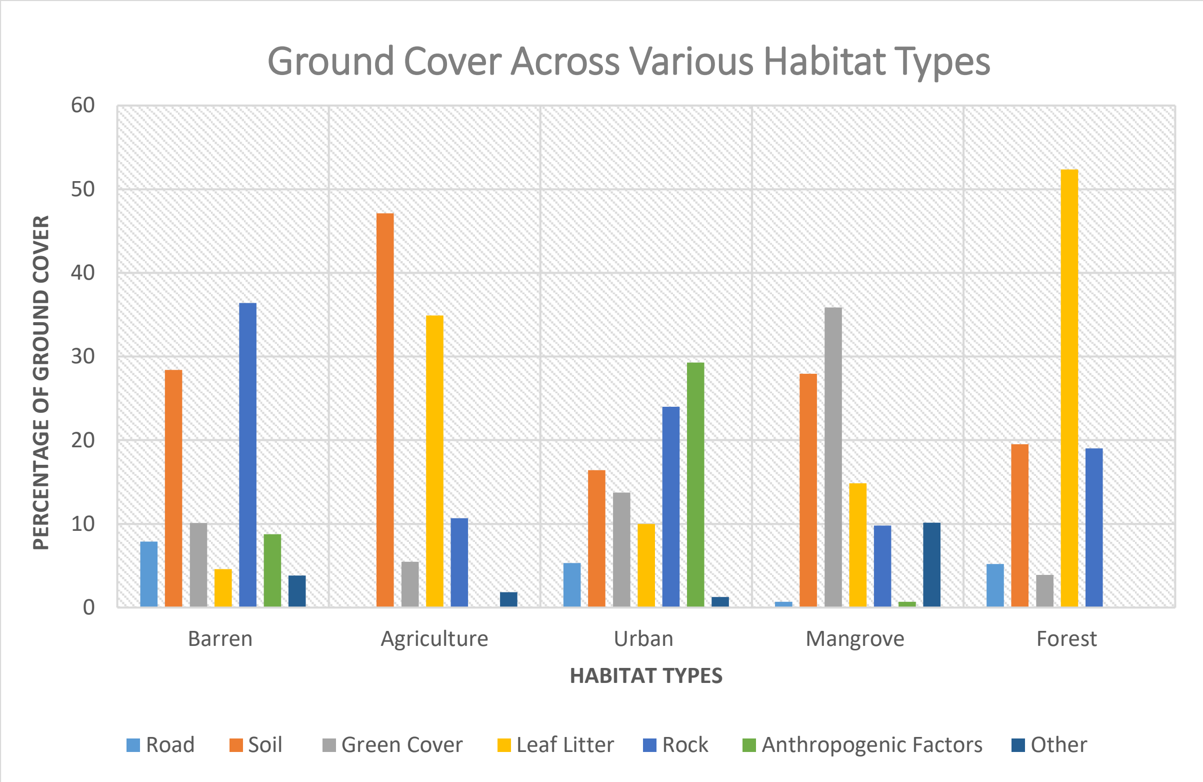

Figure 3.7 Percentage of ground cover across habitat types

The percentage of ground cover (Figure 3.7) analysed habitat wise in each circular plot of selected grids. For barren lands, percentage cover of rock is highest followed by the soil cover percentage while in agricultural fields soil cover percentage is highest followed by litter percentage cover, as survey was carried out pre-monsoon when the fields were ploughed for sowing. As can be seen from the figure, in urban areas, anthropogenic factors that comprise of built-up land and artificial obstruction, have the highest ground cover, this is followed by the percentage rock cover. Percentage green cover is highest in the mangroves followed by the soil percentage while in forests which are mainly dry deciduous in nature, the percentage of litter had covered the ground area mostly followed by soil and rock percent cover. Seasonal variation mainly along with other stressors had a significant effect on habitat wise ground cover.

3.2 Terrestrial Bird Survey: 2019-2020

Species Richness across habitats

We recorded species richness (total number of species observed) of bird species across the different habitats over two survey seasons – 1) Post monsoon (October-December 2019) and 2) Winter (January-March 2020). It can be seen from Figure 3.8, that the highest number of species in the post monsoon survey was recorded in green spaces, whereas in winter survey the richness was highest in mangrove mudlflats, and salt pans. The species richness was lowest in degraded habitat post monsoon while for winter survey it was lowest in green spaces.

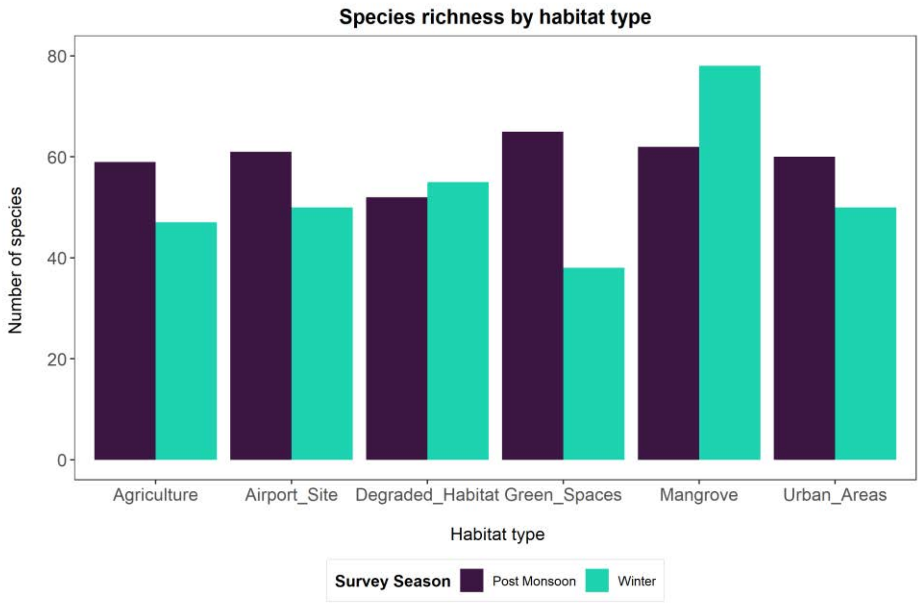

Figure 3.8. Species richness by habitat type

Species Abundance

The abundance in winter survey was found to be lesser than that of post monsoon for all species. This was attributed to the fact that some of the sites in winter could not be surveyed. Hence, we found average abundance of species at each point count station (PCS) in each habitat type, which considered the survey effort put in. To find the average abundance for each species in a habitat type, we divided the total abundance of that species in the specific habitat by the number of PCS surveyed in that habitat. We found the abundance of the four synanthropic species, namely – Common Myna, House Crow, House Sparrow, and Rock Dove separately owing to their high abundance across the habitats. The graphs below represent the average abundance (from here on will be referred to as abundance) of 10 most common bird species and synanthropic species in the study site in different habitat types.

Post Monsoon Survey – Non-synanthropic Species

In agricultural land (Figure 3.9), the abundance of Cattle Egret *Bubulcus ibis* (7.75) was highest followed by Black Kite *Milvus migrans* (4.58) and Rosy Starling *Pastor roseus* (3.53). The abundance of Asian Green Bee-eater *Merops orientalis* (2.35 individuals) was highest in degraded habitat (Figure 3,10) followed by Red-vented Bulbul *Pycnonotus cafer* (2.2) and Asian Palm-swift *Cypsiurus balasiensis* (1.9). In green spaces (Figure 3.11) the abundance of Asian Green Bee-eater (3.89) and Red-vented Bulbul *Pycnonotus jocosus* (2.82) was highest

followed by Red-whiskered Bulbul (1.63). Little Stint *Calidris minuta* (19.78), Ashy Prinia *Prinia socialis* (4.06) and Common Redshank *Tringa tetanus* (3.78) were highest in abundance in mangroves mudlflats, and salt pans (Figure 3.12) in the study area. In urban areas (Figure 3.13) the abundance of Little Egret *Egretta garzetta* (4.7 individuals) was highest followed by Little Cormorant *Microcarbo niger* (1.81) and Scaly-breasted Munia *Lonchura punctulata* (1.48).

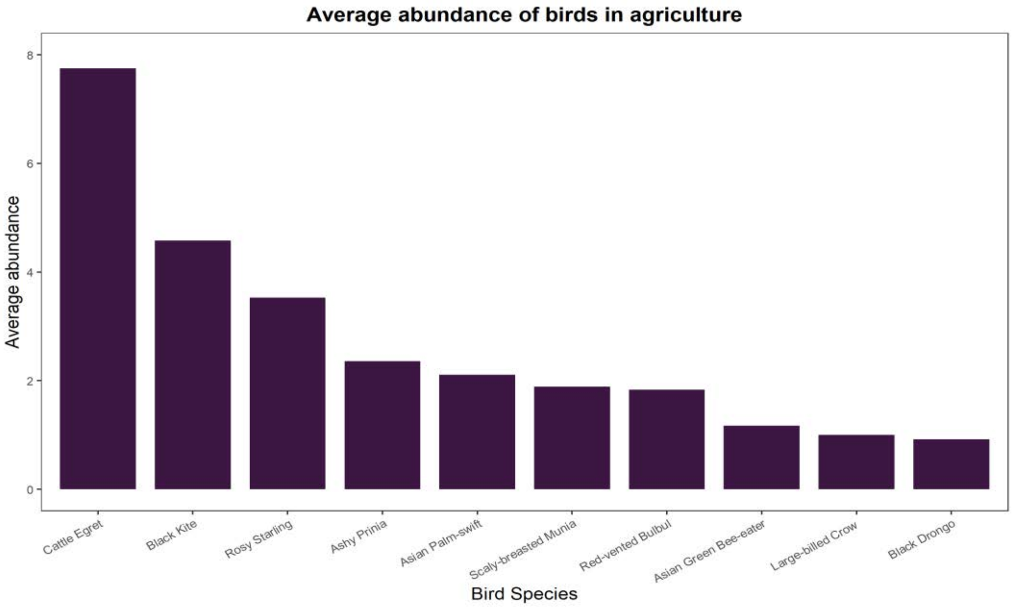

Figure 3.9. Abundance of common species in agriculture in post monsoon survey

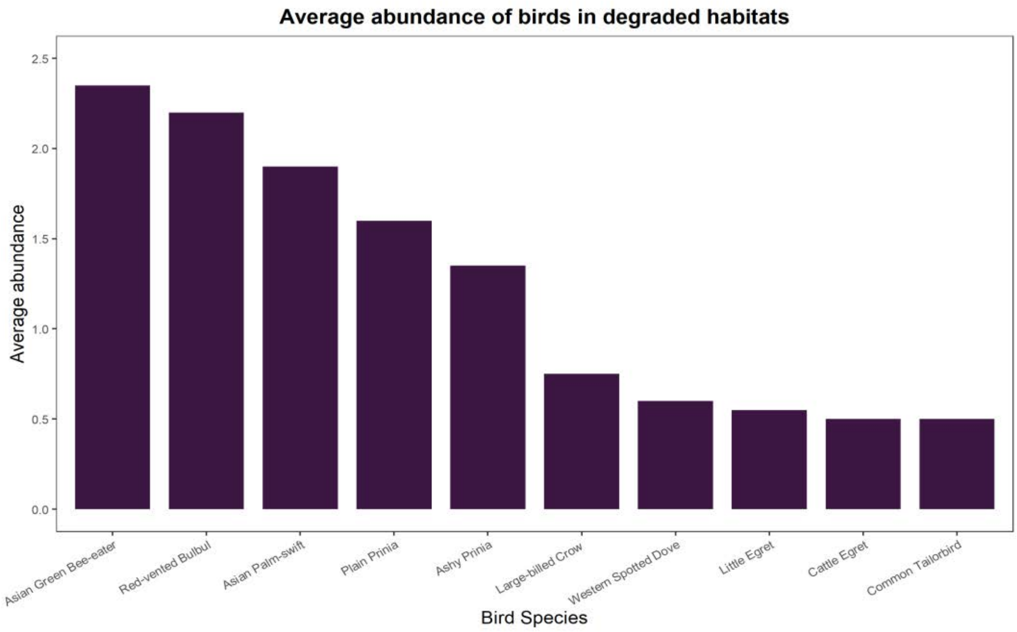

Figure 3.10. Abundance of common species in degraded habitat in post monsoon survey

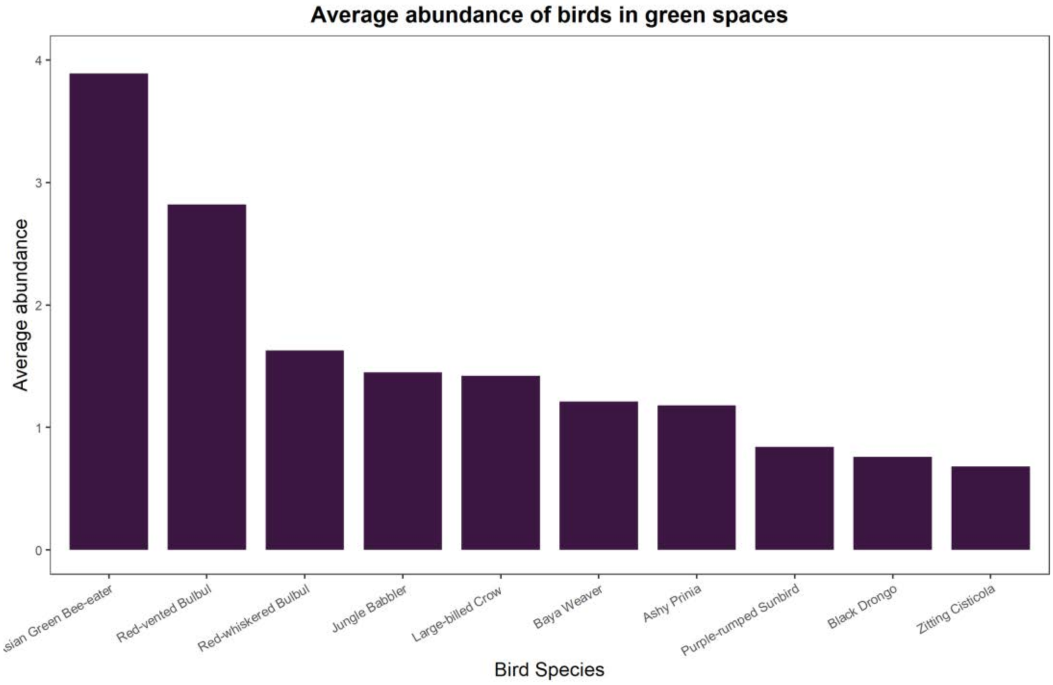

Figure3.11 Abundance of common species in green spaces in post monsoon survey

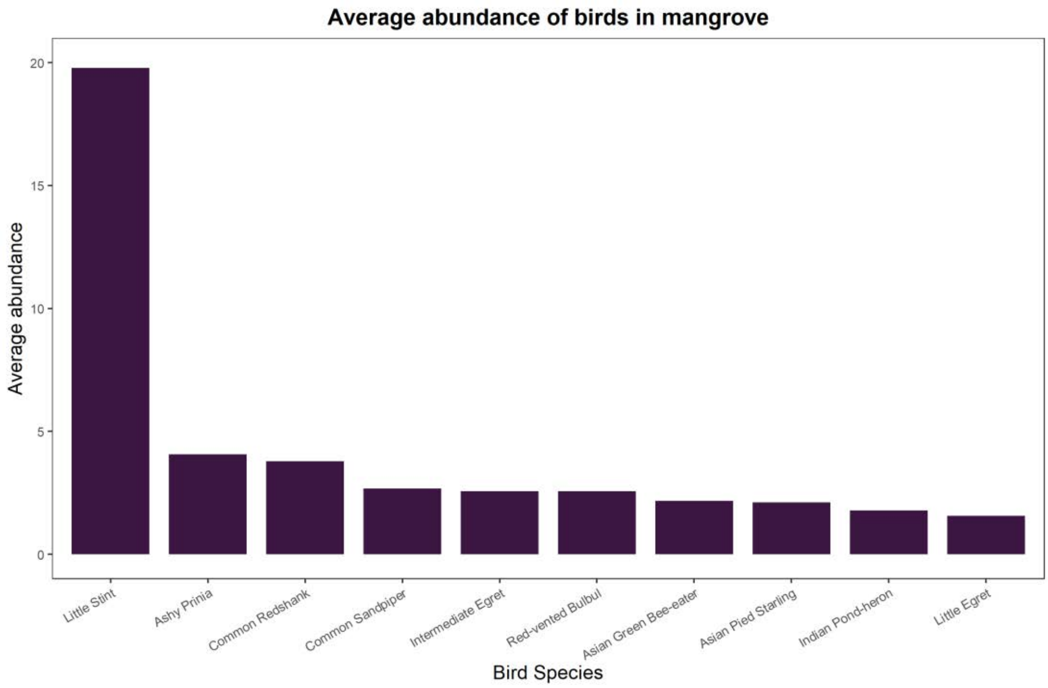

Figure 3.12. Abundance of common species in mangrove in post monsoon survey

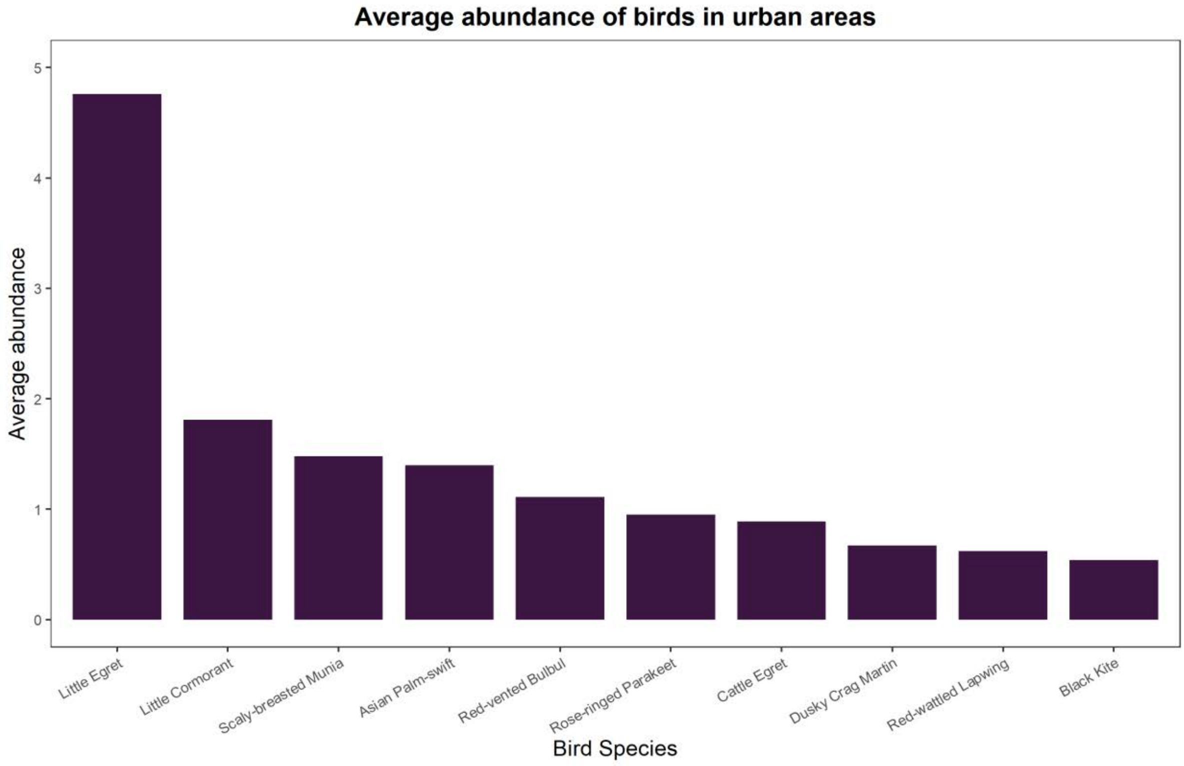

Figure 3.13 Abundance of common species in urban areas in post monsoon survey

Post Monsoon Survey – Synanthropic Species

We analysed abundance of synanthropic species separately owing to their high abundance across the study area. The abundance of Rock Dove Columba livia was highest in agriculture (Figure 3.14), degraded habitat (Figure 3.15), mangrove (Figure 3.17), and urban areas (Figure 3.18). In green spaces (Figure 3.16) the abundance of House Crow Corvus splendens (2.68 individuals) was highest. House Sparrows *Passer domesticus* were lowest in abundance in agriculture (Figure 3.14), green spaces (Figure 3.16), and mangroves (figure 3.17) while Common Myna Acridotheres tristis abundance was lowest in degraded habitat (Figure 3.15) and urban areas (Figure 3.18).

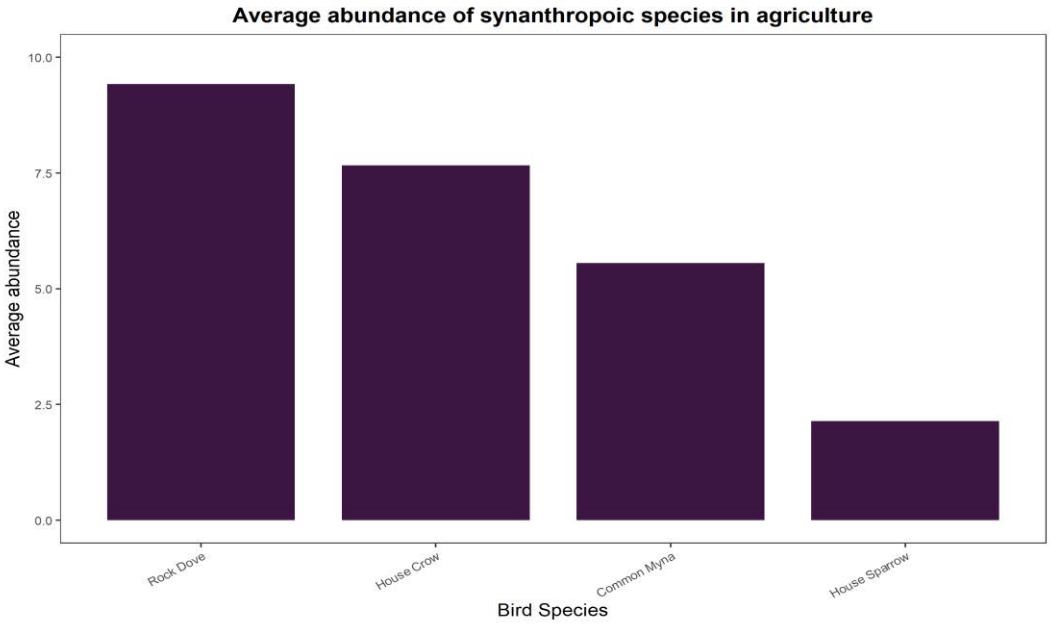

Figure 3.14. Abundance of synanthropic species in agriculture in post monsoon survey

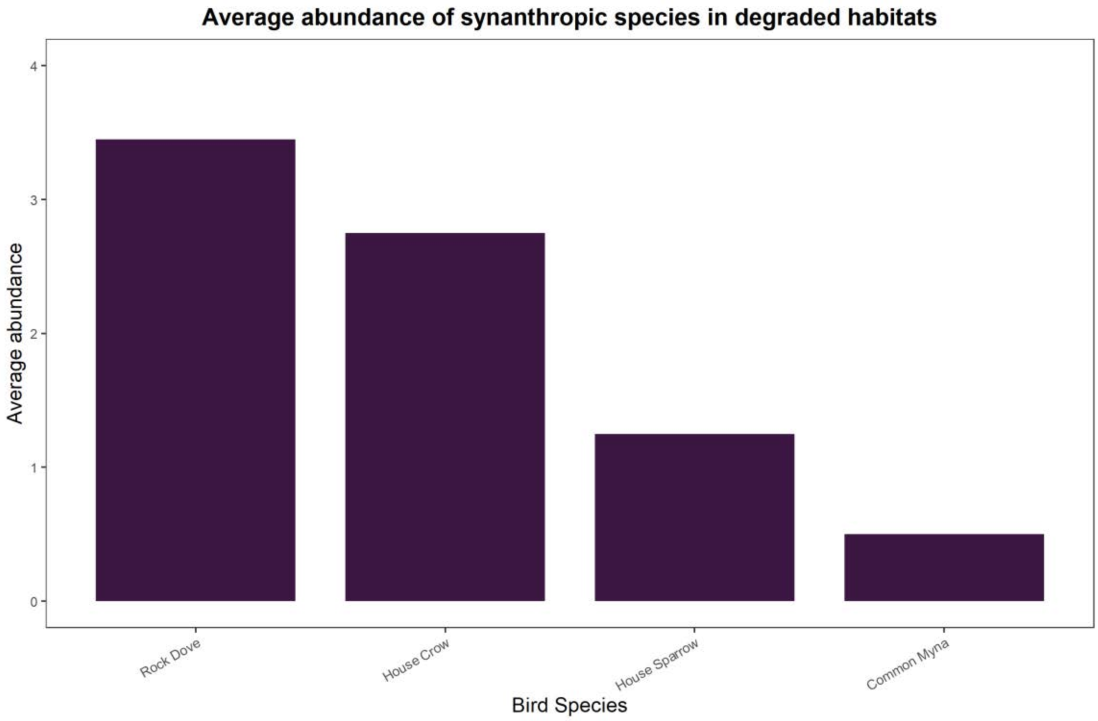

Figure 3.15. Abundance of synanthropic species in degraded habitat in post monsoon survey

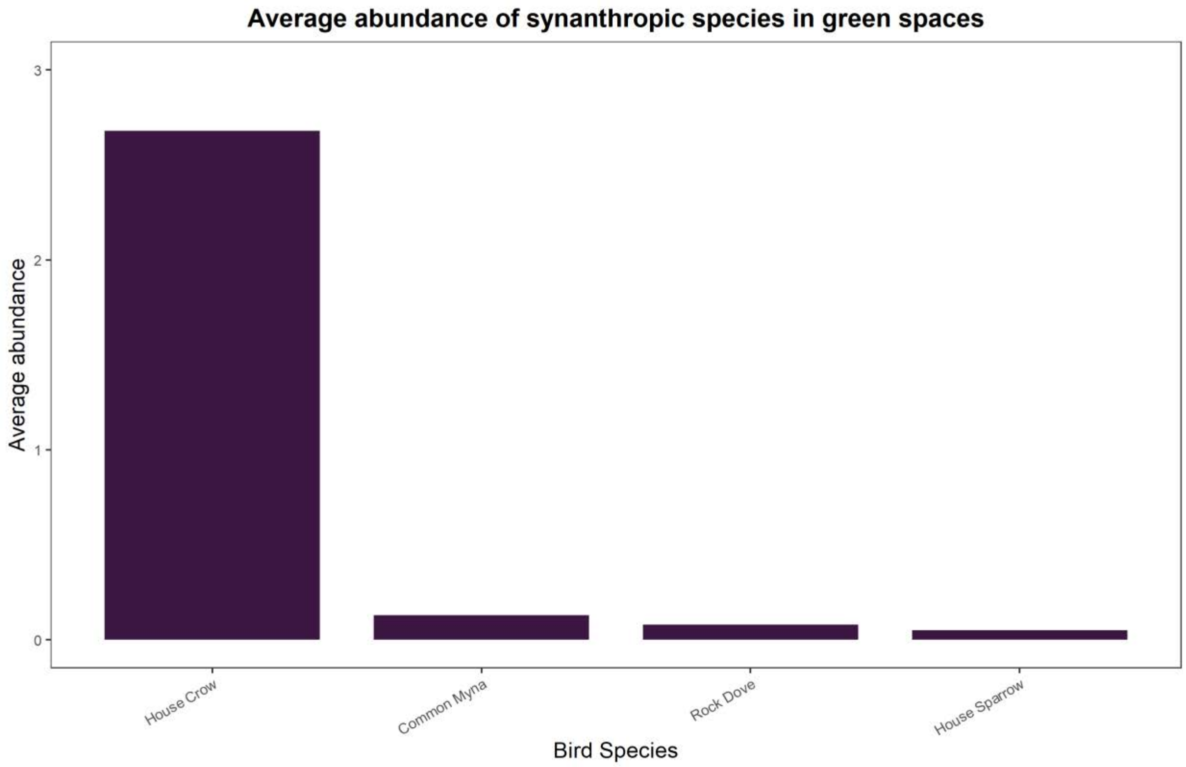

Figure 3.16. Abundance of synanthropic species in green spaces in post monsoon survey

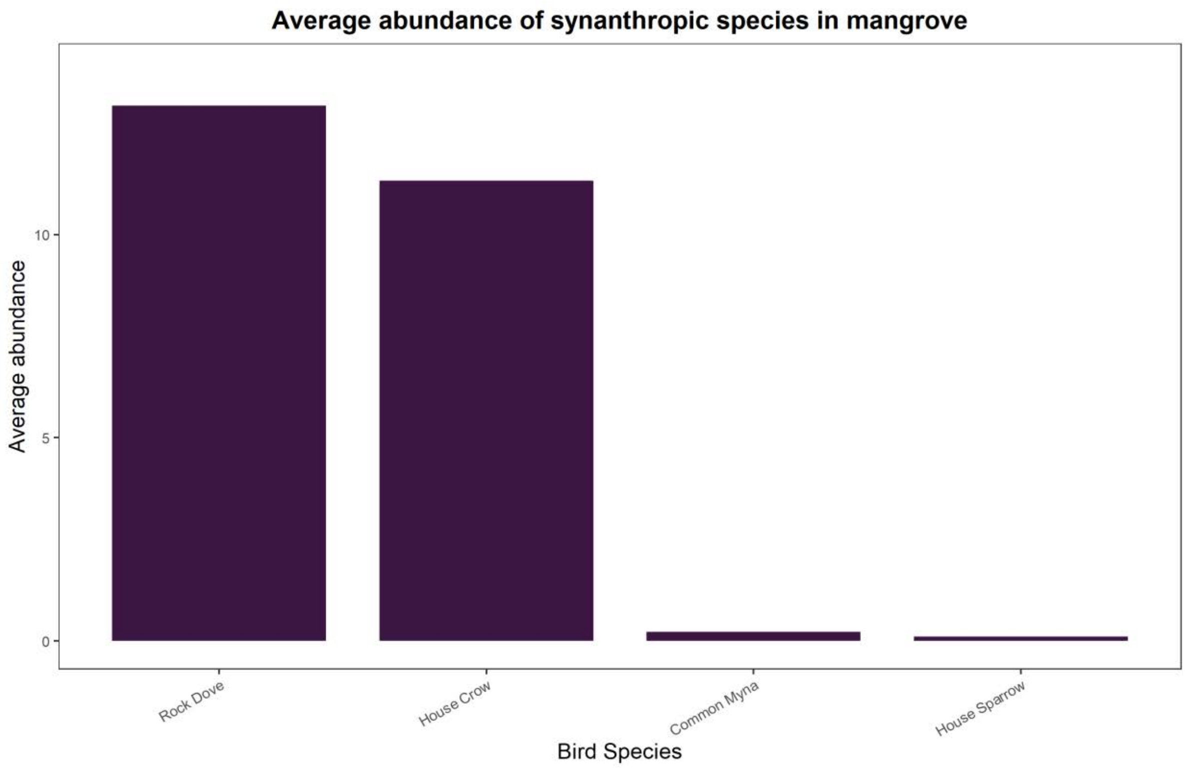

Figure 3.17. Abundance of synanthropic species in mangrove in post monsoon survey

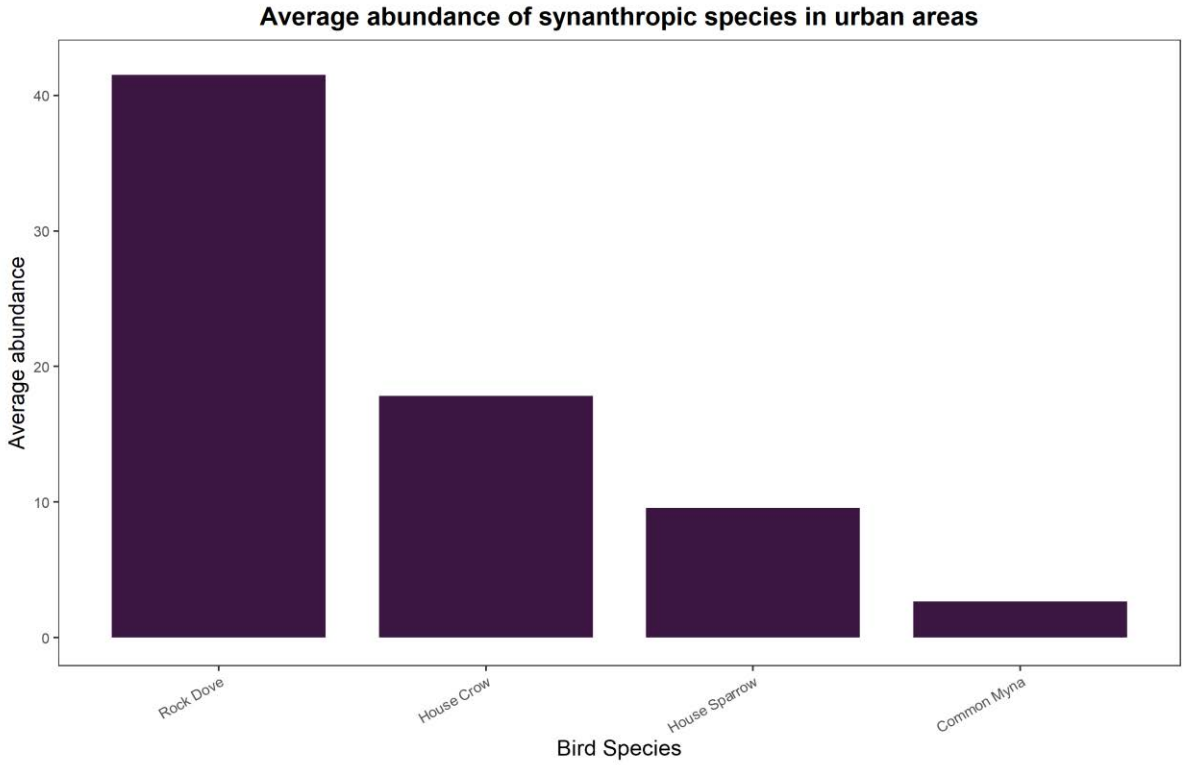

Figure 3.18. Abundance of synanthropic species in urban areas in post monsoon survey

Winter Survey – non-synanthropic species

In the winter survey (January – March 2020), we found that in agriculture (Figure 3.19), the abundance of Black Kite (9.57), Cattle Egret (4.5) and Ashy Prinia (2.36) was highest. In degraded habitat (Figure 18), the highest abundance was that of Baya Weaver *Ploceus philippinus* (8.17), Wire-tailed Swallow *Hirundo smithii* (5.67 individuals) and Scaly-breasted Munia (3.75). Red-vented Bulbul (5.71) and Jungle Babbler *Turdoides striata* (2.65) were the highest abundance in green spaces (Figure 3.20) amongst other species recorded in the habitat. In mangroves (Figure 3.21), Lesser Flamingos *Phoeniconaias minor*, Little Stint, and Ashy Prinia had the highest abundance with 17, 9, and 4.65 individuals, respectively. Apart from the synanthropic species, Indian Cormorant *Phalacrocorax fuscicollis* (3.1), Red-naped Ibis *Pseudibis papillosa* (1.11) and Rose-ringed Parakeet *Psittacula krameri* (1.07) had the highest abundance in urban areas (Figure 3.23) amongst other species.

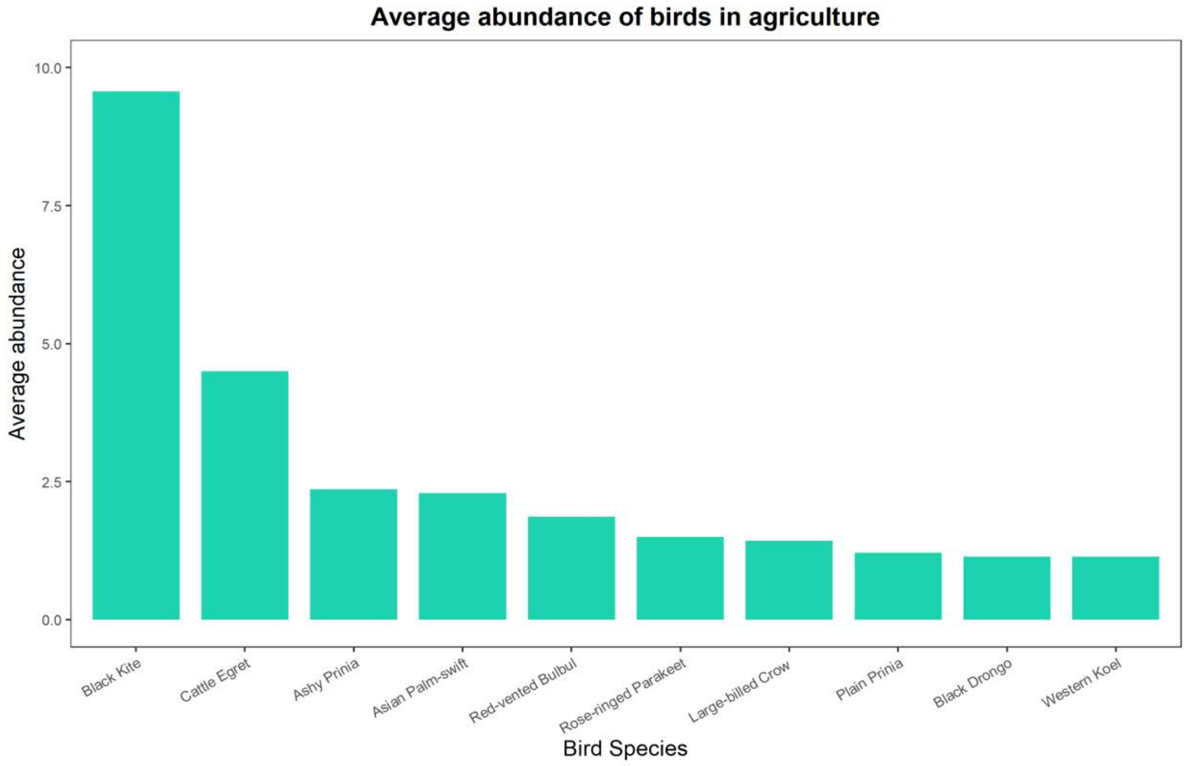

Figure 3.19. Abundance of common species in agriculture in winter survey

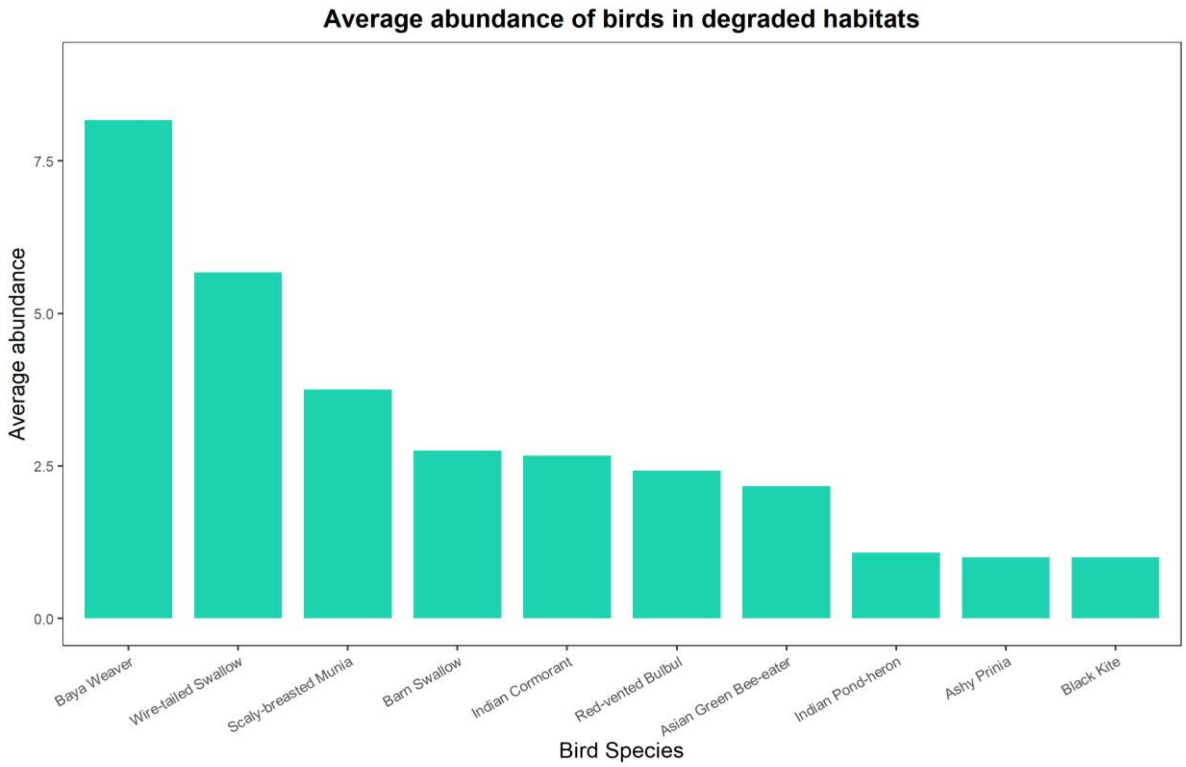

Figure 3.20. Abundance of common species in degraded habitat in winter survey

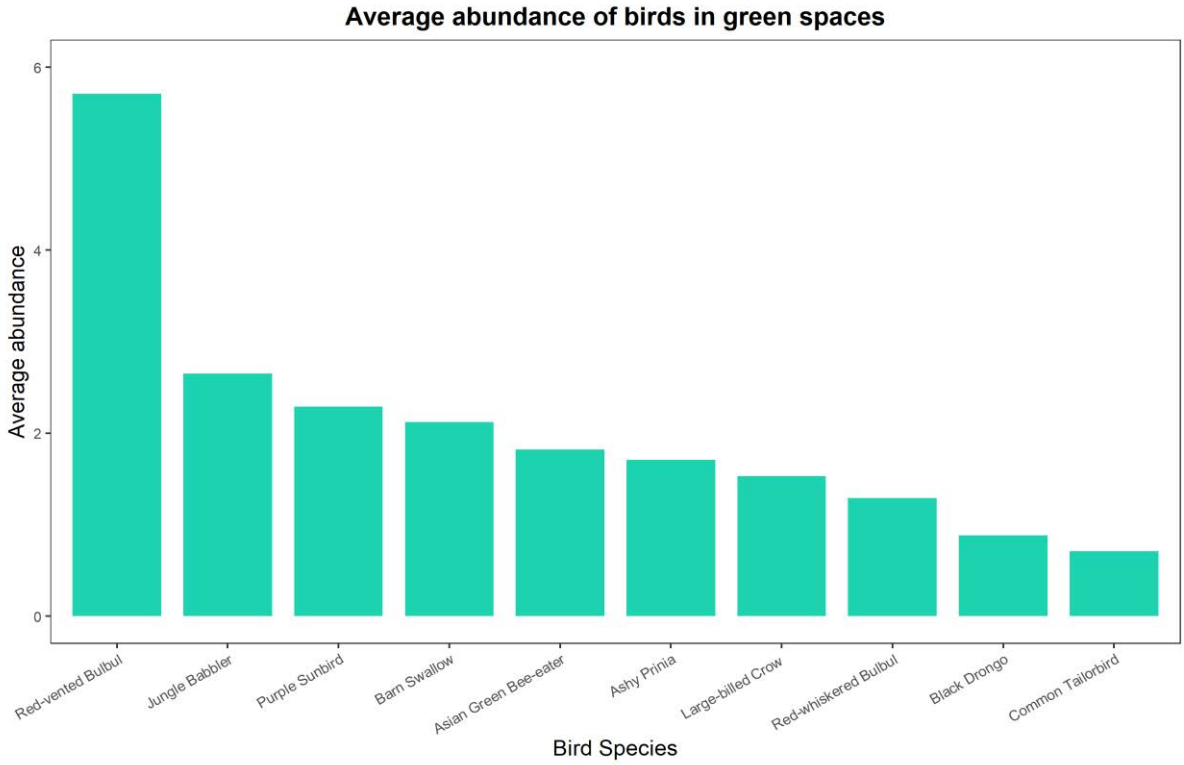

Figure 3.21. Abundance of common species in green spaces in winter survey

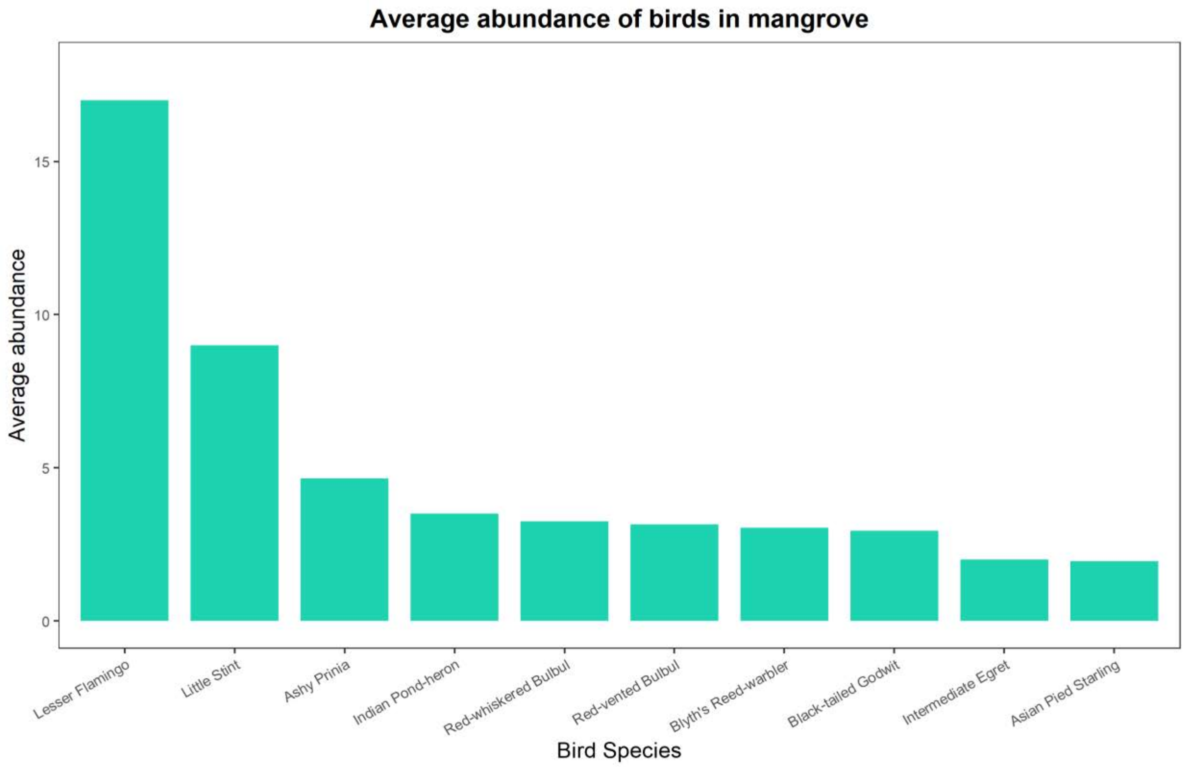

Figure 3.22. Abundance of common species in mangrove in winter survey

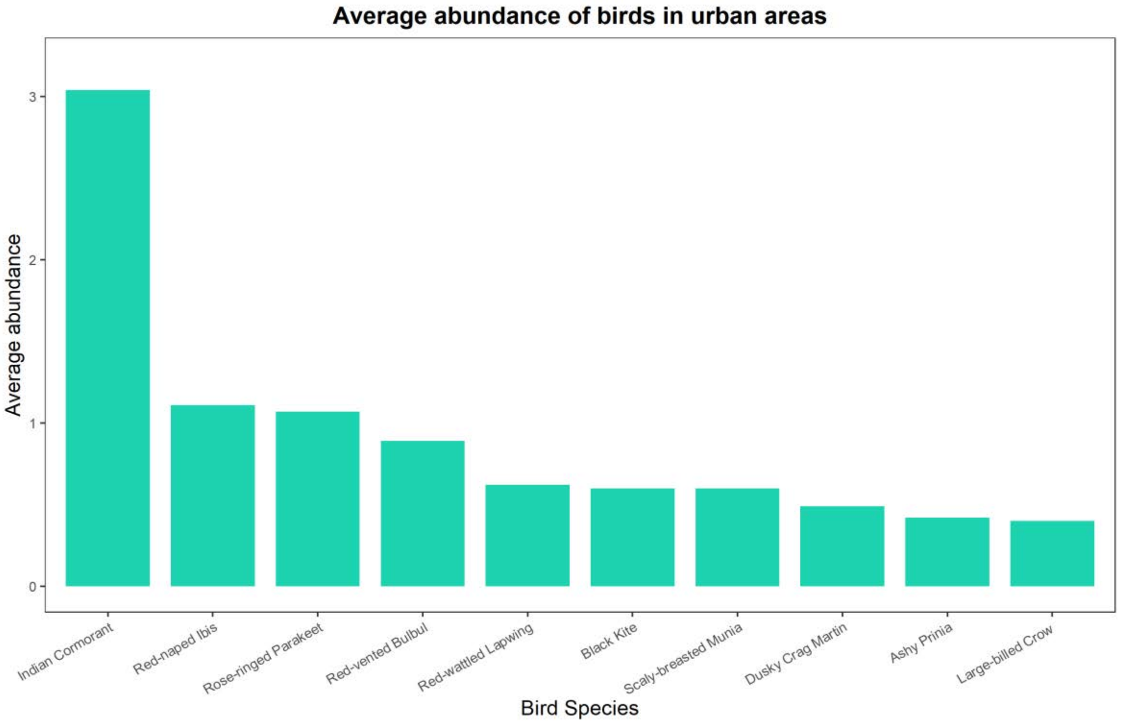

Figure 3.23. Abundance of common species in urban areas in winter survey

Winter Survey – synanthropic species

In agriculture (Figure 2.24) and urban areas (Figure 3.28), the abundance of Rock Dove was highest while that of House Sparrow (1.93) was the lowest. The abundance of House Crow was highest in degraded habitat (Figure 3.24), green spaces (Figure 3.26), and mangrove mudlflats, and salt pans (Figure 3.27). The abundance of House Sparrow was lowest in agriculture (Figure 3.24), degraded habitat (Figure 3.25), and mangrove mudlflats, and salt pans (Figure 3.27) and they were not encountered in green spaces during the surveys. In green spaces (Figure 3.26) and urban areas (Figure 3.28) the abundance of Common Myna was lowest.

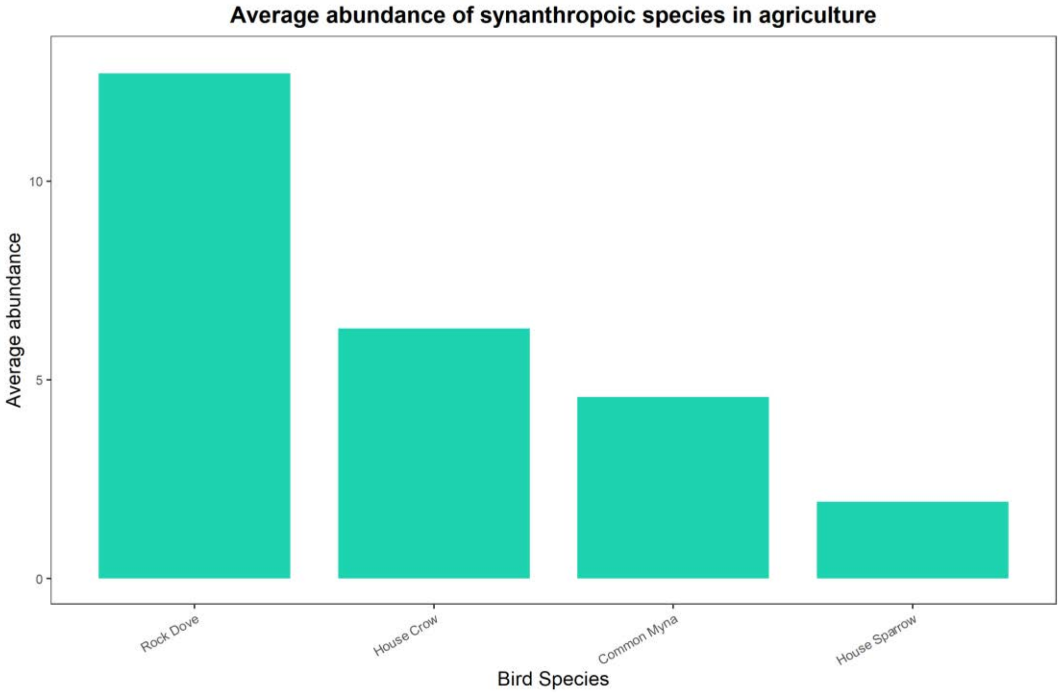

Figure 2.24. Abundance of synanthropic species in agriculture in winter survey

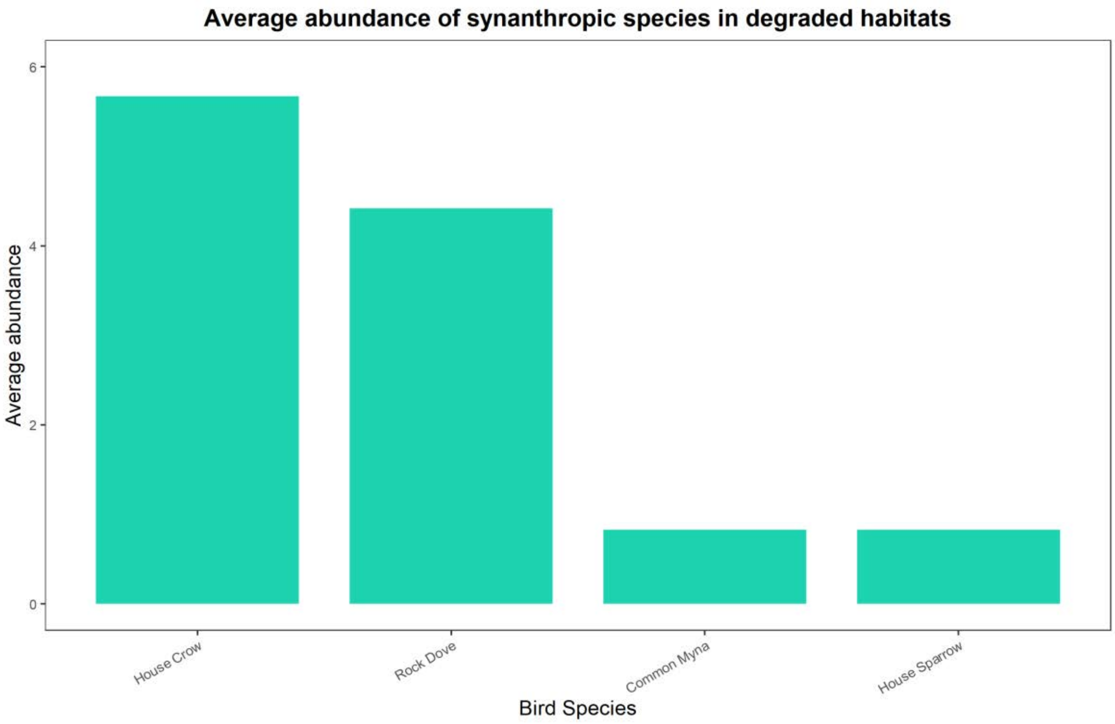

Figure 3.25. Abundance of synanthropic species in degraded habitat in winter survey

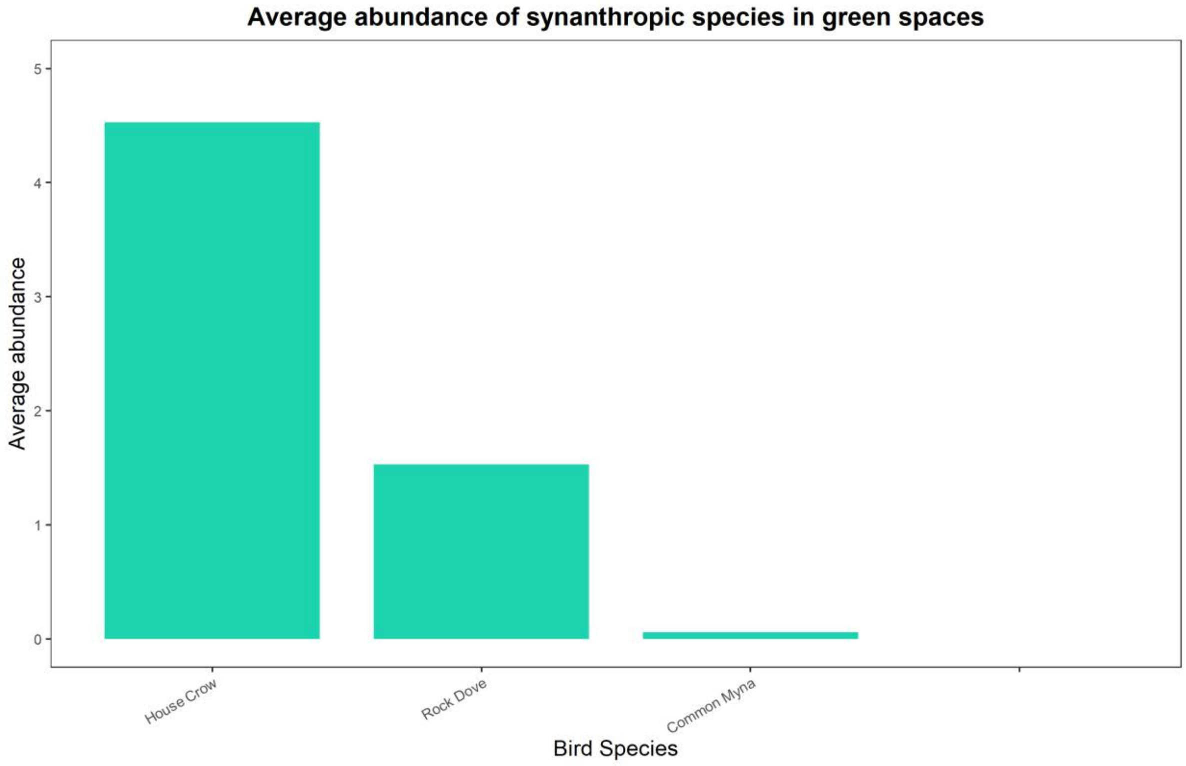

Figure 3.26. Abundance of synanthropic species in green spaces in winter survey

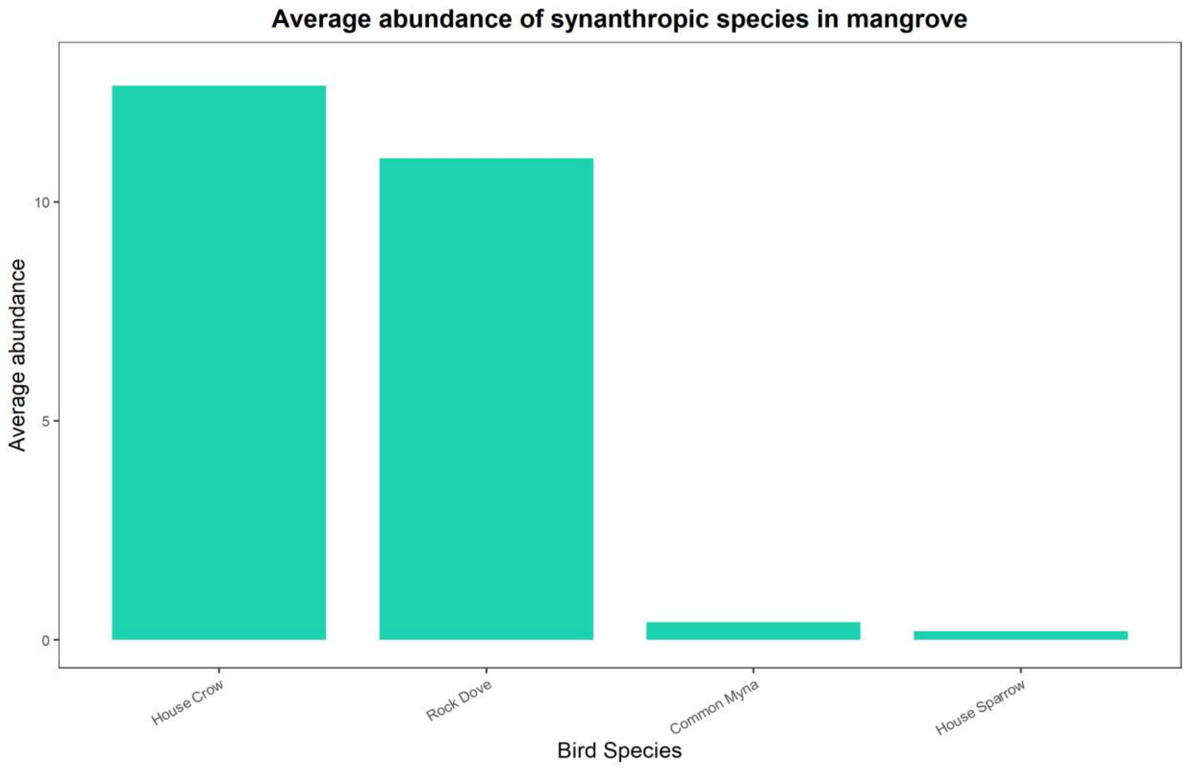

Figure 3.27. Abundance of synanthropic species in mangrove mudlflats, and salt pans in winter survey

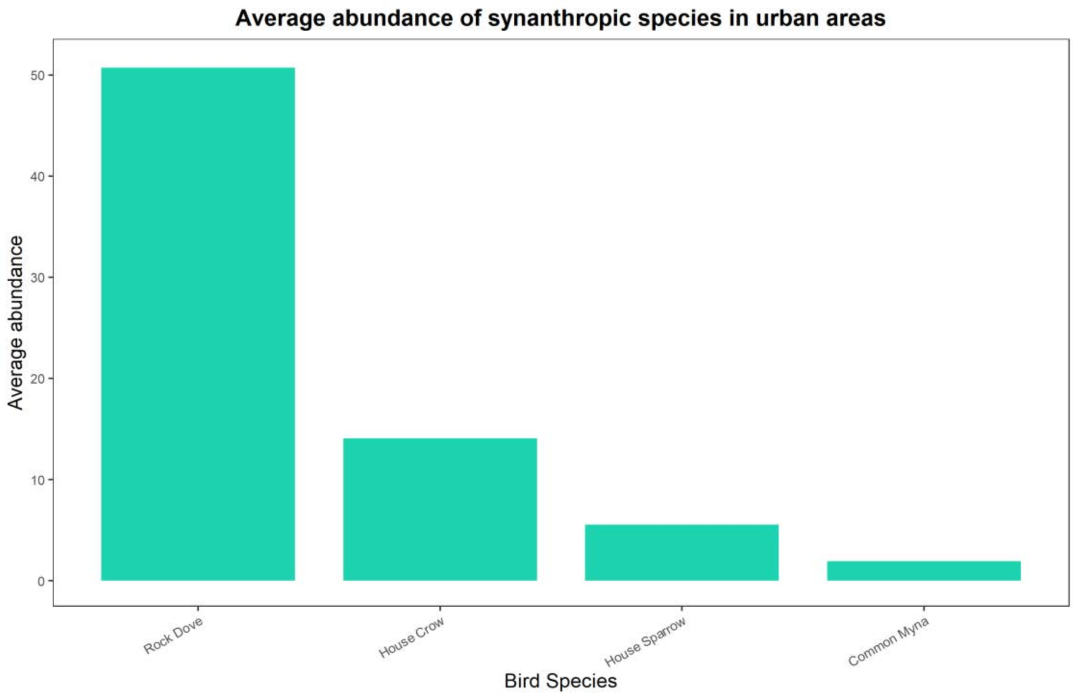

Figure 3.28. Abundance of synanthropic species in urban areas in winter survey

3.3 Terrestrial Bird Survey 2020-2021

Species Richness across habitats

We recorded species richness (total number of species observed) of bird species across the different habitats for the Winter season (December 2020 - February 2021). It can be seen in Figure 3.28, that the highest number of species in the winter survey was recorded in mangroves and Mudflats followed by agriculture, whereas the richness was lowest in the urban habitat (fig. 3.29)

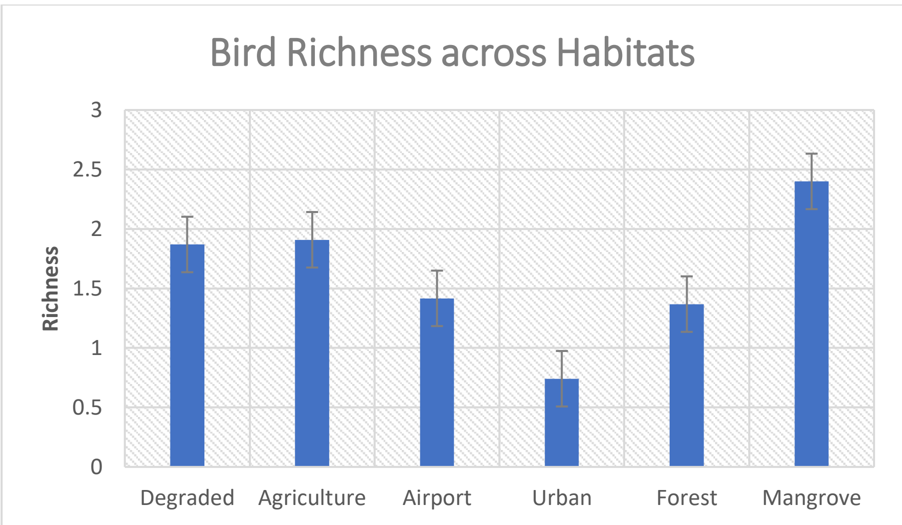

Figure 3.29: Bird species richness across different habitat types.

Species Abundance

The species abundance was recorded and calculated for each habitat in present winter season survey. The most abundant species for most of the habitats was found to be Rock Dove. We found the abundance of certain species, namely – Rock Dove, House Crow, Cattle Egret, Red Vented Bulbul and Little Stint showing high abundance across all the habitats. The graphs below (Figure 3.30 to Figure 3.35) represent the Species abundance of different bird species in the study site in different habitat types.

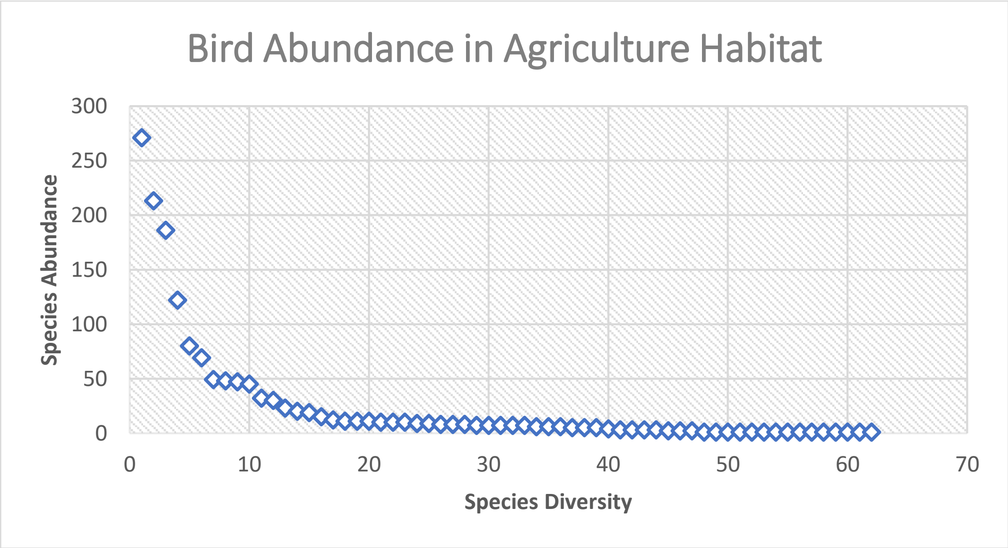

Figure 3.30: Species Abundance in agriculture habitat

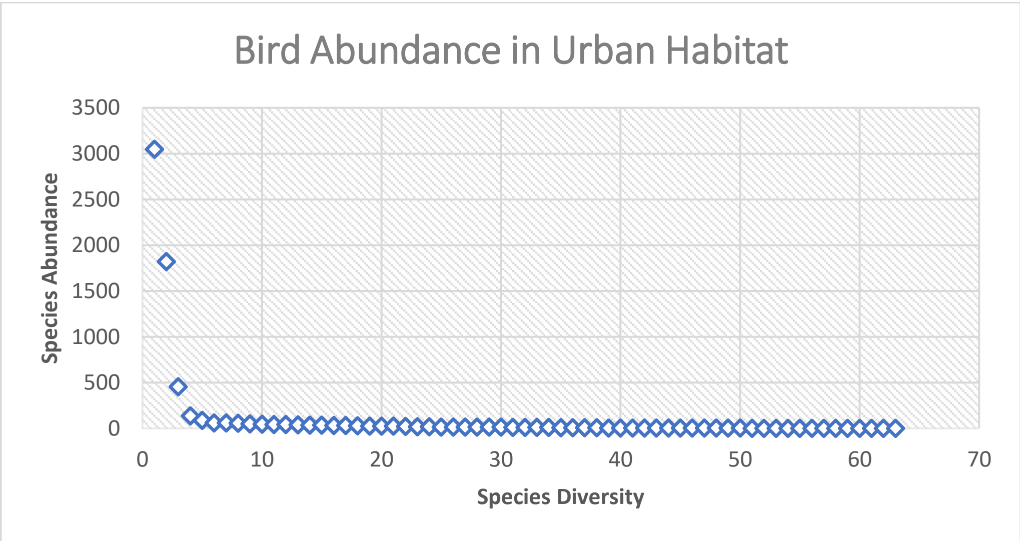

Figure 3.31 Species Abundance in urban areas

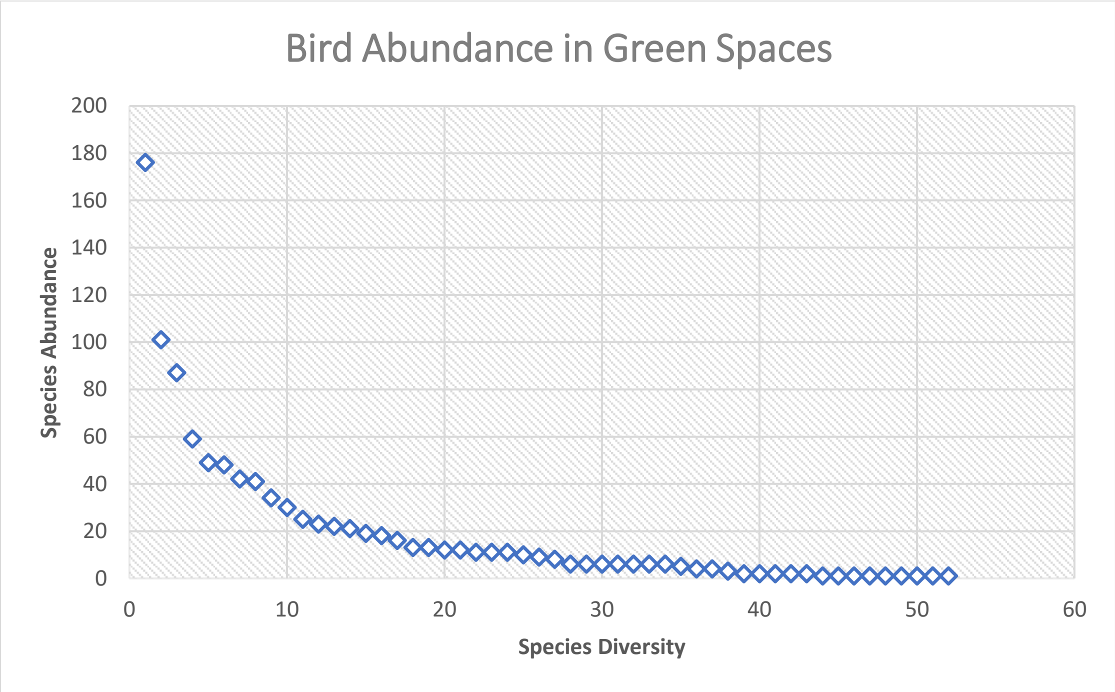

Figure 3.32: Species Abundance in green spaces

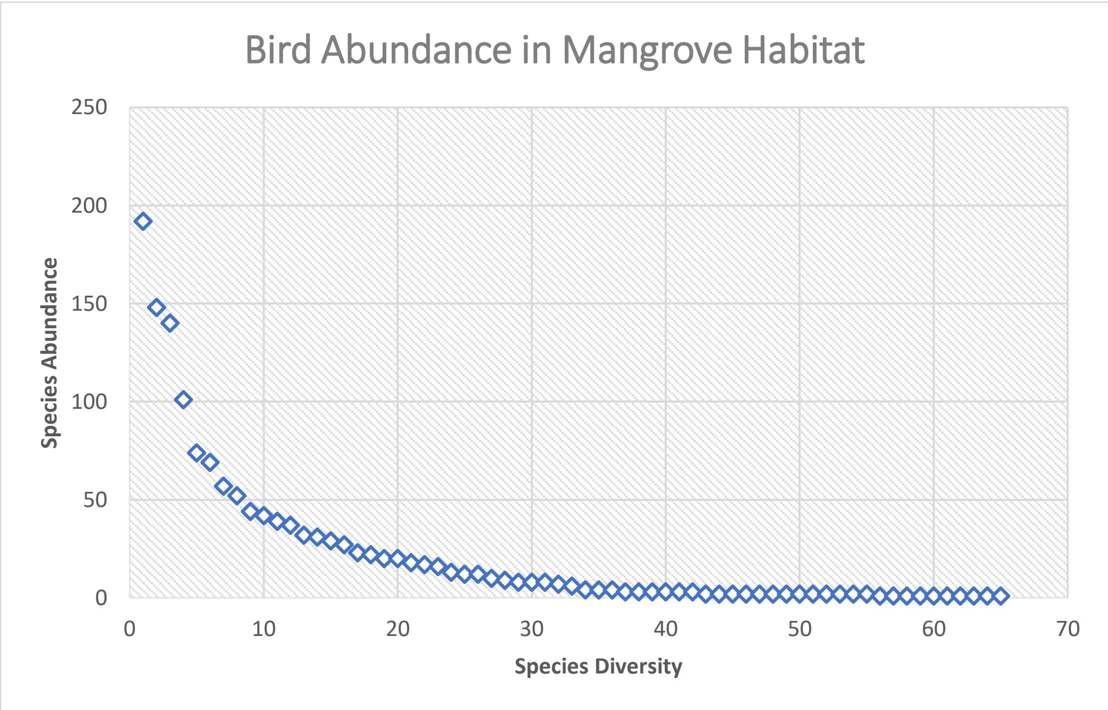

Figure 3.33: Species Abundance in mangrove

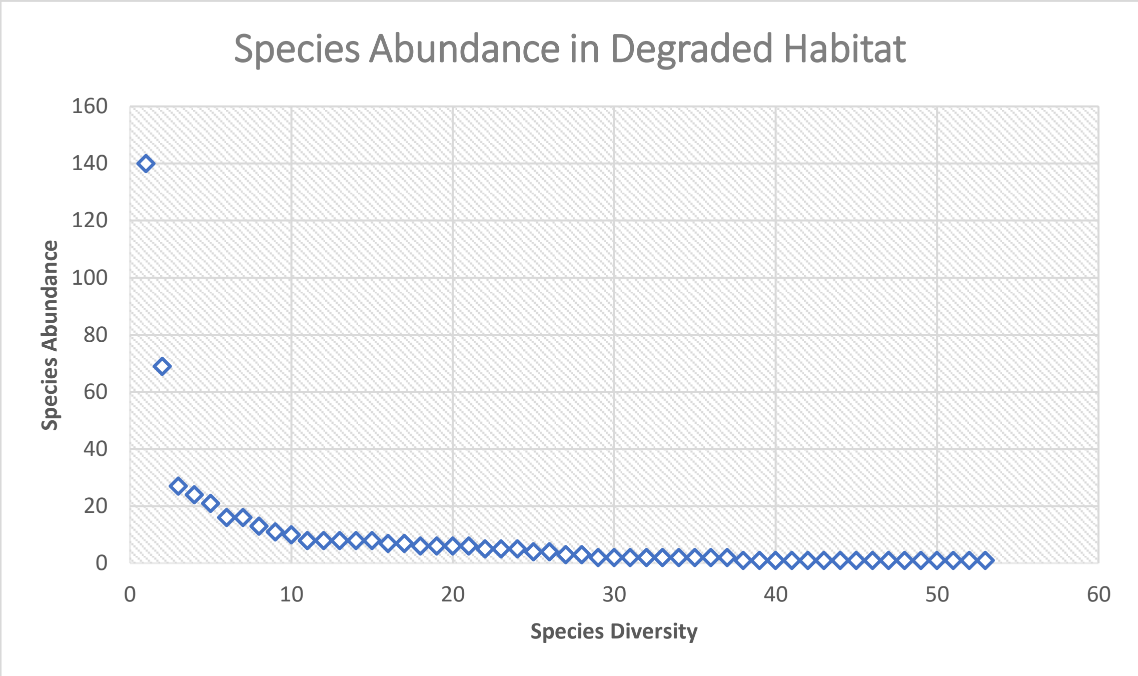

Figure 3.34: Species Abundance in degraded habitat

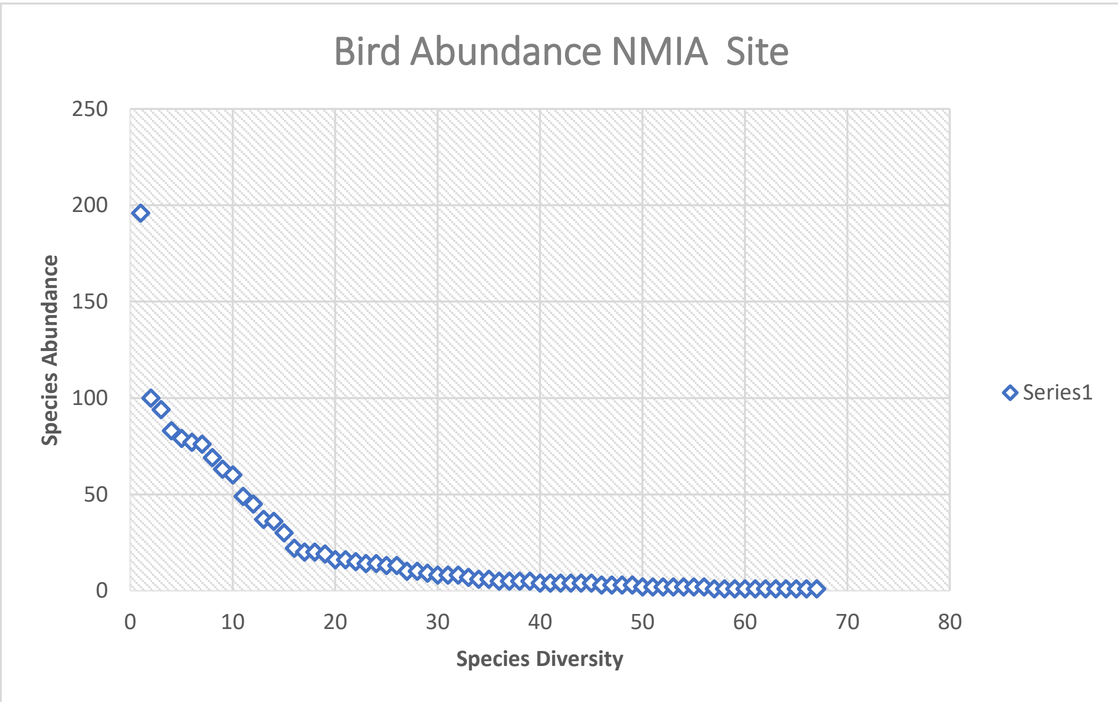

Figure 3.35: Species Abundance in Airport Site.

3.4 Terrestrial Bird Survey 2021-2022

Species Richness across habitats

Species richness is the number of species within the defined range at per unit time. We have recorded the species richness of all the bird species observed across various types in the three (3) consecutive seasons: Post Monsoon (October 2021- November 2021), Winter (December 2021- February 2022), Summer (March 2022- June 2022) in our study grids.

The highest bird species richness is observed in- 1) Mangrove habitat followed by Degraded habitat in the Post Monsoon Season 2) Mangrove habitat followed by Agricultural habitat in the Winter Season 3) Mangrove mudlflats, and salt pans habitat followed by Degraded habitat in the Summer Season. The lowest bird species rich ness is observed consistently in Urban habitat for all the consecutive seasons.

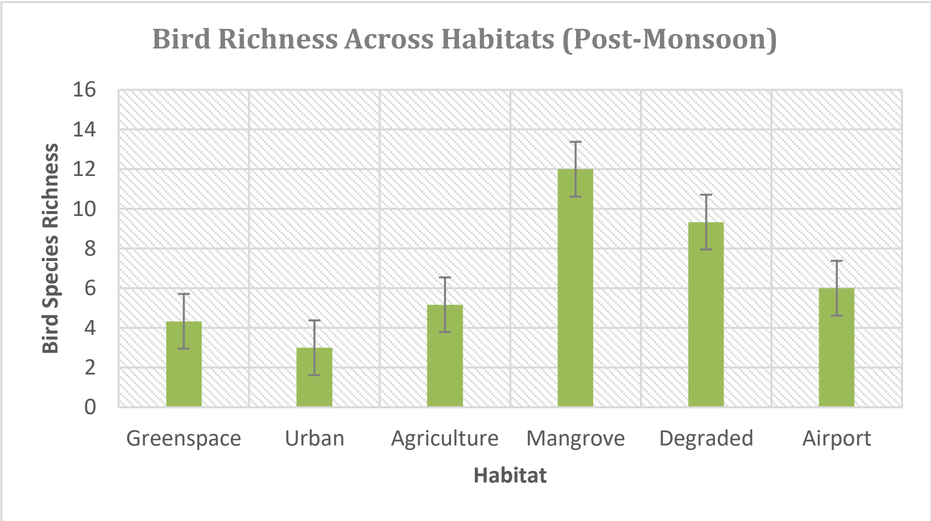

Figure 3.36: Bird richness in Post- Monsoon Season

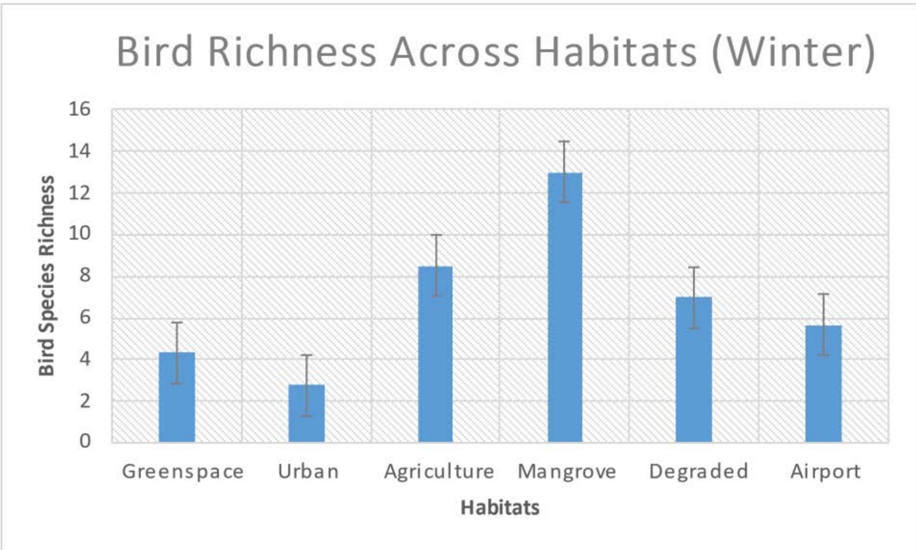

Figure 3.37: Bird richness in Winter Season

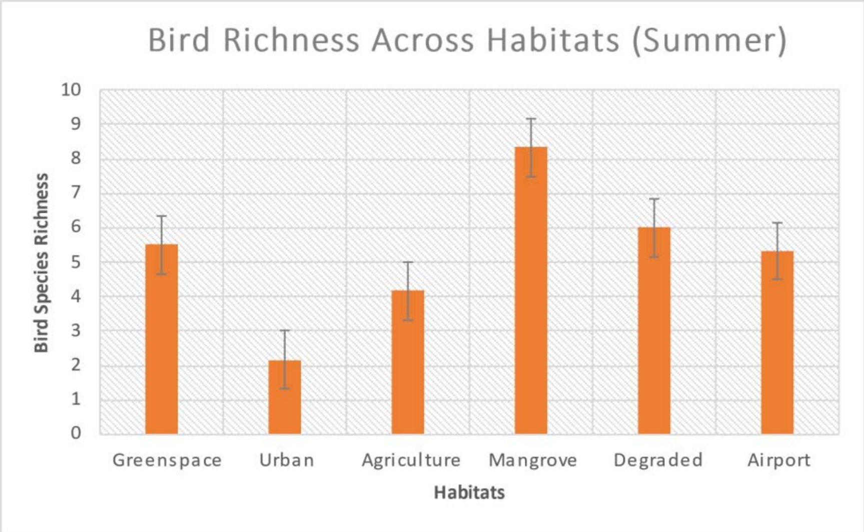

Figure 3.38: Bird richness in Summer Season

Abundance of bird species across all habitat types

Bird species abundance is the number of individuals per species. Species abundance provides clear insights regarding the bird community assembly and community functions. More the abundance of bird species, greater the stability in the ecosystem. We have calculated the species abundance across all the habitat types in all three consecutive seasons namely Post Monsoon (October 2021- November 2021), Winter (December 2021- February 2022), Summer (March 2022- June 2022) in our study grids. We have represented ten (10) most represented species based on their season-wise higher abundance in various habitats. We have also collated the data habitat-wise for all three consecutive seasons for a better representation. (Fig 3.36 to 3.38)

Urban habitat

In Urban areas, the highest abundance of Rock Dove followed by House Crow is observed in the Post-Monsoon Season. The same pattern has been maintained in both the subsequent seasons: Winter and Summer (Fig 3.39 to fig 3.41)

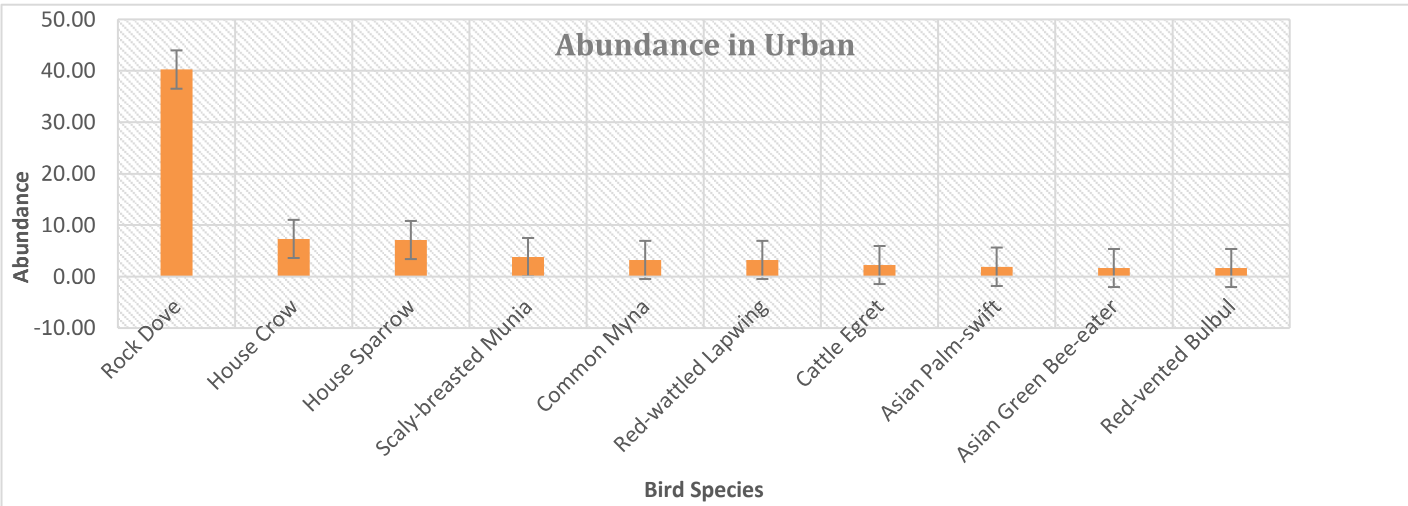

Figure 3.39: Bird abundance in Urban habitat – Post-Monsoon Season

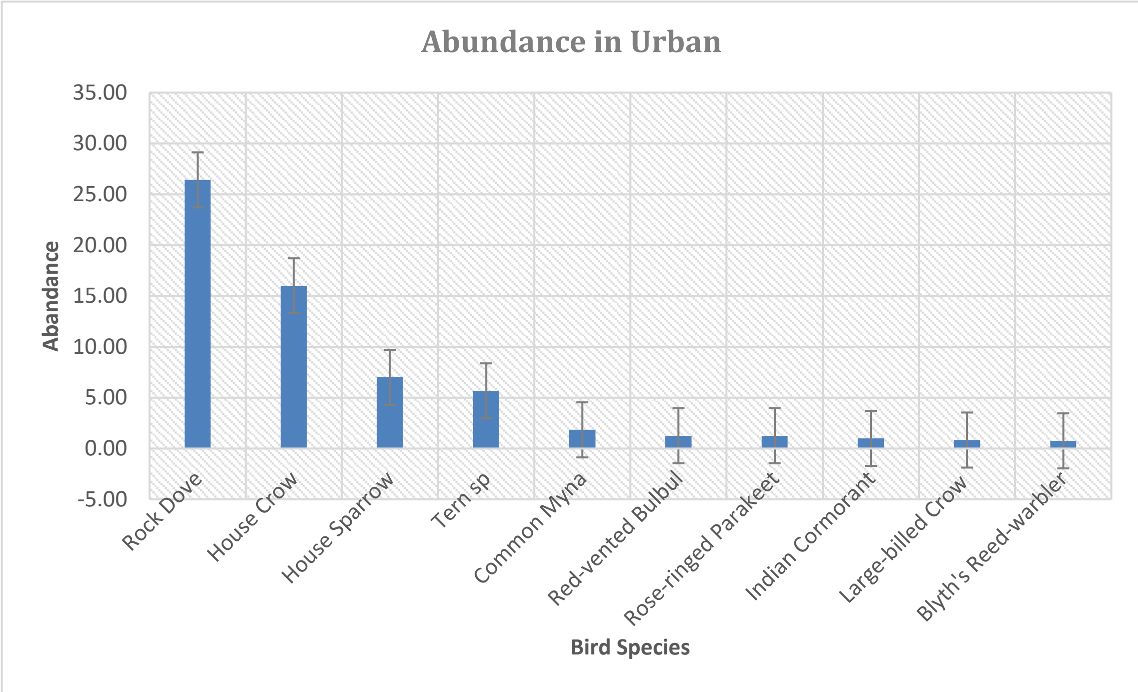

Figure 3.40: Bird abundance in Urban habitat – Winter Season

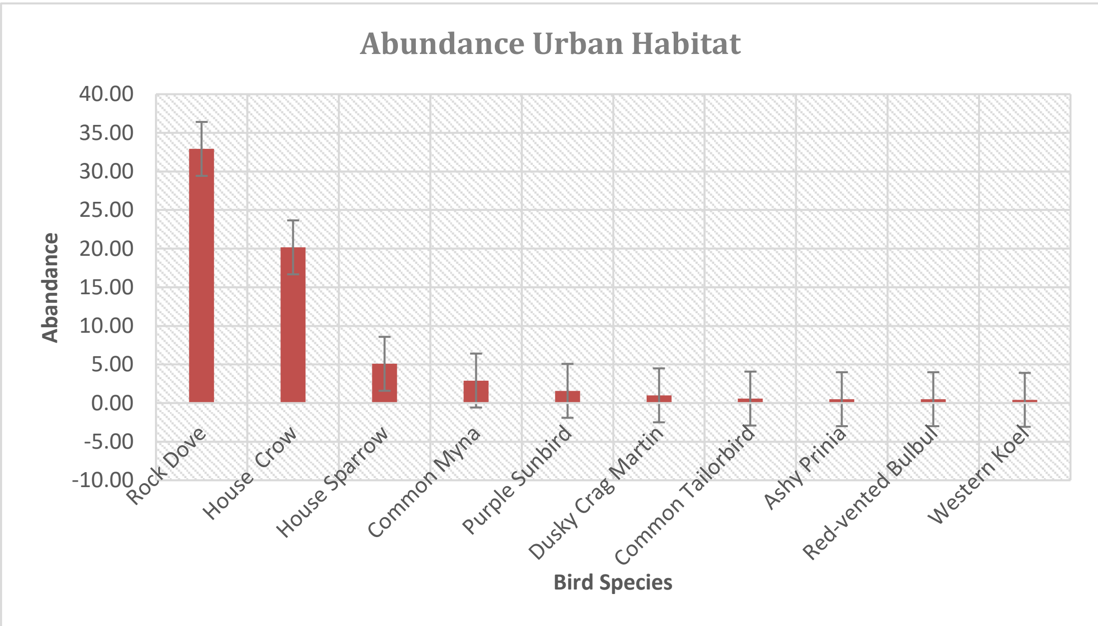

Figure 3.41: Bird abundance in Urban habitat – Summer Season

Agricultural Habitat

In the Agricultural Habitat, the highest abundance of Rosy Starling followed by Rock Dove is observed in the Post-Monsoon Season, highest abundance of Black Kite followed by Cattle Egret in the Winter Season & highest abundance of Rock Dove followed by House Crow in the Summer Season (Fig 3.42 to 3.44)

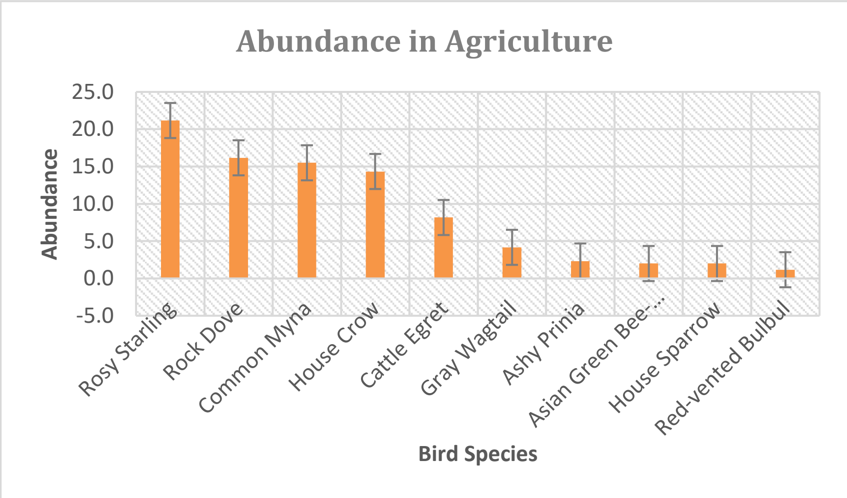

Figure 3.42: Bird abundance of Agricultural habitat – Post-Monsoon Season

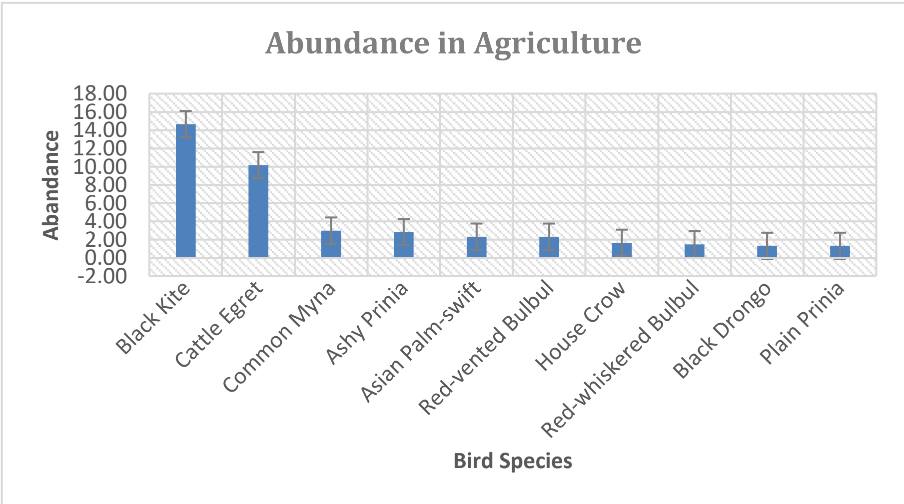

Figure 3.43: Bird abundance in Agricultural habitat- Winter Season

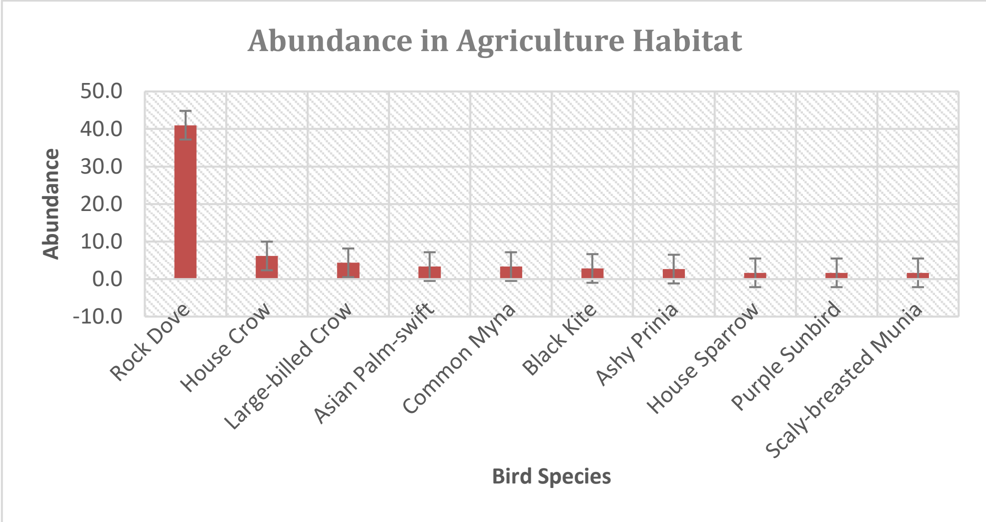

Figure 3.44: Bird abundance in Agricultural habitat – Summer Season

Degraded habitat

In the Degraded habitat, the highest abundance of House Crow followed by Plain Prinia is observed in Post-Monsoon season, the highest abundance of Barn Swallow followed by Indian Cormorant in Winter season, & highest abundance of Red-vented Bulbul followed by Rock Dove in Summer season (fig 3.45 to 3.47)

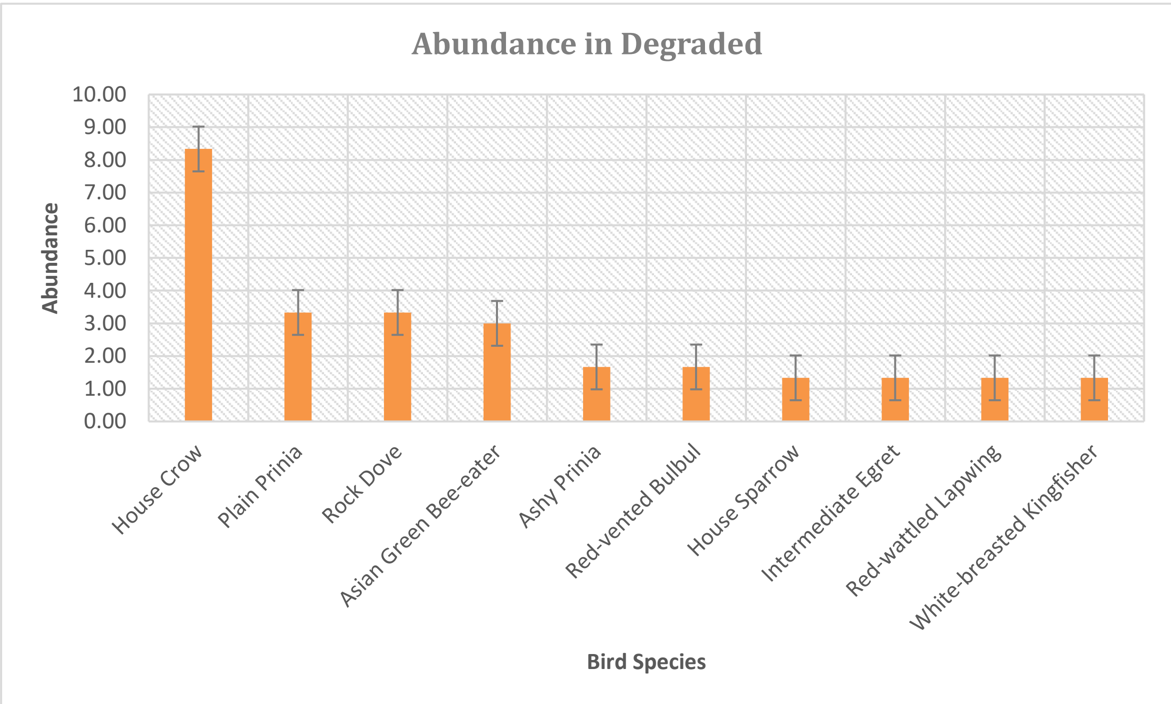

Figure 3.45: Bird abundance in Degraded habitat – Post-Monsoon Season

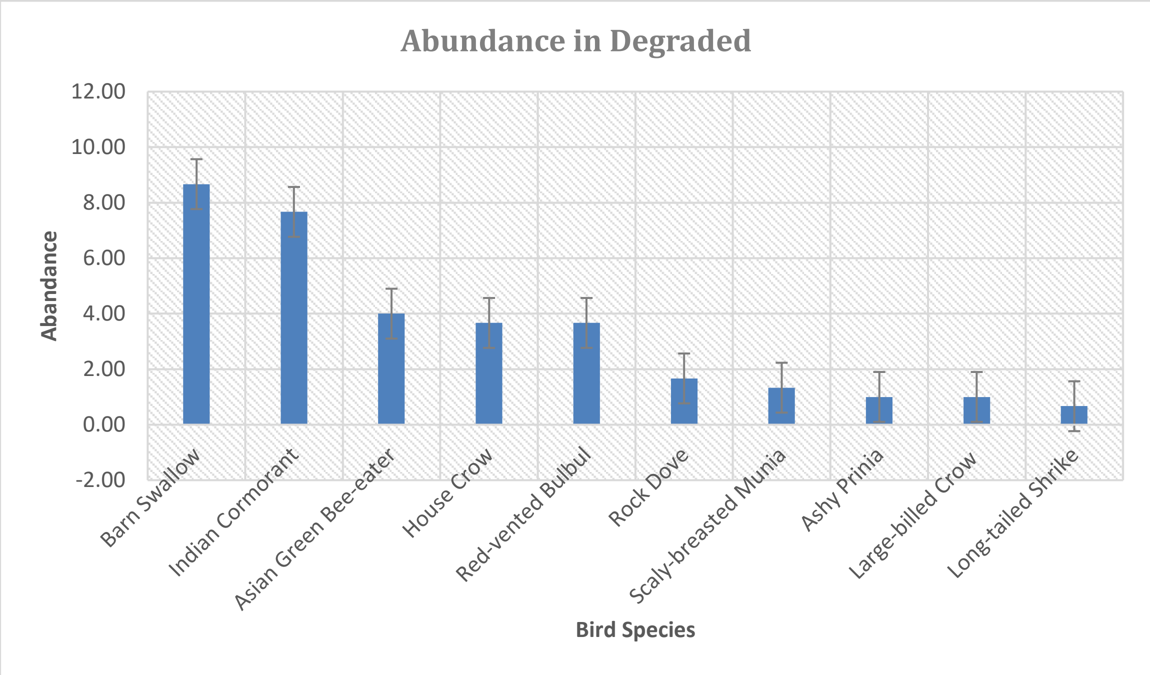

Figure 3.46: Bird abundance in Degraded habitat – Winter Season

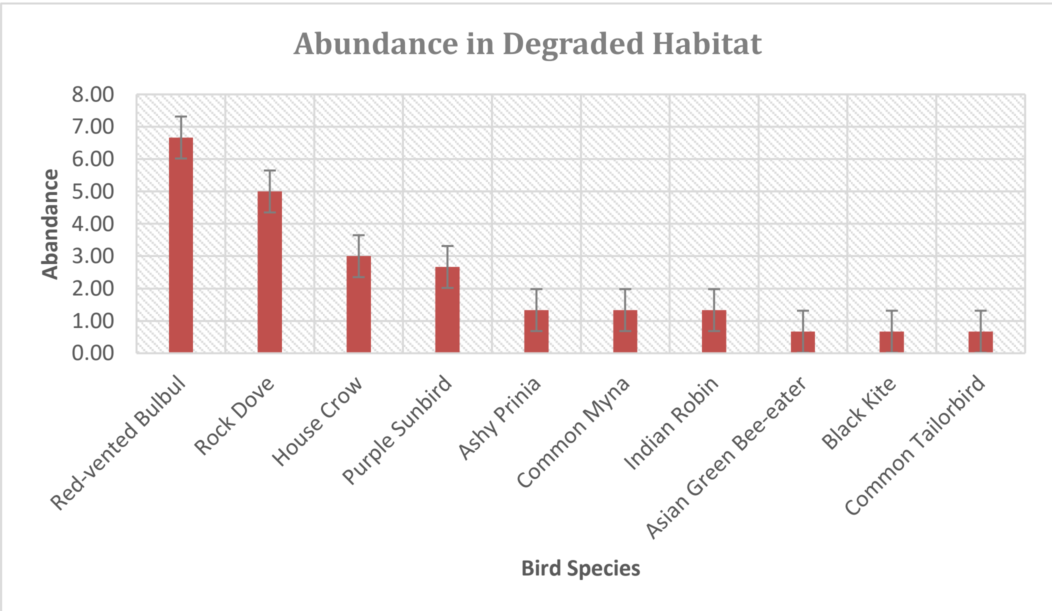

Figure 3.47: Bird abundance in Degraded habitat – Summer Season

Greenspaces

In the Greenspaces, the highest abundance of Asian Green Bee-eater followed by Barn Swallow is observed in post-monsoon season, highest abundance of House Crow followed by

Purple Sunbird in Winter season, & highest abundance of Red-whiskered Bulbul followed by Red-vented Bulbul in Summer season (fig 3.48 to 3.50)

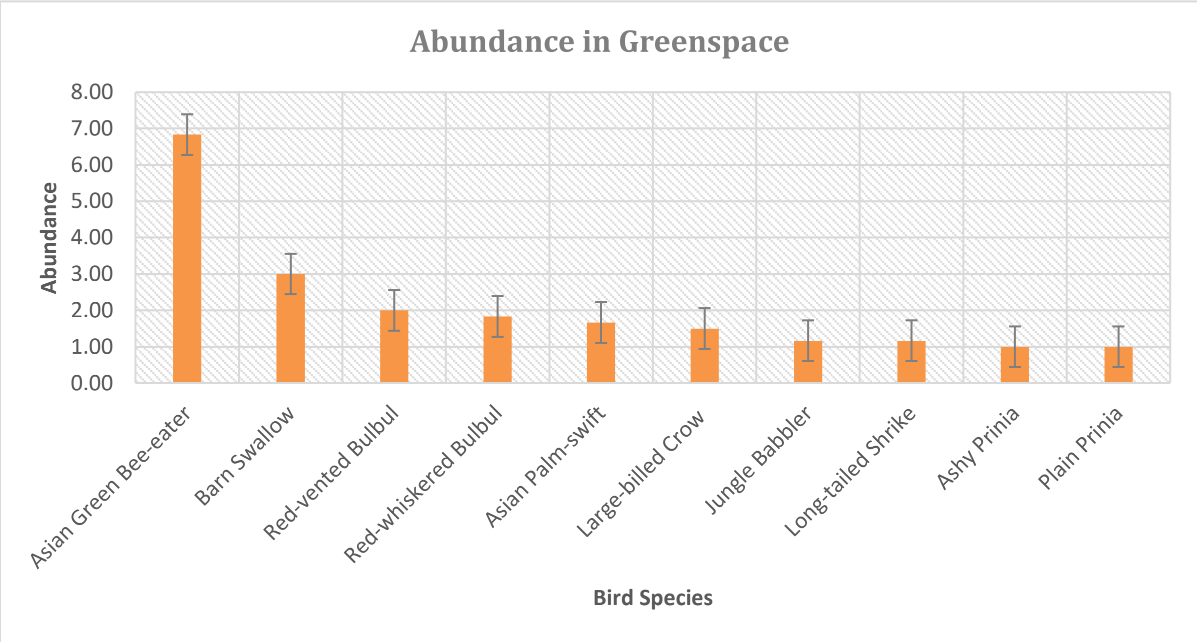

Figure 3.48: Bird abundance in Greenspaces – Post-Monsoon Season

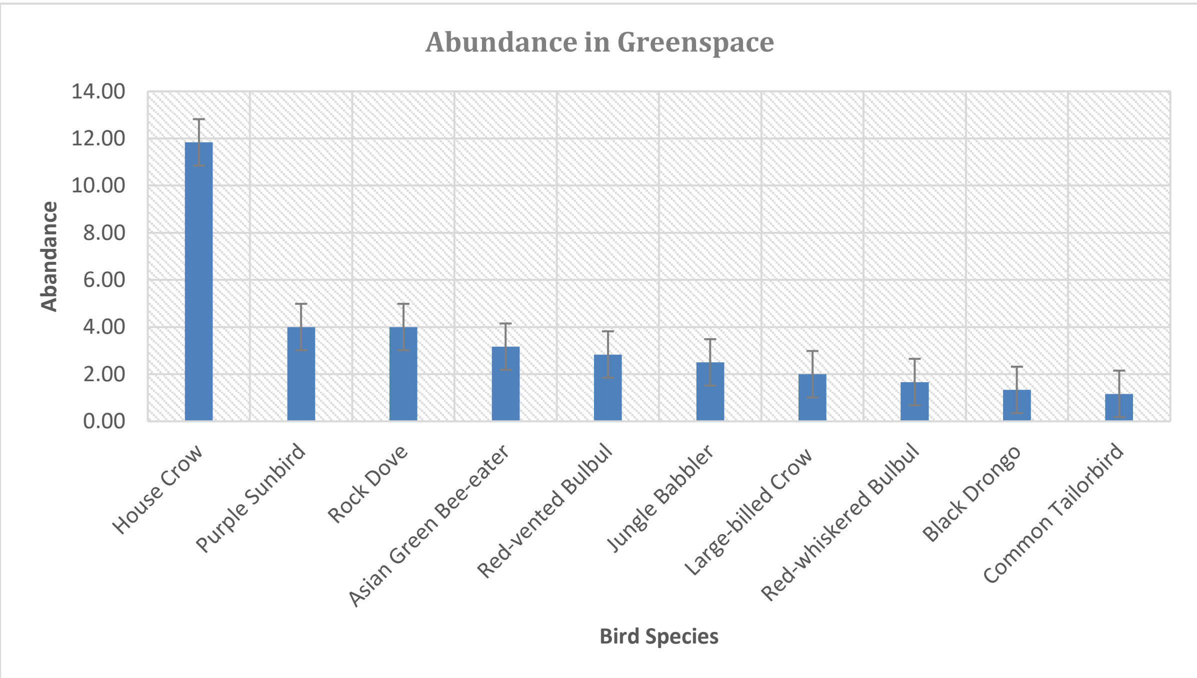

Figure 3.49: Bird abundance in Greenspaces – Winter Season

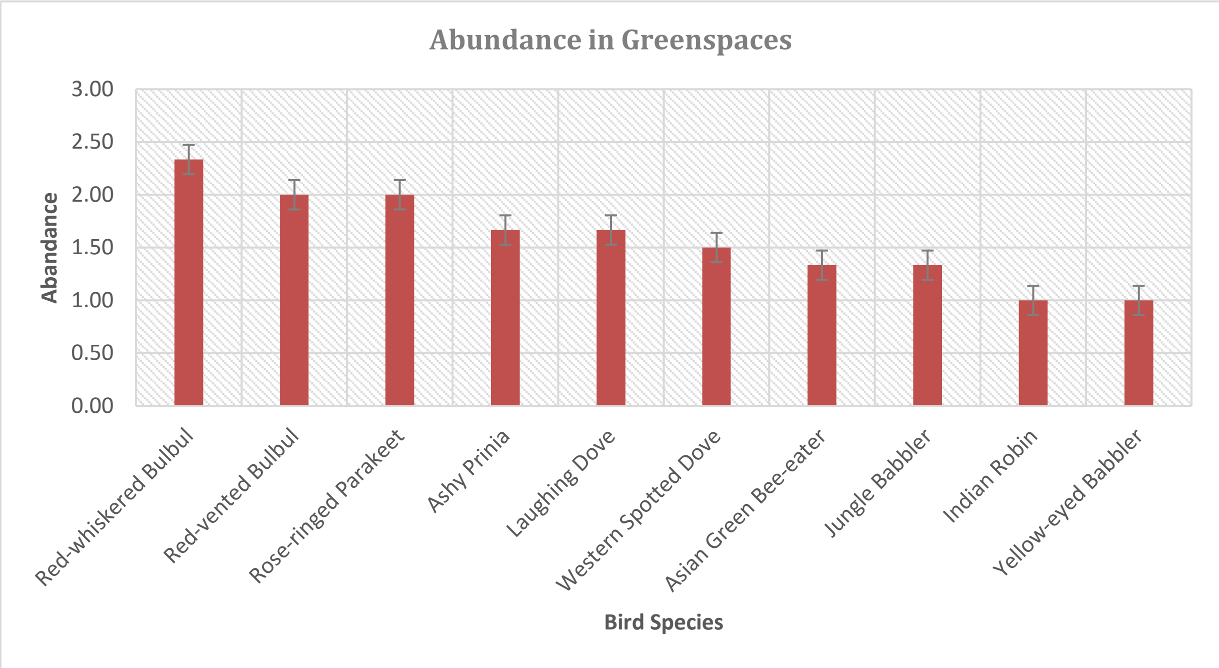

Figure: Bird abundance in Greenspaces- Summer Season

Mangrove, mudlflats, and salt pans habitat

In the Mangrove habitat, the highest abundance of House Crow followed by Rock Dove is observed in Post-Monsoon season, highest abundance of Asian Palm-swift followed by Ashy Prinia in Winter season, & highest abundance of Rock Dove followed by Rosy Starling in Summer Season (fig 3.51 to 3.53).

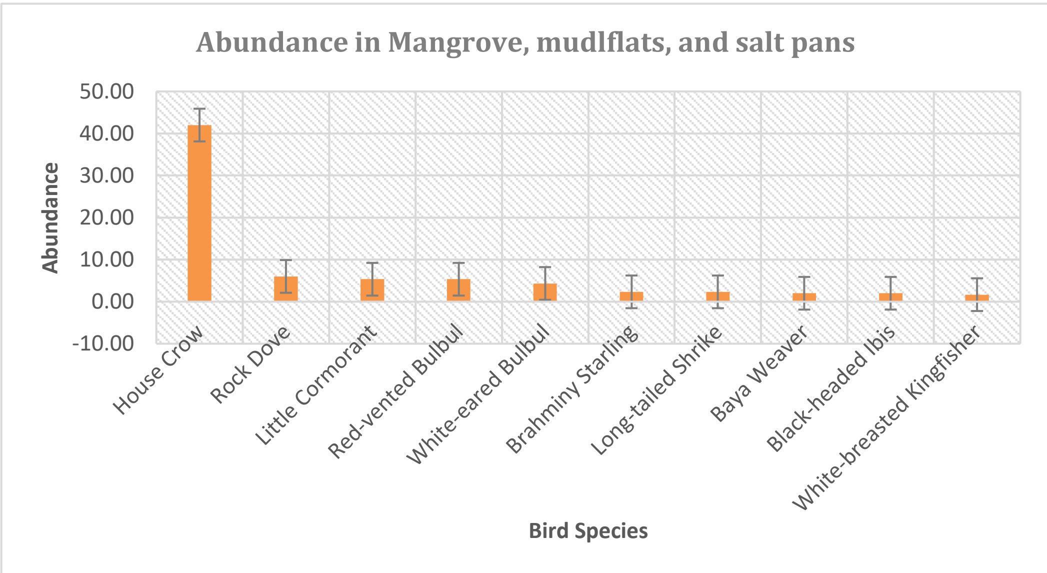

Figure 3.51: Bird abundance in Mangrove habitat – Post Monsoon Season

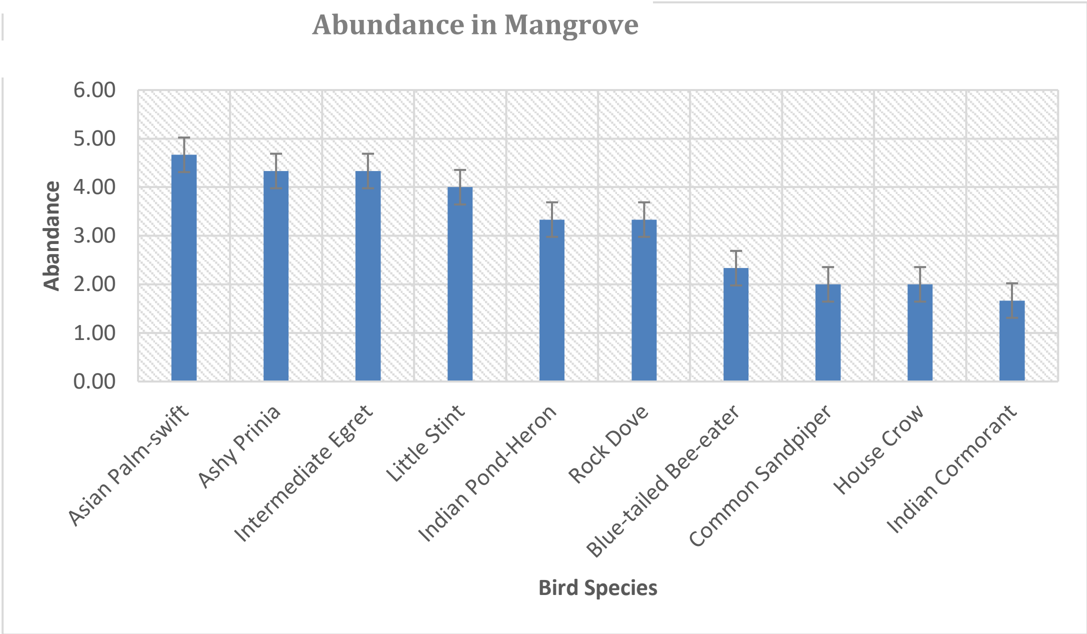

Figure 3.52: Bird abundance in Mangrove habitat – Winter Season

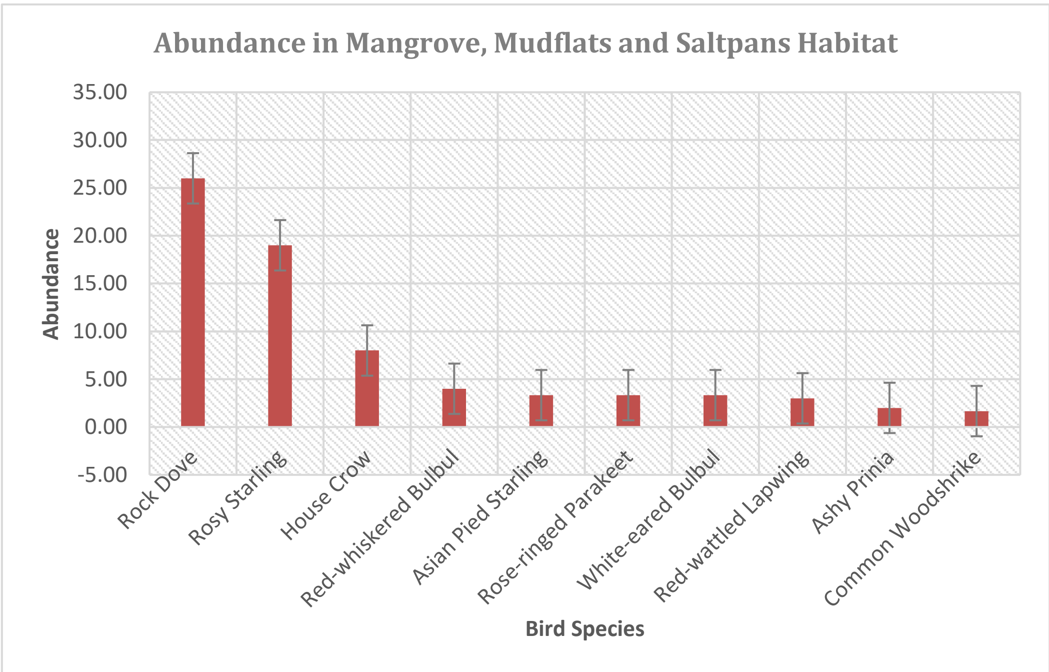

Figure 3.53: Bird abundance in Mangrove habitat- Summer Season

3.5 Terrestrial Bird Survey 2022-2023

Species Richness across habitats

Richness of bird species across all the habitat types

Species richness is the number of species within the defined range at per unit time. We have recorded the species richness of all the bird species observed across various types in the three (3) consecutive seasons: Post Monsoon (October 2022- November 2022), Winter (December 2022- February 2023), Summer (March 2023 - June 2023) in our study grids.

The highest bird species richness is observed in- 1) Mangrove, mudlflats, and salt pans habitat followed by Greenspace in the Post Monsoon Season 2) Mangrove habitat followed by Agricultural habitat in the Winter Season 3) Mangrove habitat followed by Degraded habitat in the Summer Season. The lowest bird species rich ness is observed consistently in Urban habitat for all the consecutive seasons (fig 3.54 to 3.56)

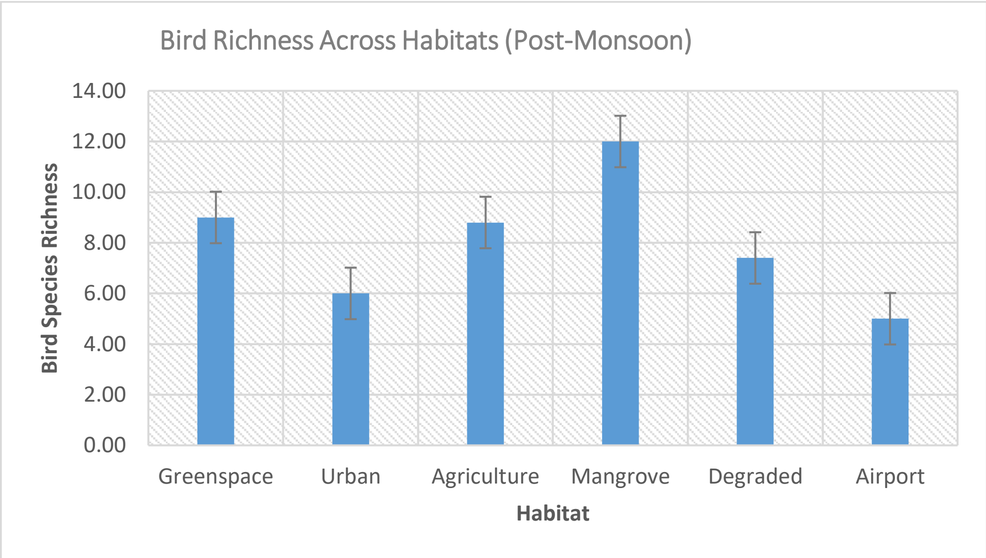

Figure 3.54 Bird richness in Post- Monsoon Season

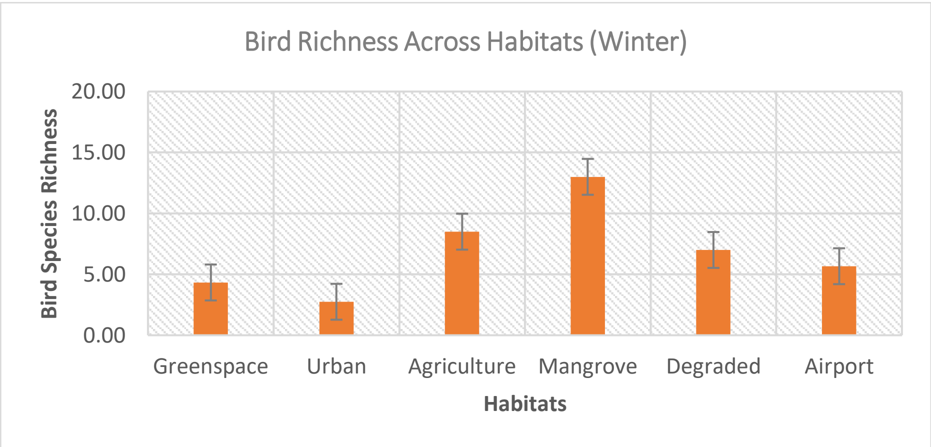

Figure 3.55: Bird richness in Winter Season

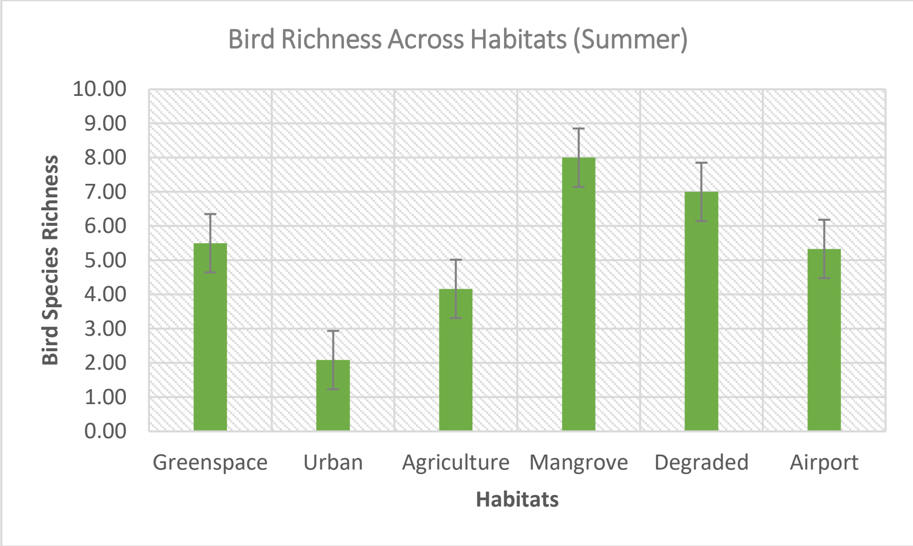

Figure 3.56: Bird richness in Summer Season

Abundance of bird species across all habitat types

Species abundance is the number of individuals per species. Species abundance provides clear insights regarding the bird community assembly, stability and community functions. We have calculated the species abundance across all the habitat types in all three consecutive seasons namely Post Monsoon (October 2022-November 2022), Winter (December 2022- February 2023), Summer (March 2023-June 2023) in our study grids. We have represented ten (10) most represented species based on their season-wise higher abundance in various habitats. We have also collated the data habitat- wise for all three consecutive seasons for a better representation.

Agricultural Habitat

In the Agricultural Habitat, the highest abundance of Oriental Magpie-robin followed by Rock Dove is observed in the Post-Monsoon Season, highest abundance of Black Kite followed by Cattle Egret in the Winter Season & highest abundance of House Crow followed by Rock Dove in the Summer Season (fig 3.60 to 3.62).

Degraded habitat

In the Degraded habitat, the highest abundance of Ashy Prinia followed by Rock Dove is observed in Post-Monsoon season, the highest abundance of Common Stonechat followed by Ashy Prinia in Winter season, & highest abundance of Red-vented Bulbul followed by Rock Dove in Summer season (fig 3.63 to 3.65).

Mangrove, mudlflats, and salt pans habitat

In the Mangrove habitat, the highest abundance of White-eared Bulbul followed by Rock Dove is observed in post-monsoon season, highest abundance of Blue-tailed Bee-eater followed by Black Drongo in Winter season, & highest abundance of Rock Dove followed by Rosy Starling in Summer Season (Fig 3.69 to 3.71).

Greenspaces

In the Greenspaces, the highest abundance of Asian Green Bee-eater followed by Red-vented Bulbul is observed in Post-Monsoon season, highest abundance of Red-vented Bulbul followed by Purple Sunbirdin Winter season, & highest abundance of Red-vented Bulbul followed by Rose-ringed Parakeet in Summer season (Fig 3.66 to 3.68).

Urban habitat

In Urban areas, the highest abundance of Rock Dove followed by House Crow is observed in the Post-Monsoon and Summer Season. The highest abundance of Rock Dove followed by House Sparrow is observed in the Winter season (fig 3.57 to 3.59).

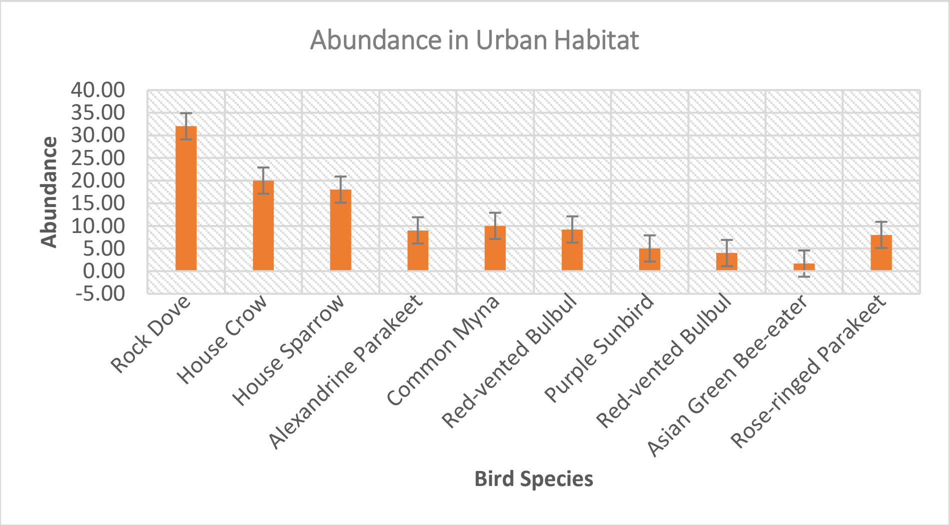

Figure 3.57: Bird abundance in Urban habitat – Post-Monsoon Season

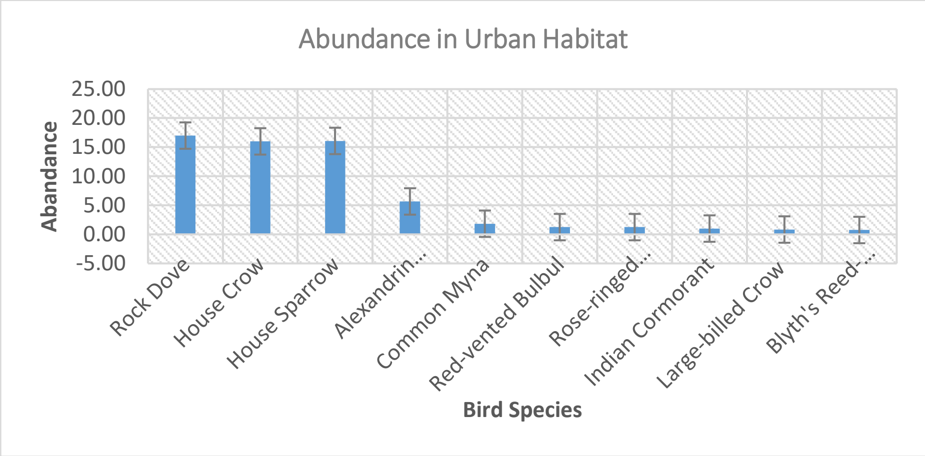

Figure 3.58: Bird abundance in Urban habitat – Winter Season

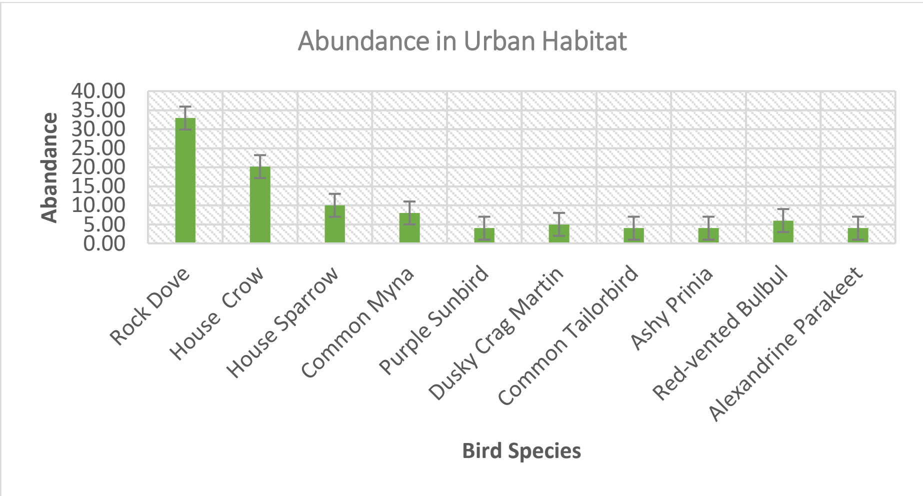

Figure 3.59 Bird abundance in Urban habitat – Summer Season

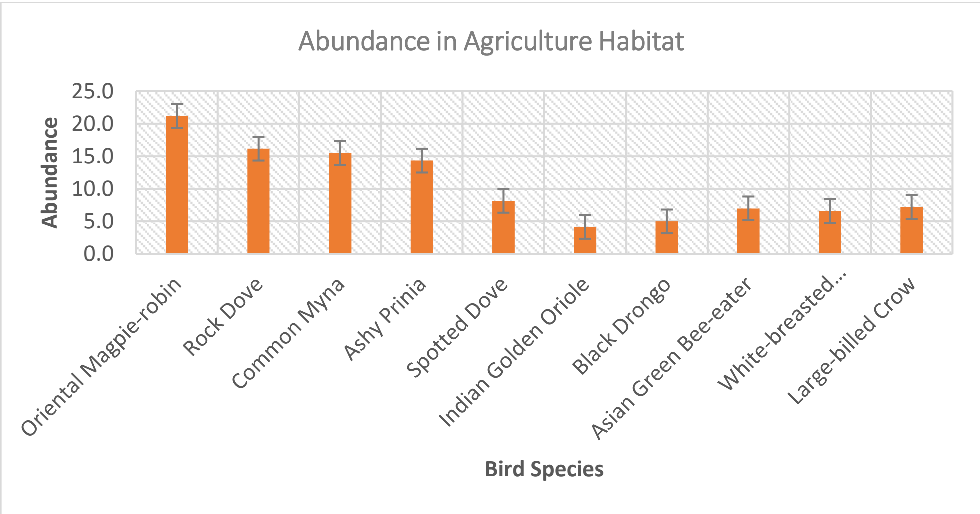

Figure 3.60 Bird abundance of Agricultural habitat – Post-Monsoon Season

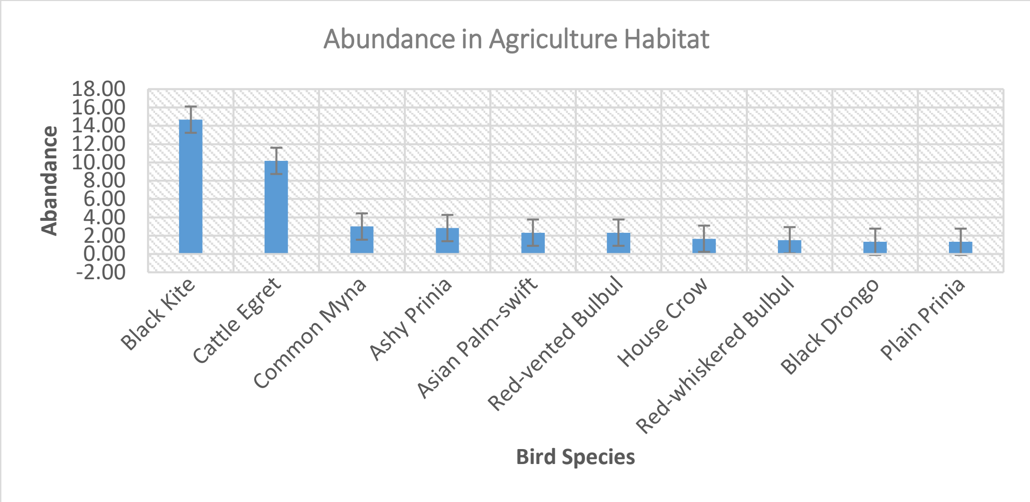

Figure 3.61 Bird abundance in Agricultural habitat- Winter Season

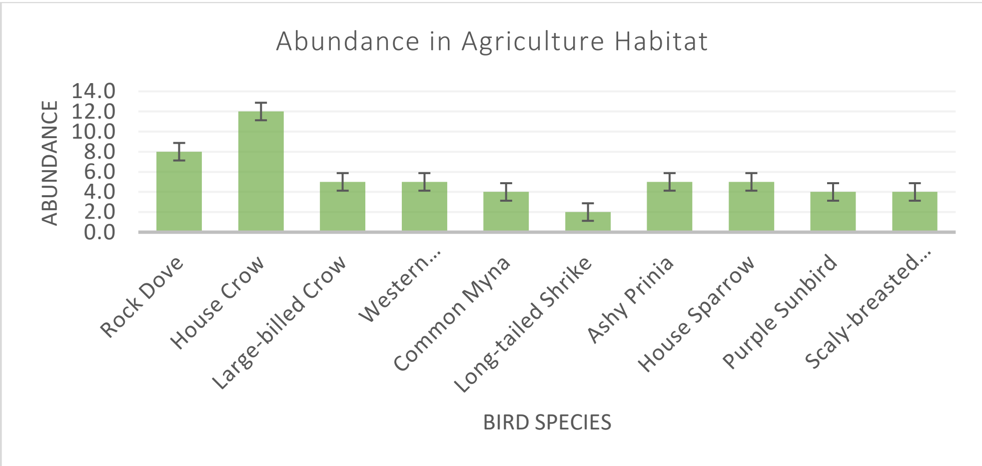

Figure 3.62 Bird abundance in Agricultural habitat – Summer Season

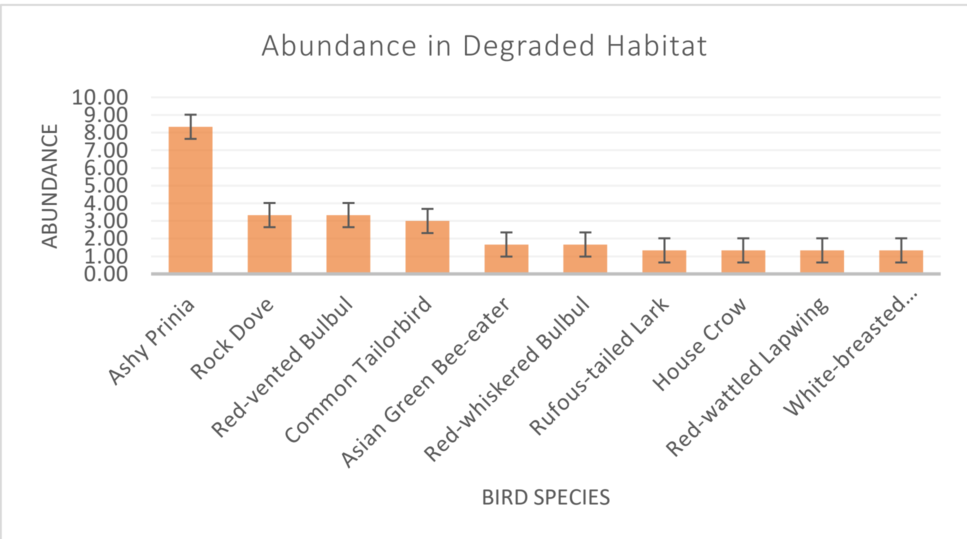

Figure 3.63 Bird abundance in Degraded habitat – Post-Monsoon Season

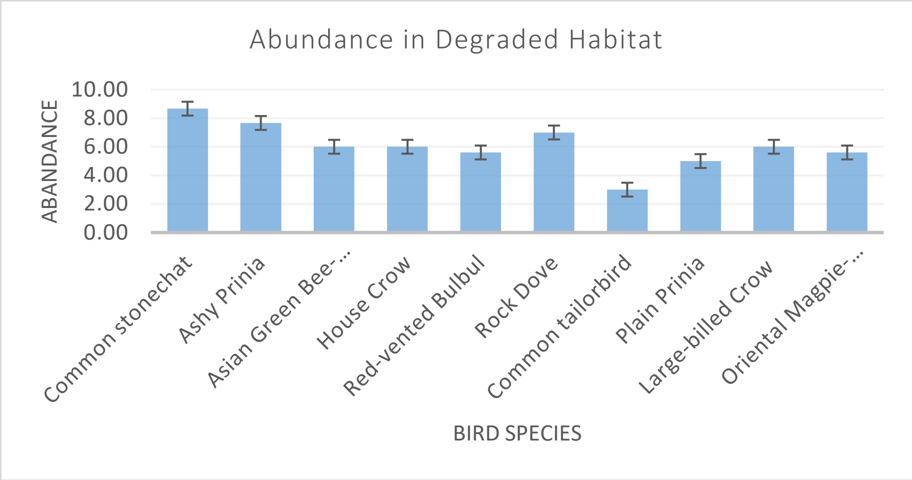

Figure 3.64: Bird abundance in Degraded habitat – Winter Season

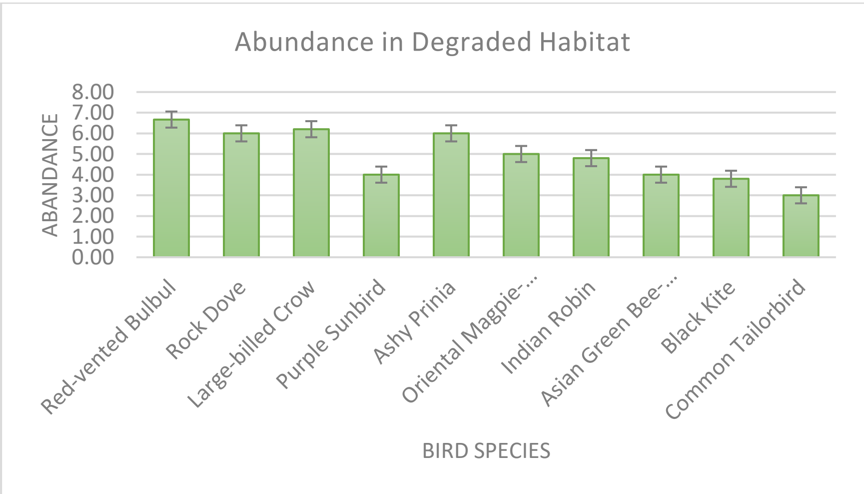

Figure 3.65 Bird abundance in Degraded habitat – Summer Season

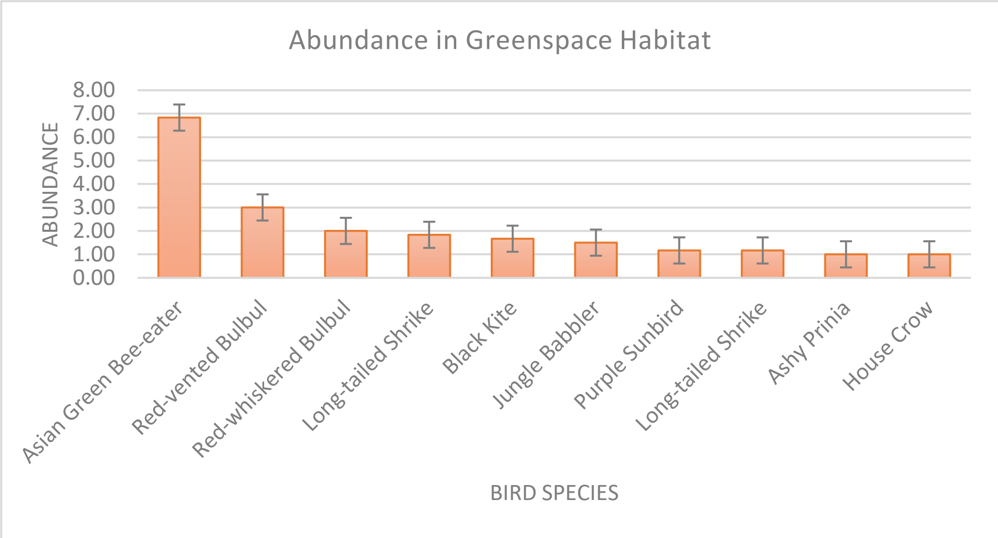

Figure 3.66 Bird abundance in Greenspaces – Post-Monsoon Season

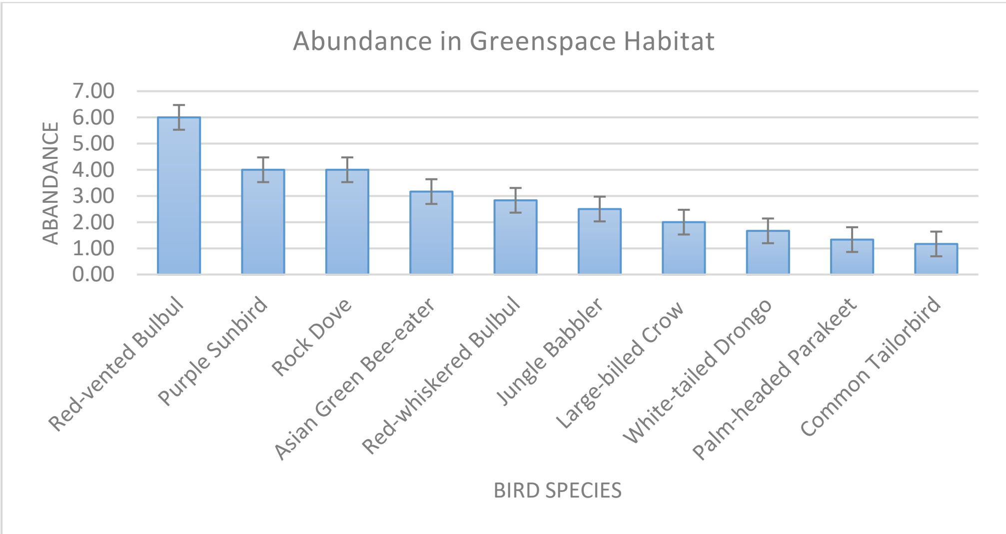

Figure 3.67 Bird abundance in Greenspaces – Winter Season

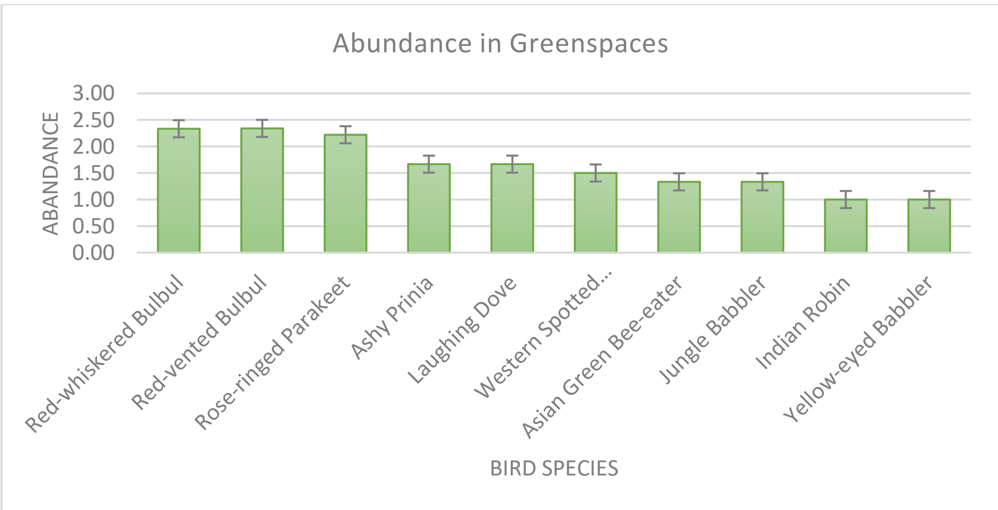

Figure 3.68 Bird abundance in Greenspaces- Summer Season

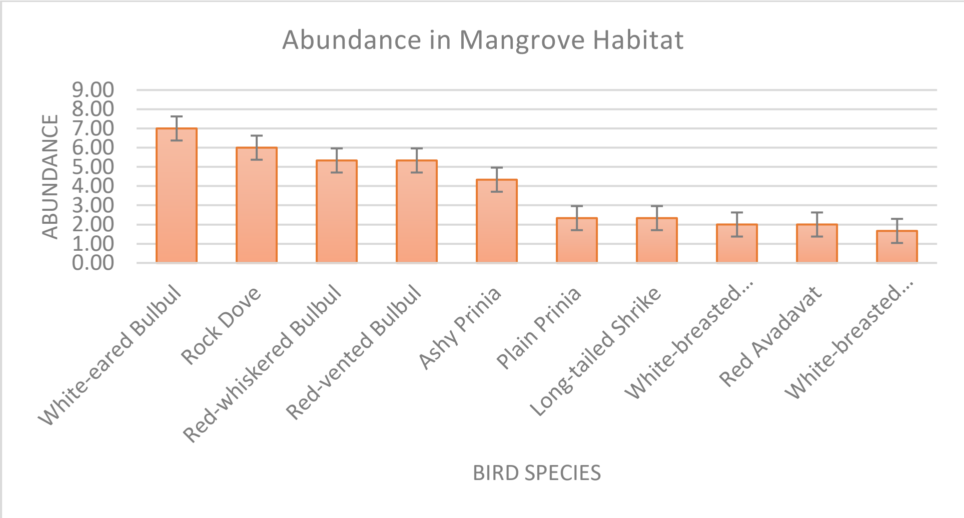

Figure 3.69: Bird abundance in Mangrove habitat – Post Monsoon Season

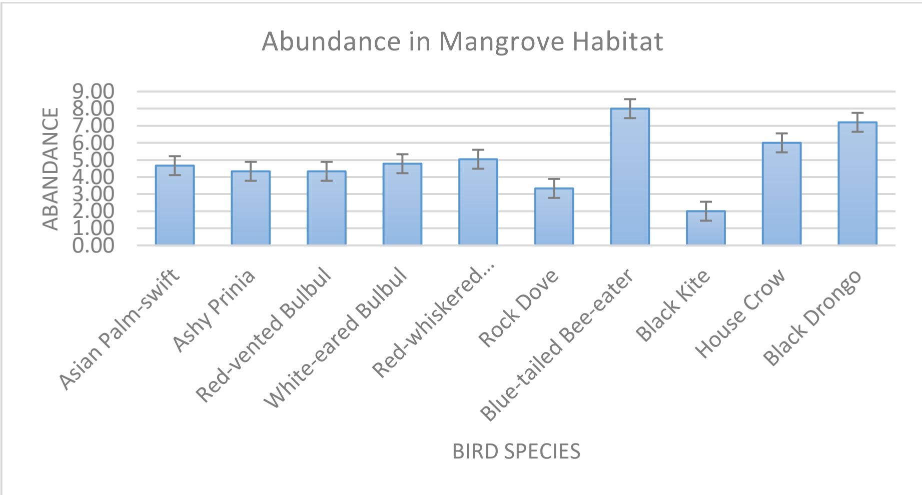

Figure 3.70: Bird abundance in Mangrove habitat – Winter Season

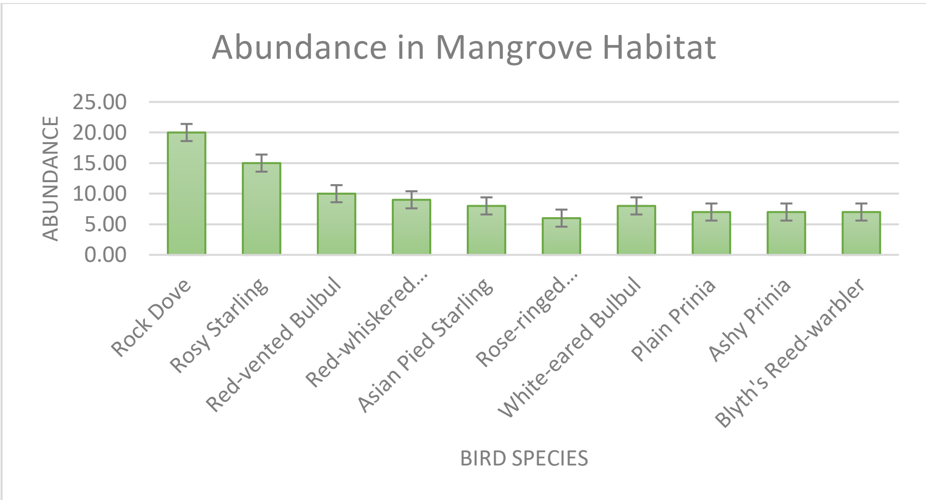

Figure 3.71 Bird abundance in Mangrove habitat- Summer Season

CHAPTER-4 Wetland Bird Survey

4.1: Wetland Bird Survey - 2019-2020

We carried out 21 Wetland Count Surveys from October 2018 to April 2019 in four wetland sites namely Panje, Belpada, NRI and TSC.

In total, 82 species of water birds were recorded from the four wetlands surveyed, of which 50 were migratory and 32 were resident. These wetlands showed substantial variation in species richness: Panje-52, Belpada-33, NRI-42, and TSC-35. Given below are the graphs for each wetland showing the species richness and abundance from October 2018 to April 2019. The detailed checklist of birds has been attached in Appendix 1.

Species Diversity

The below graphs (Figure 4.1 to 4.5) represent the diversity of bird species observed at the four wetlands in the study area. From Figure 4 it can be seen the highest diversity at Panje Wetland was recorded during the month of October, 2018 followed by November,2018. As can be seen from the figure, the diversity declined in the subsequent months, with the least diversity observed in April,2019. This trend has been observed at the other wetlands as well (Fig 4.2 to 4.5), the highest diversity was recorded during the months of October,2018 and November,2018, while the least diversity was recorded during March,2019 and April,2019. Unfortunately, the Panje wetlands are under severe threats due to the intention to commercially exploit this wetland.

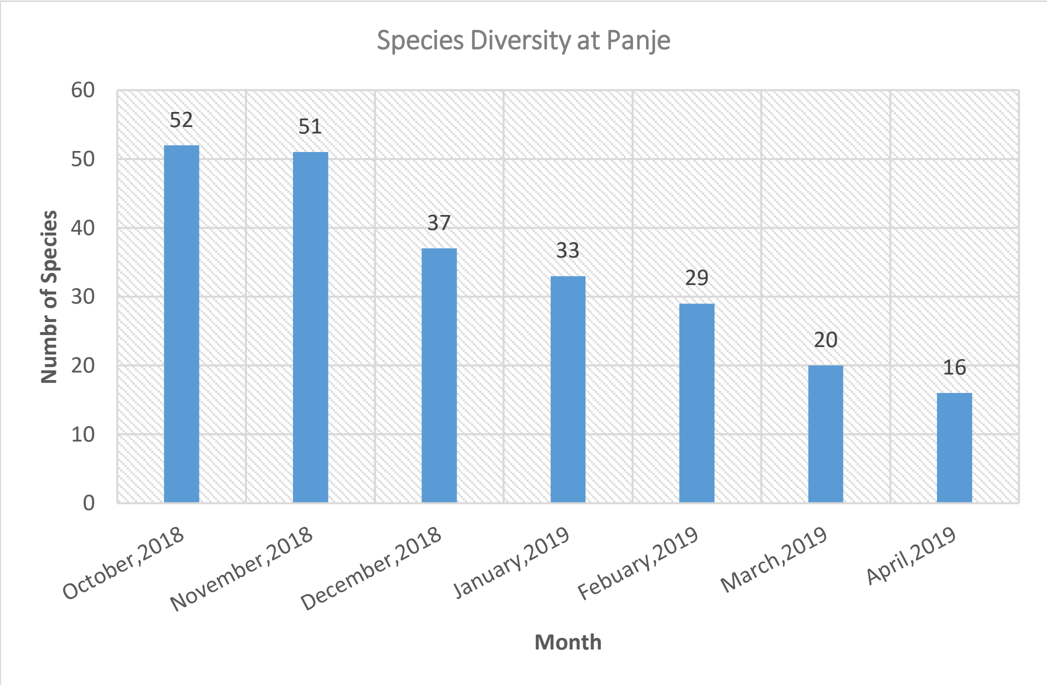

Figure 4.1 The above figure represents the diversity of bird species recorded at Panje Wetland.

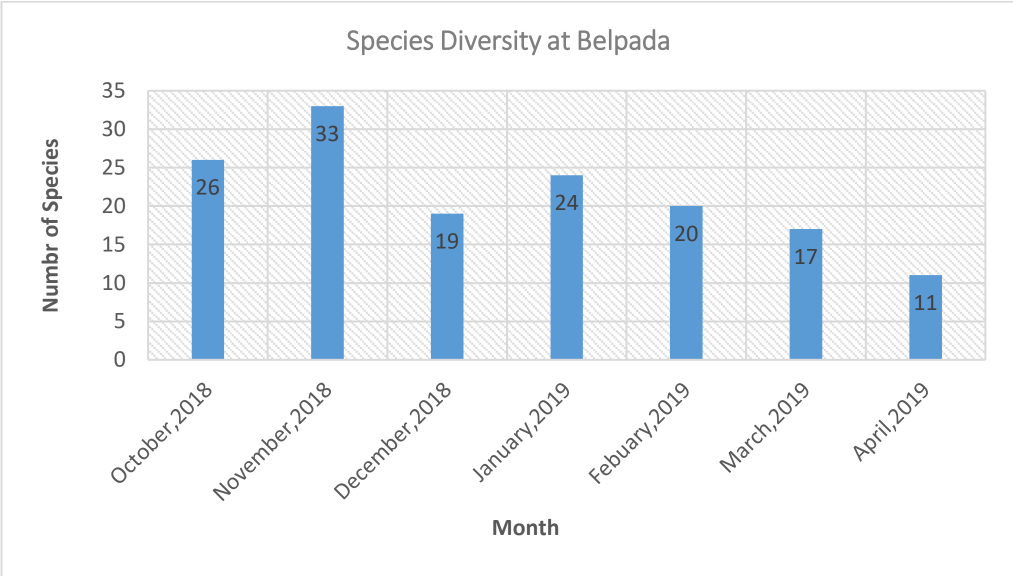

Figure 4.2 The above figure represents the diversity of bird species recorded at Belpada Wetland

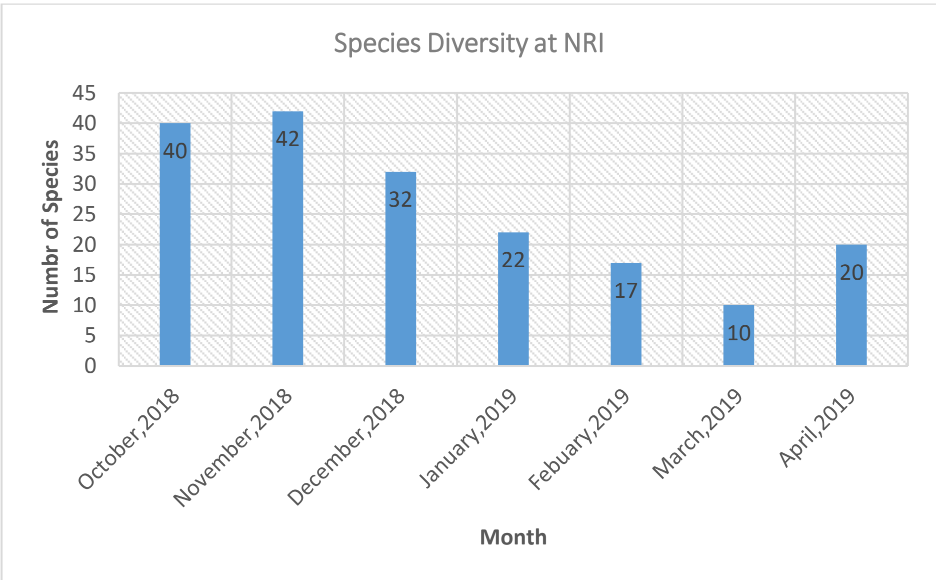

Figure 4.3 The above figure represents the diversity of bird species recorded at NRI Wetland

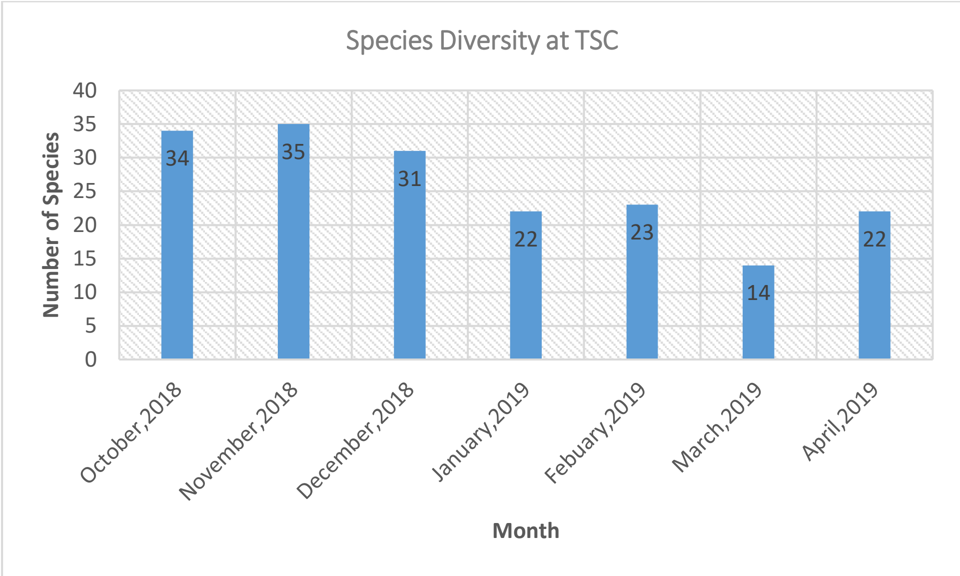

Figure 4.4 The above figure represents the diversity of bird species recorded at TSC Wetland

Species Abundance

The highest abundance of birds at Panje Wetland was observed during the month of October, 2018 while the least abundance was recorded during March, 2019(Figure 3.76). At Belpada (Figure 3.77), the highest abundance was seen during November, 2018 while the least was seen in the month of March, 2019. From Figure 3.78 it can be seen that NRI Wetland had highest abundance during the month of January, 2019 and least in March, 2019. Whereas at TSC Wetland (Figure 3.79) the abundance was highest in December, 2018 and lowest in the month of March, 2019.

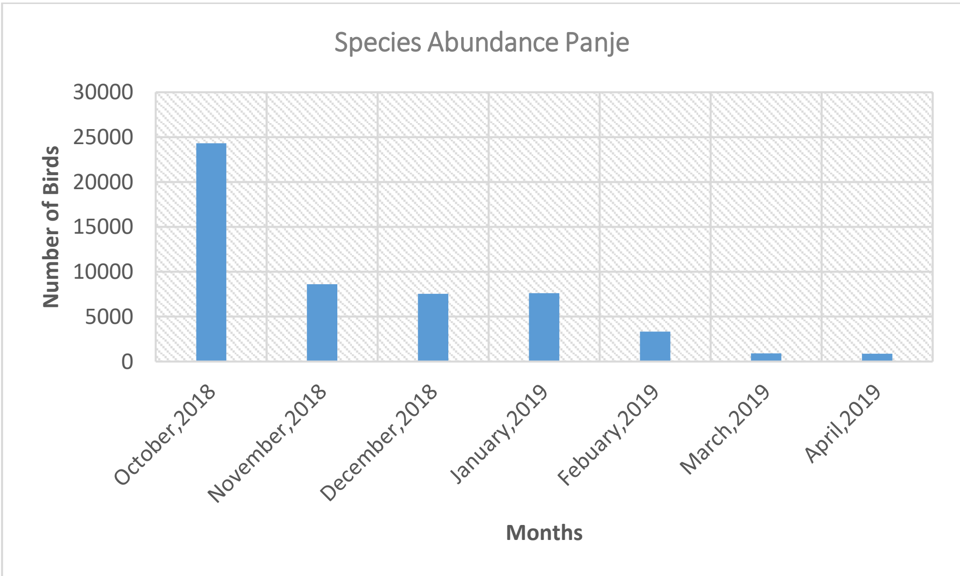

Figure 4.5 The above figure represents the abundance of birds recorded at Panje Wetland

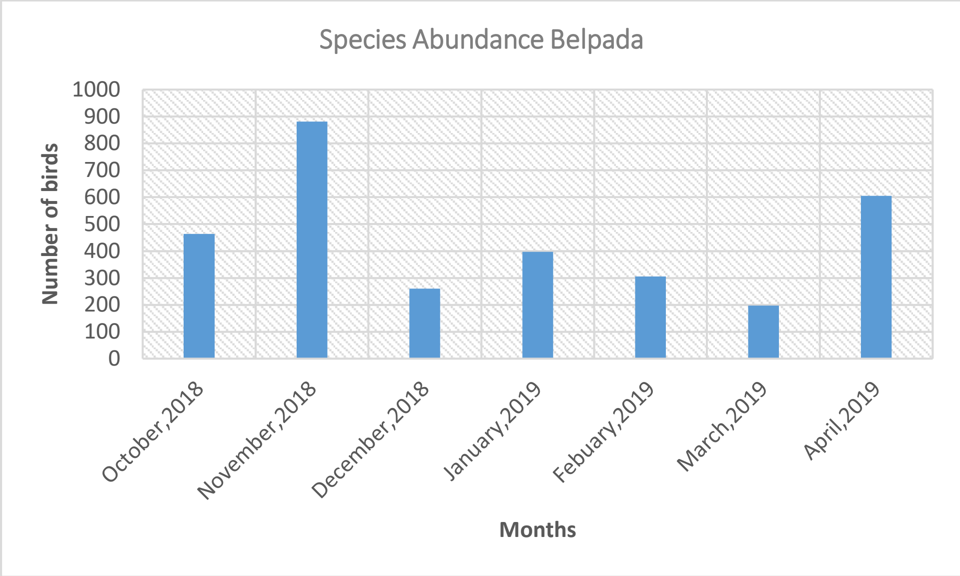

Figure 4.6 The above figure represents the abundance of birds recorded at Belpada Wetland

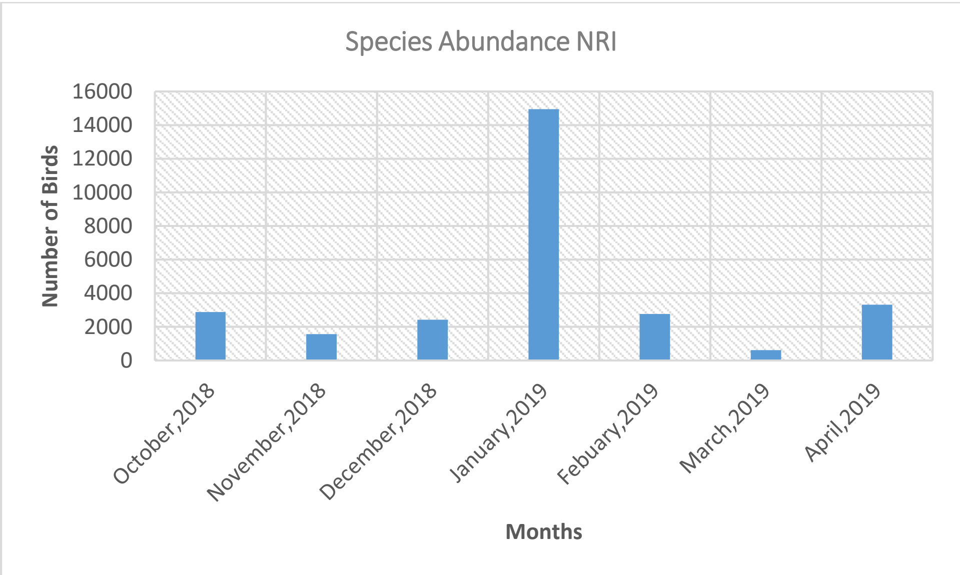

Figure 4.7 The above figure represents the abundance of birds recorded at NRI Wetland

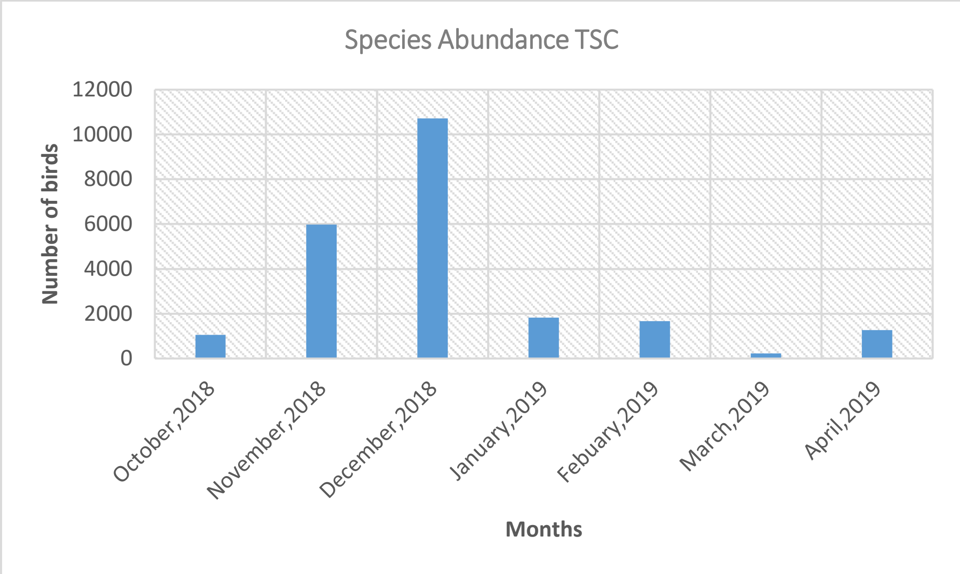

Figure 4.8 The above figure represents the abundance of birds recorded at TSC Wetland

4.2: Wetland Bird Survey - 2020-2021

Wetlands studied in the survey area

Owe dam

Owe dam, Kharghar (19.076014, 73.056780) is a serene place to experience nature with some bird activity around. However, while surveying we could not spot substantial number of bird species but sighting of some seasonal and local migratory water bird species made some important observations to be considered. We were mesmerized by the beauty, green hills all around; the calm and quiet waterbody in centre. The journey started with wide clean roads and ended with off roading on muddy ground and ultimately with a village, Owe camp. Muddy roads surrounded by rice fields accompanied us till the destination which is completely free from the hustle and bustle of the city. On our way back, it was disappointing to see that the stone quarrying activities have increased to a significant level. In the middle of such enriched biodiversity, it was alarming. Number of water bird species present is nineteen (19). There are six (6) migratory bird species along with one (1) near-threatened species.

Ulwe Wetland

Adjacent to Nava-Sheva Creek area and associated mangroves, mudlflats, and salt pans, there are mainly two connecting wetlands which are connected through roads by Ulwe Township. We named these wetlands as 'Ulwe Wetland' (18.986034,73.020357;18.987431,73.021178). During our morning and afternoon survey, we came across many anthropogenic activities like chaos of the local people while doing morning walk and, fishing activities, etc. While doing our reconnaissance and intensive survey during January and February, we observed very less bird species except few common and migratory water birds. Although we observed many mangrove-associated bird species including some migratory species in the Ulwe mangrove and mudlflats area and associated creek area. More seasonal surveys, during post-monsoon and summer month, are needed to get an entire scenario of bird species present in this area. Number of water bird species present is fifteen (15). There are four (4) migratory species.

Lotus Lake

Just behind the majestic corporation building of Navi Mumbai, Sector 27 Nerul, where a natural lake filled with lotuses (19.01763, 73.02587; 18.98513, 73.01924) of various varieties is in neglected condition. Situated in the middle of the urban colony of Nerul, this wetland with floating vegetation and weeds, houses various local migrants and other water birds, even in the presence of several anthropogenic interferences. During our regular survey to this lake, we have observed that it is a nesting ground for Little Grebe and Bronze-winged Jacana, foraging ground of Purple Swamphen, Common Moorhen, Pheasant-tailed Jacana with many other common water bird species. Necessary conservation actions should be taken to prevent the degradation of this habitat. Number of water bird species present is nineteen (19). One (1) migratory bird species is also found in the study site.

Wetlands of Kharghar

During the present study, a reconnaissance was conducted to identify the potential wetlands present in the Kharghar. During which a long stretch of water body was identified which was segregated in two sectors namely, sector 17 and sector 25. The stretch was monitored to identify the bird species using these sites. The wetlands being monitored in Kharghar are as follows:

Sector 17

This wetland is located in sector 17 (19°02′57.44″, 73°05′10.26 ″) and is a continuation of the Panvel Creek. The east side of this wetland is bordered by a mangrove patch, whereas the west and south sides surrounded by a residential complex. A bund passes through this wetland. The area covered by the wetland was 26 ha.

Sector 25

The wetland is located in Sector 25 in Kharghar (19°03′14.16″, 73°05′02.29 ″). It is also a continuation of the inlet of the Panvel Creek. It is located to the north of the Sector 17 wetland. The bunds in this wetland further divide it in four smaller parts. The area covered by the wetland was 3.23 ha. Number of water bird species present are thirty-five (35). We also observed fifteen (15) migratory bird species along with two (2) near-threatened species.

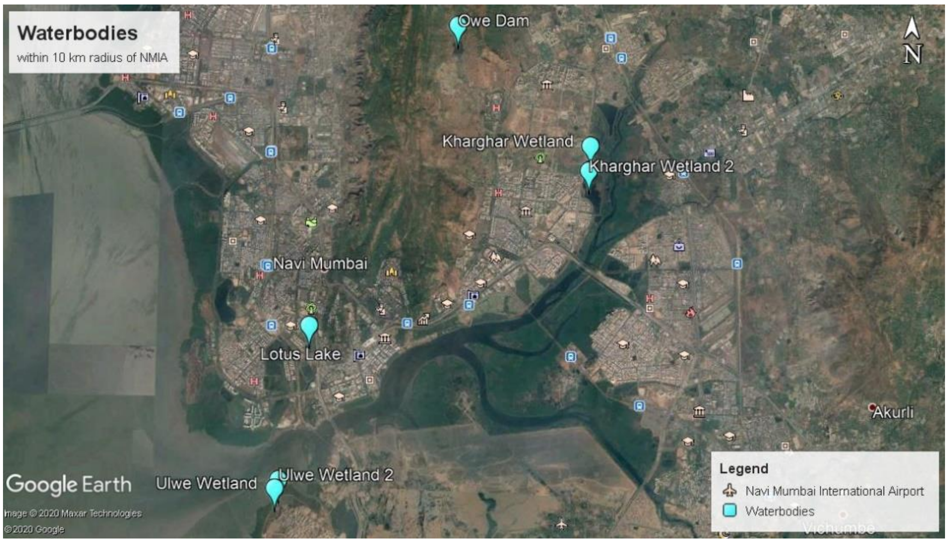

Figure 4.9 Location of inland waterbodies in the study area

Methodology

We carried out a reconnaissance survey for selecting the suitable waterbodies depending on their area, probability of congregations of migratory birds, presence of local migrants, seasonal migrants and common water birds. We shortlisted four waterbodies based on the above-mentioned criteria where we selected creek-associated wetlands in Ulwe and Kharghar, a natural lake in Nerul, and a dam in Kharghar. Bird species were counted at each site, preferably from a vantage point if available, with binoculars or spotting scope (Bibby et al. 2000). The bird species were recorded based on sighting or call. Birds were identified following Birdlife International (2019).

- Type of Count: Total count of individual species observed one hour before and one hour after high tide in case of wetland birds. For dam & lake, total count of bird species had been taken twice for 30 minutes with a break for 30 minutes in between to avoid overcounting.
- Condition: In case of wetlands, we carried out survey during high tide when birds came out of the creek due to inundation of mudflats, in search of roosting sites.
- Frequency of the survey: Intensive Survey – Monthly once (February 2020), Reconnaissance survey was carried out in the month of January.

Inpite of the COVID 19 pandamic, we could complete systematic regular survey for the month of January and February, 2021. Site-wise variation and presence-absence data of bird species richness has been presented through individual detailed checklists.

Table 4.1 Presence Absence data of birds observed in the Wetlands

S.no.	Common Name	Scientific Name	Resident/ Migratory	WPA Schedule	IUCN Status	Kharghar Wetland	Lotus Lake	Owe Dam	Ulwe Wetland
1	White-throated Kingfisher	*Halcyon smyrnensis*	R	IV	LC	+	+	+	+
2	Pied Kingfisher	*Ceryle rudis*	R	IV	LC	+		+	+
3	Common Kingfisher	*Alcedo atthis*	R	IV	LC	+	+	+	+
4	Indian Spot-billed Duck	*Anas poecilorhyncha*	R	IV	LC	+	+	+	+
5	Common Teal	*Anas crecca*	M	IV	LC	+			+
6	Indian Pond-heron	*Ardeola grayii*	R/LM	IV	LC	+	+	+	+
7	Grey Heron	*Ardeacinerea*	R/LM	IV	LC	+		+	+
8	Purple Heron	*Ardeapurpurea*	R/LM	IV	LC	+		+	+
9	Intermediate Egret	*Mesophoyx intermedia*	R/LM	IV	LC	+	+	+	+
10	Little Egret	*Egret tagarzetta*	R/LM	IV	LC	+	+	+	+
11	Cattle Egret	*Bubulcus ibis*	R/LM	IV	LC	+	+	+	+
12	Red-wattled Lapwing	*Vanellus indicus*	R	IV	LC	+	+	+	+
13	Pacific Golden Plover	*Plover Pluvialis fulva*	M	IV	LC	+			+
14	Greater Sandplover	*Charadrius leschenaultia*	M	IV	LC	+			+
15	Lesser Sandplover	*Charadrius mongolus*	M	IV	LC	+			+
16	Painted Stork	*Mycteria leucocephala*	R/LM	IV	NT	+		+	+
17	Asian Openbill	*Ana stomusoscitans*	R/LM	IV	LC	+		+	+

18	Barn Swallow	*Hirundo rustica*	M	IV	LC	+	+		+
19	Wire-tailed Swallow	*Hirundo smithii*	R	IV	LC	+			+
20	Caspian Tern	*Hydroprogne caspia*	M	IV	LC	+			+
21	Whiskered Tern	*Chlidonia shybrida*	M	IV	LC	+			+
22	Little Cormorant	*Phalacrocorax niger*	R/LM	IV	LC	+	+	+	+
23	Indian Cormorant	*Phalacrocorax fuscicollis*	R/LM	IV	LC	+	+	+	+
24	White-breasted Waterhen	*Amaurornisphoen icurus*	R	IV	LC	+	+		+
25	Purple Swamphen	*Porphyrio porphyrio*	R	IV	LC	+	+	+	+
26	Black-winged Stilt	*Himantopus Himantopus*	R	IV	LC	+	+	+	+
27	Ruff	*Philomachus pugnax*	M	IV	LC	+			
28	Common Greenshan k	*Tringa nebularia*	M	IV	LC	+		+	+
29	Common Redshank	*Tringa tetanus*	M	IV	LC	+	+		+
30	Wood Sandpiper	*Tringa glareola*	M	IV	LC	+		+	+
31	Terek Sandpiper	*Xenus cinereus*	M	IV	LC	+		+	+
32	Common Sandpiper	*Actitishypo leucos*	M	IV	LC	+	+	+	+
33	Little Stint	*Calidris minuta*	M	IV	LC	+		+	+
34	Black-headed Ibis	*Threskiornismela no cephalus*	R/LM	IV	NT	+		+	+
35	Glossy Ibis	*Plegadis falcinellus*	M	IV	LC	+			+
36	Bronze-winged Jacana	*Metopidius indicus*	R	IV	LC		+		+
37	Little Grebe	*Tachybaptusrufic ollis*	R	IV	LC	+	+	+	+
38	Common Moorhen	*Gallinula chloropus*	R	IV	LC		+		+

39	Pheasant-tailed Jacana	*Hydrophasianus chirurgus*	R/LM	IV	LC		+	+	
40	Red-naped Ibis	*Pseudibis papillosa*	R	IV	LC	+		+	
41	Brown-headed Gull	*Chroicocephalus brunnicephalus*	M	IV	LC	+		+	+
42	Black-headed Gull	*Chroicococephalu s ridibundus*	M	IV	LV	+		+	+
43	Bar-tailed Godwit	*Limosa lapponica*	M	IV	LC	+			
44	Black-tailed Godwit	*Limosa limosa*	M	IV	NT	+			+
45	Curlew Sandpiper	*Calidris ferruginea*	M	IV	NT	+			+
46	Heuglin's Gull	*Larus heuglini*	M	IV	LC	+			
47	Eurasian Curlew	*Numenius arquata*	M	IV	NT	+			+
48	Great Egret	*Ardea alba*	R	IV	LC	+			+
49	Gull-billed Tern	*Gelochelidon nilotica*	M	IV	LC	+			+
50	Lesser Flamingo	*Phoeniconaias minor*	M	I	NT	+			
51	Little Ringed Plover	*Charadriusdubius*	R	IV	LC	+			+
52	Asian Woollyneck	*Ciconia episcopus*	R	IV	VU	+			

The study indicated the local movement of birds is driven by tide height and water depth in high tide roosting sites (inland wetlands) which highlighted the importance of these wetlands in conservation and management of the birds in these areas. Apart from the observational examination, we also conducted ringing studies around Mumbai for investigating migratory ecology of shorebirds. Mumbai has been identified as one of the crucial areas in the Central Asian Flyways which play a vital role in maintaining the fragile group of wader population wintering in India.

4.3: Wetland Bird Survey - 2021-2022

The wetlands of Navi Mumbai have a significant ecological history. Navi Mumbai, where these wetlands are located, had been covered with large expanses of salt pans and paddy fields till the 1970s. Eventually, the development of this region into a new metropolitan area occurred as the population of old Mumbai was reaching beyond it carrying capacity (Chatterjee and Chatterjee 2016). Thus, increasing land prices, changing hydrology and economy due to construction activities, government policies, and changing lifestyles could have made people abandon farming and fishing (Oliver-Smith 2009). This might have brought transformation in this region — new wetlands were formed naturally in abandoned salt pans and paddy fields, and artificially by soil excavation — existing wetlands became shallow or disappeared due to heavy siltation and landfilling. Presently, these wetlands are facing serious threats from developmental activities, especially landfilling for residential, recreational, and commercial uses. Though these wetlands occupy a small fraction of the area, they sustain a myriad of local and seasonal bird migrants. Breeding habitats are important to identify among these wetlands because they help in the successful recruitment, colonization, and long-term maintenance of bird populations. Drying the wetlands containing breeding colonies can severely reduce populations, affecting community structure, and driving extinctions in local populations (Bino *et al.* 2015). Habitat destruction is also considered one of the key reasons for such a decline in bird population as they have specific habitat requirements from season to season (Adhikari 2019). Hence, it is vital to assess the potential of these wetlands and the threats to them in order to understand the ecological aspects and implement suitable conservation and management actions for the long-term preservation of these habitats.

Tide- independent inland wetlands

Ballaleshwar Lake or Vadale Lake

Ballaleshwar Lake (18.9940°N,73.1117°E) the oldest lake in Panvel, is located in HOC (Hindustan Organic Chemical) Colony, next to Ballaleshwar Temple, just beside the New Panvel Flyover along the Sion- Panvel Highway, Mumbai. The area of the lake is 6 acres. Historically, Ballaleshwar Lake was built by Peshwa Chimaji Appa, brother of the eminent Maharashtrian ruler, Peshwa Bajirao. Beautification of this lake was planned and executed (quite) recently as previously it had been gradually covered with weeds slimes, sludges, and garbage. The lake harbours a wide variety of aquatic floral and faunal diversity. The lake supports around 34 water bird species (24 resident species, and 10 migratory birds).

Owe dam

Owe dam, Kharghar (19.076014 N, 73.056780 E) is a serene place to experience nature with some bird activity around. However, while surveying we could not spot substantial number of bird species but sighting of some seasonal and local migratory water bird species made some important observations to be considered. We were mesmerized by the beauty of green hills all around; the calm and quiet waterbody in centre. The journey started with wide clean roads and ended with off roading on muddy ground and ultimately with a village, Owe camp. Muddy roads surrounded by rice fields accompanied us till the destination which is completely free from the hustle and bustle of the city. On our way back, it was disappointing to see that the stone quarrying activities have increased to a significant level. In the middle of such enriched biodiversity, it was alarming. Number of water bird species present is sixteen (16). There is one (1) migratory along with fifteen (15) resident bird species.

Lotus Lake

Just behind the majestic corporation building of Navi Mumbai, Sector 27 Nerul, where a natural lake filled with lotuses (19.01763 N, 73.02587 E; 18.98513 N, 73.01924 E) of various varieties is in neglected condition. Situated in the middle of the urban colony of Nerul, this wetland with floating vegetation and weeds, houses various local migrants and other water birds, even in the presence of several anthropogenic interferences. During our regular survey to this lake, we have observed that it is a nesting ground for Little Grebe and Bronze-winged Jacana, foraging ground of Purple Swamphen, Common Moorhen, Pheasant-tailed Jacana with many other common water bird species. Necessary conservation actions should be taken to prevent the degradation of this habitat. Number of water bird species present is nineteen (19). One (1) migratory bird species is also found in the study site.

Morbe Dam

Morbe Dam is a gravity dam on the Dhavari river near Khalapur, Raigad district in the state of Maharashtra, India (18.9261397 N,73.246285 E). The dam was constructed to supply drinking water to the Navi Mumbai and Nhava Sheva regions. Located nearly half an hour from Matheran, this dam is surrounded by the hills of northern Western Ghats. The vegetation of the area around the dam mostly includes deciduous trees of the montane rainforests and open scrublands. The habitat supports a variety of terrestrial and aquatic bird species. Due to its scenic location, there is an increased construction of hotels in the area, the natural vegetation is being cleared which can lead to a reduction of bird species in the area. A total of 22 bird species (1 migratory, 21 resident) were observed in Morbe Dam.

Gadeshwar Dam

Surrounded by lush green paddy fields and hilly terrains, Gadeshwar dam is treat to the visitors' eyes. The dam is perfectly nestled amidst of Chanderi, Mhaismal, Peb and Matheran Hills near Panvel (19.0327797 N, 73.2425364 E). The region around the dam mostly comprises of deciduous forests and hilly terrain. Due to its location and alluring surroundings the place attracts a lot of tourists, who come for a getaway or to enjoy activities like trekking. This is the reason why there is an increase in constructions for hotels and stays around the dam. The conversion of the natural habitat to human use lands might have a detrimental effect on the bird species which reside in the dam. A total of 26 species of birds (5 migratory, 21 residents) were observed in Gadeshwar Dam.

Tide Dependent High-Tide Roosting Sites

Ulwe

Adjacent to Nava-Sheva Creek area and associated mangroves, mudlflats, and salt pans there are mainly two connecting wetlands which are connected through roads by Ulwe Township. We named these wetlands as 'Ulwe Wetland' (18.986034,73.020357;18.987431,73.021178). During our morning and afternoon survey, we came across many anthropogenic activities like chaos of the local people while doing morning walk and, fishing activities. While doing our reconnaissance and intensive survey during January and February, we observed very less bird species except few common and migratory water birds. Although we observed many mangrove-associated bird species including some migratory species in the Ulwe mangrove area and associated creek area. More seasonal surveys, during post-monsoon and summer month, are needed to get an entire scenario of bird species present in this area. Number of water bird species present is forty-two (42). There are sixteen (16) migratory species.

Kharghar

The present study was conducted to identify the potential wetlands present in the Kharghar in which a long stretch of water body was identified which was segregated in two sectors namely, sector 17 and sector 25. The stretch was monitored to identify the aquatic bird species using these sites as their feeding and roosting grounds. The wetlands being monitored in Kharghar are as follows:

Sector 17

This wetland is located in sector 17 (19°02′57.44″, 73°05′10.26 ″) and is a continuation of the Panvel Creek. The east side of this wetland is bordered by a mangrove patch, whereas the west and south sides surrounded by a residential complex. A bund passes through this wetland. The area covered by the wetland was 26 ha.

Sector 25

The wetland is located in Sector 25 in Kharghar (19°03′14.16″, 73°05′02.29 ″). It is also a continuation of the inlet of the Panvel Creek. It is located to the north of the Sector 17 wetland. The bunds in this wetland further divide it in four smaller parts. The area covered by the wetland was 3.23 ha.

Number of water bird species present in these wetlands are Forty-Nine (49) where twenty-five (25) migratory and twenty-four (24) resident bird species.

Methodology

Wetland Count:

We carried out systematic monthly surveys in six waterbodies based on the above-mentioned criteria where we selected creek-associated tide dependent wetlands in Ulwe and Kharghar, a natural lake in Nerul, Owe dam in Kharghar, Morbe and Gadeshwar Dam in Raigad district. Bird species were counted at each site, preferably from a vantage point if available, with binoculars or spotting scope (Bibby *et al.* 2000). The bird species were recorded based on sighting or call. Birds were identified following Birdlife International 2019.

- Type of Count: Total count of individual species observed one hour before and one hour after high tide in case of wetland birds. For dam & lake, total count of

  bird species had been taken twice for 30 minutes with a break for 30 minutes in between to avoid overcounting.

- Condition: In case of wetlands, we carried out survey during high tide when birds came out of the creek due to inundation of mudflats, in search of roosting sites.
- Frequency of the survey: Monthly Twice

Creek Survey

The Panvel Creek is a 7-km-long creek that passes through Taloja, Panvel and Ulwe, before entering the sea at Belapur. Since the Panvel Creek surrounds a major portion of the Navi Mumbai International Airport and acts as feeding ground for a number of water birds, it was extremely important to carry out monitoring of birds in this area. During the survey large flocks of Northern Shoveler, Indian Cormorant, Whiskered Tern, Black-winged Stilt and mixed flocks of many other waterbirds were identified in the area, which accounted to 36 species of water birds. Number of aquatic bird species observed in the Panvel Creek is around 30 including 15 Resident and 15 Migratory bird species.

Creek Survey Methodology on Waterbirds

The bird species were recorded based on sighting or call. Birds were identified following BirdLife International 2019.

- Type of Count: The survey was conducted on the 3 km accessible stretch in peripheral pathway just beside the creek. Total count of individual species observed in the entire accessible range of 3 km by dividing it into two transects of 1 km each with a gap of 1km in between, in order to avoid overcounting. We followed the Bell Transect method, where we considered vantage point count stations (the total number of 3-point count stations) on the transect to count the bird species abundance and diversity from those particular points.
- Condition: Transect surveys were carried out during low tide when birds return to the creek due to the exposure of mudflats, in search of roosting sites. As the Panvel Creek was found to be narrow, one team of researchers simultaneously observed both the banks and recorded all the species of birds and their population using Binoculars and a Spotting Scope.
- Frequency of the survey: Twice a month.

Preliminary Observations

Based on our year-long monthly wetland bird count in all the wetlands namely Lotus Lake, Ballaleshwar Lake, Kharghar Wetland, Ulwe Wetland, Owe Dam, Morbe Dam, Gadeshwar Dam and Panvel-Belapur Creek, we have collated the presence-absence data of all the waterbirds present in all these mentioned waterbodies and represented those in a tabular format to provide a comprehensive idea regarding the diversity of species here:

Table 4.2: Presence- absence of waterbirds in all the wetlands of study site

Birds	Scientific Name	LOTUS LAKE	ULWE WETLAND	BALLALESHWAR LAKE	MORBE DAM	GADESHWAR DAM	OWE DAM	BELAPUR CREEK	KHARGHAR WETLAND
Asian Openbill	*Anastomus oscitans*		✓	✓	✓	✓	✓		
Black-crowned Night-heron	*Nycticorax nycticorax*		✓	✓					✓
Black-headed Gull	*Chroicococ ephalus ridibundus*		✓					✓	✓
Black-headed Ibis	*Threskiorni smelano cephalus*		✓					✓	✓
Black-tailed Godwit	*Limosa limosa*							✓	✓
Black-winged Stilt	*Himantopus himantopus*		✓			✓		✓	✓
Broad-billed Sandpiper	*Limicola falcinellus*								✓
Bronze-winged Jacana	*Metopidius indicus*	✓	✓	✓					
Brown-headed Gull	*Chroicocep halus brunniceph alus*		✓					✓	✓
Caspian Tern	*Hydroprogn e caspia*		✓		✓				✓
Cattle Egret	*Bubulcus ibis*	✓	✓	✓	✓	✓	✓	✓	✓

Common Coot	*Fulica atra*			✓					
Common Greenshank	*Tringa nebularia*		✓			✓	✓	✓	✓
Common Gull-billed Tern	*Gelochelidon nilotica*	✓	✓			✓		✓	✓
Common Kingfisher	*Alcedo atthis*	✓	✓	✓	✓	✓	✓	✓	
Common Moorhen	*Gallinula chloropus*	✓	✓	✓					
Common Redshank	*Tringa totanus*		✓					✓	✓
Common Sandpiper	*Actitis hypoleucos*		✓	✓	✓	✓	✓	✓	✓
Common Shelduck	*Tadorna tadorna*								
Common Snipe	*Gallinago gallinago*								✓
Cotton Pygmy-goose	*Nettapus coromandelianus*	✓							
Eurasian Curlew	*Numenius arquata*		✓					✓	✓
Eurasian	*Platalealeucorodia*							✓	✓

Spoonbill									
Garganey	*Anas querquedula*								✓
Glossy Ibis	*Plegadis falcinellus*	✓				✓			✓
Great White Egret	*Ardea alba*		✓						✓
Greater Sandplover	*Charadrius leschenaultii*		✓						✓
Green-backed Heron	*Butorides striata*					✓			
Grey Heron	*Ardeacinerea*		✓			✓		✓	✓
Grey Plover	*Pluvialis squatarola*		✓						
Grey Wagtail	*Motacilla cinerea*						✓		
Great Cormorant	***Phalacrocorax carbo***								✓
Great crested grebe	*Podiceps cristatus*				✓				
Grey-headed Swamphen	*Porphyrio porphyrio*		✓	✓					✓
Heuglin's Gull	*Larus heuglini*							✓	✓
Indian Cormorant	*Phalacrocorax fuscicollis*	✓	✓	✓	✓	✓	✓	✓	✓
Indian Pond-Heron	*Ardeola grayii*	✓	✓	✓	✓	✓	✓	✓	✓

Indian Spot-billed Duck	*Anas poecilorhyncha*		✓	✓	✓	✓		✓	✓
Intermediate Egret	*Mesophoyx intermedia*	✓	✓	✓	✓	✓	✓	✓	✓
Lesser Flamingo	*Phoeniconaias minor*		✓						
Lesser Sandplover	*Charadrius mongolus*		✓						✓
Lesser Whistling-duck	*Dendrocygna javanica*	✓	✓	✓	✓	✓			
Little Cormorant	*Phalacrocorax niger*	✓	✓	✓	✓	✓	✓	✓	✓
Little Egret	*Egrettagarzetta*	✓	✓	✓	✓	✓	✓	✓	✓
Little Grebe	*Tachybaptusruficollis*	✓		✓	✓	✓	✓		✓
Little stint	*Calidris minuta*		✓					✓	✓
Little-ringed Plover	*Charadrius dubius*				✓			✓	✓
Mallard	*Anas platyrhynchos*		✓						✓
Marsh Sandpiper	*Tringa stagnatilis*		✓			✓			✓
Northern Pintail	*Anas acuta*								✓
Northern Shoveler	*Spatula clypeata*							✓	

Oriental Pratincole	*Glareola maldivarum*					✓			
Pacific Golden Plover	*Plover Pluvialis fulva*		✓					✓	✓
Painted Stork	*Mycteria leucocephala*		✓					✓	✓
Pheasant-tailed Jacana	*Hydrophasianus chirurgus*	✓							
Pied Kingfisher	*Ceryle rudis*		✓		✓		✓		
Purple Heron	*Ardeapurpurea*	✓		✓	✓	✓			✓
Red-naped Ibis	*Pseudibis papillosa*					✓		✓	
Red-wattled Lapwing	*Vanellus indicus*	✓	✓	✓	✓	✓	✓		✓
River Tern	*Sterna aurantia*								✓
Ruddy Shelduck	*Tadorna ferruginea*								✓
Ruff	*Philomachus pugnax*								✓
Western Reef Egret	*Egrettagularis*		✓		✓	✓		✓	✓
Whiskered Tern	*Chlidonia shybrida*		✓			✓		✓	✓
White-breasted Kingfisher	*Halcyon smyrnensis*	✓	✓	✓	✓	✓	✓		✓

White-breasted Waterhen	*Amaurornis phoenicurus*	✓		✓	✓	✓			✓
Wood Sandpiper	*Tringa glareola*	✓	✓					✓	✓
Yellow wagtail	*Motacilla flava*						✓		
Yellow-wattled Lapwing	*Vanellus malabaricus*				✓				

Aquatic bird species abundance

In ecology, species abundance is the relative representation of a species in that particular area which we calculate as the number of individual of species per unit area per unit time. While preforming our systematic surveys, we have calculated the abundance of species in all the wetlands including the creek area. Here, the ten (10) 'most represented' waterbirds are shown for all the wetlands and creek based on their year-long overall maximum abundance in all those particular sites. In the Lotus Lake, the highest abundance was seen in Lesser Whistling-duck (308), followed by Bronze-winged Jacana (229). In the Ulwe Wetland, we observed the highest abundance of Lesser Sandplover (2357) followed by Common Redshank (687). In the Gadeshwar Dam, the highest abundance of Little Egret (131) followed by Little Cormorant (129). In the Owe Dam, we recorded the highest abundance of Red-wattled Lapwing (55) and Little Cormorant (55) followed by Little Egret (25). Moreover, we recorded the highest abundance of Little Cormorant (73) followed by Red-wattled Lapwing (69) in the Morbe Dam. In the Ballaleshwar Lake, we observed the highest abundance of Lesser Whistling-duck (548) followed by Common Coot (151). In the Kharghar Wetland, we recorded highest abundance of Little Stint (3370) followed by Black-tailed Godwit (2764). Additionally, in the Panvel-Belapur Creek survey, we recorded the highest abundance of Northern Shoveler (800) followed by Indian Cormorant (559). Here, we provided the graphical presentation of ten 'most represented' species in all the wetlands along with the Belapur-Panvel creek:

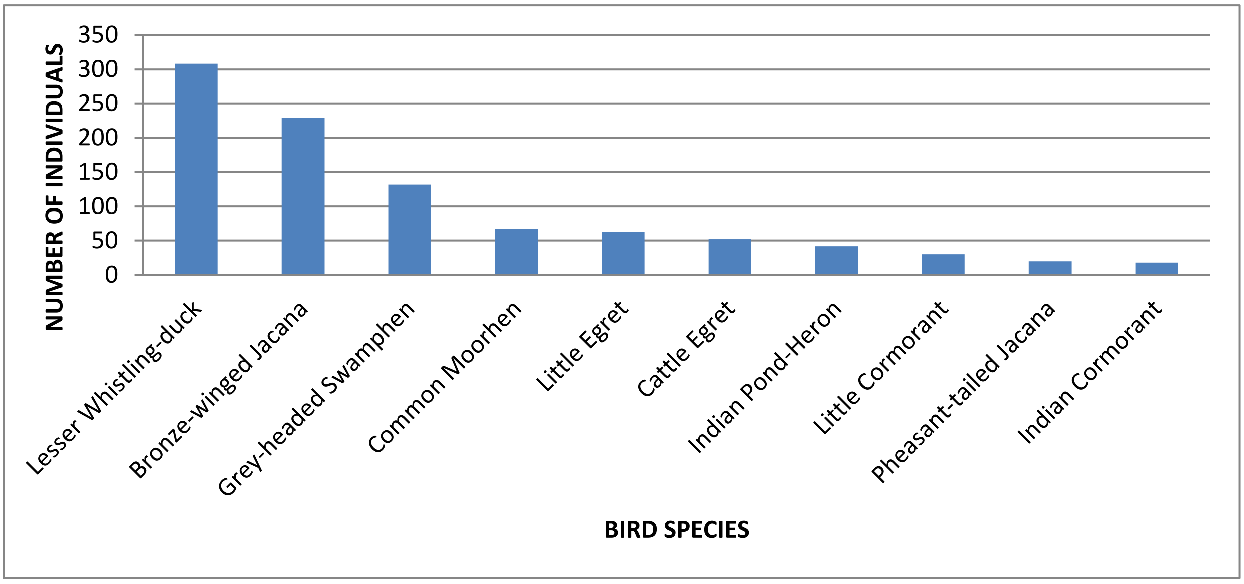

Figure 4.10: Most represented aquatic bird species abundance of Lotus Lake

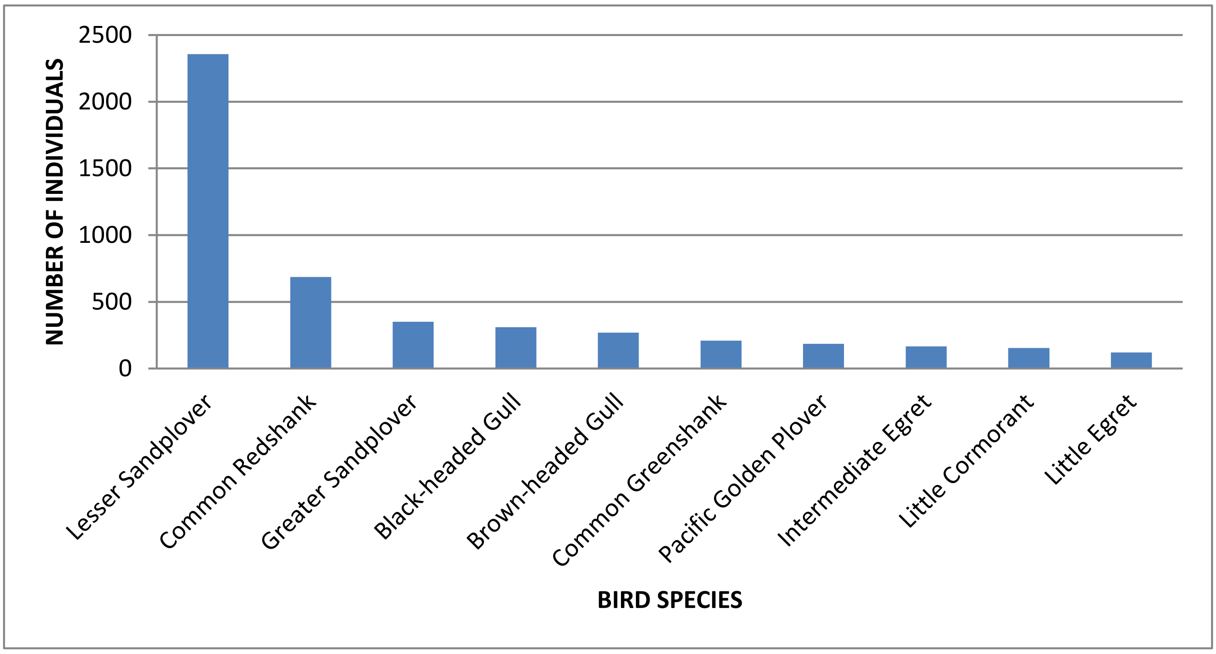

Figure 4.11 Most represented aquatic bird species abundance of Ulwe

Wetland

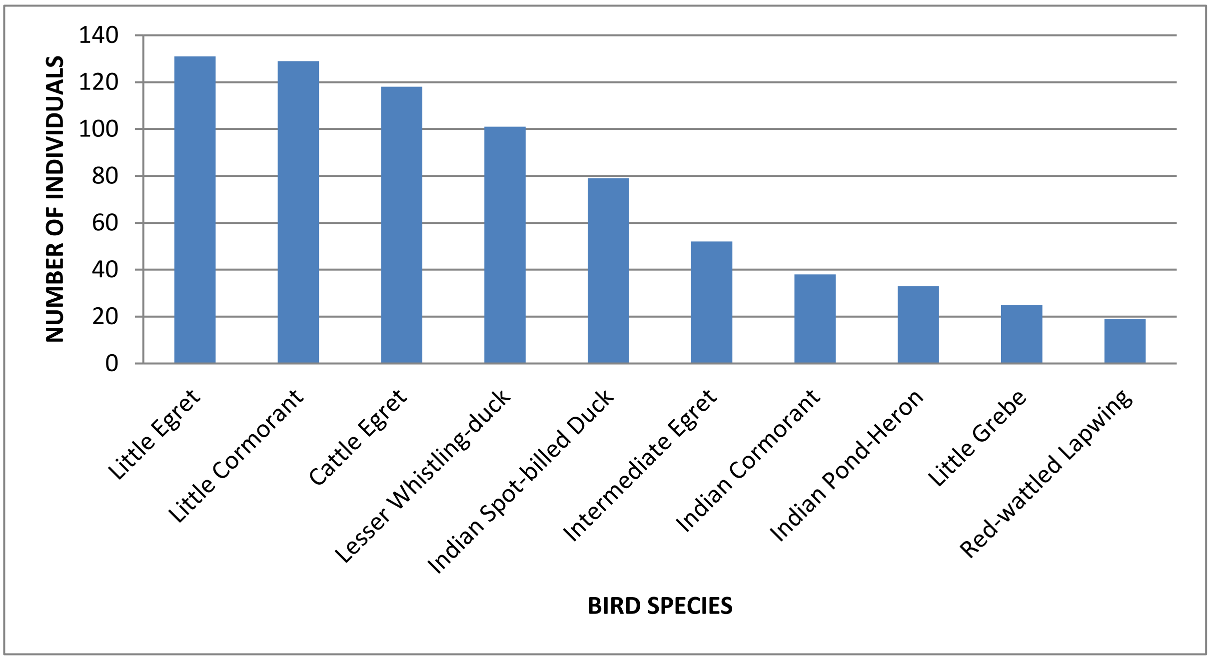

Figure 4.12: Most represented aquatic bird species abundance in Gadeshwar Dam

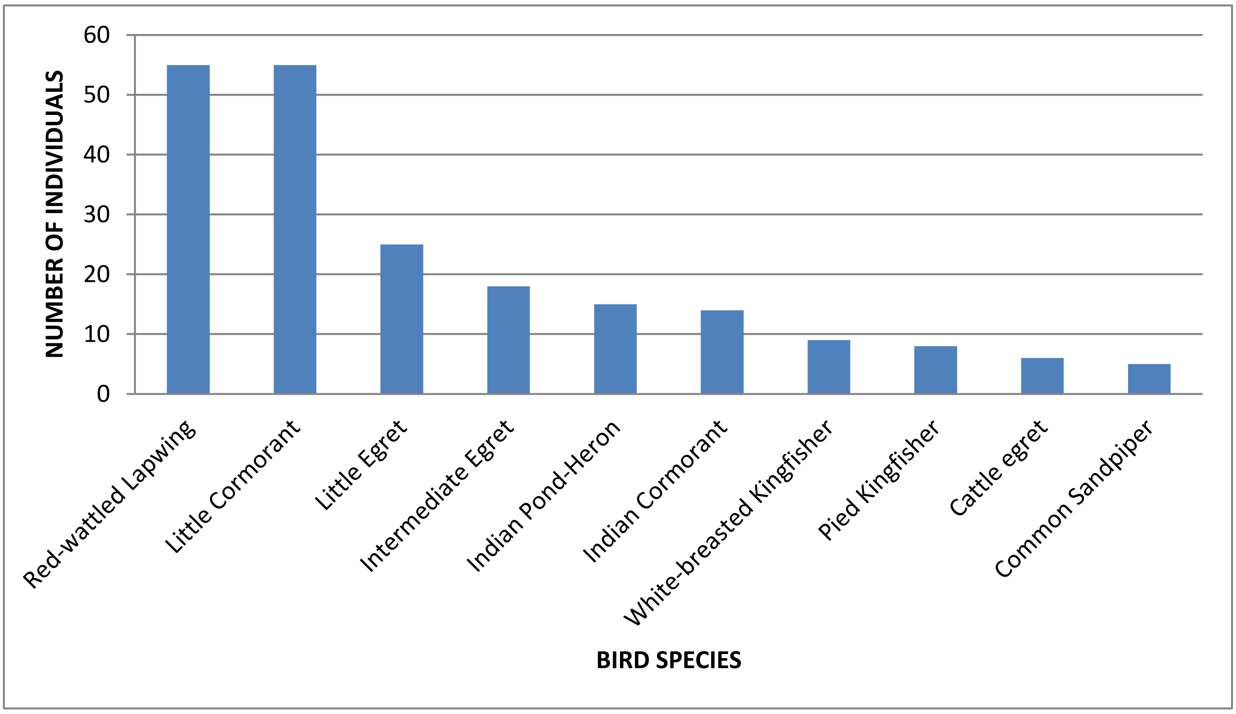

Figure 4.13 Most represented aquatic bird species abundance in Owe Dam

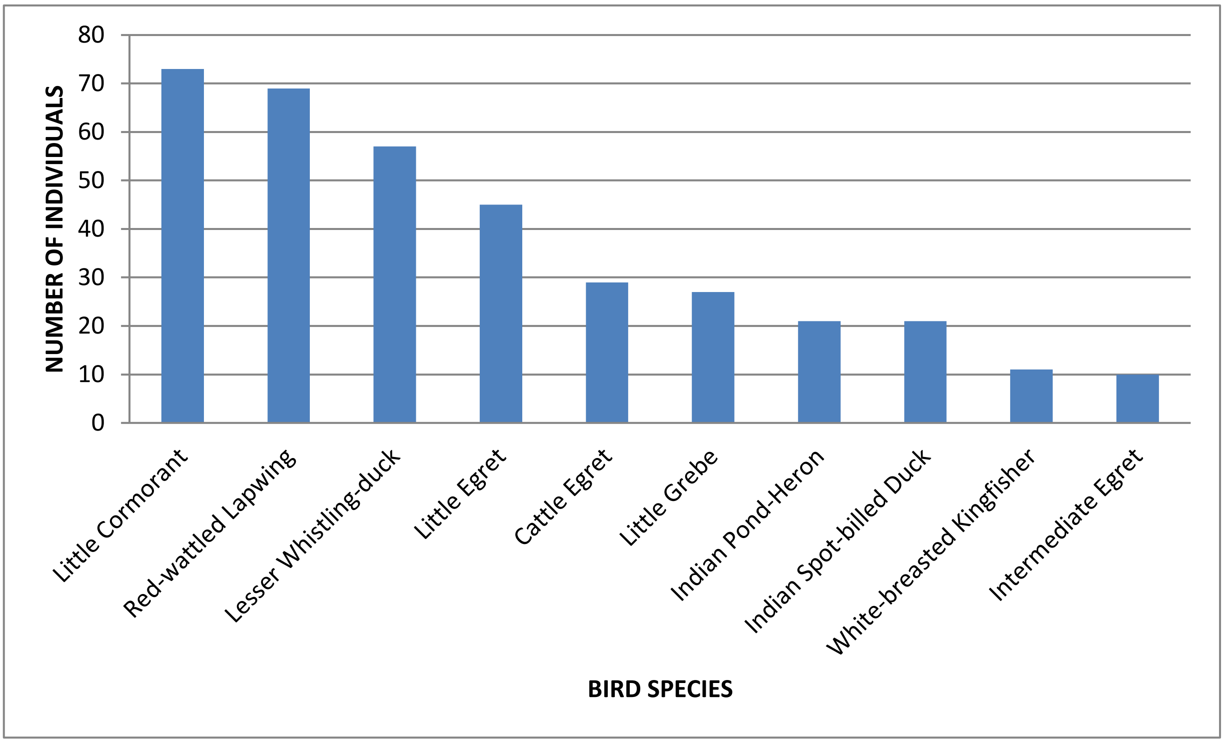

Figure 4.14 Most represented aquatic bird species abundance in Morbe Dam

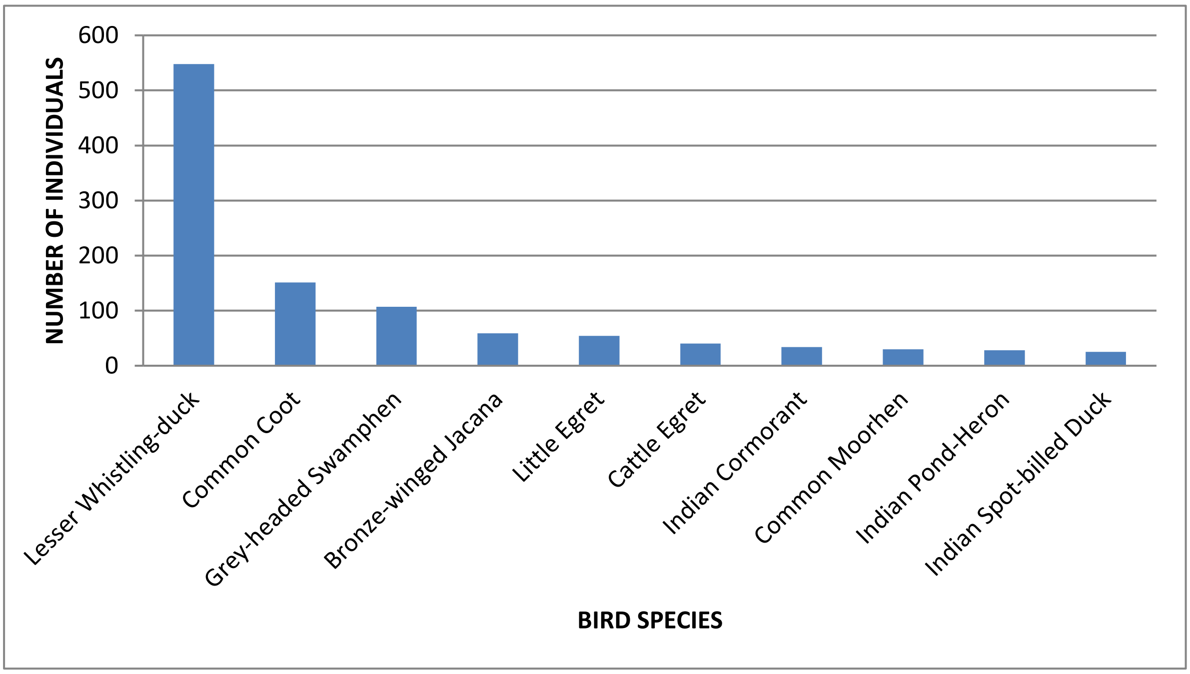

Figure 4.15 Most represented aquatic bird species abundance in Ballaleshwar Lake

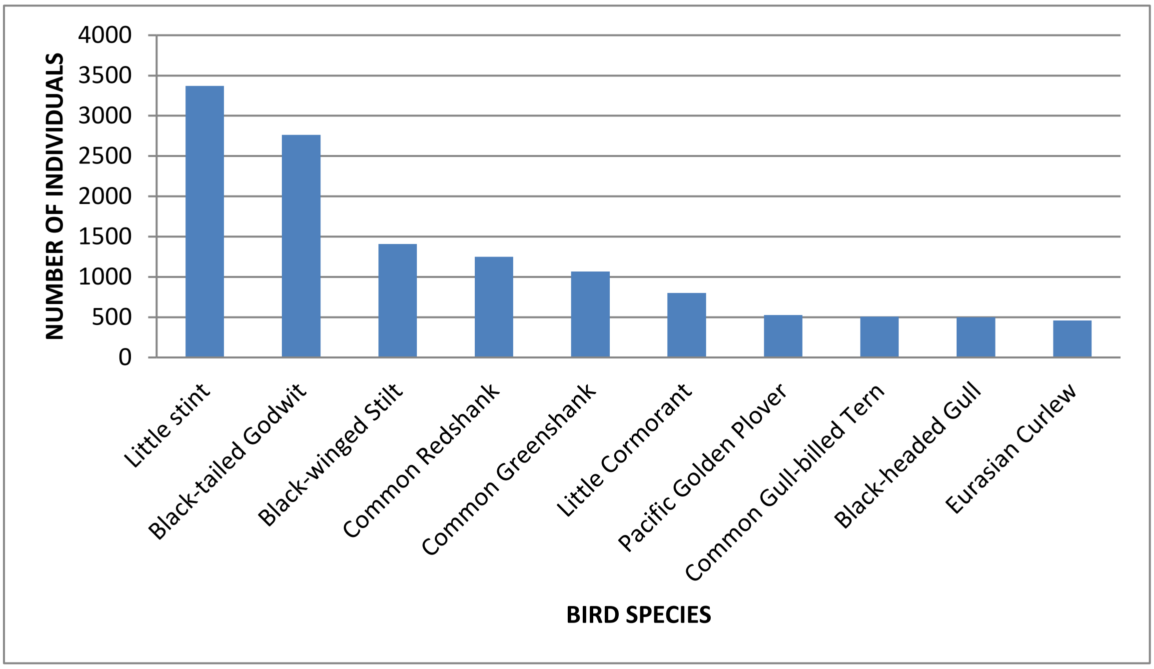

Figure 4.16 Most represented aquatic bird species abundance in Kharghar Wetland

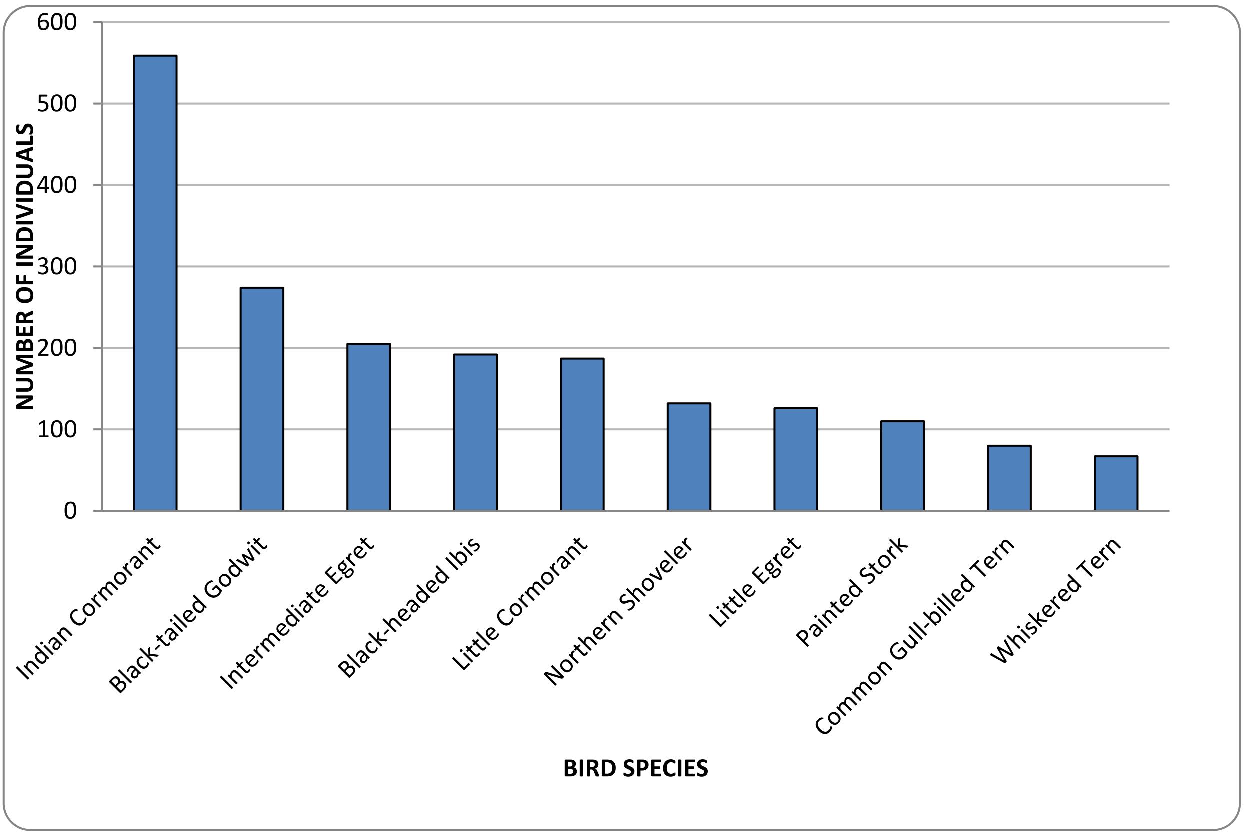

Figure 4.17: Most represented aquatic bird species abundance in Belpur-Panvel Creek

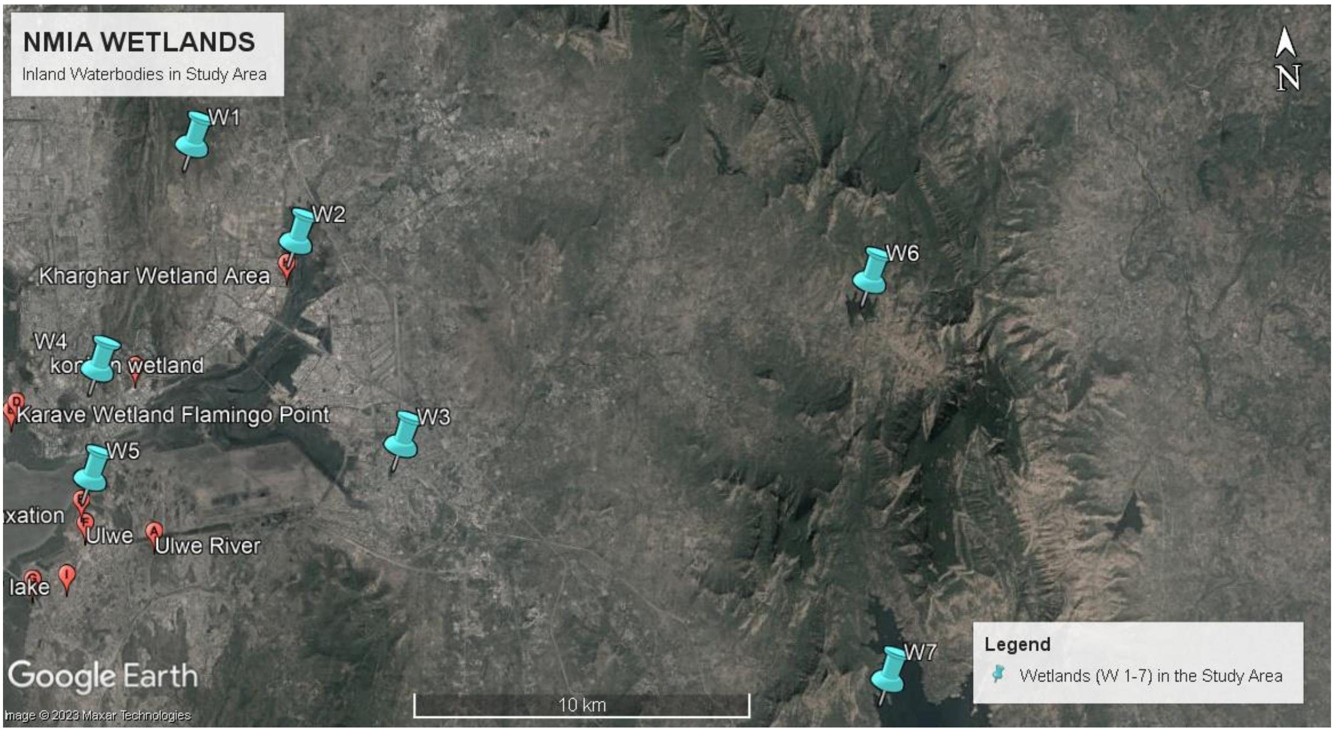

Figure 4.18: Map Showing locations of wetlands

4.4: Wetland Bird Survey - 2022-2023

Navi Mumbai wetlands had been covered with large expanses of salt pans and paddy fields till the 1970s. Eventually, the development of this region into a new metropolitan area occurred as the population of old Mumbai was reaching beyond its carrying capacity (Chatterjee and Chatterjee 2016). Thus, increasing land prices, changing hydrology and economy due to construction activities, government policies, and changing lifestyles could have made people abandon farming and fishing (Oliver-Smith 2009).

Presently, these wetlands are facing serious threats from developmental activities, especially landfilling for residential, recreational, and commercial uses. Though these wetlands occupy a small fraction of the area, they sustain a myriad of local and seasonal bird migrants. Breeding habitats are important to identify among these wetlands because they help in the successful recruitment, colonization, and long-term maintenance of bird populations. Drying the wetlands containing breeding colonies can severely reduce populations, affecting community structure, and driving extinctions in local populations (Bino et al. 2015). Habitat destruction is also considered one of the key reasons for such a decline in bird population as they have specific habitat requirements from season to season (Adhikari 2019). Hence, it is vital to assess the potential of these wetlands and the threats to them in order to understand the ecological aspects and implement suitable conservation and management actions for the long- term preservation of these habitats.

Tide- independent inland wetlands

Lotus Lake

Just behind the majestic corporation building of Navi Mumbai, Sector 27 Nerul, where a natural lake filled with lotuses (19.01763 N, 73.02587 E; 18.98513 N, 73.01924 E) of various varieties is in neglected condition. Situated in the middle of the urban colony of Nerul, this wetland with floating vegetation and weeds, houses various local migrants and other water birds, even in the presence of several anthropogenic interferences. During our regular survey to this lake, we have observed that it is a nesting ground for Little Grebe and Bronze-winged Jacana, foraging ground of Purple Swamphen, Common Moorhen, Pheasant-tailed Jacana with many other common water bird species. Necessary conservation actions should be taken to prevent the degradation of this habitat. Number of total resident and migratory water bird species present is Twenty-seven (27).

Ballaleshwar Lake or Vadale Lake

Ballaleshwar Lake (18.9940°N,73.1117°E) the oldest lake in Panvel, is located in HOC (Hindustan Organic Chemical) Colony, next to Ballaleshwar Temple, just beside the New Panvel Flyover along the Sion- Panvel Highway, Mumbai. The area of the lake is 6 acres. Historically, Ballaleshwar Lake was built by Peshwa Chimaji Appa, brother of the eminent Maharashtrian ruler, Peshwa Bajirao. Beautification of this lake was planned and executed quite recently as previously it had been gradually covered with weeds slimes, sludges, and garbage. The lake harbours a wide variety of aquatic floral and faunal diversity. The lake supports total around 42 resident and migratory water bird species.

Morbe Dam

Morbe Dam is a gravity dam on the Dhavari river near Khalapur, Raigad district in the state of Maharashtra, India (18.9261397 N,73.246285 E). The dam was constructed to supply drinking water to the Navi Mumbai and Nhava Sheva regions. Located nearly half an hour from Matheran, this dam is surrounded by the hills of northern Western Ghats. The vegetation of the area around the dam mostly includes deciduous trees of the montane rainforests and open scrublands. The habitat supports a variety of terrestrial and aquatic bird species. Due to its scenic location, there is an increased construction of hotels in the area, the natural vegetation is being cleared which can lead to a reduction of bird species in the area. A total of Twenty-eight (28) bird species were observed in Morbe Dam.

Gadeshwar Dam

Surrounded by lush green paddy fields and hilly terrains, Gadeshwar dam is treat to the visitors' eyes. The dam is perfectly nestled amidst of Chanderi, Mhaismal, Peb and Matheran Hills near Panvel (19.0327797 N, 73.2425364 E). The region around the dam mostly comprises of deciduous forests and hilly terrain. Due to its location and alluring surroundings the place attracts a lot of tourists, who come for a getaway or to enjoy activities like trekking. This is the reason why there is an increase in constructions for hotels and stays around the dam. The conversion of the natural habitat to human use lands might have a detrimental effect on the bird species which reside in the dam. A total of 44 species of resident and migratory birds were observed in Gadeshwar Dam.

Owe dam

Owe dam, Kharghar (19.076014 N, 73.056780 E) is a serene place to experience nature with some bird activity around. However, while surveying we could not spot substantial number of bird species but sighting of some seasonal and local migratory water bird species made some important observations to be considered. We were mesmerized by the beauty of green hills all around; the calm and quiet waterbody in centre. The journey started with wide clean roads and ended with off roading on muddy ground and ultimately with a village, Owe camp. Muddy roads surrounded by rice fields accompanied us till the destination which is completely free from the hustle and bustle of the city. On our way back, it was disappointing to see that the stone quarrying activities have increased to a significant level. In the middle of such enriched biodiversity, it was alarming. Number of water bird species present is Twenty-one (21).

Tide dependent low-tide roosting sites

Ulwe Wetland :

Adjacent to Nava-Sheva Creek area and associated mangroves, there are mainly two connecting wetlands which are connected through roads by Ulwe Township. We named these wetlands as ‘Ulwe Wetland’(18.986034,73.020357;18.987431,73.021178). During our morning and

afternoon survey, we came across many anthropogenic activities like chaos of the local people while doing morning walk and fishing activities. While doing our reconnaissance and intensive survey during January and February, we observed very less bird species except few common and

migratory water birds. Although we observed many mangrove-associated bird species including some migratory species in the Ulwe mangrove area and associated creek area. More seasonal surveys, during post-monsoon and summer month, are needed to get an entire scenario of bird species present in this area. Total number of resident and migratory water bird species present is Fifty-seven (57).

Wetlands of Kharghar

The present study was conducted to identify the potential wetlands present in the Kharghar in which a long stretch of water body was identified which was segregated in two sectors namely, sector 17 and sector 25. The stretch was monitored to identify the aquatic bird species using these sites as their feeding and roosting grounds. Number of resident and migratory water bird species present in these wetlands are Sixty-six (66).

Methodology

Wetland Count:

We carried out systematic monthly surveys in six waterbodies based on the above-mentioned criteria where we selected creek-associated tide dependent wetlands in Ulwe and Kharghar, a natural lake in Nerul, Owe dam in Kharghar, Morbe and Gadeshwar Dam in Raigad district. Bird species were counted at each site, preferably from a vantage point if available, with binoculars or spotting scope (Bibby et al. 2000). The bird species were recorded based on sighting or call. Birds were identified following Birdlife International 2019.

- **Type of Count**: Total count of individual species observed one hour before and one hour after high tide in case of wetland birds. For dam & lake, total count of bird species had been taken twice for 30 minutes with a break for 30 minutes in between to avoid overcounting.
- **Condition**: In case of wetlands, we carried out survey during high tide when birds came out of the creek due to inundation of mudflats, in search of roosting sites.
- **Frequency of the survey**: Monthly Twice

Creek Survey

The Panvel Creek is a 7-km-long creek that passes through Taloja, Panvel and Ulwe, before entering the sea at Belapur. Since the Panvel Creek surrounds a major portion of the Navi Mumbai International Airport and acts as feeding ground for a number of water birds, it was extremely important to carry out monitoring of birds in this area. During the survey large flocks of Northern Shoveler, Indian Cormorant, Whiskered Tern, Black-winged Stilt and mixed flocks of many other water birds were identified in the area, which accounted to 60 species of resident and migratory water birds.

Creek Survey Methodology on Water birds

The bird species were recorded based on sighting or call. Birds were identified following Birdlife International 2019.

- **Type of Count**: The survey was conducted on the 3 km accessible stretch in peripheral pathway just beside the creek. Total count of individual species observed in the entire accessible range of 3 km by dividing it into two transects of 1 km each with a gap of 1km in between, in order to avoid over-counting. We followed the Bell Transect method where we considered vantage point count stations (total number of 3-point count stations) on the transect to count the bird species abundance and diversity from those particular points.

- **Condition**: Transect surveys were carried out during low tide when birds return to the creek due to the exposure of mudflats, in search of roosting sites. As the Panvel Creek was found to be narrow, one team of researchers simultaneously observed both the banks and recorded all the species of birds and their population using Binoculars and Spotting Scope.

- **Frequency of the survey**: Monthly twice.

4.5 Preliminary Observations

1. Based on our year-long monthly wetland bird count in all the wetlands, namely Lotus Lake, Ballaleshwar Lake, Kharghar Wetland, Ulwe Wetland, Owe Dam, Morbe Dam, Gadeshwar Dam and Panvel-Belapur Creek, we have collated the presence-absence data of all the waterbirds present in all these mentioned waterbodies and represented those in a tabular format to provide a comprehensive idea regarding the diversity of species here.
2. Based on the data obtained by BNHS on migratory birds it is observed that these birds fly at a high altitude when they are flying over long distances during their migration journey, and after reaching their preferred destination they descend / land into wetlands & mud flat areas. In the case of Mumbai & Navi Mumbai, they land in the wetlands along Thane Creek.
3. These migratory birds prefer to stay at a preferred locations in wetlands as long as the site is sustainable for the arriving bird population, post which the birds relocate to the nearby roosting sites during high tide.
4. It is seen that migratory birds, being fairly large in size, they tend to fly closer to the water surface while flying over short distances, to move from a primary site to a nearby roosting site. This phenomenon is observed from the data gathered by BNHS from the trackers around NMIA site, in Thane Creek area. The local movement of birds is observed to be restricted to an altitude of less than 50 m above sea level.
5. The flight pattern of birds in Thane Creek, including in approach path of NMIA runways 08L & 08R (westerly take off /landing) has been studied by BNHS. The same has been superimposed by NMIAL on the approach paths of NMIA runways (08L & 08R). Based on this it has been noticed that the aircraft taking off or landing on NMIA runways are at height well above the observed flight elevation of birds in Thane Creek.
6. The identified flight paths and patterns of migratory birds in Thane Creek are presented in Annexure-1
7. BNHS studies in this regard shall continue further, as more data is collected on flight path of birds in Thane Creek area.

Table 4.3: Presence- absence of water birds in all the wetlands of study site

Birds	Scientific Name	LOTUS LAKE	ULWE WETLAND	BALLALESHWARLAKE	MORBE DAM	GADESHWAR DAM	OWE DAM	BELAPUR CREEK	KHARGHAR WETLAND
Asian Openbill	*Anastomus oscitans*	√	√	√	√	√	√	√	√
Black-crowned Night-heron	*Nycticorax nycticorax*	√	√	√				√	√
Black-headed Gull	*Chroicococephalus ridibundus*		√	√	√	√	√	√	√
Black-headed Ibis	*Threskiornismelano cephalus*		√	√	√	√	√	√	√
Black-tailed Godwit	*Limosa limosa*		√					√	√
Black-winged Stilt	*Himantopus himantopus*		√	√	√	√		√	√
Broad-billed Sandpiper	*Limicola falcinellus*		√					√	√
Bronze-winged Jacana	*Metopidius indicus*	√	√	√		√			√
Brown-headed Gull	*Chroicocephalus brunnicephalus*		√	√	√	√	√	√	√
Caspian Tern	*Hydroprogne caspia*	√	√	√		√	√	√	√
Cattle Egret	*Bubulcus ibis*	√	√	√	√	√	√	√	√
Common Coot	*Fulica atra*		√	√		√			√
Common Greenshank	*Tringa nebularia*		√	√		√		√	√
Common Gull-billed Tern	*Gelochelidon nilotica*		√	√	√	√		√	√
Common Kingfisher	*Alcedo atthis*	√	√	√	√	√	√	√	√
Common Moorhen	*Gallinula chloropus*	√	√	√	√	√			√
Common Redshank	*Tringa totanus*		√	√	√	√		√	√
Common Sandpiper	*Actitis hypoleucos*	√	√	√	√	√		√	√
Common Shelduck	*Tadorna tadorna*							√	√
Common Snipe	*Gallinago gallinago*		√	√		√		√	√
Cotton Pygmy-goose	*Nettapus coromandelianus*	√		√		√		√	√
Eurasian Curlew	*Numenius arquata*		√					√	√

Birds	**Scientific Name**	**LOTUS LAKE**	**ULWE WETLAND**	**BALLALESHWAR LAKE**	**MORBE DAM**	**GADESHWAR DAM**	**OWE DAM**	**BELAPUR CREEK**	**KHARGHAR WETLAND**
Eurasian Spoonbill	*Platalealeu corodia*		√	√		√		√	√
Garganey	*Anas querquedula*							√	√
Glossy Ibis	*Plegadis falcinellus*	√	√	√	√	√	√	√	√
Great White Egret	*Ardea alba*		√	√	√	√	√	√	√
Greater Sandplover	*Charadrius leschenaultii*		√					√	√
Green-backed Heron	*Butorides striata*		√	√				√	√
Grey Heron	*Ardeacinerea*		√	√	√	√		√	√
Grey Plover	*Pluvialis squatarola*		√					√	√
Grey Wagtail	*Motacilla cinerea*	√	√	√	√	√	√	√	√
Great Cormorant	*Phalacrocorax carbo*		√					√	√
Great crested grebe	*Podiceps cristatus*							√	√
Grey-headed Swamphen	*Porphyrio porphyrio*	√	√	√	√	√			√
Heuglin's Gull	*Larus heuglini*							√	√
Indian Cormorant	*Phalacrocorax fuscicollis*	√	√	√	√	√	√	√	√
Indian Pond-Heron	*Ardeola grayii*	√	√	√	√	√	√	√	√
Indian Spot-billed Duck	*Anas poecilorhyncha*	√	√	√	√	√		√	√
Intermediate Egret	*Mesophoyx intermedia*	√	√	√	√	√	√	√	√
Lesser Flamingo	*Phoeniconaias minor*		√					√	
Lesser Sandplover	*Charadrius mongolus*		√					√	√
Lesser Whistling-duck	*Dendrocygna javanica*	√	√	√	√	√		√	√
Little Cormorant	*Phalacrocorax niger*	√	√	√	√	√	√	√	√
Little Egret	*Egrettagarzetta*	√	√	√	√	√	√	√	√
Little Grebe	*Tachybaptusruficollis*	√	√	√	√	√	√	√	√
Little stint	*Calidris minuta*		√					√	√
Little-ringed Plover	*Charadrius dubius*		√			√		√	√
Mallard	*Anas platyrhynchos*							√	√

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Birds	**Scientific Name**	**LOTUS LAKE**	**ULWE WETLAND**	**BALLALESHWAR LAKE**	**MORBE DAM**	**GADESHWAR DAM**	**OWE DAM**	**BELAPUR CREEK**	**KHARGHAR WETLAND**
Marsh Sandpiper	*Tringa stagnatilis*		√					√	√
Northern Pintail	*Anas acuta*							√	√
Northern Shoveler	*Spatula clypeata*							√	√
Oriental Pratincole	*Glareola maldivarum*					√			
Pacific Golden Plover	*Plover Pluvialis fulva*		√					√	√
Painted Stork	*Mycteria leucocephala*		√	√		√		√	√
Pheasant-tailed Jacana	*Hydrophasianus chirurgus*	√	√	√		√			√
Pied Kingfisher	*Ceryle rudis*	√	√	√		√	√	√	√
Purple Heron	*Ardeapurpurea*	√	√	√		√		√	√
Red-naped Ibis	*Pseudibis papillosa*		√			√	√	√	√
Red-wattled Lapwing	*Vanellus indicus*	√	√	√	√	√	√	√	√
River Tern	*Sterna aurantia*							√	√
Ruddy Shelduck	*Tadorna ferruginea*								√
Ruff	*Philomachus pugnax*		√						√
Western Reef Egret	*Egrettagularis*		√					√	√
Whiskered Tern	*Chlidonia shybrida*		√	√		√		√	√
White-breasted Kingfisher	*Halcyon smyrnensis*	√	√	√	√	√	√	√	√
White-breasted Waterhen	*Amaurornis phoenicurus*	√	√	√	√	√		√	√
Wood Sandpiper	*Tringa glareola*		√					√	√
Yellow wagtail	*Motacilla flava*	√	√	√	√	√	√	√	√
Yellow-wattled Lapwing	*Vanellus malabaricus*					√			

Aquatic bird species abundance

While preforming our systematic surveys, we have calculated the abundance of species in all the wetlands including the creek area. Here, the ten (10) 'most represented' waterbirds are shown for all the wetlands and creek based on their year-long overall maximum abundance in all those particular sites. In the Lotus Lake, the highest abundance was seen in Lesser Whistling-duck (220), followed by Bronze-winged Jacana (200). In the Ulwe Wetland, we observed the highest abundance of Common Redshank (509) followed by Lesser Sandplover (500). In the Gadeshwar Dam, the highest abundance of Lesser Whistling-duck (90) followed by Indian Spot-billed Duck (82). In the Owe Dam, we recorded the highest abundance of Little Cormorant (60)followed by Little Egret (57). Moreover, we recorded the highest abundance of Little Cormorant (70) followed by Red-wattled Lapwing (65) in the Morbe Dam. In the Ballaleshwar Lake, we observed the highest abundance of Lesser Whistling-duck (345) followed by Common Coot (178).In the Kharghar Wetland, we recorded highest abundance of Little Stint (3200) followed by Black-tailed Godwit (2378). Additionally, in the Panvel-Belapur Creek survey, we recorded the highest abundance of Northern Shovelar (900) followed by Little Cormorant (560). Here, we provided the graphical presentation of ten 'most represented' species in all the wetlands along with the Belapur-Panvel creek:

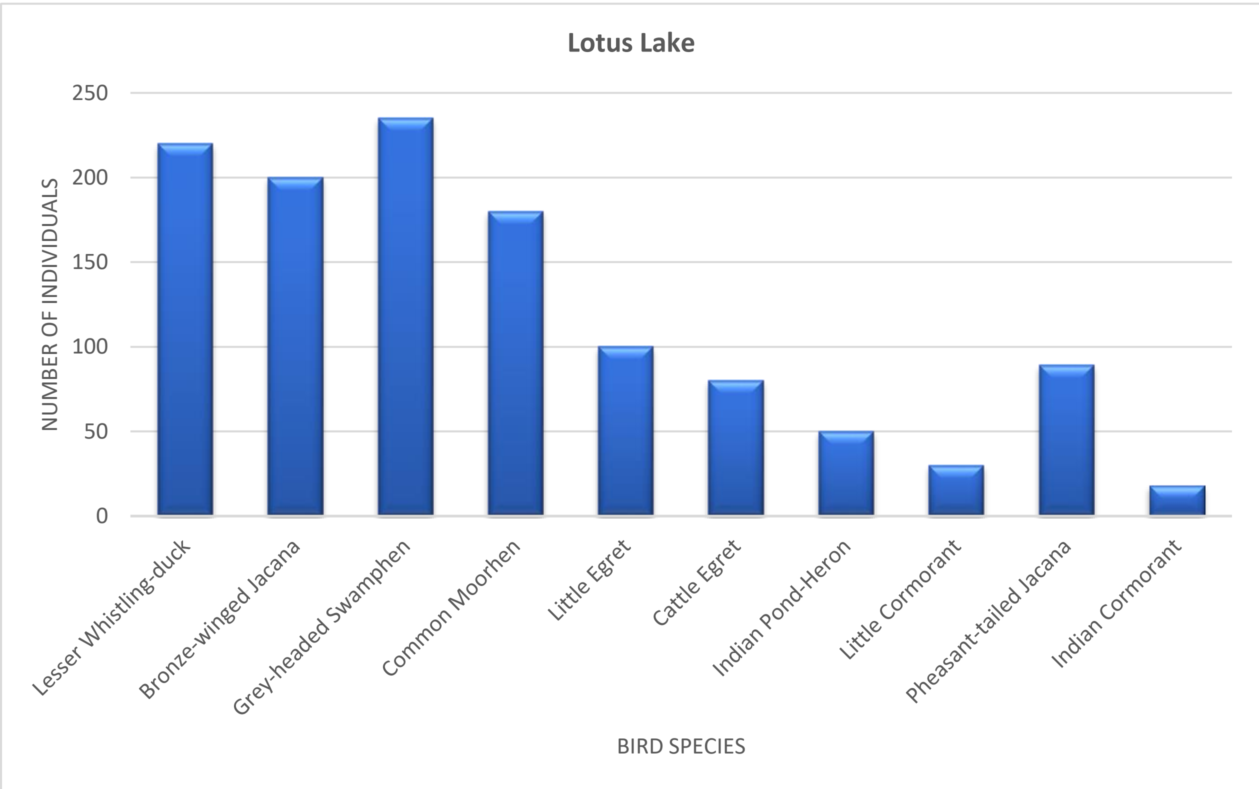


Figure 4.19: Most represented aquatic bird species abundance of Lotus Lake

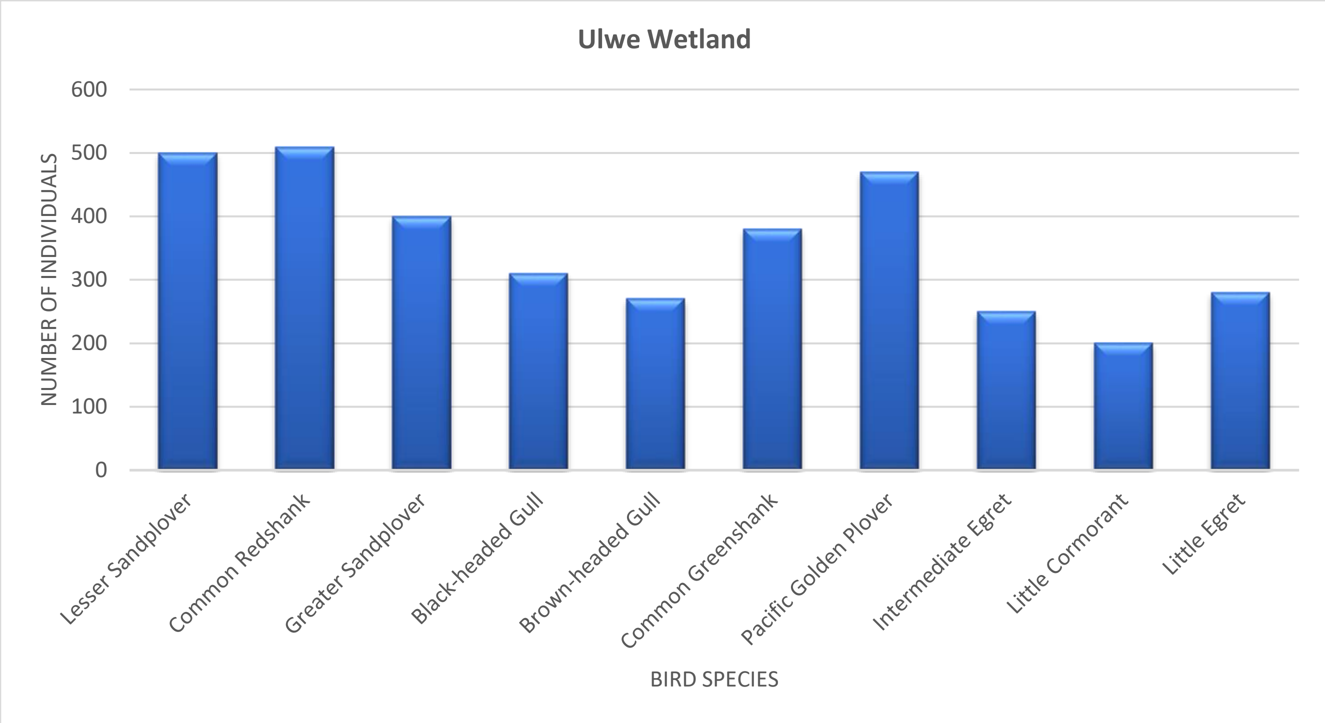


Figure 4.20: Most represented aquatic bird species abundance of Ulwe Wetland

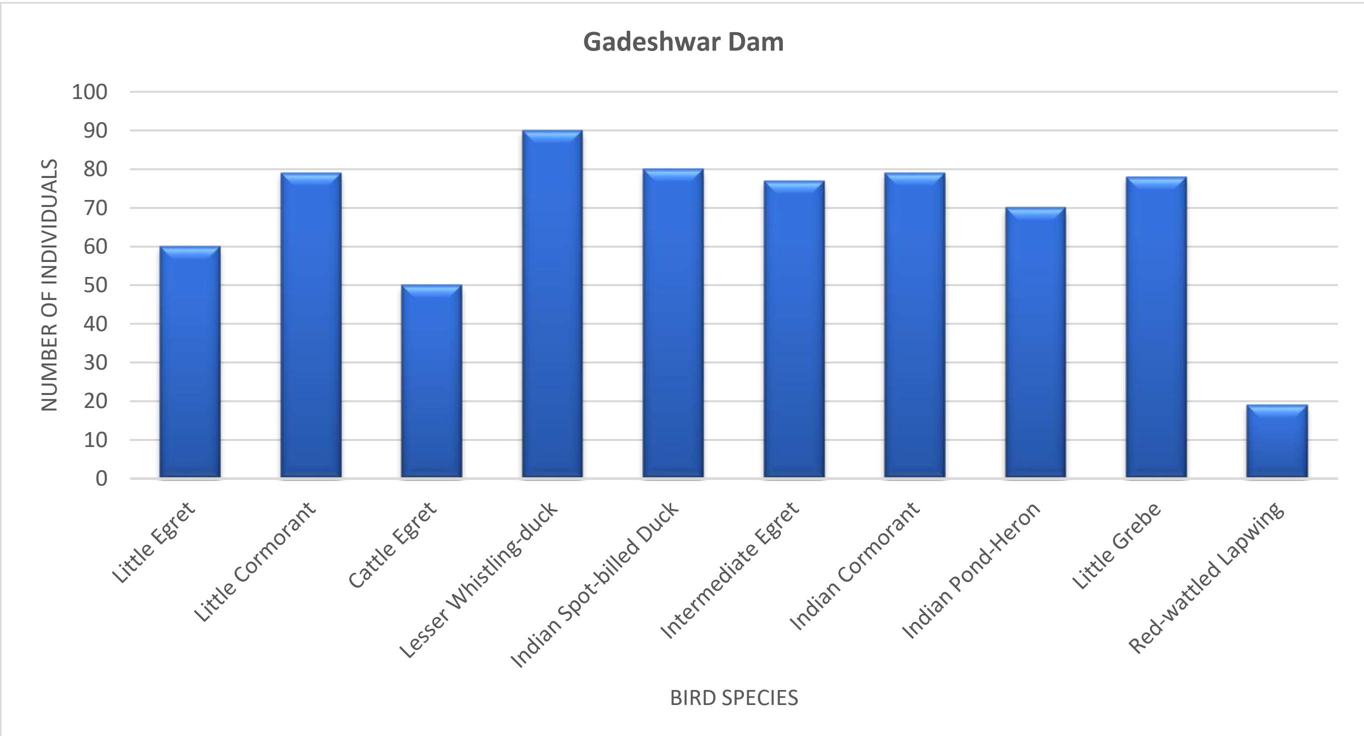


Figure 4.21: Most represented aquatic bird species abundance in Gadeshwar Dam

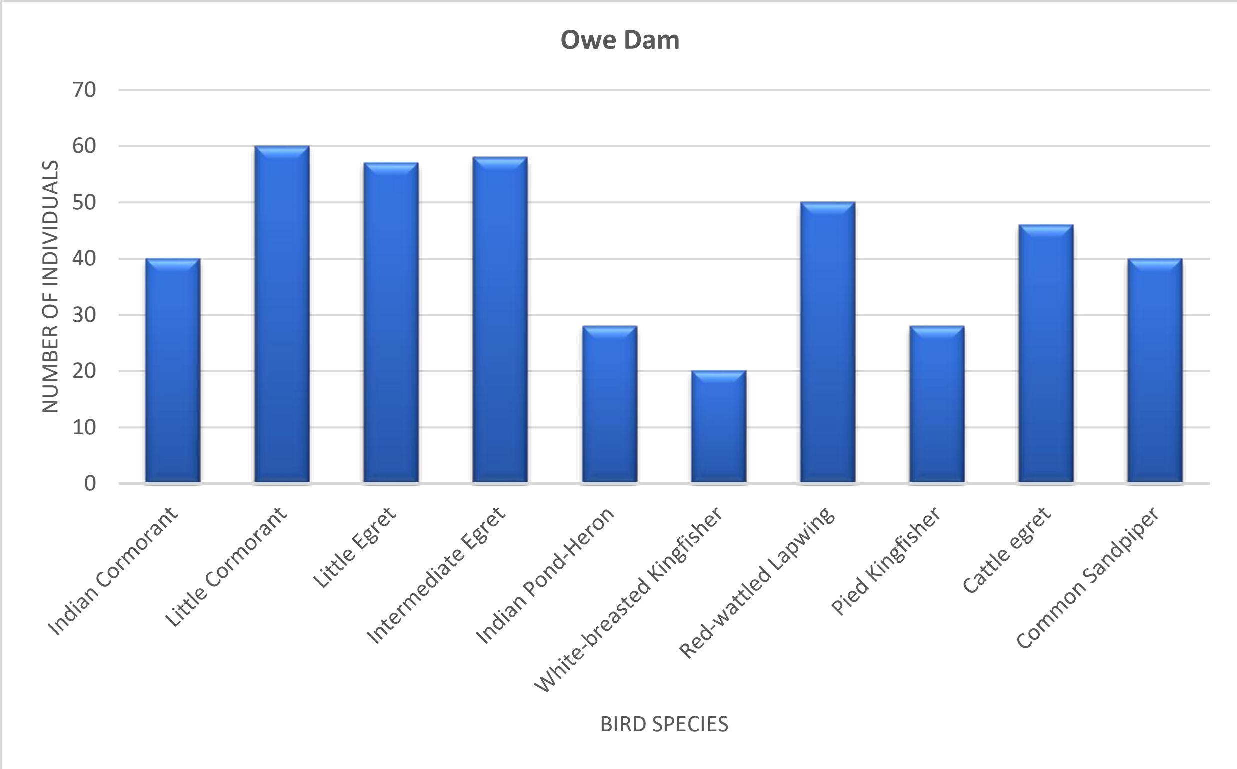


Figure 4.22: Most represented aquatic bird species abundance in Owe Dam

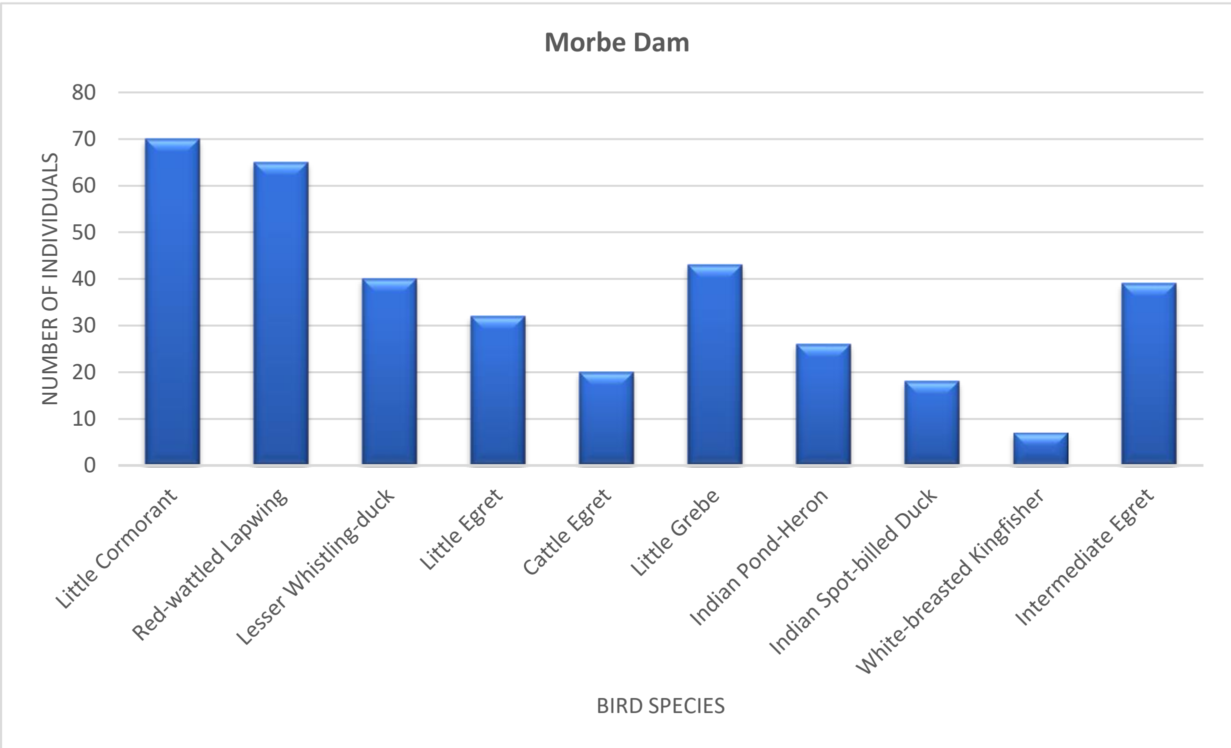


Figure 4.23: Most represented aquatic bird species abundance in Morbe Dam

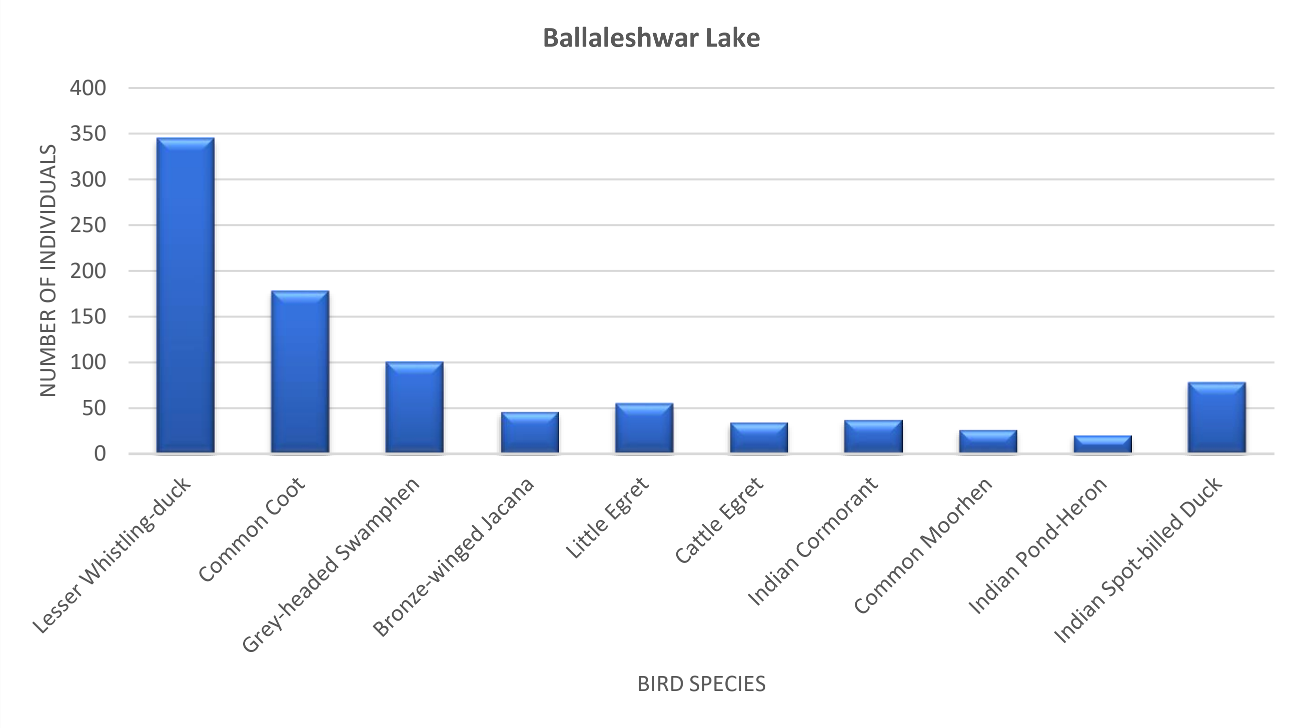


Figure 4.24: Most represented aquatic bird species abundance in Ballaleshwar Lake

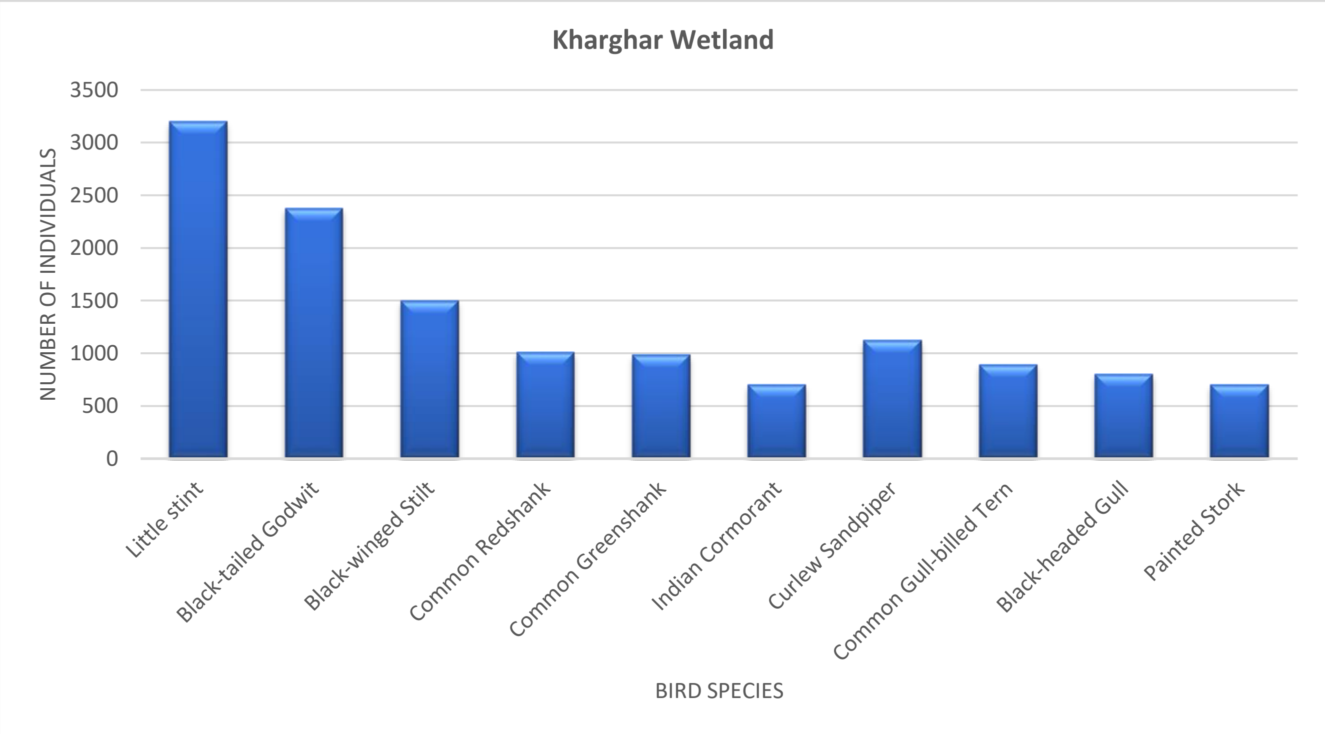


Figure 4.25: Most represented aquatic bird species abundance in Kharghar Wetland

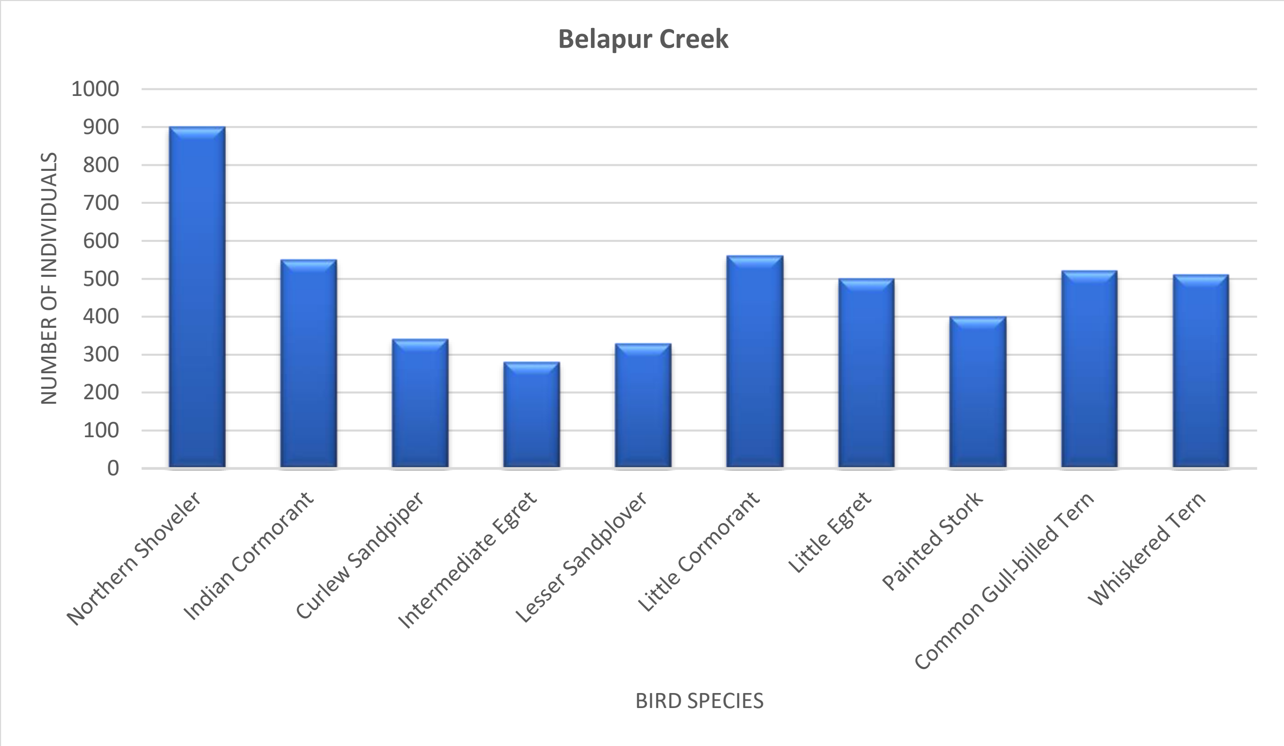


Figure 4.26: Most represented aquatic bird species abundance in Belpur-Panvel Creek

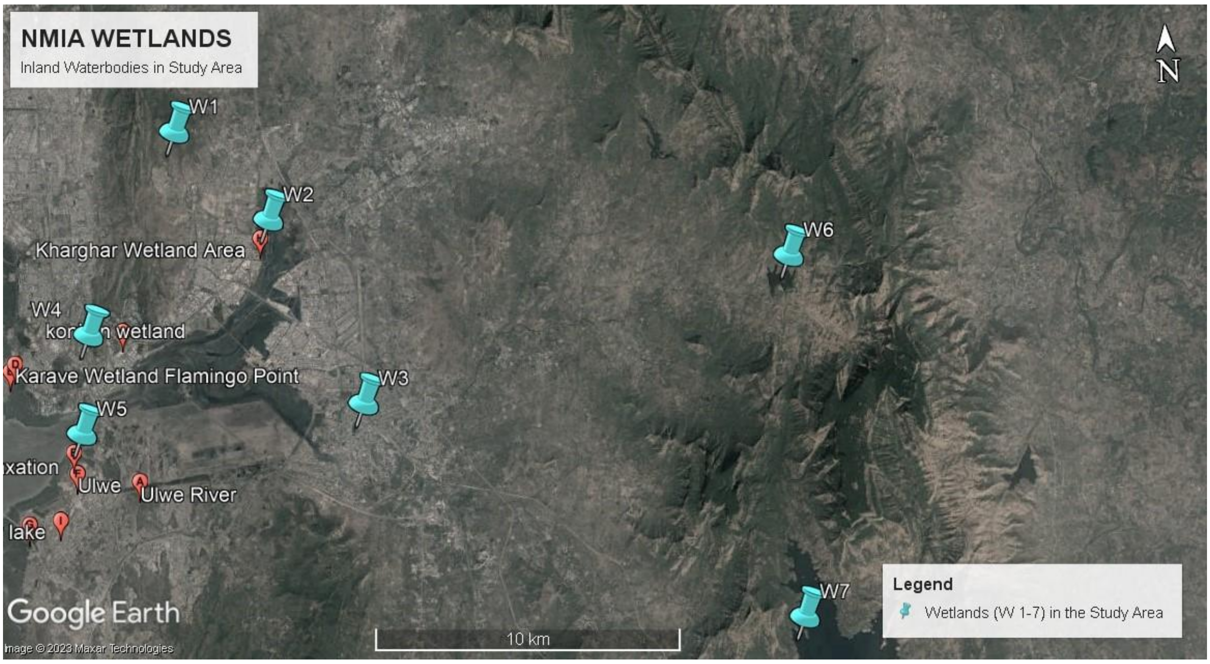


Figure 4.27: Wetlands in the study area

CHAPTER- 5: Study on Heronries around the NMIA Site

- Heronry (¼ rookery) is group nesting of colonial waterbirds of the orders Ciconiformes, Pelecaniformes, and Suliformes, which comprises of herons, egrets, storks, pelicans, ibises, spoonbills, darter, and cormorants, which displays spatial and temporal gathering of nests.
- Even though heronry birds vary in their habitat preference, diet, and behaviour, their fundamental requirements for nesting remain more or less the same.
- Colonial waterbirds use cities for nesting and foraging and monitoring the population ecology of heronry birds is mainly suitable to understand the impact of urbanization.
- Multiple factors affect habitat selection and colony site dynamics of waterbirds where the habitat quality along with the nesting tree quality, has been established as one of the most important habitat selection criteria. Therefore, studying nesting ecology of the birds in urban ecosystems can suggest methods to improve their urban habitats.
- While horizontal expansion of urban habitats may have a direct effect on the nesting tree density and natural feeding grounds, vertical expansion is likely to affect the behaviour of the heronry birds.
- It is also found that heronry birds abandon the age-old heronries in sites, where over bridges and fly-over bridges are being constructed as vehicular traffic at the tree canopy level is a major disturbance for the birds (Roshnath & Sinu 2017)

Long-term Objective of the present study

(1) To identify the nesting tree species of heronry birds along with the richness and abundance of dwelling species;

(2) To determine the tree characteristics crucial for nest tree selection and nest abundance in the heronries of city streets and the adjoining mangrove islets

Methodology

The heronry study had been conducted in the 10km radius around the NMIA Airport site across all the habitat types. We also extended our study area in some cases as we found few potential heronries, beyond the 10km boundary around the NMIA Site. The study had been conducted in Monsoon 2021 from July to September. We initially did a reconnaissance survey to find the new heronries in our study area. After encountering a potential site, the GPS coordinates have been noted along with some basic characteristics of the nesting site and nesting species. In the next phase, we will plan our intensive data collection in all the heronries. In the given table, we have jotted down all the new heronries found in our study along with the old ones mentioned in the previous NMIA preconstruction phase final report.

Preliminary Observation

Table 5.1 List of Old and New Heronries

		Old Heronries from previous NMIA final report			
S. No.	**Location Name**	**Location Description**	**GPS Coordinates**	**Species Found**	**Count**
1	Mosare Forest	Mosare-Patnoli Reserve Forest-moist deciduous forest patch, agricultural lands, trees like: Jamun,Teak, Banyan, Red Silk Cotton present.	18.95666,73.08569	Black Crowned Night Heron	50
				Cattle Egret	500
				Great Egret	50
2	CIDCO Garden	CIDCO garden, Sector 9, Khanda Colony, Navi Mumbai	19.002592°, 73.123840°	Indian Pond Heron	30
				Cattle Egret	65
				Indian Cormorant	100
3	Parsik Hill area, Belapur	Near Parsik Hill Link Road, Belapur	19.0198170, 73.0323622	Indian Cormorant	700
				Indian Pond Heron	50
				Cattle Egret	30
4	Panvel Railway Station Area	Sector 16, New Panvel Railway Station Area	18.989087°, 73.122186°	Indian Cormorant	180
5	Panvel Rest/Guest House	Trees opposite to Panvel Rest/Guest House	18.995849°, 73.119628°	Indian Cormorant	50
6	Chouk Village near Morbe Dam	Outside 10km radius area of NMIA	18.898015°, 73.245559°	Cattle Egret	30
				Little Cormorant	15
				Indian Cormorant	50
				Black-Headed Ibis	15
7	NMIA Site	Mangrove area, Power line station near Khandeshwar Railway Station	18.98399, 73.06043	Grey Heron	30-40
			New Heronries		
S. No.	**Location Name**	**Location Description**	**GPS Coordinates**	**Species Found**	**Count**
1	Kharghar wetland	Section 17 Kharghar Wetland in the interior patches just beside	19.045383°, 73.086337°	Purple Heron	20
				Indian Cormorant	40
				Grey Heron	8

		the Bird Watching area Kharghar		Little Egret	15
				Intermediate Egret	10
2	Kalundre River	Green patches near the ONGC just beside the Kalundre River	18.979195°, 73.119689°(A); 18.979129°, 73.120427°(B)	Cattle Egret	10
				Intermediate Egret	10
3	Kopra Ground	Just beside By-pass Road, adjacant to Kopra Ground	19.038944°, 73.073949°	Intermediate Egret	12
4	Beside the Bangalore-Mumbai Highway	Fragmented green patches (on a particular tree) just beside the highway, near the Kharghar toll	19.037230°, 73.079272°	Intermediate Egret	25
5	NH48, Sector AWC, Kalamboli, Taloja	Just under the Roadpali bridge, beside the Kasardi river	19.047268°,73.102250°	Cattle Egret	10
6	Sector 3, New Panvel	Just beside the sector CIDCO Garden Sector 3 New Panvel East	19.001086°, 73.118942°	Black-crowned Night-heron	60
7	Janardhan Bhagat Marg in front of CIDCO Mango Garden	Beside the CIDCO Mango Garden on a large tree (species name?)	18.992930° , 73.126276°	Black-crowned Night-heron	40
8	NRI Lake	Inside the NRI Lake, Beside the Seawoods Estates Road	19.006984°, 73.012200°	Painted Stork	15
				Little Egret	10
				Intermediate Egret	10
				Indian Cormorants	10

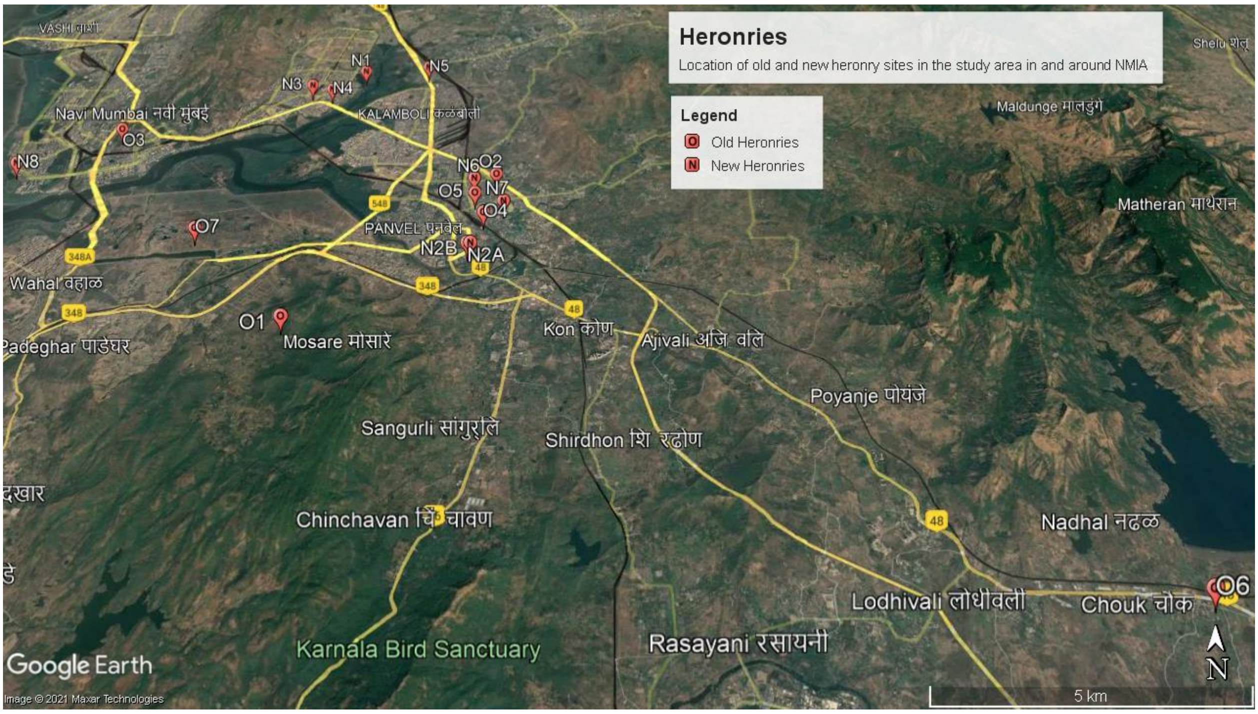


Figure 5.1: Map Showing location of Old and New Heronries

In the study area, since most of the nesting trees are positioned along the road, development and expansion of roads will be responsible for the felling of these centuries' old trees, which will have a direct influence on the population of nesting heronry birds. Conservation of nesting sites should be necessitated to maintain these waterbird diversities in the relevant waterbodies. The conservation of mangrove forests is also obligatory for the conservation of heronry birds. This study will help to produce a comprehensive map of the nesting tree locations and the nesting tree species of the heronry birds after the subsequent intensive sampling, which may be found valuable during landscape planning and conclusive understanding of the terrains for the town planners and other stakeholders

Chapter 6-Wetland shorebird diversity and abundance

6.1Richness and diversity

The total species richness of migratory shorebirds in the wetlands varied from lowest at Bhendkhal, 14 species (n=3), to highest at BPS, 50 species (n=73). Similarly, non-migratory species richness was between 17 (n=22; DPS) to 28 species (n=30; Kharghar). The richness of the migratory shorebird species in the wetlands slightly declined. Overall, migratory shorebirds mean species richness (i.e., richness per survey) was relatively higher (7.13–12.26 species) than that of the non-migratory shorebirds (4.93–9; Fig. 6.1). The mean species richness of migratory birds was highest in winter (9.13–12.26, n=188), followed by autumn (7.65 – 12.06, n=86) and summer (7.13 – 10.10, n=111). Non-migratory shorebirds also showed a seasonal richness pattern similar to migratory shorebirds.

BPS and TSC consistently showed high mean migratory shorebird richness (7.41– 7.33, n=73 and 70, respectively), while was lowest at DPS (3.16–4.12, n=22; Fig. 6.2). In contrast, non-migratory shorebird richness was highest at Kharghar (11.27–11.41, n=30) and lowest at DPS (3.16 – 5.18). Richness was dropped at Belpada, Kharghar, NRI, Panje and TSC in recent years (2020– 2022), however, it rose at BPS, DPS and Mankhurd. In contrast, non-migratory shorebird richness had increased at all the sites except Belpada, where it was fallen.

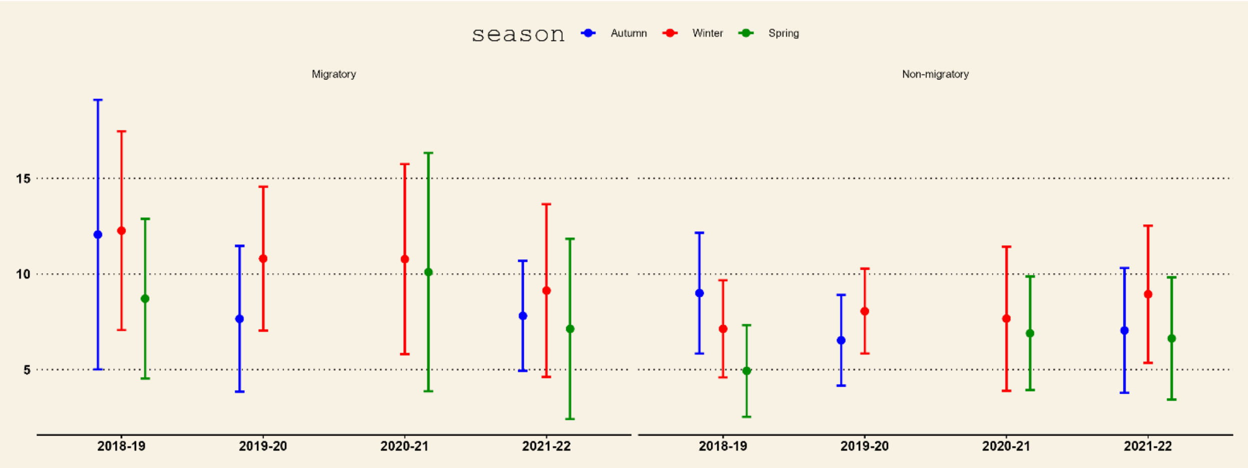


Figure 6.1. Mean species richness (with standard deviation) of migratory and non-migratory shorebirds in various seasons, pooled across wetlands.

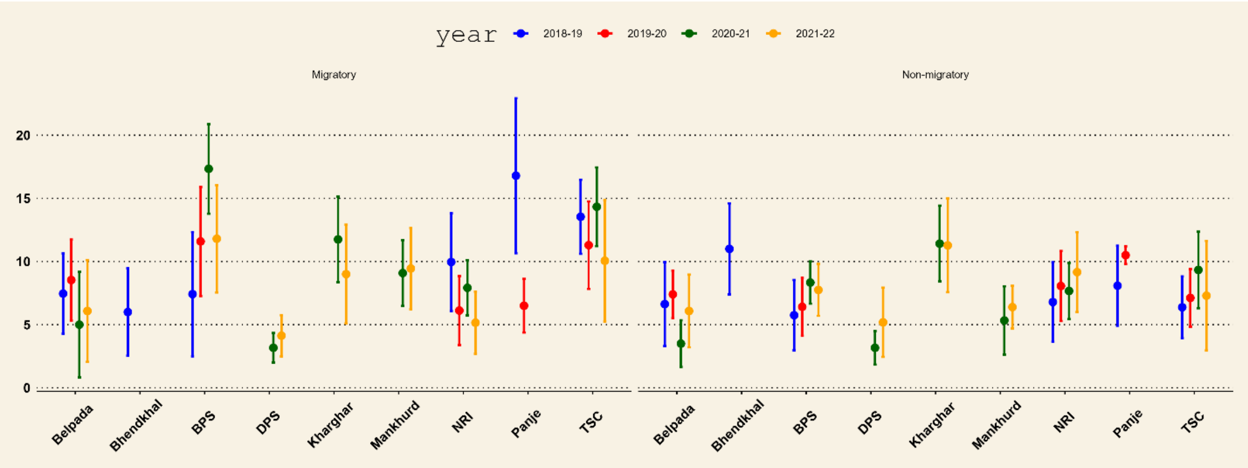


Fig. 6.2. Mean species richness (with standard deviation) of migratory and non-migratory shorebirds at various wetland sites, pooled across seasons.

Overall, we observed a decline in the diversity of the migratory shorebirds in the wetlands. The migratory shorebird Shannon diversity index was marginally higher in autumn (1.10–1.39, n=34) than in winter (1.10–1.31) and lowest in spring (0.82–1.20, Fig. 6.3). The difference was statistically significant ($F(2)=5.12$, $p<0.001$; Table 6.1). Turkey's post-hoc test showed that significant pairwise difference between spring than that of autumn (-0.21) and winter (-0.14). Besides, difference is also significant between years. Interestingly, non-migratory birds showed a diversity pattern similar to migratory birds — diversity peaked in autumn (1.21–1.41), followed by winter (1.13– 1.37) and spring (1.09–1.20; Fig 6.3). The difference was significant between seasons ($F(2)=3.85$, $p<0.01$) and years ($F(3)=4.05$, $p<0.05$; Table 6.1). However, Turkey's post-hoc test revealed only the difference between spring and autumn was significant. The diversity index of migratory shorebirds was highest at Kharghar (1.57–1.77) and lowest at DPS (0.06–0.33). We found that the diversity index of migratory shorebirds at Belpada, BPS, Kharghar and TSC had lowered in recent years (2020–2022), but it increased at Mankhurd, NRI and DPS. On the contrary, non-migratory shorebird diversity increased in all the wetlands except Belpada, where it declined.

6.2 Abundance

We have seen substantial variations in the abundance of shorebirds in the wetlands, for instance, 9985 individuals of lesser flamingo to an individual of little grebe.

Greater and lesser flamingo, duck and coot numbers seem to be dropped at BPS, in contrast, spoonbills, birds of prey, stilt, avocets, plovers, sandpipers, godwits, storks, herons, egrets and cormorants showed increasing trends. Lapwing and terns showed the unimodal-shaped abundance trend (Fig. 6.5). In TSC, duck, greater flamingo, small plover, small sandpipers, godwit and tern numbers were dropped, however, lesser flamingo, birds of prey, stilt, avocet, large sandpiper, gull, kingfisher, heron, egret, cormorant, coot and lapwings had increased (Fig. 6.6). Large and medium plover and stork numbers appear stable. We found that at NRI, greater and lesser flamingo, stilt, and avocet, large plover, large sandpiper, stork and coot abundance had fallen, on the other hand, spoonbill, birds of prey, medium sandplover, kingfisher, cormorant and lapwing numbers were rose (Fig. 6.7). The abundance of the remaining groups seems unchanged. Greater flamingo, stork and egret numbers dropped at Belpada, on the opposite, duck, spoonbill, birds of prey, large plover, medium plover, godwit, kingfisher, heron, cormorant and lapwing were increased (Fig. 6.8).

In Mankhurd saltpans, we noticed that large sandpiper, large sandpiper and heron had decreased, but large plover, small sandpiper, small plover, tern and egret were increased (Fig. 6.9). Lapwing, cormorant, kingfisher, stilt and avocet abundance showed unimodal patterns. Medium plover numbers appear to be stable. Most of the species showed a declining trend at Kharghar wetland. Surprisingly, at DPS, greater and lesser flamingo numbers increased recently, along with small sandpiper, tern, heron and lapwing (Fig. 6.11). Whereas duck, gull, stork, egret and cormorant numbers had dropped. We had only one year of count data for Panje wetland due to social and land ownership issues; hence, we did not use it for the abundance pattern exploration (Fig. 6.12).

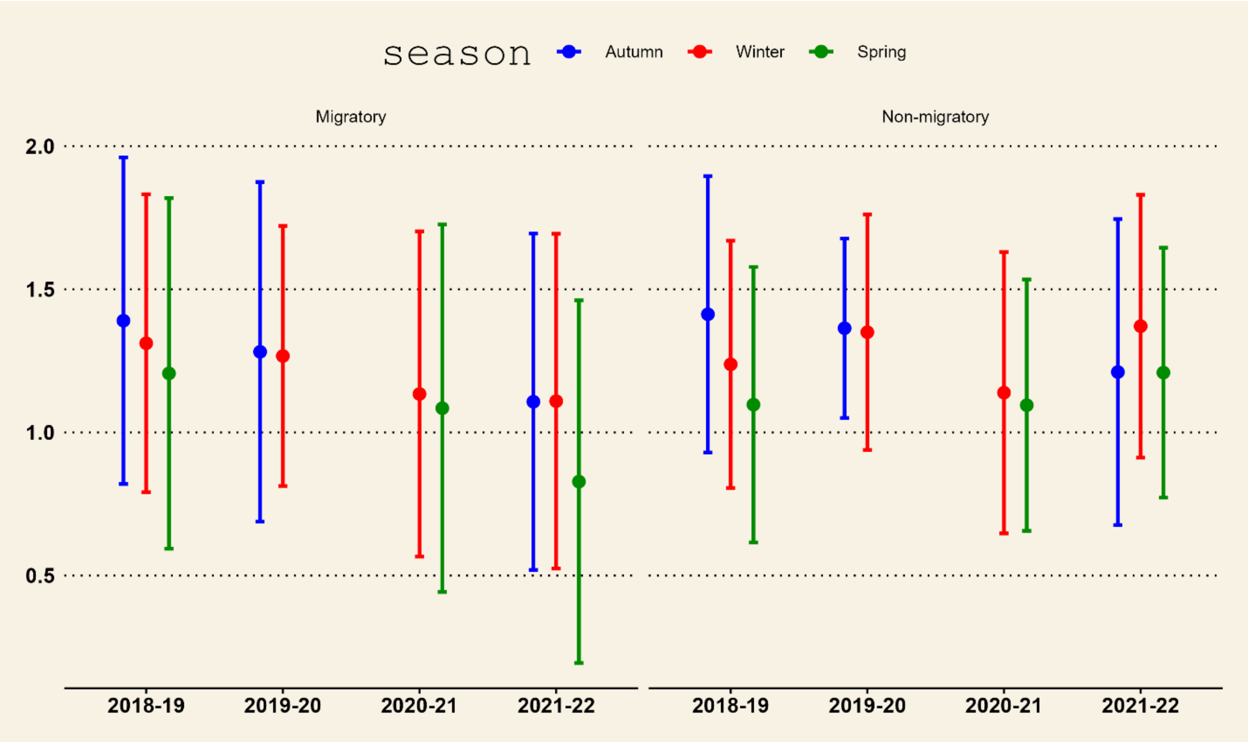


Fig. 6.3 Shannon's diversity index (with standard deviation) of migratory and non-migratory shorebirds in various seasons, pooled across seasons.

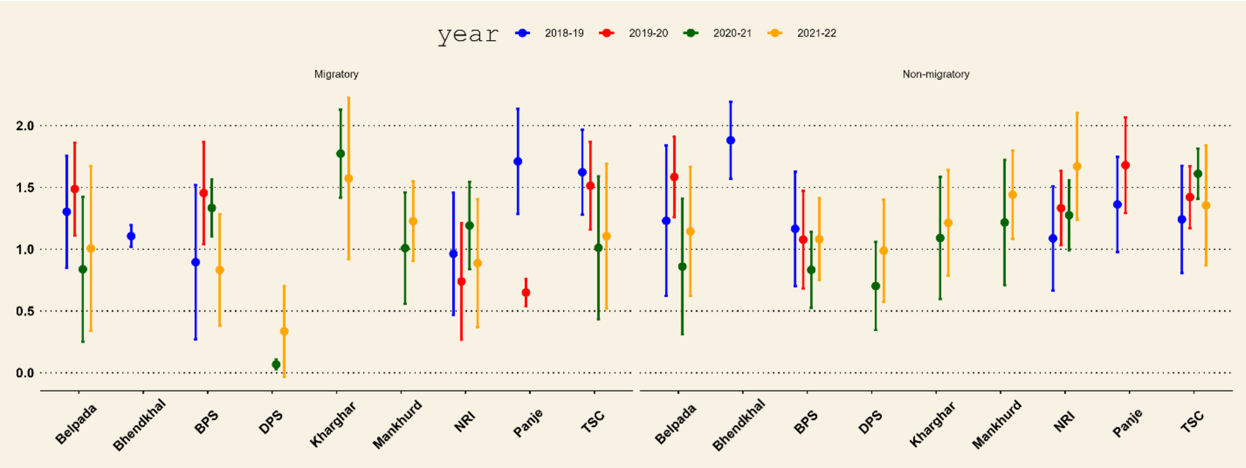


Fig. 6.4. Shannon's diversity index (with standard deviation) of migratory and non-migratory shorebirds in various seasons, pooled across wetlands.

Table 6.1. Analysis of variance (ANOVA) table testing the effect of year, site and season on species diversity of migratory and non-migratory shorebirds in Nahava and Sewri.

	DF	SS	MS	*F*	*P*
Migratory shorebirds					
Season	8	38.272	4.784	19.5962	<0.001***
Year	2	2.502	1.2508	5.1236	0.0064**
Site	3	2.453	0.8176	3.3489	0.0192*
Residuals	371	90.571	0.2441		
Non-migratory shorebirds					
Season	8	8.764	1.09554	5.9064	<0.001***
Year	2	1.43	0.71513	3.8555	0.0220*
Site	3	2.255	0.75183	4.0534	0.0075**
Residuals	371	68.814	0.18548		

Note: DF for degrees of freedom; SS for sum of squares; MS for mean sum of squares; and *F* and *P* for F-ratio and P-value of a significance test.*** <0.001;**<0.01;*<0.05

6.3 Discussion

The relatively high species richness of the migratory shorebirds and seasonal patterns in shorebirds were anticipated, and they were similar to the patterns observed in Thane Creek, and Nhava and Sewri (please refer to discussion section of Chapters 4 and 5 for details). The declining trend of the shorebird richness in the wetlands was worrisome, however, we have inadequate data (four years of data) to check the statistical significance of this trend. This decline in species richness could be associated with the increasing human pressure on these wetlands (Prabhu et al., 2022). We were not surprised by the high migratory shorebird richness at BPS and TSC. These sites were fairly large, relatively low in vegetation cover and more open with good visibility, which reduces the predation risk and human interferences and makes them ideal for shorebird roosting.

In contrast, DPS, which had the lowest species richness, is relatively small and adjacent to a large road with heavy traffic. Interestingly, the richness dropped at Belpada, Kharghar, NRI, Panje and TSC and increased at BPS, DPS, and Mankhurd might be related to the temporal variation in the intensity of the human disturbances at these sites or may also be a temporary change. For instance, Recent decline in the species richness at Belpada may indicate the adverse impact of human disturbances, especially construction activities. Shannon diversity index patterns of migratory and non-migratory shorebirds were similar to the richness patterns. We anticipated a significant difference in diversity during autumn and spring (please refer to Chapters 4 and 5 for details). Migratory shorebird diversity declined in most wetlands except Mankhurd, NRI and DPS. The increase in diversity at Mankhurd and DPS is perhaps because of sampling efforts, as we started monitoring these sites recently (2020–2022) while the rest of the sites had been surveyed for four years. The diversity and richness of non-migratory shorebirds had increased in almost all the wetlands, whereas migratory shorebird diversity and richness dropped at several sites. This pattern might suggest that the roosting sites are becoming more suitable for the non-migratory shorebirds but less so for the migratory shorebirds. This local decline of the migratory shorebird diversity and richness would be worth investigating. We found that greater flamingo numbers dropped at BPS, TSC, NRI, and Belpada. Similarly, lesser flamingos also declined at these sites, except TSC, where they increased. Surprisingly, their numbers also shot up recently at DPS. These fluctuations in flamingos' abundance may be related to the spatial variation in usage of the sites rather than actual change in their populations. For example, during 2018–2020, flamingos did not use DPS, but in 2020–2022 we recorded a large congregation of the birds. Our GPS satellite telemetry data showed that the birds were using multiple sites, moreover, they were using sites we were not monitoring. For instance, during relatively low high tides or even hide tides, they eighter float in the creek or roost in the open patches among mangrove forests. This example highlights the limitations of the high tide roosting site monitoring as a proxy to detect the low magnitude population changes in the birds. We noticed at several sites that increase in abundance of non-migratory shorebirds such as herons, egrets and cormorants, which did not deter by relatively deep water. In contrast, small- to medium-sized plovers and sandpipers, who prefer shallow waters, were dropped at various sites. This pattern was also reflected by the increase in richness and diversity of non-migratory shorebirds and the decrease in migratory shorebirds. The mismanagement of the wetlands, such as their intensive use for the fishery or as a holding pond, were some of the key drivers in changing wetland habitat, adversely affecting migratory species. On the other hand, the small plovers and sandpipers numbers were shot up in Mankhurd because it is a saltpan with shallow holding ponds and bunds ideal for roosting the small waders. These observations may also highlight the migratory shorebird movements or short or permanent shifts from unsuitable to suitable roosting sites. Similarly, godwit numbers increased at most sites, as observed in the creek. It perhaps shows an overall increase in the godwit population in the MMR.

Interestingly, birds of prey abundance rose at most of the sites. An increase in mangrove cover or other tree plantations around high-tide roosting sites, which provide perching and shelter to the birds of prey, may be one of the reasons behind an upsurge in their numbers. Besides, increasing vegetation cover around roosting sites also makes hunting relatively easy for free-ranging dogs, which infested all the roosting sites. The increasing risk of predation from birds of prey, dogs and other mammalian predators due to habitat or vegetation changes around the roosting site had put the migratory shorebirds, which prefer open and extensive wetlands or saltpans, under stress.

In conclusion, decreasing migratory shorebird richness and diversity at high-tide roosting sites was worrisome. Several local reasons for this decline ranged from mismanagement of wetlands to urbanization (Prabhu et al. 2022). The simultaneous rise and fall of the shorebird numbers at various sites suggested their connectivity, further supported by bird resighting and satellite telemetry data (for details, please refer to Chapter 8; Prabhu et al., 2022). Though wetland bird monitoring may not be a good proxy for low-magnitude local bird population changes, it can detect high-magnitude population changes and is worth continuing. Our data analysis is based on four-year shorebird count data collected at wetlands, which is relatively short compared to the life span of the migratory shorebirds, in addition, we did only exploratory analysis on broad groups. The long-term count data with species-specific analysis using predictive or inferential statistical models would produce more credible inferences.

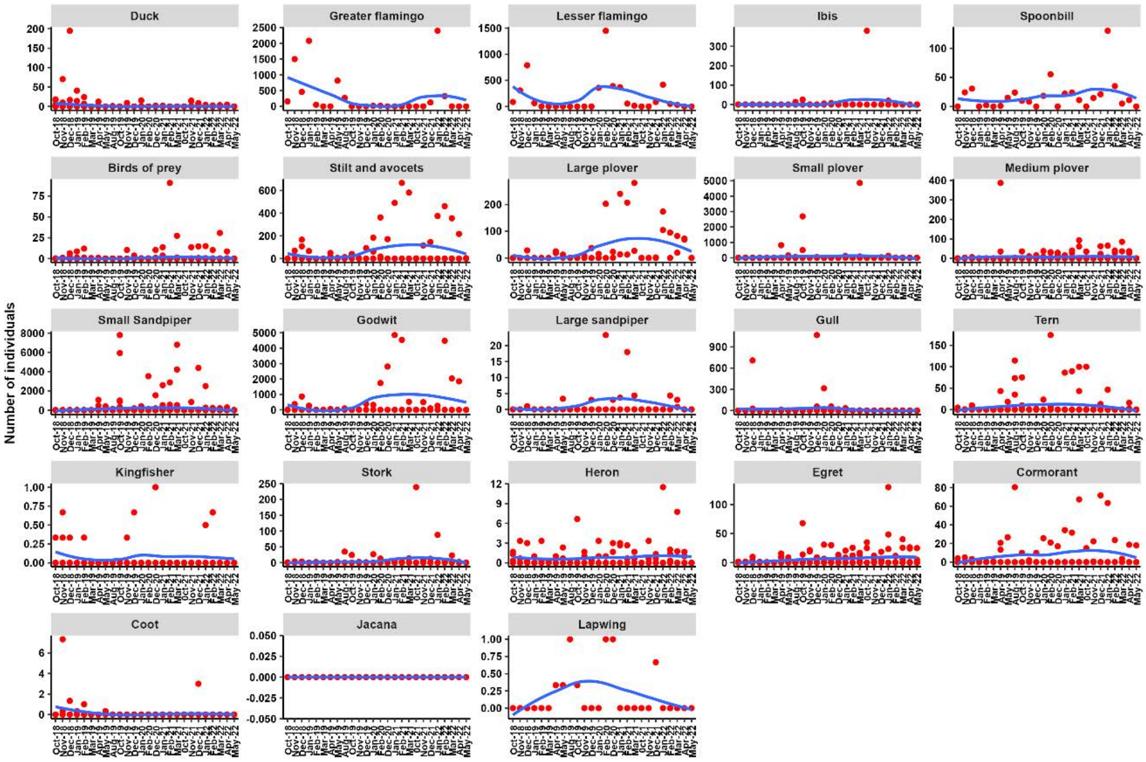


Fig.6.5. Temporal changes in shorebird abundance in BPS wetland. Red dots are mean counts and blue lines are smooth curves fitted to aid visual interpretation.

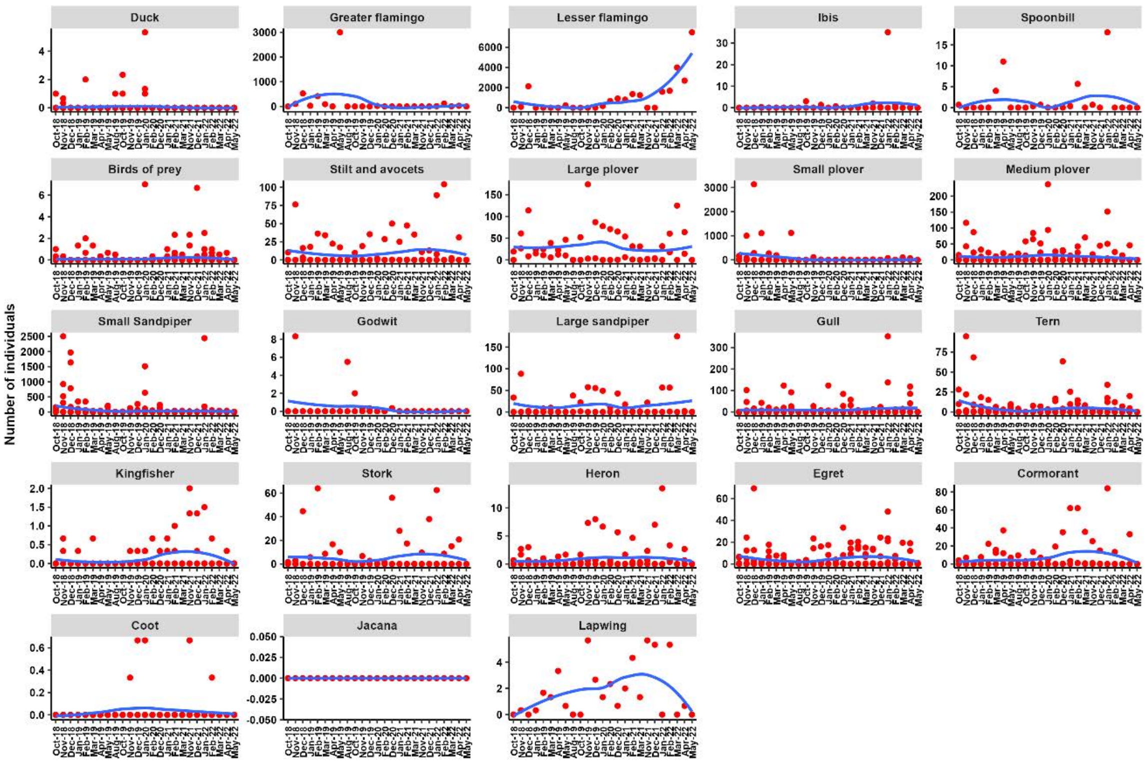


Fig. 6.6. Temporal changes in shorebird abundance in TSC wetland. Red dots are mean counts and blue lines are smooth curves fitted to aid visual interpretation.

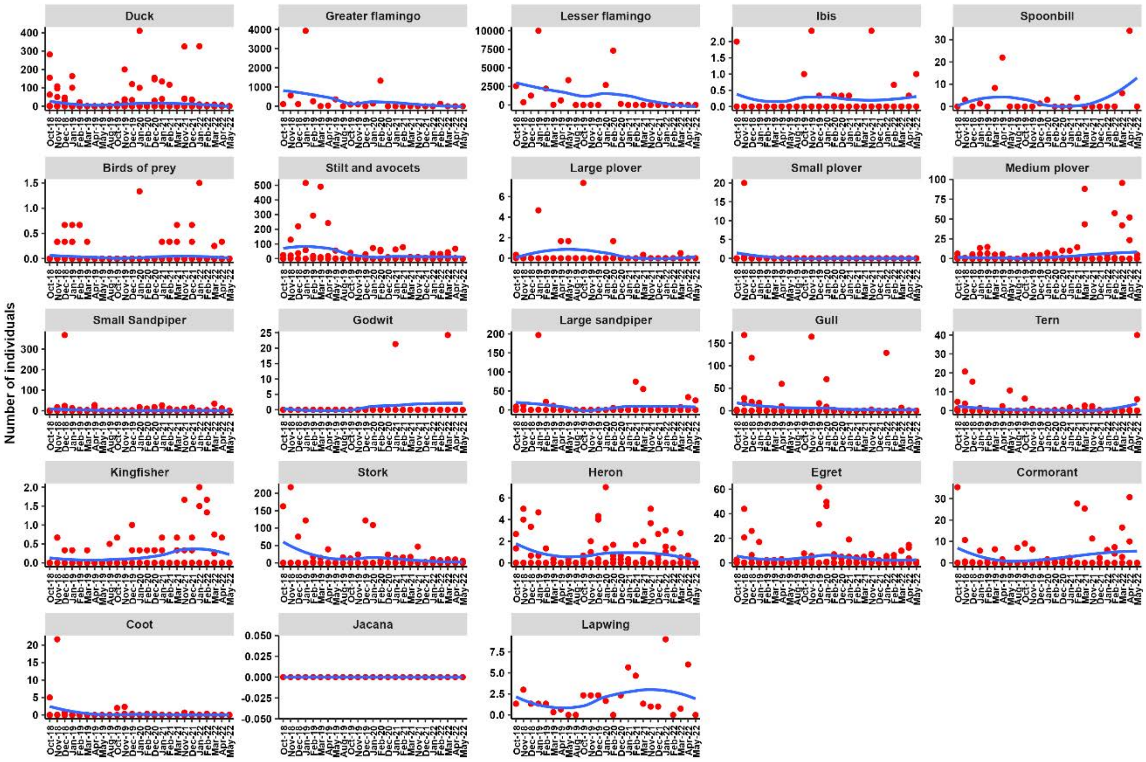


Fig. 6.7. Temporal changes in shorebird abundance in NRI wetland. Red dots are mean counts and blue lines are smooth curves fitted to aid visual interpretation.

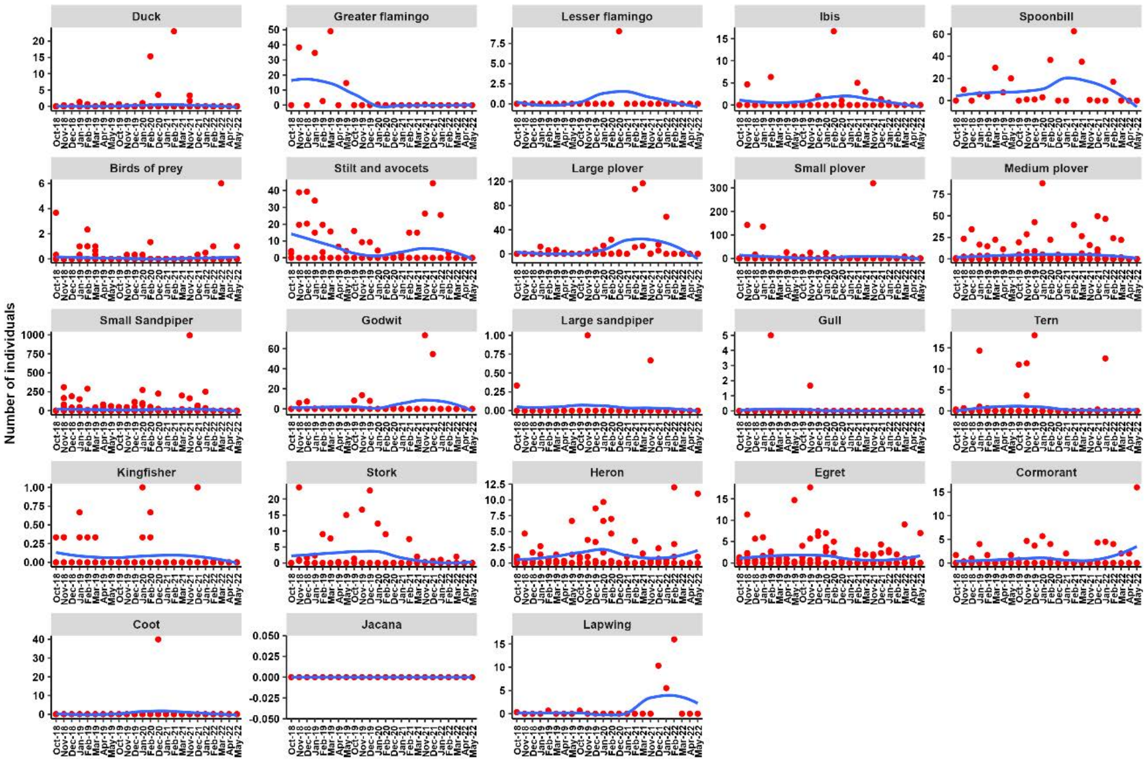


Fig. 6.8. Temporal changes in shorebird abundance in Belpada wetland. Red dots are mean counts and blue lines are smooth curves fitted to aid visual interpretation.

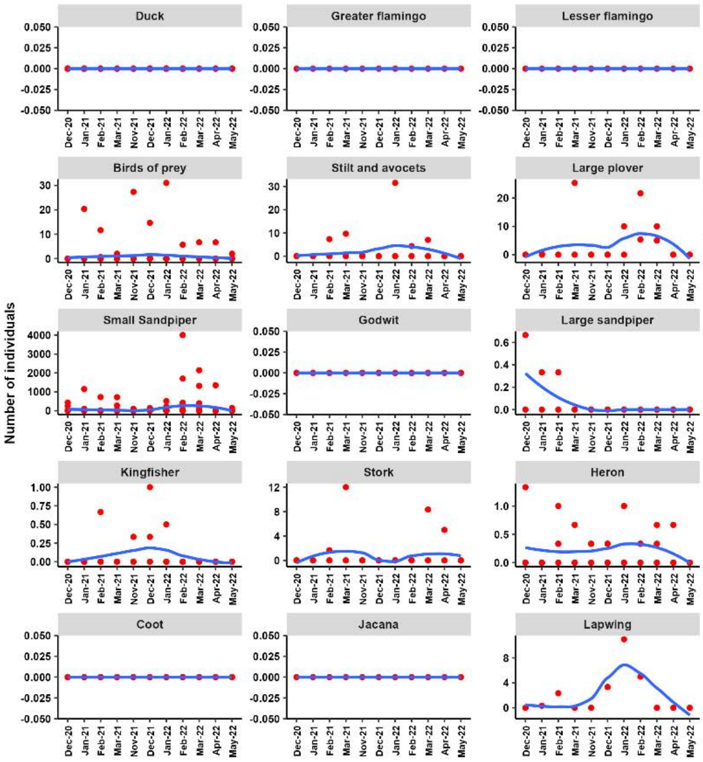


Fig. 6.9. Temporal changes in shorebird abundance in Mankhurd wetland. Red dots are mean counts and blue lines are smooth curves fitted to aid visual interpretation.

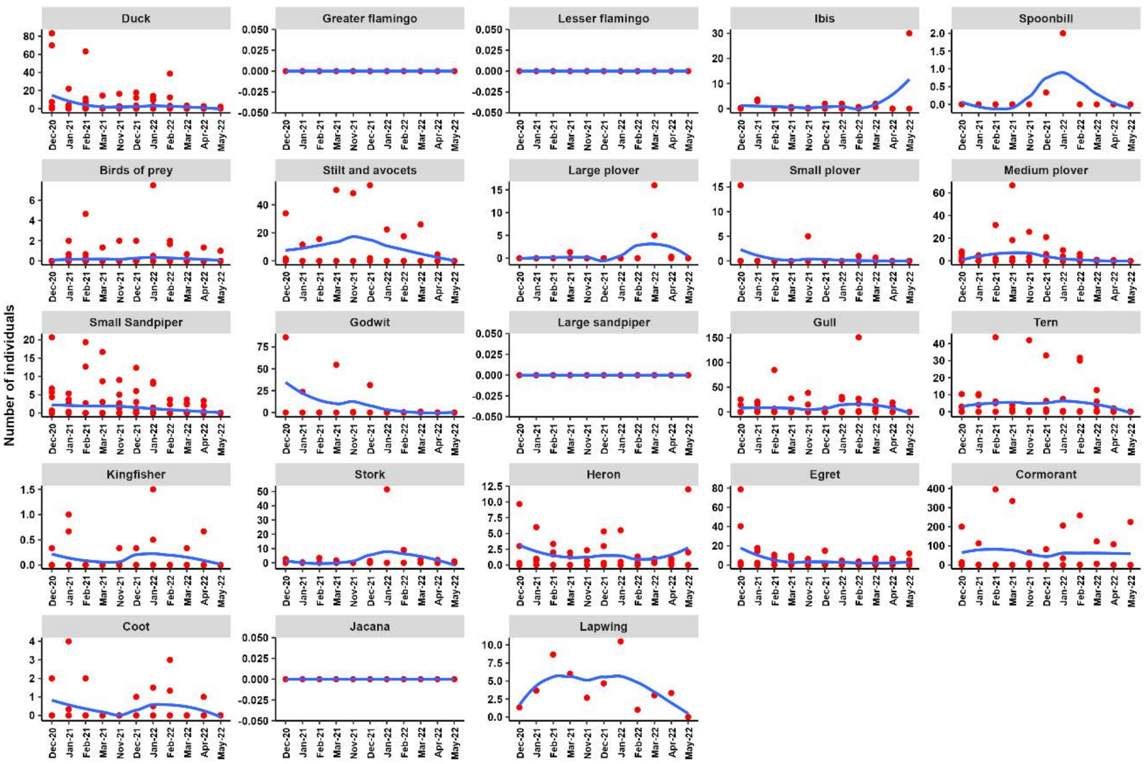


Fig. 6.10 Temporal changes in shorebird abundance in Kharghar wetland. Red dots are mean counts and blue lines are smooth curves fitted to aid visual interpretation.

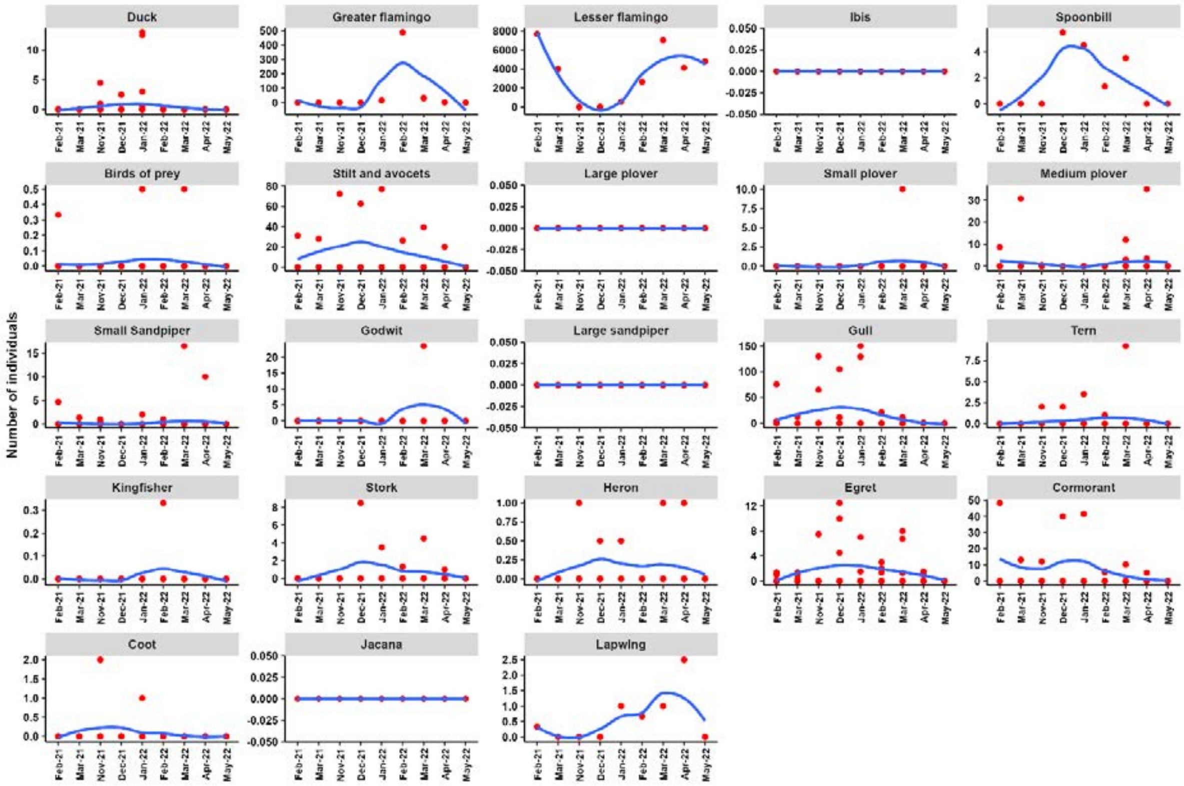


Fig.6.11. Temporal changes in shorebird abundance in DPS wetland. Red dots are mean counts and blue lines are smooth curves fitted to aid visual interpretation.

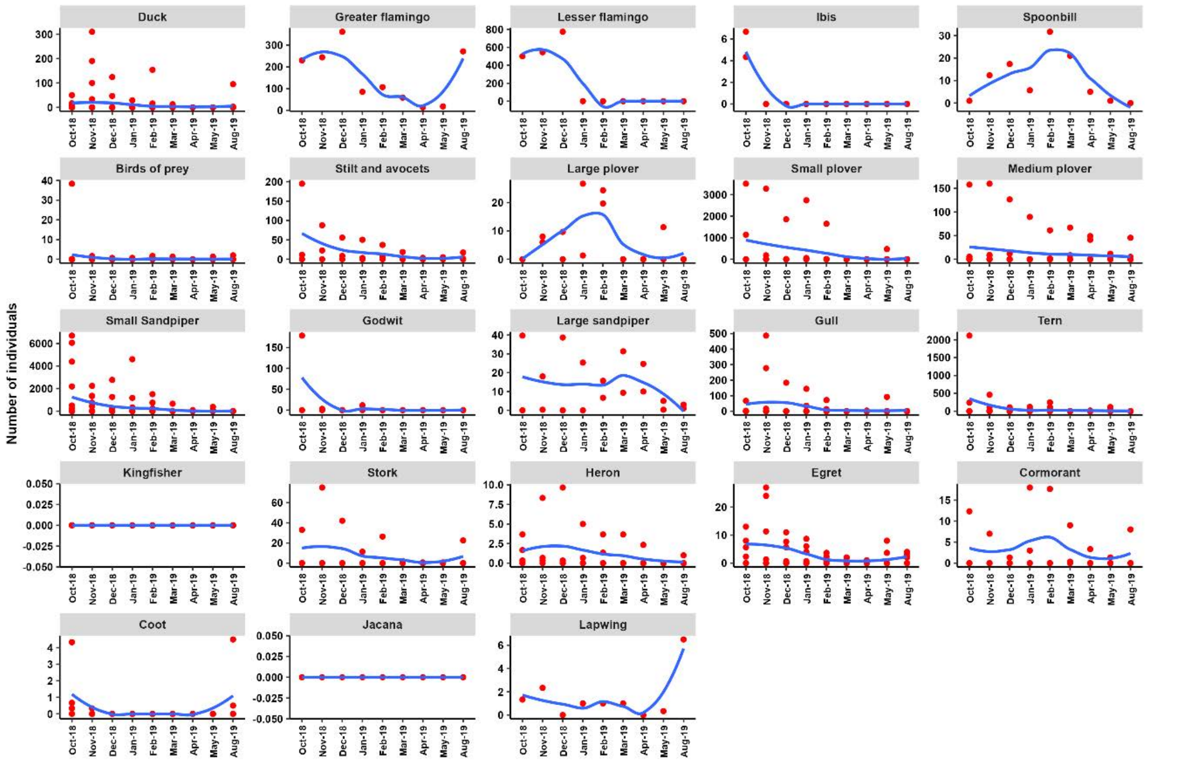


Fig. 6.12. Temporal changes in shorebird abundance in Panje wetland. Red dots are mean counts and blue lines are smooth curves fitted to aid visual interpretation.

Chapter 7-Bird behavior

7.1 Result

To understand the effect of disturbance on bird behaviour were studies in hightide roosts, Thene Creek and Sewari and Nhava, we divided sites in two categories feeding and roosting and studied behaviours like aggression, maintenance, feeding, resting, movement, and vigilance. The Sewari and Nhava sites were also considered as disturbed sites due to construction activity of MTHL bridge to understand impact of anthopogenic activities on bird behaviou. We transcribed 6871 one-minute videos of ten migratory shorebird species for comparative behavioral study. Greater flamingos had decreased aggression at construction and roosting sites compared to feeding sites, but the evidence was weak (Fig. 7.1). In contrast, time spent in feeding, maintenance, movement and resting at construction and roosting sites was moderately higher than that of feeding sites. Vigilance was significantly higher at construction and roosting than that at feeding sites. Interestingly, resting time decreased with the presence of the dogs, but the effect was moderate. Overall, lesser flamingos spent less time in all the activities at construction sites than that at roosting and feeding sites, however, the effects were not significant (Fig. 7.1). Their feeding time decreased with the presence of the dogs but with moderate evidence. At the same time, construction activities also moderately reduce the time spent in maintenance. The presence of predators significantly lessens the resting of the flamingos. Surprisingly, human disturbance reduced vigilance, but the effect was moderate with a very low magnitude.

Time spent by common greenshank in all activities at construction sites was slightly lower than that of feeding sites but did not differ significantly (Fig. 7.2). In contrast, activities at construction and feeding sites are moderate to significantly higher than that of roosting sites. We found that their maintenance time decreases moderately with increased predator presence. Movement and resting reduce significantly with the presence of vehicles and predators. Common redshank showed high aggression at feeding sites, followed by roosting and construction sites, but the evidence was weak (Fig. 7.2). The time spent in the rest of the activities at construction sites was slightly but non-significantly higher than that at feeding and roosting sites. Increasing human disturbances moderately reduced the aggressions and maintenance but significantly increased the movement and vigilance in the redshanks. Insistingly, they showed an inverse relationship between vigilance and construction activities, however, the effect was moderate.

Though the curlew sandpiper spent relatively more time in all activities at the construction site than that of roosting and feeding sites, none of the effects were significant (Fig. 7.3). Maintenance was moderately decreased with an increase in construction activities. Whereas movement is elevated strongly with the presence of vehicles. The incidences of predators significantly reduced the resting time and increased vigilance. Eurasian curlew reduced almost all activities significantly at roosting and construction sites than at feeding sites (Fig. 7.3). Interestingly, vigilance decreased significantly at roosting and construction sites than at feeding sites. Surprisingly, time spent in maintenance elevated significantly with increasing human disturbances. Movement of Eurasian curlew increased strongly with the presence of vehicles. In contrast, the resting reduced significantly with the presence of predators. Vigilance and construction activities had a moderately inverse relationship.

Lesser sandplover behaviour at feeding and construction sites was comparable, while at roosting sites, they spent relatively more time in all activities; however, the effects were not significant except resting (Fig. 7.4). Interestingly, feeding time increased even in the presence of vehicles. In contrast, it decreased significantly by the occurrence of predators and moderately by dogs. Similarly, resting moderately reduced in the presence of predators and dogs but increased strongly with human disturbances. Vigilance elevated significantly with an increase in human disturbances. Unlike lesser sandplover, little stints spent more time in all activities at construction sites than roosting and feeding sites, but the effects were moderate to strong for resting and vigilance (Fig. 7.4). Vehicular presence significantly reduced their feeding time and moderately lessened time spent on maintenance. Interestingly, human disturbances decreased little stints movements, in contrast, predator presence increased it. Construction activities and human disturbances also reduced their resting time. Surprisingly, construction activities lowered vigilance significantly and increased significantly by vehicle presence.

7.2 Discussion

Greater flamingos showed less aggression at construction and roosting sites. It was not surprising, especially at roosting sites, as they use these sites mainly for resting. However, low aggression at construction sites may suggest more food abundance, lower bird density or fewer disturbances. It was shocking that they spent more time feeding at roosting sites than feeding sites, which may highlight the additional role of these high-tide roosting sites in providing supplementary food. Though greater flamingos appeared to be doing all activities, usually at roosting and construction sites, they also showed significantly higher vigilance — perhaps because of the increased risk from predators or human disturbances at construction and roosting sites. The heightened vigilance may reduce the feeding time and adversely affect the birds. In addition, their resting time is reduced by presence of dogs as expected.

Similarly, lesser flamingo feeding time also decreased with dog′s occurrence. We have seen several incidences of dogs chasing flamingos. Likewise, we also reported the incidences of avian predators or scavengers attacking lesser flamingos, especially juveniles or injured adults, which can infer from a significant reduction in their resting time in the presence of predators. Unlike greater flamingos, lesser flamingos relatively spent less time in all activities at construction sites, but the effect was insignificant. This may indicate the low preference of the species for disturbed sites like construction sites, which could have poor habitat quality. In contrast, surprisingly, human disturbance reduced their vigilance which perhaps indicates tolerance towards human disturbances, but the effect was not significant.

Common greenshank may also suggest poor habitat quality at construction sites as it relatively spent less time in all activities than feeding sites. On the contrary, we were not surprised that it spent significantly or moderately more time in all activities at construction and feeding sites than at roosting sites because the former two categories are feeding sites while the latter is resting site. This species was relatively sensitive to disturbances and predators, reflected by its significant decrease in time spent in movement and resting in the presence of vehicles and predators.

Common redshank showed high aggregation at the feeding site, which was expected because they feed in densely packed large flocks and hence frequently bumped into the feeding spot of the neighbours. We had seen common redshank flocks often at construction sites which may indicate species is relatively more resilient to disturbed sites. This observation was supported by the time spent by the common redshank in behavioural activities, which was comparatively higher at construction sites; nonetheless, the effects were insignificant. On the other hand, their movement and vigilance significantly increased with human disturbances, but vigilance decreased with construction activities. These observations highlight the differential response of the species to various disturbances, and hence including more homogenous categories of disturbances may decipher their impact on the species.

Like the common redshank, curlew sandpiper also spent more time in all activities at construction sites, but the effects were weak, which may also indicate the suitability of the habitat despite disturbances. The presence of vehicles significantly increases their movement, which may lead to more energy expenditure and negatively affect the fat accumulation necessary for migration and breeding. This species, along with other small waders, is often hunted by avian predators, therefore, it was not surprising that it showed a significant reduction in resting time and gain in vigilance in the presence of the predators.

Eurasian curlew showed higher aggregation at construction sites that might be related to inferior habitat quality due to a low food abundance and stress from disturbances. We anticipated a significant reduction in all activities at construction sites, followed by roosting sites for Eurasian curlew. This species possesses one of the longest beaks amongst shorebirds, and they need soft and deep substratum to access food from the lower stratum to exclude competition with other waders. This kind of substratum was not available at high-tide roosting sites, and thus they were least active at these sites; even vigilance also reduced significantly. Like common redshank, their movement also increased significantly with the presence of vehicles. They also seemed to be experiencing predation pressure as their resting time reduced strongly with predator occurrence. Shockingly, their vigilance decreased with construction activities, which perhaps indicated their tolerance for such activities, but the effect was moderate and should be used with caution.

The construction sites are mudflats that are contiguous with the Thane Creek mudflats, thus, time spent in various behavioural activities by lesser sandplover was comparable between construction and feeding sites. Interestingly, they also appeared to be relatively more active at roosting sites, highlighting their importance in providing additional food to obtain the critical fat reserves. Their feeding time increased significantly even in the presence of vehicles, and resting increased with human disturbances, which may suggest their tolerance towards such disturbances. On the contrary, their vigilance was elevated significantly with human disturbances. This emphasizes the unclear role of human disturbances on the species. However, like other small waders, they experience high predation risk, especially from avian predators, which can be inferred from a strong decline in their resting time in the presence of predators and dogs (moderate effect).

Relatively higher activities of little stints at construction sites further strengthen the importance of these sites despite the current disturbances. Their vigilance increased significantly at construction sites, highlighting the stress/risk associated with such sites. We found that they seemed more disturbed by vehicles as their feeding time declined, and vigilance increased significantly with the presence of vehicles. Like Eurasian curlew, their vigilance also decreased strongly with construction activities, which may further enforce these species tolerance towards such disturbances. We are not surprised by a significant increase in the movement of little stints with the occurrence of predators, as these small waders are particularly at high risk from avian predators.

In general, species-specific variations in the behaviours had seen among the shorebirds. They showed mixed responses, such as some species were more active and did normal activities at construction sites, while others changed their time allocation to various behaviours compared to feeding sites. Except for three species and two behaviour types that differ significantly between feeding and construction sites, the remaining behaviours did show any significant difference. For example, greater flamingos showed significantly higher vigilance at construction sites than at feeding sites, in contrast, Eurasian curlew had significantly lower vigilance at construction sites, and little stints had spent substantially more time resting at construction sites. However, most species exhibited strong negative impacts due to vehicles, predators and human disturbances.

In conclusion, we did not find any significant difference in the behaviour of the shorebirds, except for a few species and behaviours, between feeding and construction sites, which perhaps suggests the habitat suitability at construction despite the disturbances. However, more detailed behavioural analysis, for instance, using different behaviour sub-types of the broader categories we used and adopting other behavioural models, would give contracting results, and hence these findings should be treated as exploratory but not inferential.

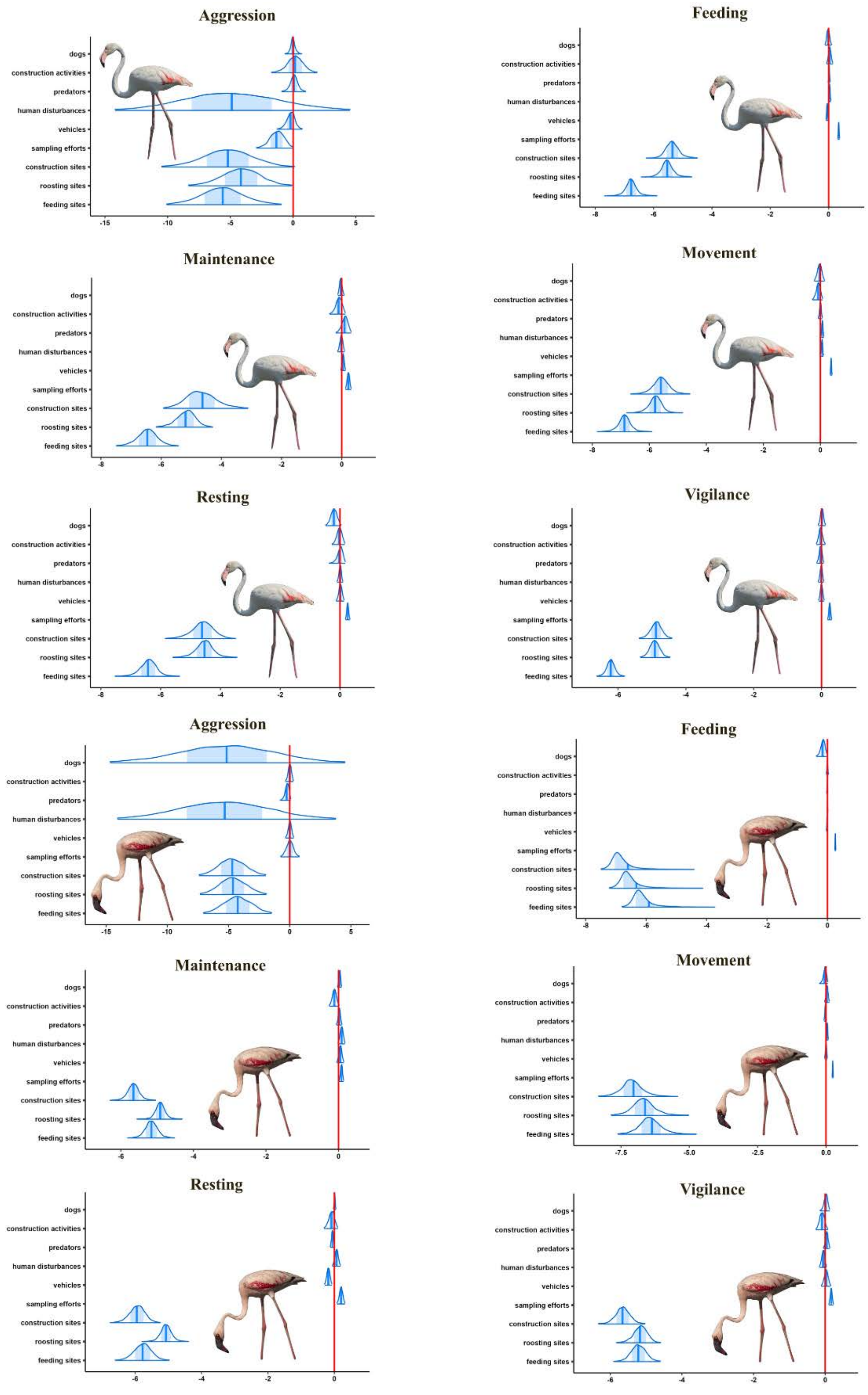


Figure 7.1. Posterior probability distribution plots of the regression coefficients in the zero-inflated beta mixed Bayesian models fitted to lesser and greater flamingo behaviour data. The density plot covers an area corresponding to 95% probability; the inner blue shaded area corresponds to 50% probability; the thick vertical blue line shows the distribution's mean; and the red vertical line marks zero.

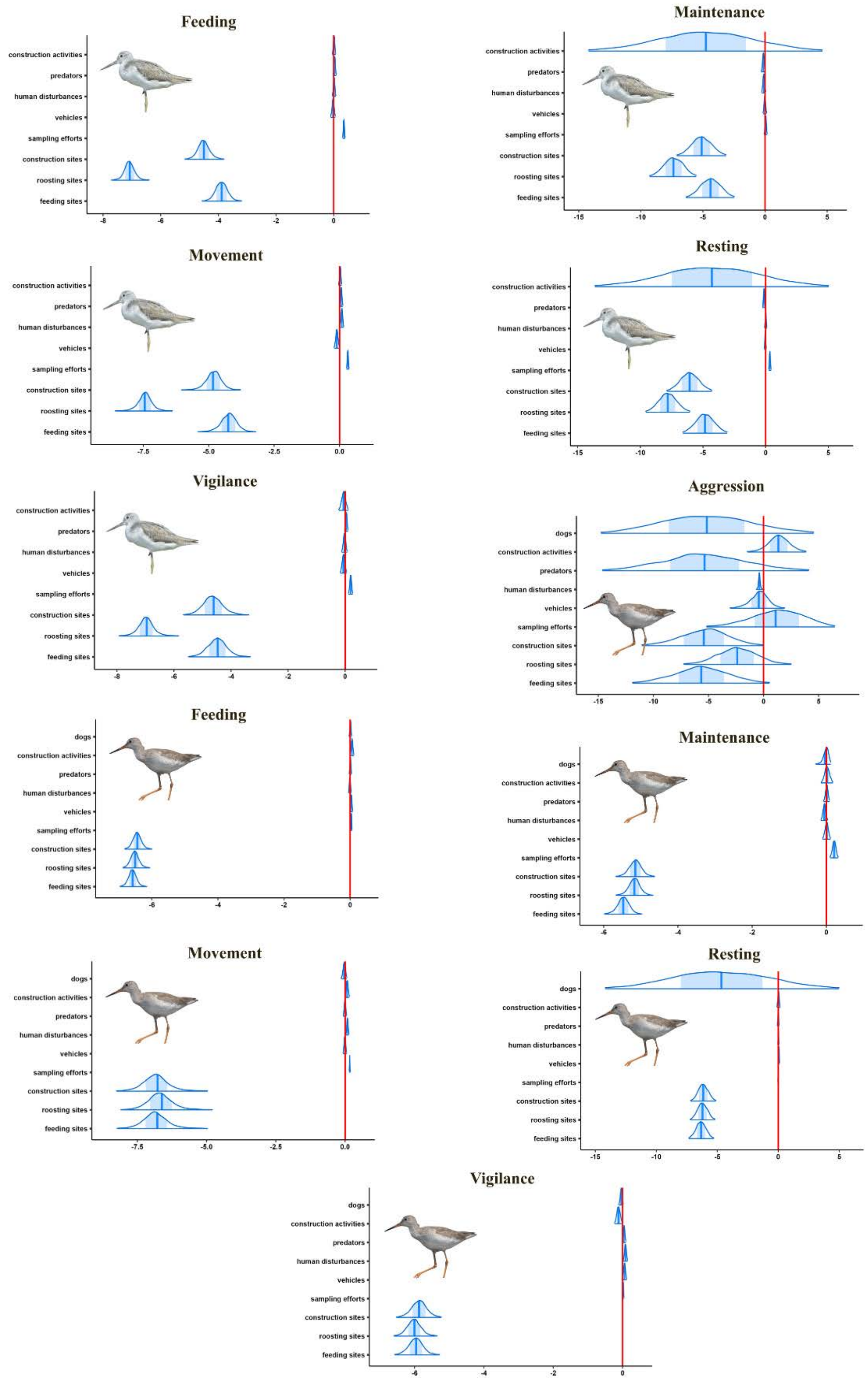


Fig. 7.2. Posterior probability distribution plots of the regression coefficients in the zero-inflated beta mixed Bayesian models fitted to common greenshank and redshank behaviour data. The density plot covers an area corresponding to 95% probability; the inner blue shaded area corresponds to 50% probability; the thick vertical blue line shows the distribution's mean; and the red vertical line marks zero.

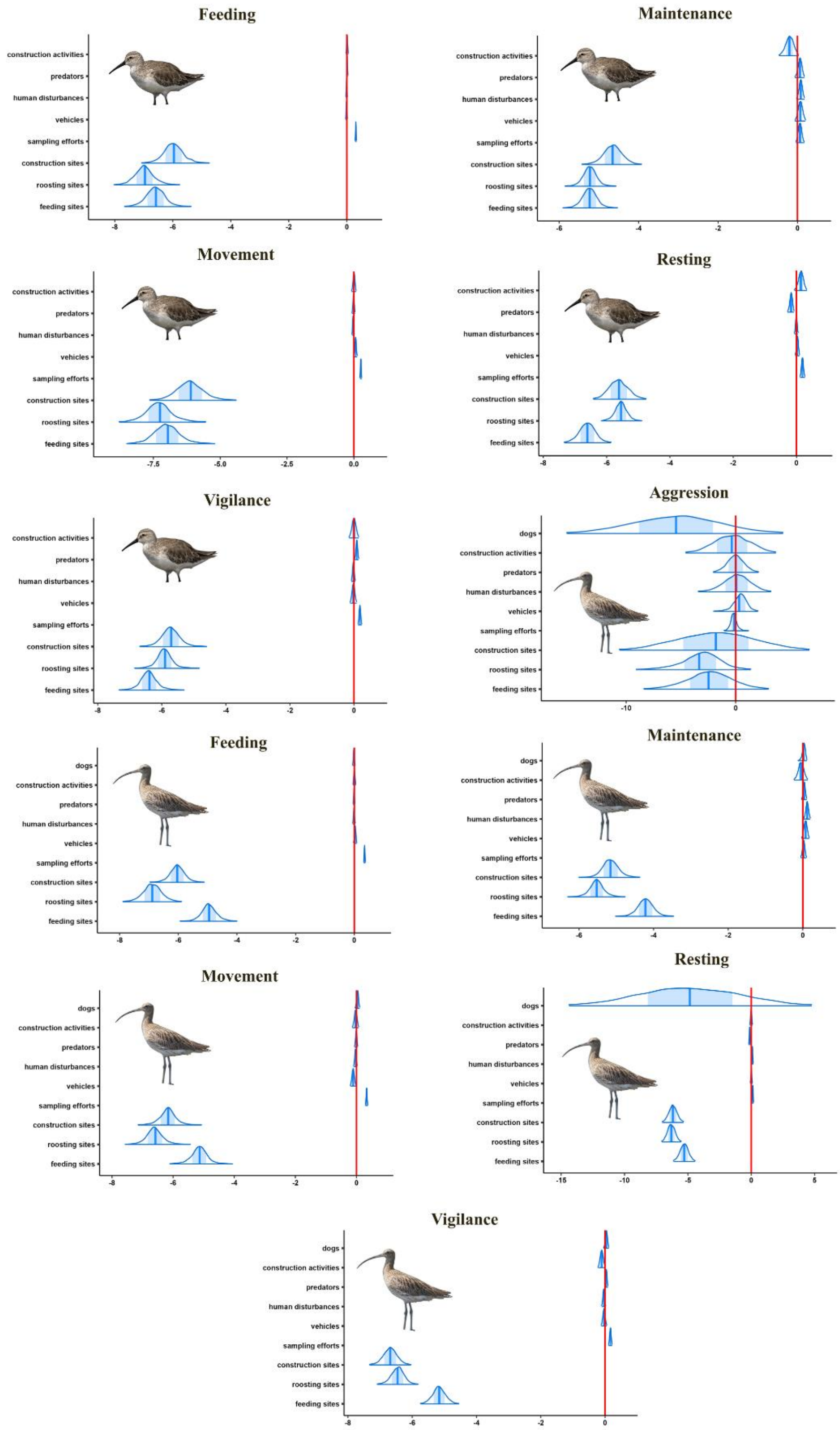


Fig. 7.3. Posterior probability distribution plots of the regression coefficients in the zero-inflated beta mixed Bayesian models fitted to curlew sandpiper and Eurasian curlew behaviour data. The density plot covers an area corresponding to 95% probability; the inner blue shaded area corresponds to 50% probability; the thick vertical blue line shows the distribution's mean; and the red vertical line marks zero.

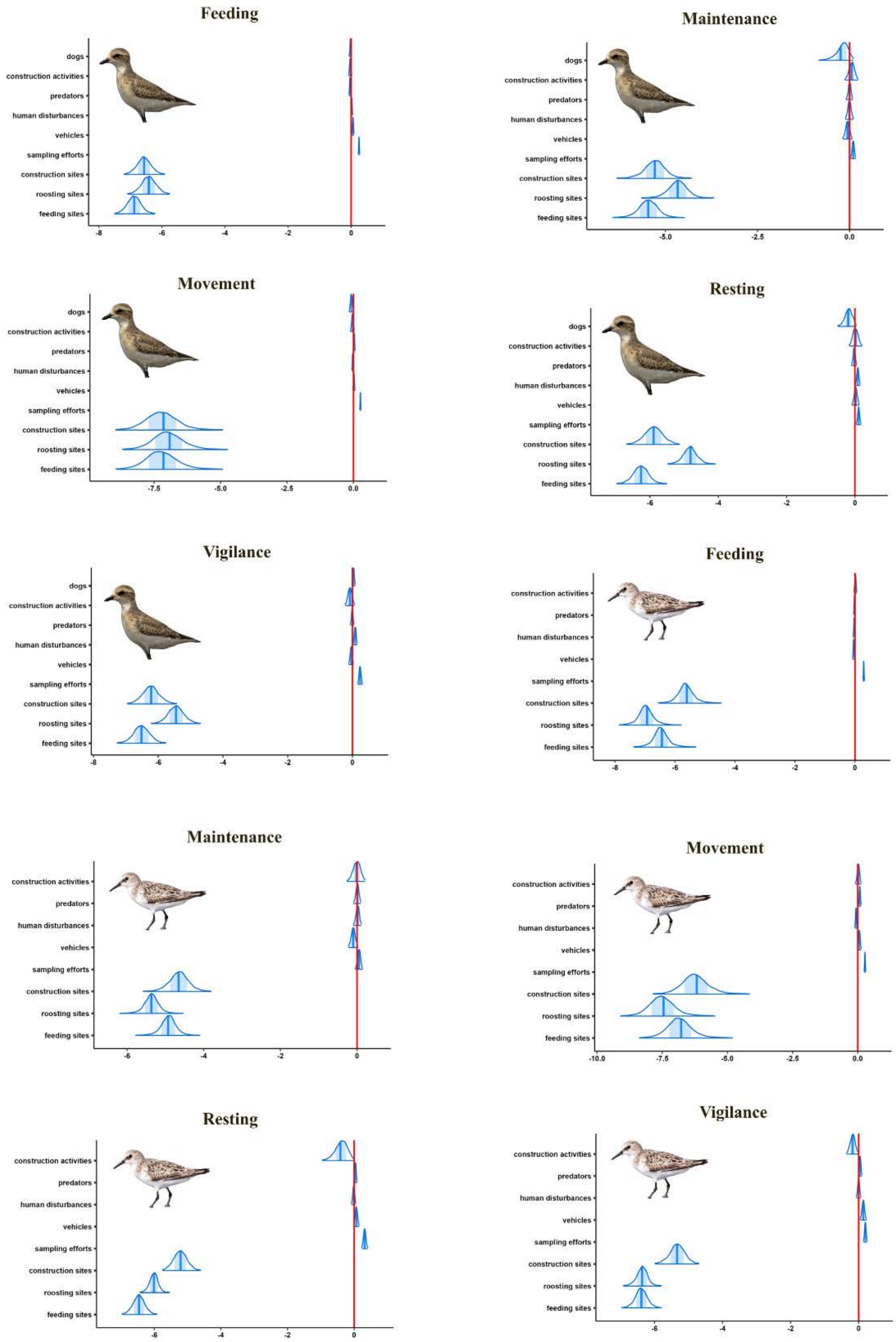


Fig. 7.4. Posterior probability distribution plots of the regression coefficients in the zero-inflated beta mixed Bayesian models fitted to lesser sandplover and little stint behaviour data. The density plot covers an area corresponding to 95% probability; the inner blue shaded area corresponds to 50% probability; the thick vertical blue line shows the distribution's mean; and the red vertical line marks zero.

Chapter 8 Bird Ringing and Satellite Telemetry

8.1 Ringing

We ringed 21380 birds in 257 trapping nights between January 2018 to May 2022. The five most abundant species, which contributed 86% of the total birds trapped, were little stint (5311 individuals, 24.84% of total birds trapped) followed by lesser sandplover (4385, 20.51%), curlew sandpiper (4138, 19.35%), common redshank (3532, 16.52%) and Terek sandpiper (1142, 5.34%; Fig. 6.1). A large number of birds had ringed at BPS saltpan (8812), Mankhurd saltpan (6254), TSC wetland (3649) and BPS mangrove (1618).

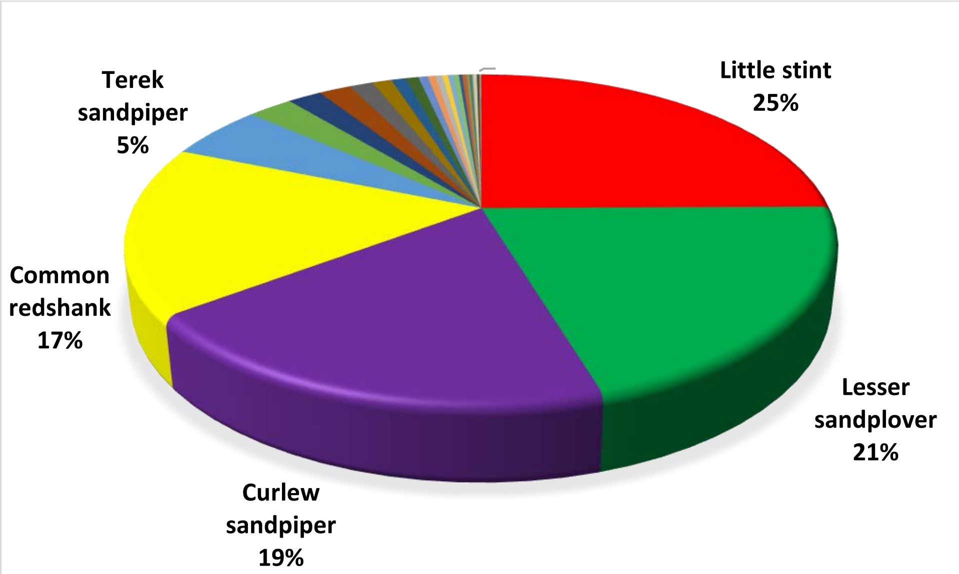


Figure 8.1. Pie chart of the proportion of the birds trapped during this study, highlighting the most abundant species.

In general, species richness in autumn had shown an increasing trend, in contrast, it showed decreasing trend in spring and appeared relatively stable in winter (Fig. 8.2). Though, overall, mean species richness was highest in autumn (6.27–8.80, n=60), interestingly, the richness in spring (6.33 – 9.02, n=91) was comparable to or highest than that of autumn during (2018–2020). The richness was highest at BPS mangrove (5.83–7.06, n=22), BPS saltpan (7.58–8.92, n=79) and Mankhurd (8.67– 10, n=50) and lowest at BPS wetland (1–3, n=2; Fig. 8.3). Almost a 50% drop in shorebird species richness and diversity at TSC was alarming.

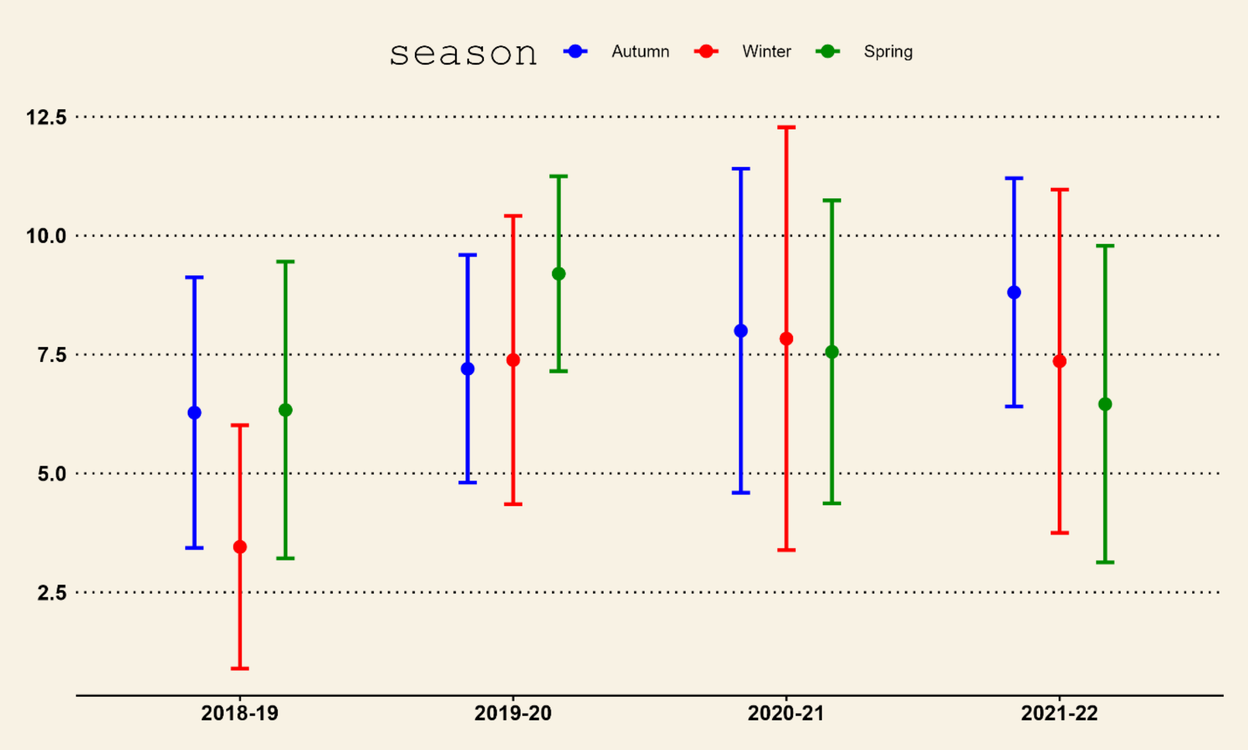


Fig.8.2. Mean species richness (with standard deviation) of migratory shorebirds ringed in various seasons, pooled across sites.

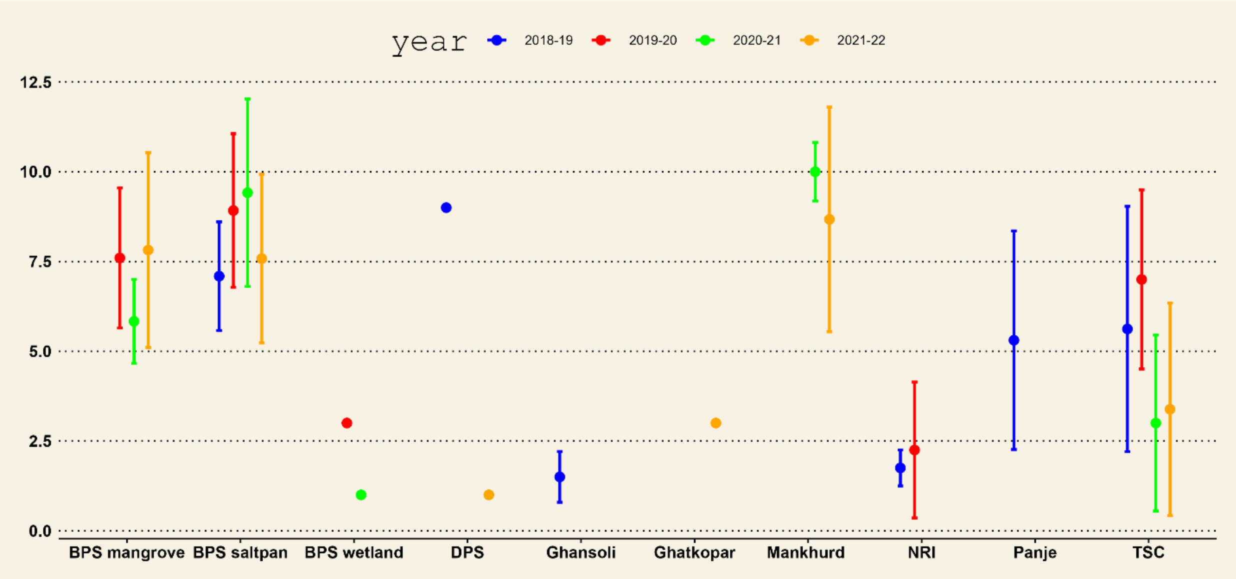


Fig. 8.3. Mean species richness (with standard deviation) of migratory shorebirds ringed in various sites, pooled across seasons.

Shannon diversity index was highest in autumn (1.25–1.49, n=60), followed by spring (1.16–1.35, n=91) and winter (0.70–1.25, n=106; Fig. 8.4). The diversity index was highest at BPS saltpan (1.35–1.56, n=79) and Mankhurd (1.49–1.65, n=50) and lowest at BPS wetland (0.68, n=2, Fig. 8.5). Diversity had slightly increased at BPS mangrove and saltpan.

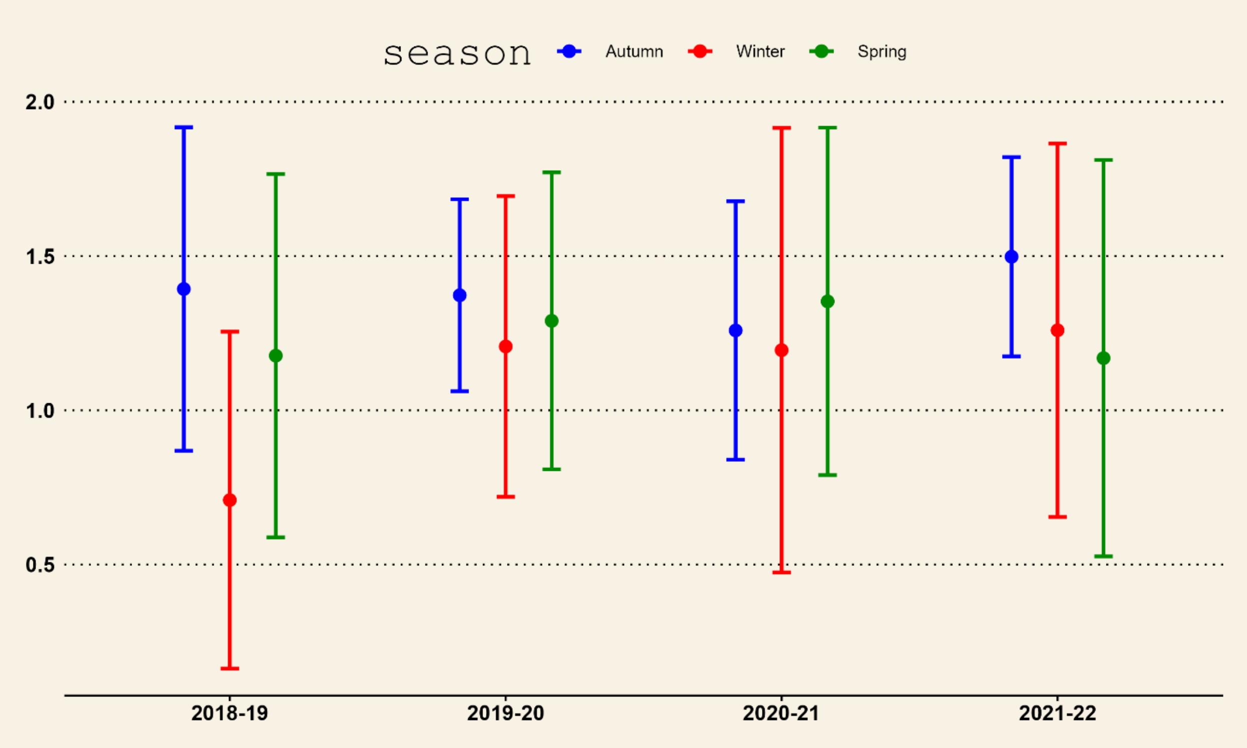


Fig. 8.4. Shannon diversity index (with standard deviation) of migratory shorebirds ringed in various seasons, pooled across sites.

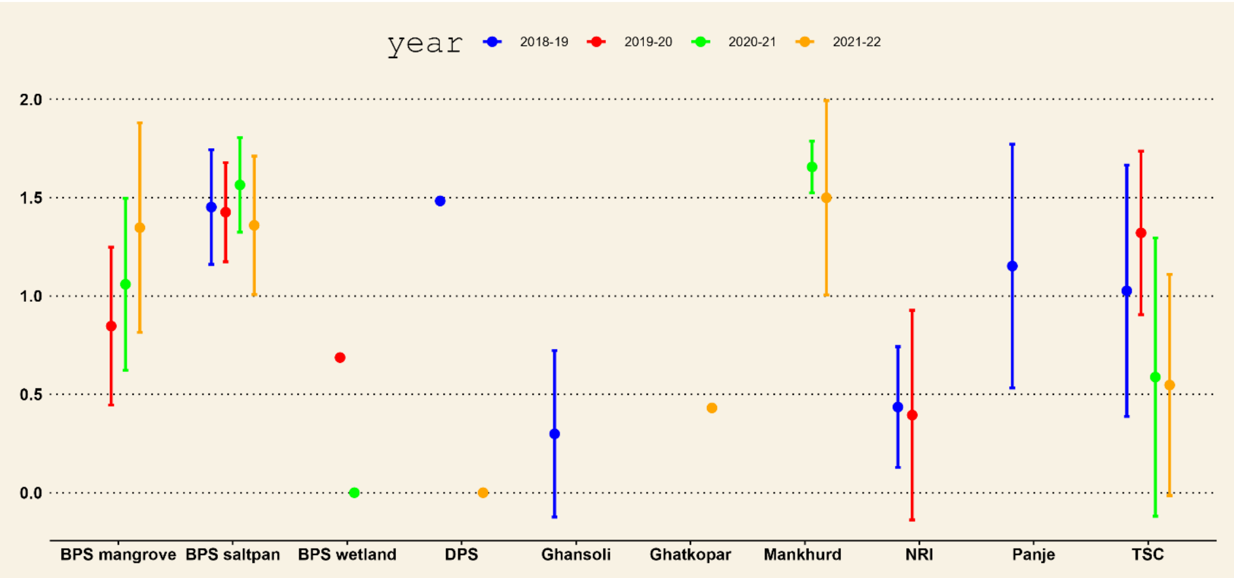


Fig. 8.5. Shannon diversity index (with standard deviation) of migratory shorebirds ringed in various sites, pooled across seasons.

8.2 Recapture

We recorded 196 individuals from 19 species and subsequently recaptured them 1013 times (Prabhu et al. 2022). Among them, common redshank had the most frequently recaptured that accounted for 21.49% of total recaptures, followed by lesser sandplover (13.76%), curlew sandpiper (6.58%), and little stint (1.34%).

Most recaptures were recorded at TSC (n=426), followed by BPS saltpans (n=327), BPS mangrove (n=140) and Panje (n=86), while the remaining sites had < 20 observations.

8.3 Return rates

Return rates varied across sites, species and years. For instance, common sandpiper (10%, 30 marked individuals) and common redshank (5.88%, 85 marked individuals) showed relatively higher return rates than lesser sandplover (3.73%, 241 marked individuals), Terek sandpiper (3.65%, 219 marked individuals), curlew sandpiper (1.29%, 232 marked individuals) and little stint (0.65%, 306 marked individuals) at BPS saltpans in 2019–20 (Prabhu et al. 2022). At the same time, common redshank (16.71%, 64 individuals) and curlew sandpiper (2.79%, 16 individuals) were returned in large numbers at TSC. In contrast, in 2020–21, waders had low return rates at BPS, for example, common redshank (1.24%, six individuals) and less than two individuals (0.12 to 0.62%) each for common sandpiper, lesser sandplover, Terek sandpiper and little stint. On the other hand, BPS mangrove had a return rate of 5.03% (23 individuals) for common redshank.

We found that birds ringed during 2014–15 at NRI and Panje wetlands were recaptured and resighted at BPS saltpans, Panje, TSC and DPS wetlands and Thane Creek after 3 to 5 years. For instance, common redshank ringed at NRI wetland in 2014–15 was resighted in Thane Creek during 2020–21. Similarly, a curlew sandpiper marked at Panje wetland in 2014–15 had observed at TSC in 2019–20.

8.4 Bird movement

Waders utilized the network of feeding and roosting sites (Fig. 8.6). The network diagram showed that BPS saltpans, TSC and Panje had maximum wader movements. Generally, the movements were mainly confined between the nearest roosting and feeding sites, for example, waders from mudflats of Vashi were seen at TSC and NRI, and those from Airoli and Ghansoli mudflats were found at BPS saltpans and BPS mangrove. These movements were primarily represented by common redshank, curlew sandpiper, lesser sandplover, and marsh sandpiper (Figs 4–7 in Prabhu et al. 2022).

The movements of common redshanks' were mainly confined to BPS saltpans and TSC and adjoining feeding sites, and the lesser degree to BPS mangrove, NRI and DPS wetlands (Fig. 8.6). Curlew sandpipers linked with comparatively more roosting sites, however, considerable movements were between BPS saltpans, BPS mangrove, TSC, NRI and Panje (Fig. 5). Lesser sandplover, unlike other species, in addition to the local movements, was also recorded at distant sites (Fig. 8.6). For instance, individuals ringed at BPS and Mankhurd saltpans were found at Bhuigaon beach (32 km from the trapping site), Akshi beach (50 km), Kalbadevi wetland, Ratnagiri (238 km) and Mulki, Mangalore (697 km); and an individual marked in Panje resighted in Kerala (*c*. 950 km). Marsh Sandpipers had a weak network as most recaptures or re-sightings were at roosting sites (Fig. 8.7).

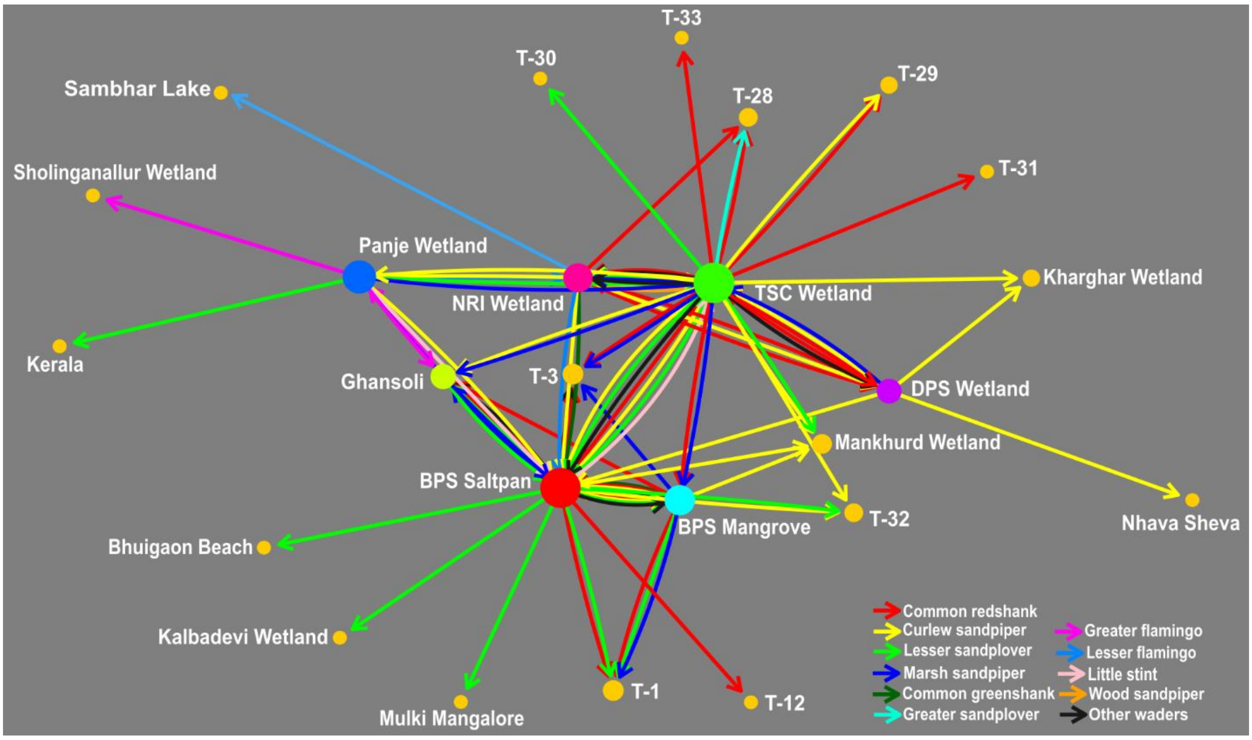


Fig. 8.6. Network graph of shorebird movements between capture and recapture/re-sightings sites. Circles are nodes (sites), and arrows are edges. The circle size represents the number of movements, and arrows show the direction of movements. T=transect, e.g., T-3 is a transect no. 3 in the Thane Creek.

A greater flamingo that we marked at Panje wetland had seen at Sholinganallur wetland (*c.* 1000 km southeast of Panje), Tamil Nadu and a lesser flamingo ringed at NRI wetland resighted at Sambhar Lake (*c.* 900 km north of TSC). Similarly, a greater flamingo marked in Gujarat was resighted at NRI. Two little stints ringed in BPS saltpans were found at Kolshet (9 km), Vasai Creek. Similarly, two dunlin individuals marked at Mankhurd saltpan were spotted in Akshi Beach (50 km). An individual of curlew sandpiper ringed at Panje was resighted at Alibaug Beach (30 km). An individual of common redshank marked at Mankhurd saltpan was observed in Gujjarbettu Beach, Karnataka (660 km south). A broad-billed sandpiper from BPS saltpans was observed at Akshi Beach. Overall, shorebirds travelled mean and median distances of 11.96 and 22.42 km, respectively, with minimum distances of 820 m and a maximum of 1000 km, but there were substantial species-specific variations in the movements (Prabhu et al., 2022).

8.5 Satellite telemetry

Five of six tagged flamingos at Thane Creek (feeding or wintering ground) went to Gujarat (breeding ground), but only two returned to the creek (Fig. 8.7). The northward migration. i.e., migration towards the breeding ground, commenced between 29 June to 1 August 2022 (n=5), whereas during southward migration, i.e., migration towards feeding grounds, two individuals arrived in Thane Creek on 17 December 2022 (Salim) and 31 January 2023 (McCann). Humayun (adult lesser flamingo) and Lester (sub-adult greater flamingo) were still in Gujarat. Khengarji, an adult greater flamingo, stopped sending the data from 6 August 2022 after reaching the breeding ground in Little Rann of Kachchh, Gujarat. Similarly, we did not receive data from Navi Mumbai, a juvenile lesser flamingo, since 14 July 2022, which never left Thane Creek.

Bala, a black-tailed godwit fitted with a GPS radio transmitter at BPS, Thane Creek, went to its breeding grounds in southwest Siberia, Russia and returned to the creek covering a distance of 9665 km between April 23 to July 21, 2022 (Bajaru et al. 2023).

There was noticeable spatial segregation in the movement pattern of the lesser and greater flamingo (Fig. 8.8–8.13). For example, greater flamingos' movements were mainly confined north of the Vashi bridge (Fig. 8.11–

8.13). Similarly, black-tailed godwit's movements are restricted north of the Vashi bridge (Fig. 6.14). In contrast, lesser flamingos (Humayun and Navi Mumbai; Fig. 8.9 and 8.10) seem to prefer the south-eastern part of the creek (lies south of Vashi bridge), except Salim (Fig. 8.8), whose movement overlapped with that of greater flamingos north of Vashi bridge and Sewri Mudflat.

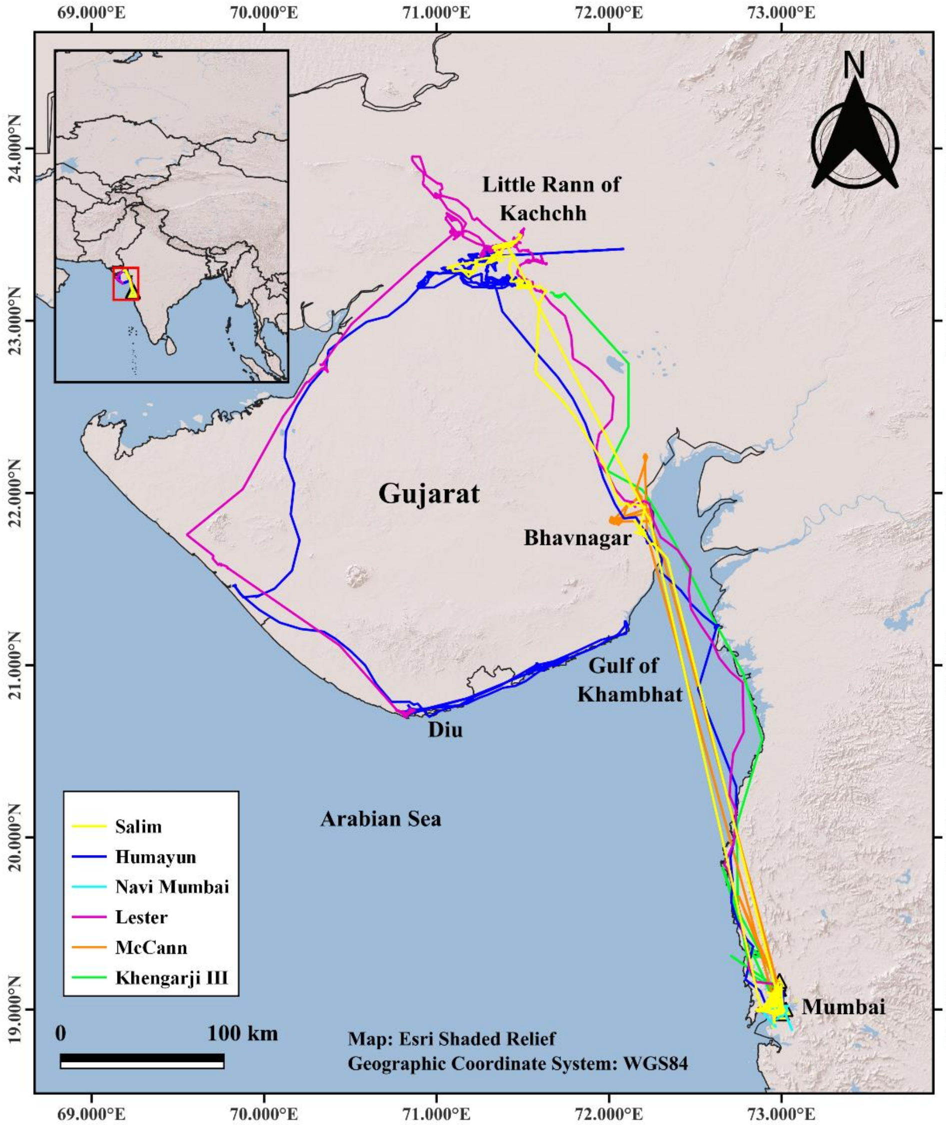


Fig.8.7. The migration tracks of the flamingos tagged in Thane Creek, India.

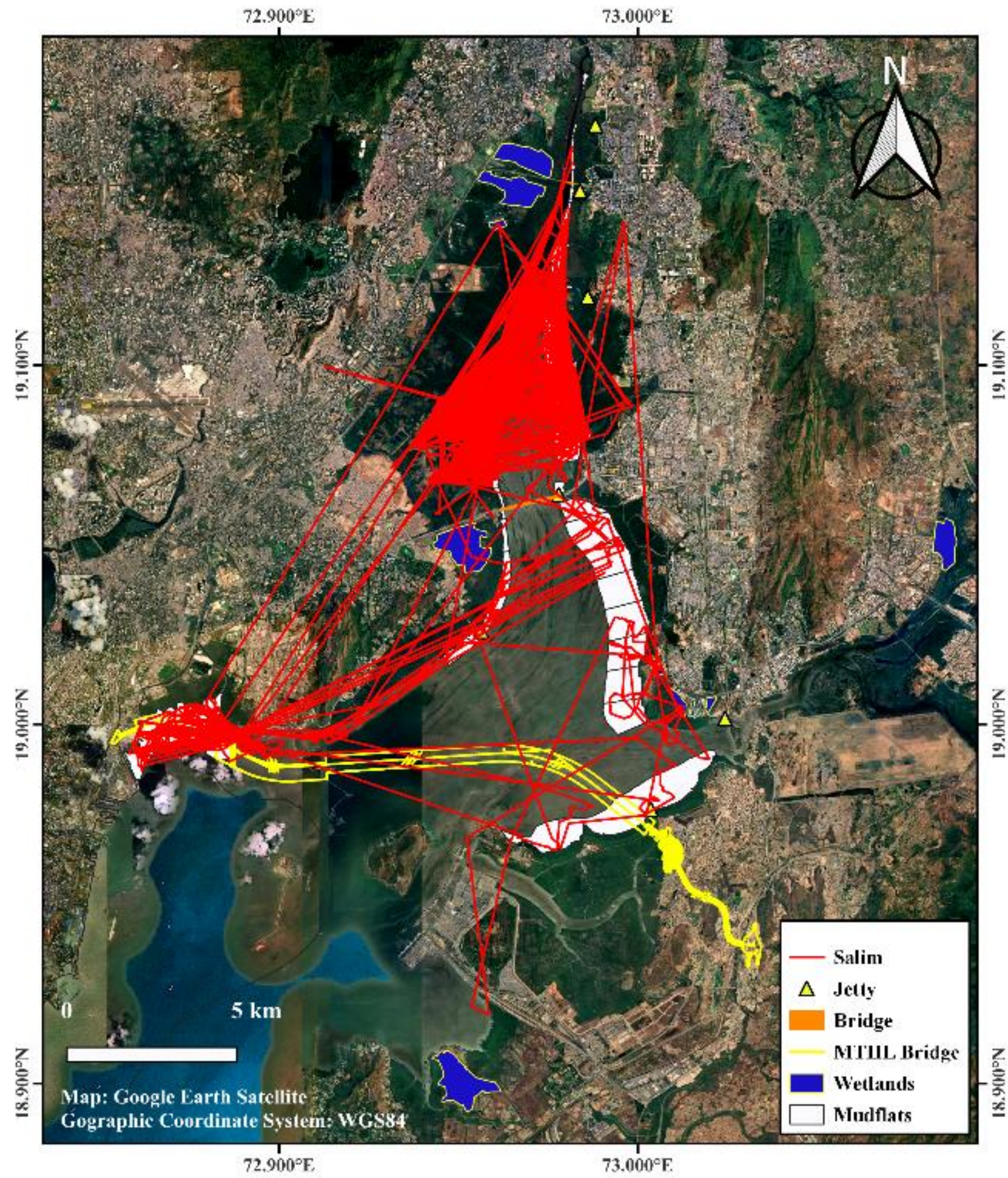


Fig. 8.8. Movement tracks of Salim, an adult lesser flamingo in Thane Creek.

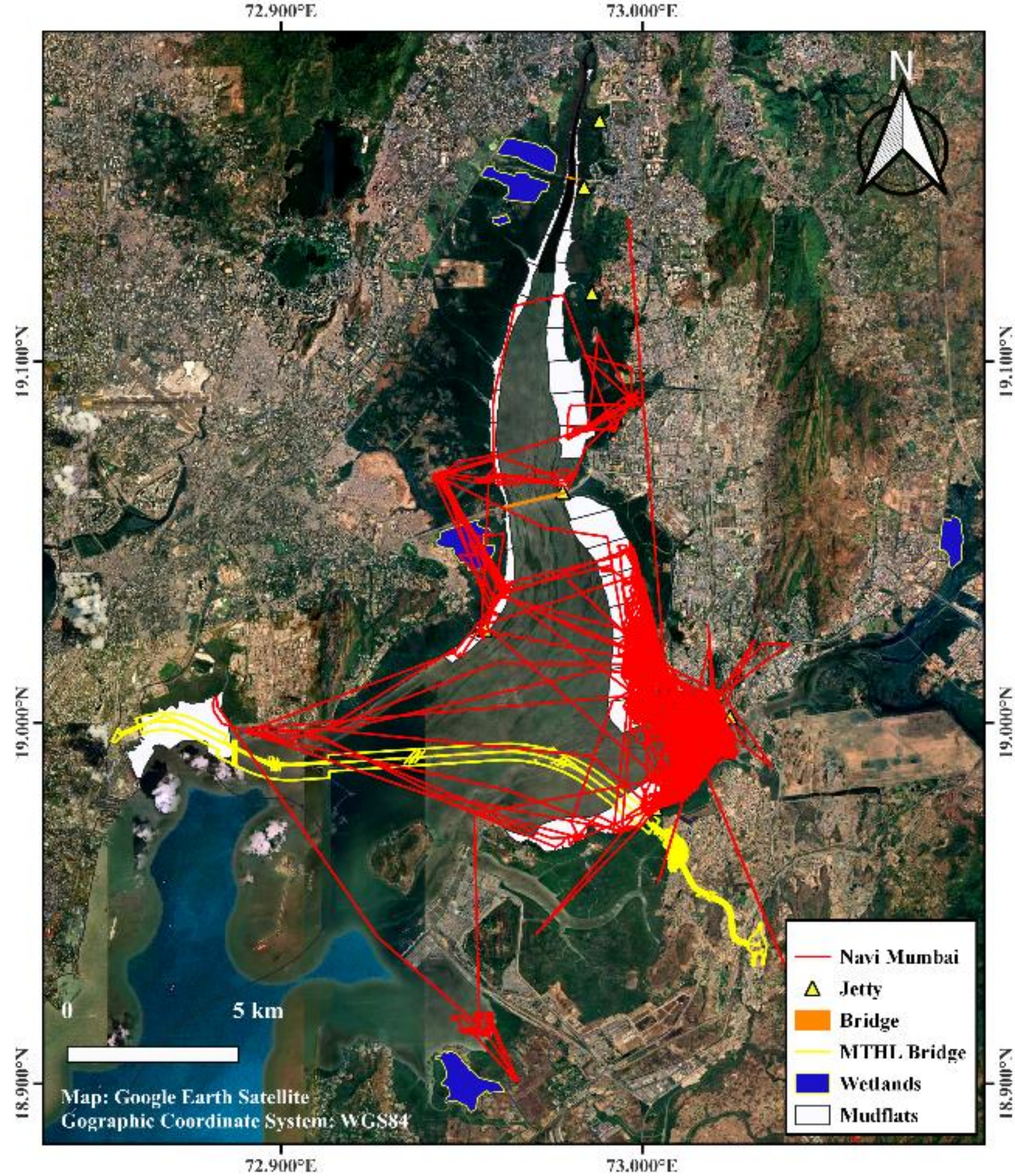


Fig. 8.9. Movement tracks of Navi Mumbai, a juvenile lesser flamingo in Thane Creek.

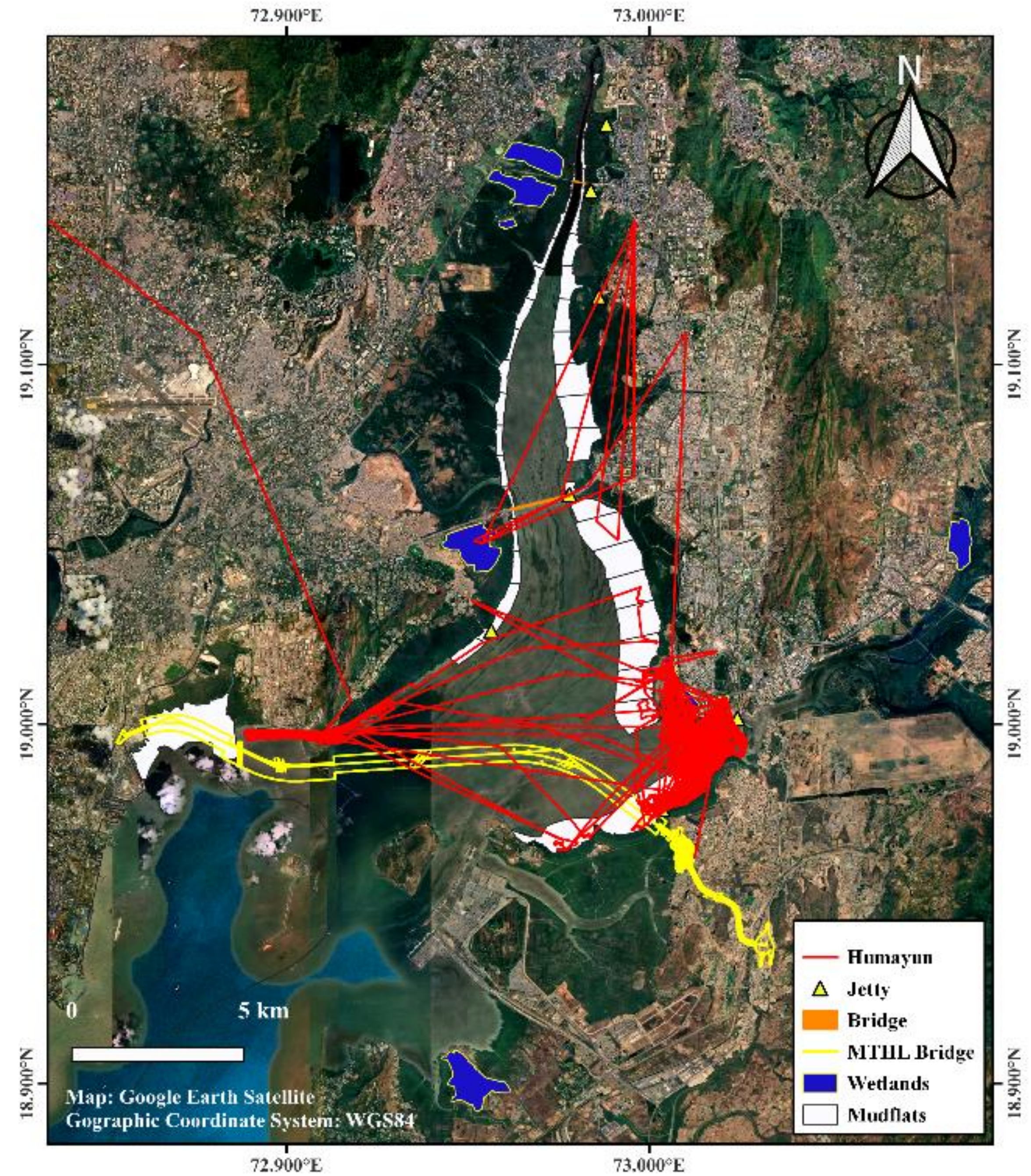


Fig. 8.10. Movement tracks of Humayun, an adult lesser flamingo in Thane Creek.

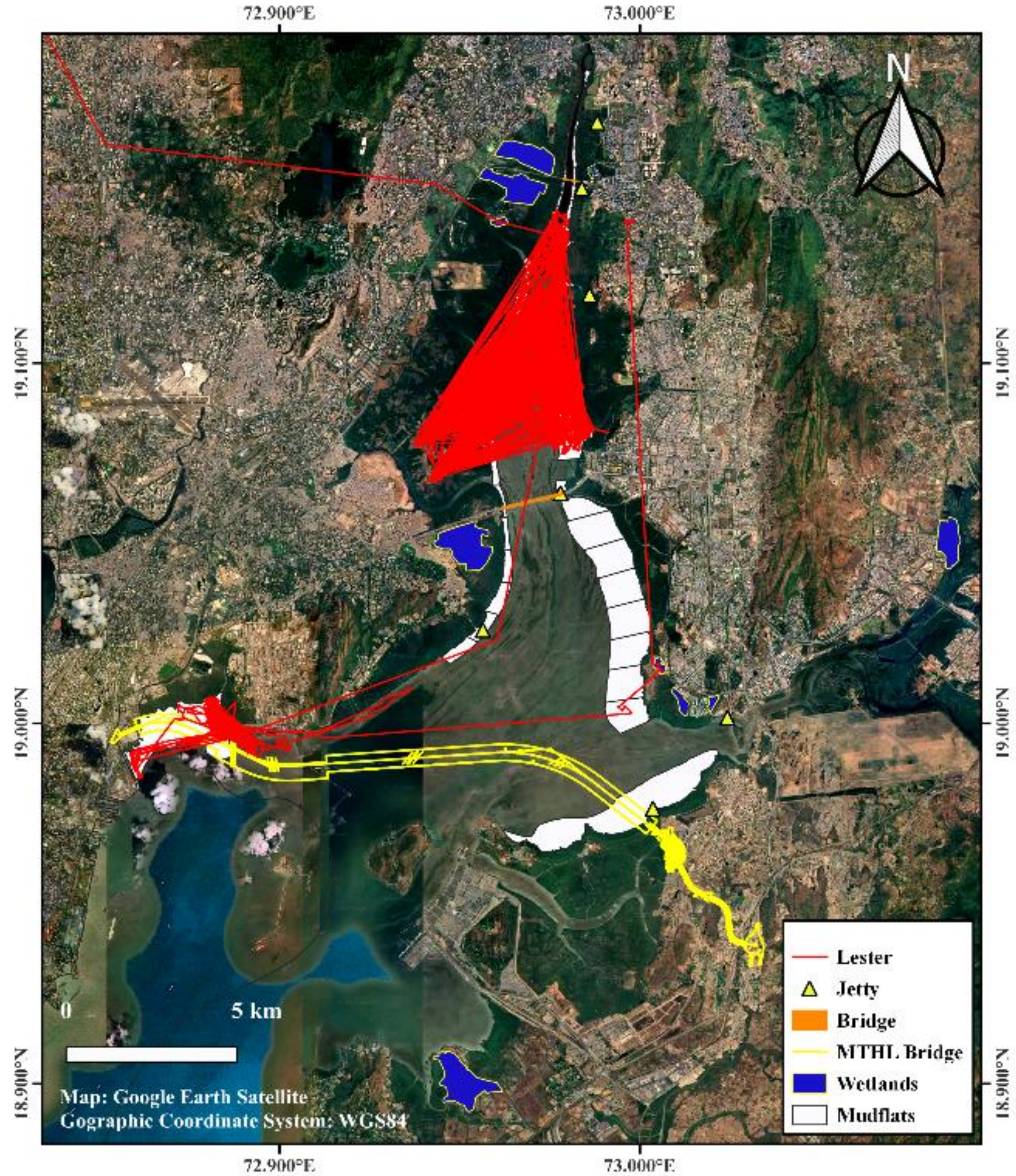


Fig. 8.11. Movement tracks of Lester, a sub- adult greater lesser flamingo in Thane Creek.

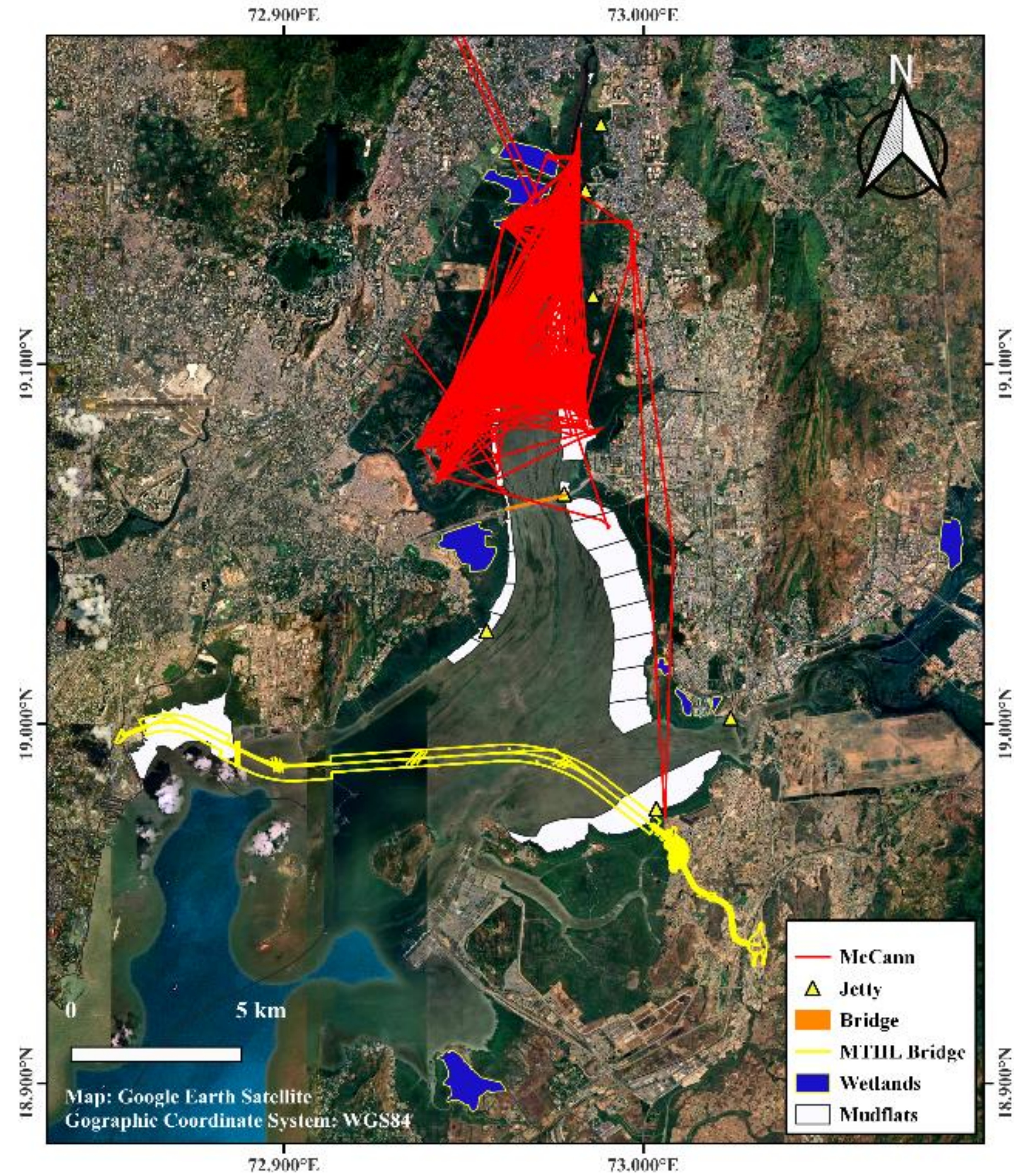


Fig. 8.12. Movement tracks of McCann, a juvenile greater flamingo in Thane Creek

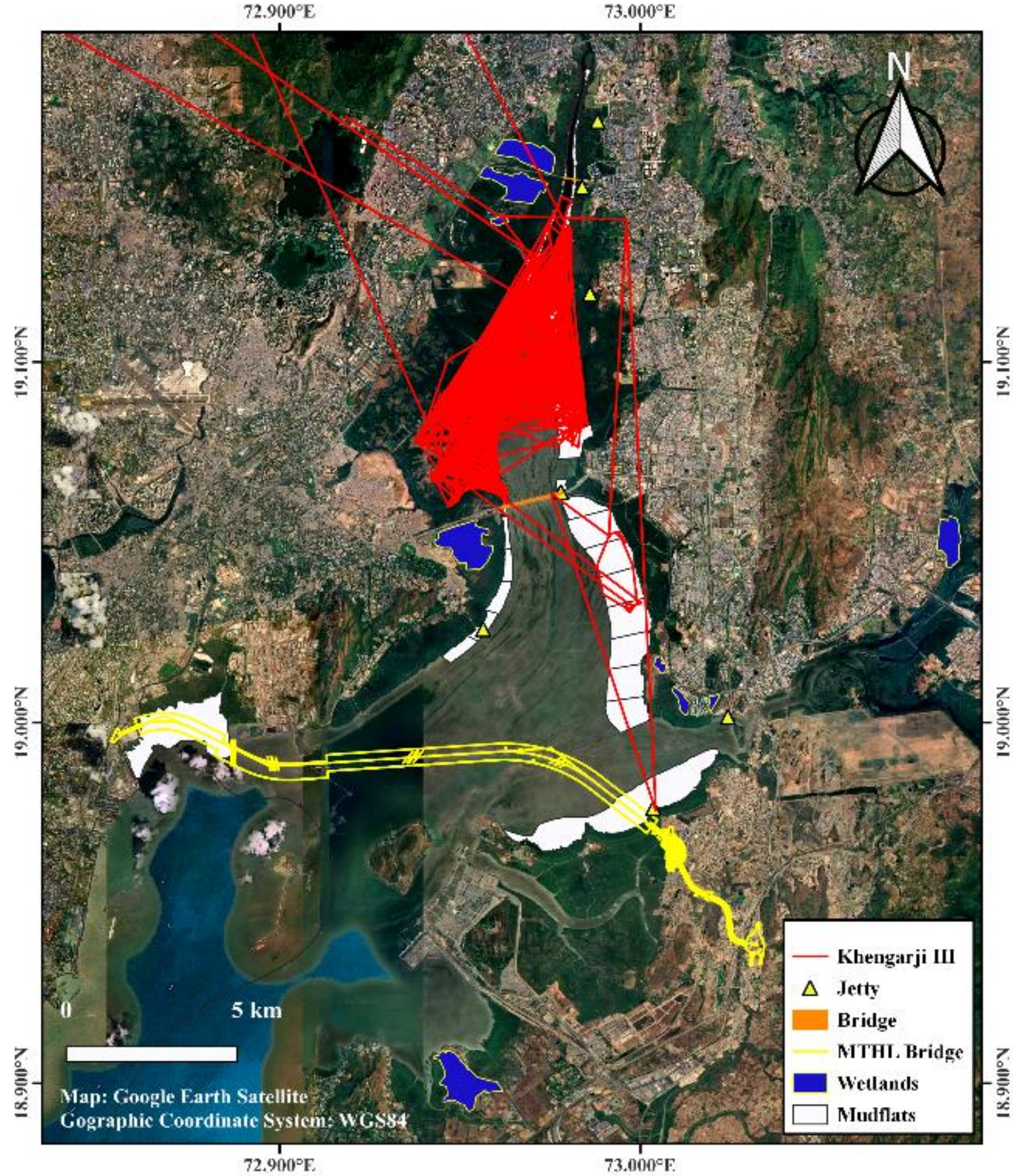


Fig.8.13. Movement tracks of Khengarji, an adult greater flamingo in Thane Creek.

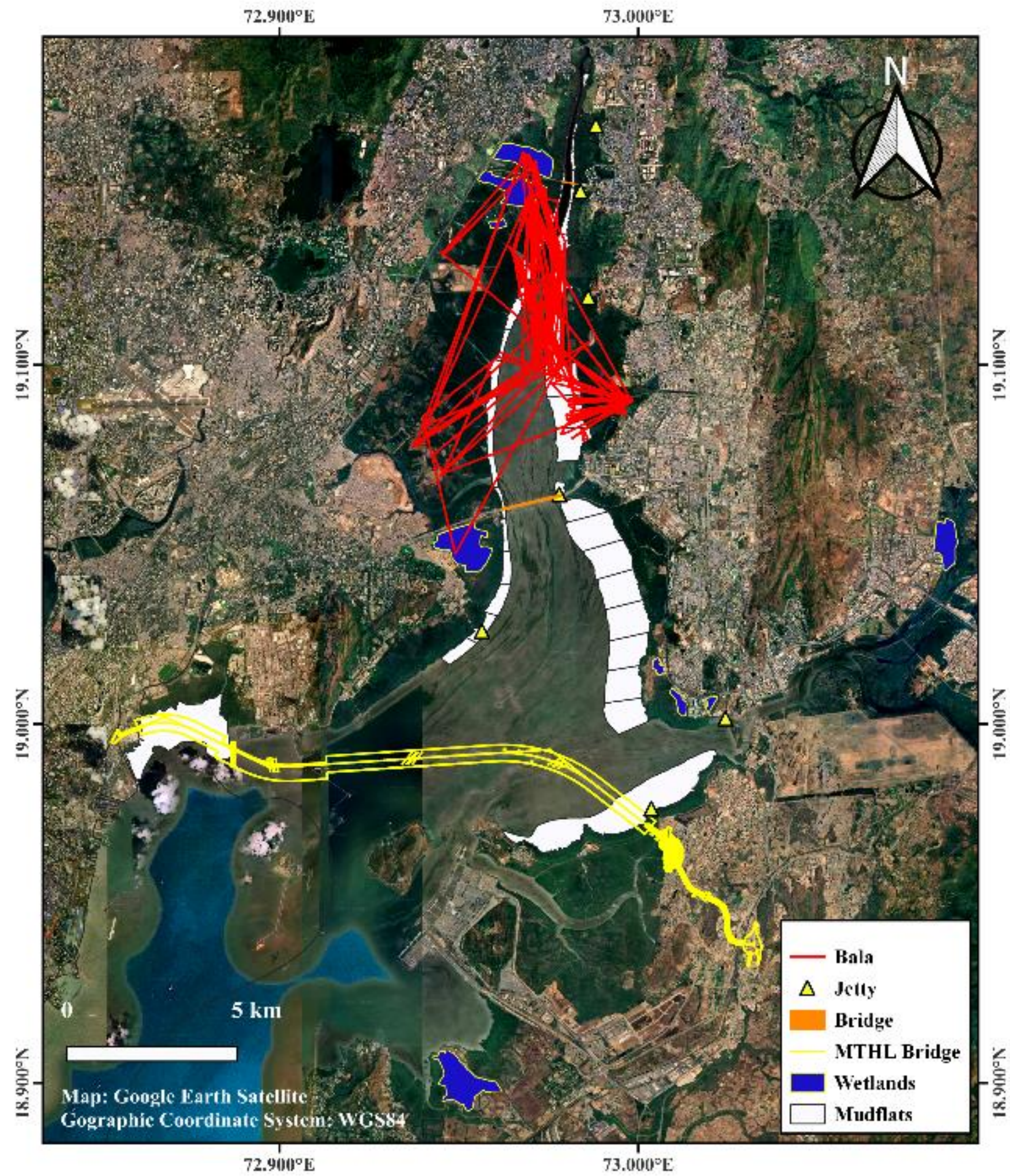


Fig. 8.14. Movement tracks of Bala, a black-tailed godwit in Thane Creek.

8.6 Habitat use

Both the species showed a substantial preference for sea or creek (55.46–63.90% of total GPS locations, n=50074) and wetland (12.72–38.06%, n=50074) habitats (Fig. 8.15). They were relatively more frequent in degraded mangroves and Mudflats than in young or thick mangroves, as well as in salt pans. Interestingly, juvenile greater flamingos spent more time in degraded mangroves than adults. Lesser flamingos appeared comparatively more tolerant towards urban or built-up habitats such as salt pans than greater flamingos. Godwit preferred sea or creek and wetlands, followed by degraded mangroves mudflats and other habitats (Fig. 8.16).

8.7 Distance from existing jetties and bridges

The range of mean distance of greater flamingo from the nearest jetty (2777–3520m) was higher than that of lesser flamingo (1161– 2851m; Fig 8.17). In both the species, juveniles (1161m - lesser flamingo (n=17773); 2777m - greater flamingo (n=2876)) approached more closely to the jetty than the adults (2851m - lesser flamingo (n=16713); 2947m - greater flamingo (n=4234)). The histogram also revealed that juveniles moved relatively closer to the jetty than adults — there were multiple peaks of GPS locations, usually more than 500m away from the jetty.

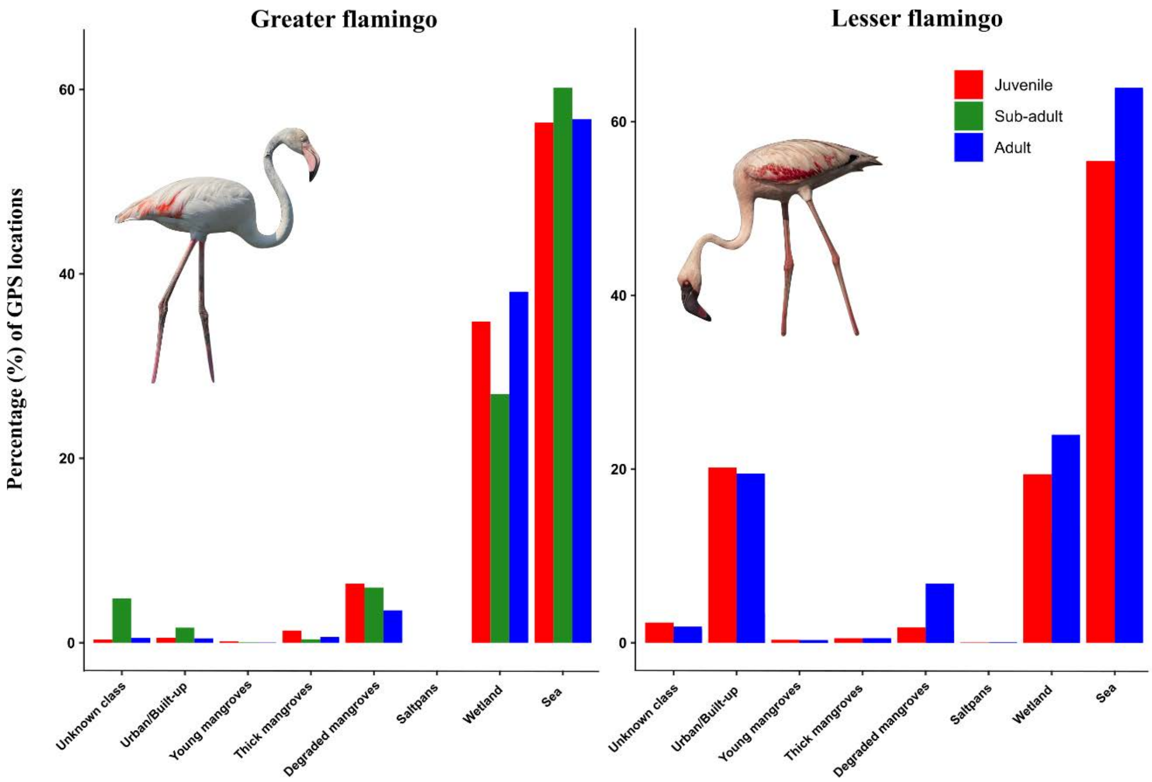


Fig. 8.15. Percentage of GPS locations of flamingos in each habitat obtained from satellite telemetry.

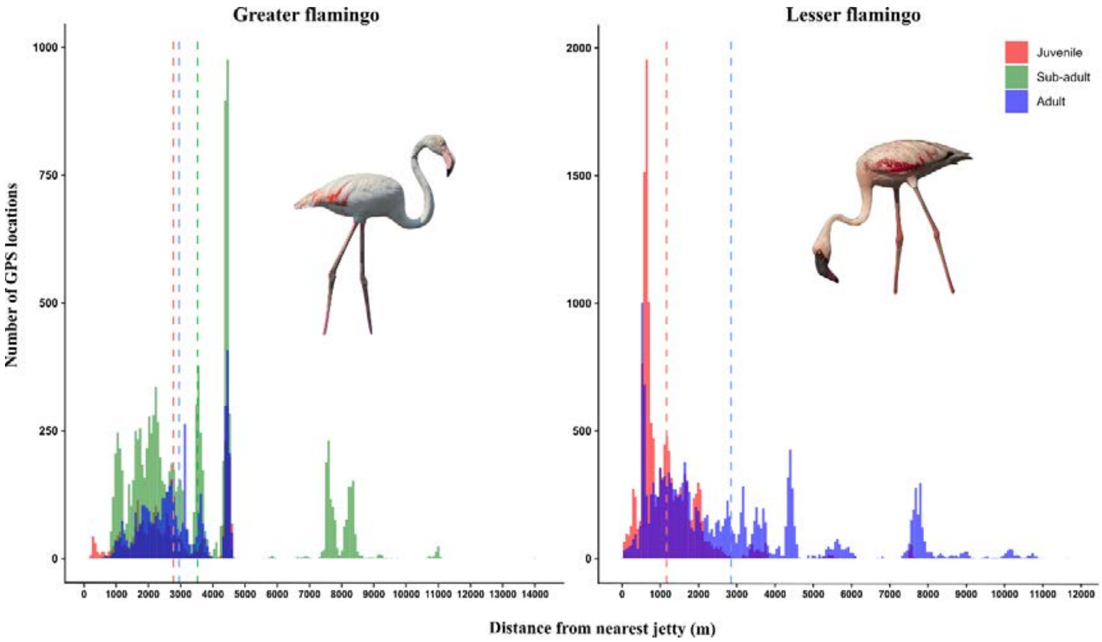


Fig. 8.16. Percentage of GPS locations of black-tailed godwit in each habitat obtained from satellite telemetry.

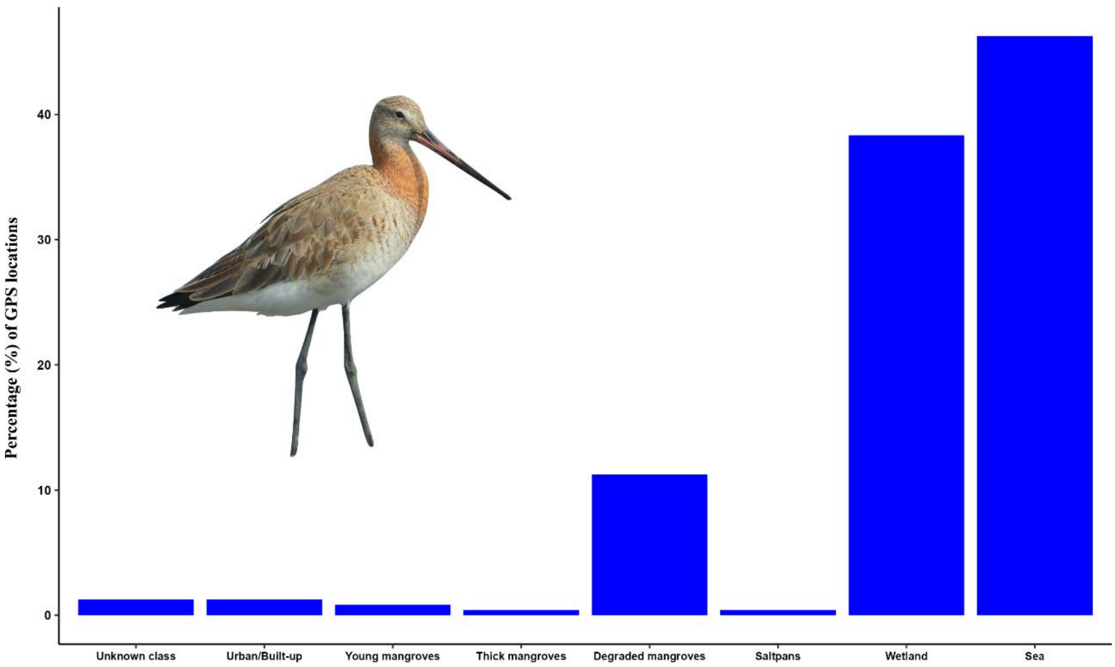


Fig. 8.17. Histogram of the distance of GPS locations of tagged flamingos from the nearest jetty. Broken vertical lines are means.

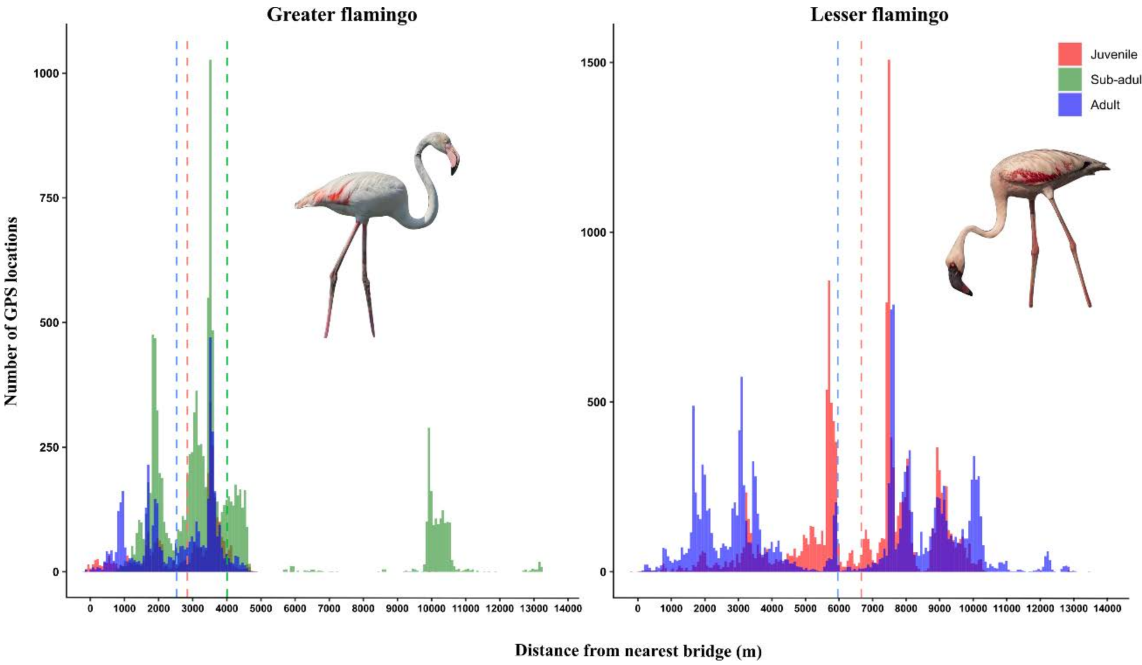


Fig. 8.18. Histogram of the distance of GPS locations of tagged flamingos from the nearest bridge. Broken vertical lines are means.

In contrast, greater flamingos (2720–4196m) moved closer to the bridge than lesser flamingos (6158–6857m; Fig. 8.18). Similarly, juveniles (6857m - lesser flamingo; 3036m - greater flamingo) appeared to stay further away from the bridge than the adults (6158m - lesser flamingo; 2720m greater flamingo). The histogram showed multiple peaks of GPS locations around or more than 1000m away from the bridge.

8.8 Flight altitude

The mean flight altitude of the adult greater flamingo (40m, n=908) was higher than juveniles (16.69, n=62; Fig. 8.19). In contrast, juvenile lesser flamingos flew higher (24m, n=10975) while adults made low-altitude flights (10m, n=12618). The histogram also revealed that most of the observations lie below 25m. For instance, less than 6 meters in altitude accounted for 75% of the observations and below 17 m constitutes 90% of records. Godwit had a mean flight altitude of 4.40m (n=240), with 75% observations below 5m and 90% less than 13m.

The Thane Creek and surrounding areas host huge congregations of flamingos in the winter months. The number of lesser flamingos has been recorded to exceed 1.3 lakhs in 2020. There is also a resident flock of flamingos numbering a few thousand that are found throughout the year. The flamingos arrive in flocks of a few hundred birds during the months of October to December, and leave in flocks of similar sizes in May and June every year. The flight altitudes of these flocks during migration are much higher than their normal day to day behaviour after they arrive. Also, if there is disturbance at their High Tide roosting sites, the flamingos will circle around their roosting sites at higher altitudes until the disturbance is abated.

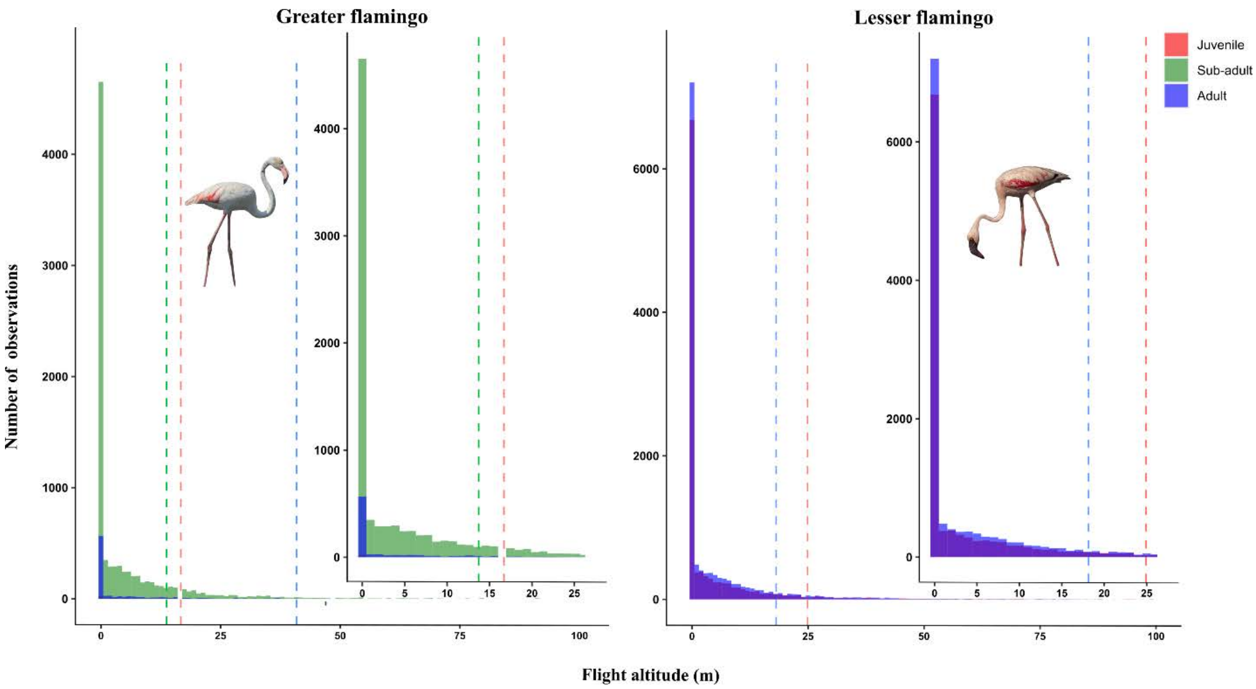


Fig. 8.19. Histogram of the flight altitude of tagged flamingos. Inside figures are zoomed portions of the outer figures. Broken vertical lines are means.

8.9 Discussion

The species richness and diversity patterns based on the ringing study differed slightly from those observed using count data (Please refer to the discussion section of Chapters 4 to 7 for details). For instance, richness and diversity peaked during autumn and spring and were relatively low during winter, whereas based on count data, richness and diversity were also topped during winter. These contrasting results are perhaps an outcome of the different sampling methods. For example, while netting, not all species of wintering shorebirds were captured as they have differential capture probabilities, and besides, we also focused on trapping the small- to medium-sized waders. Hence, diversity and richness estimates based on ringing represented small- to medium-sized waders.

We anticipated the high diversity and richness during autumn and spring as these were the autumn and spring migration periods, respectively, and hence have high species turnover rates. Thane Creek is one of the critical stagging, stopover and wintering sites in the Central Asian Flyway (CAF, Prabhu et al., 2022), thus, many migratory species populations stay briefly here during autumn and spring. The decline in diversity and richness of migratory shorebirds in TSC is a concern, as similar results were produced by richness and diversity analysis using wetland abundance data (Please refer to the discussion section of Chapters 4 to 7 for details). Ongoing human disturbances such as wetland filling might be one of the reasons for the shorebird decline in TSC.

The shorebird return and recapture or resighting rates suggested strong site fidelity and highlighted the importance of Thane Creek and adjoining wetlands. Movement patterns based on recapture and resighting revealed connectivity between Thane Creek, nearby wetlands, and distant sites in India and abroad which further strengthened the significance of the creek and the wetlands in the conservation of the shorebirds in CAF. We found that the birds preferred wetlands closest to the creek, and all the wetlands we were monitoring were located 4–5 km from their feeding areas in the creek and had large congregations of shorebirds (Prabhu et al., 2022). This could be because shorebirds would spend less energy or generate little heat in hot months (Roger *et al*. 2007) and reduce predation risk while moving between feeding to roosting areas if they were close.

The satellite telemetry data analysis sheds light on the migration of the flamingos of Thane Creek, which was a mystery for several decades. Our study established a link between breeding grounds of greater and lesser flamingos in Gujarat and feeding or wintering grounds in Thane Creek, Maharashtra. This data further reinforced the northward migration of the flamingos to their breeding grounds in Gujarat during monsoon, June to August, and arrival during winter, December to February, in Thane Creek. The four flamingos, two lesser and two greater, went to the Little Rann of Kachchh, which was not surprising as it is a well-known breeding site for the flamingos. Interestingly, a juvenile greater flamingo (McCann) flew to Bhavnagar and returned that indicating juveniles may not visit breeding grounds and use non-breeding sites until winter.

The flamingos revealed species- and age-specific local spatial movement patterns, which could result from food availability, habitat selection, tolerance to human disturbances and life history traits of the species. For example, the greater flamingos are usually confined to the creek north of the Vashi bridge. We have seen that the greater flamingos are relatively sensitive towards human disturbances, and north of the Vashi bridge large part of the creek is under the flamingo sanctuary, therefore, relatively less disturbed, which could be one of the reasons for greater flamingo prefers it. Their low tolerance to human disturbances can also be inferred from comparatively less utilization of habitats near or including urban and built-up areas. Lesser flamingos, especially juveniles of both species, appeared rather more tolerant to urban and built-up areas. It is common for adult individuals to occupy the best quality habitat that pushes juveniles into suboptimal habitats. Flamingos and godwit showed the least preference for thick and young mangroves, which we anticipated as these species feed on open mudflats with good visibility and such areas are rare in dense and young mangroves patches.

The greater flamingos stayed away from the jetty, but they approached relatively close to the bridge, in contrast, lesser flamingos showed a reverse pattern. It was not unexpected as disturbances are relatively proximate at jetties such as boats and humans than of bridges, and thus sensitive species like greater flamingos affect more. Though flamingos approached jetties or bridges, their occurrences peaked 500 to 1000 m away from these structures, indicating they avoided the proximity to jetties or bridges. Flight altitude data showed low height preference of the flamingos (75% of observations were less than 6m and 90% were less than 17m), that indicate the construction of bridges put the species under stress to take high flights, leading to energy loss and could affect the species survival.

In conclusion, ringing, movement and telemetry data showed the significance of Thane Creek and adjoining wetlands as a critical site to conserve migratory shorebirds in CAF. Habitat utilization analysis revealed that creek, sea, wetlands, saltpans, mudflats and degraded mangroves were crucial habitats for shorebirds, and human disturbances in these habitats would affect their survival. Increasing jetties and bridges in the creek would put the shorebirds under stress and cause them to lose excessive energy in flight, ultimately reducing their survival.

Chapter 9-Estimating the Severity of a Bird Strike in Aircraft

Collisions between bird and aircraft cause substantial losses to the aviation industry in terms of damage and delay every year (Allan 2000). Bird strikes are a frequent event and depending on the country, average bird strike rates between 2.83 and 8.19 per 10,000 aircraft movements were reported in civil aviation for the past years (Metz *et al*. 2020). According to reports bird strikes cause annual economic cost of $1.2 billion to commercial aircraft worldwide (Ning *et al*. 2015).

'Bird strikes are defined as a collision between a bird and an aircraft which is in flight or on a take-off or landing roll' (Metz *et al*. 2020). Bird strikes have become a major problem to aviation safety in the past few decades due to development of civil aviation and growth of bird populations (Ning *et al*. 2015). Depending on the location, bird-strike occurs either on the airdrome environment or enroute (Walker *et al*. 1985).

According to Metz *et al*. 2020, several parameters that determine the bird strike include altitude, time of day, environmental conditions, geographical location, season and the aircraft itself. Low altitudes have the highest probability of bird aircraft collisions although the damage caused increases with increasing altitudes. Due to increased bird activity in the night, especially of the migratory birds most of the bird strikes occur during the night time. Airports environment also strongly influences the risk of bird strikes; attractants such as source of food, water should be eliminated, as it greatly influences risk of bird strikes. Another determining factor is the aircraft characteristic, due to their large size and high suction effect; turbofan engines are more likely to ingest birds than other engine types.

Noise emissions from aircraft also have a detrimental effect, the quieter the aircraft the higher the risk that the birds cannot avoid those. Apart from this chance of a bird strike is 5 times higher during migratory season (Sodhi 2002).

Bird strikes need to be accessed using standardised, scientific process to improve flight safety and reduce economic losses (Hu *et al.* 2020). Multiple bird risk factors affect the aircraft safety and various research results have shown different sets of risk factors system (Qiao *et al*, 2019). A flow chart for bird strike risk assessment was constructed, based on the ISO 31000 risk management process (Hu *et al*., 2020).

Bird management can be divided into long term and short-term actions, each airport has its own specific bird hazard problems and hence a single management plan applied to all airports is not possible (Sodhi 2002). Conventionally bird control comprises of two main elements habitat management and active bird deterrence (Allan 2000). A sound ornithological understanding is needed for long term management solutions of this problem, as birds provide the inspiration to build aircrafts a detailed understanding of their biology is needed to reduce bird-aircraft collisions (Sodhi 2002)

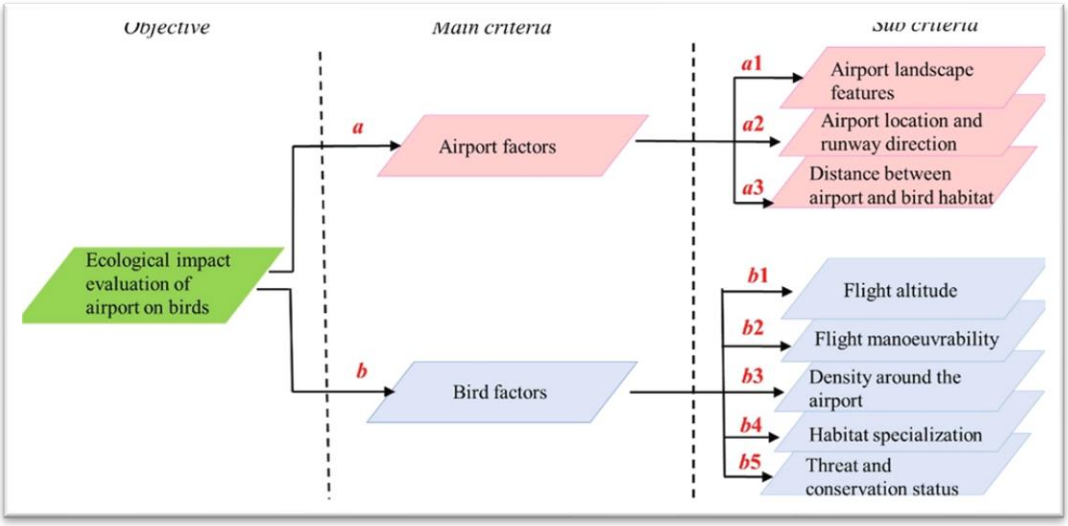


Figure 9.1: Flow chart of catagorization of criteria and their overlaying (Zhao et al. 2019)

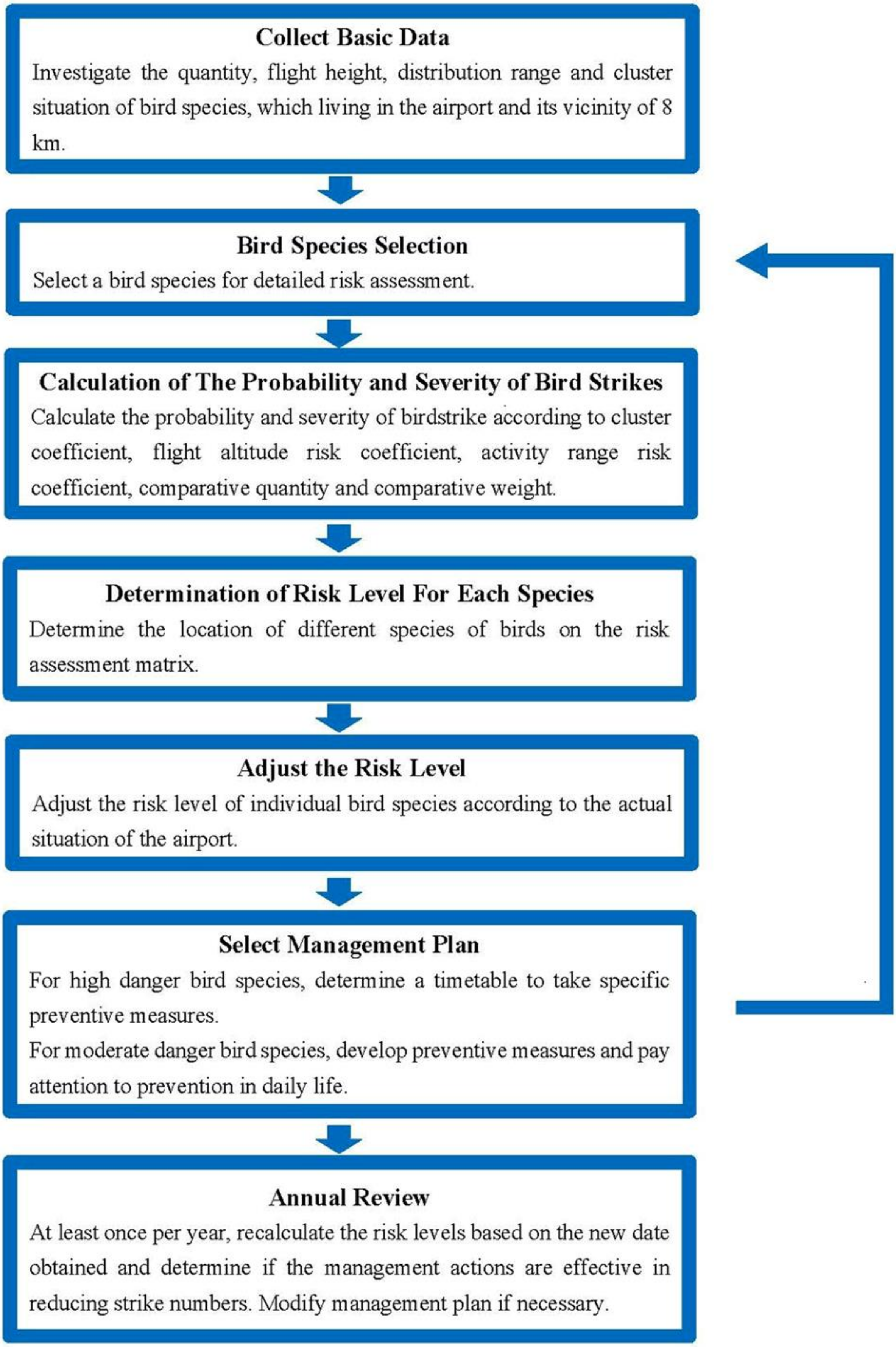


Figure 9.2 Flow chart of the airport bird strike risk assessment process (Hu et al. 2020)

Urban settlements are increasing rapidly and it is estimated that 66% of the world's population will reside in urban areas by 2050 (Kandpal et al. 2018). Urbanisation is the concentration of population cause by the transformation of land with near-natural habitats or agricultural areas, to land that is used for non-agricultural production, housing, or trading, these changes reduce the number of bird species (Meffert et al. 2013). The presence of biodiversity is important for human residents and this relationship between human and wildlife has advantages and disadvantages for both parties (Taylor et al. 2012).

The state of Maharashtra has the biggest urban population in India and approximately 45% of that urban population resides in the Mumbai Metropolitan Region (MMR) (Kandpal et al. 2018). The Navi Mumbai region has diverse habitat types such as mangroves, mudflats, saltpans, creek, grasslands, and agricultural fields and is home to various bird species, including several migrant species that visit the area. As the Chhatrapati Shivaji Maharaj International Airport has reached its saturation there is a need for the construction of a second international airport to ensure effective air travel. The construction of the Navi Mumbai International Airport is causing rapid urbanisation and generating tremendous pressure upon the already declining natural habitats, especially on the mangroves, saltpans, mudflats, wetlands and remnant patches of the natural forests which would eventually impact the biodiversity (Nagendra et al., 2012).

9.1 Factors Contributing to Bird-Aircraft Collisions:

Bird strikes are influenced by various factors, including bird species, aircraft speed, altitude, and environmental conditions. Urbanization exacerbates these risks as it brings birds into close proximity to airports, creating potential conflict zones.

Urbanization, characterized by rapid population growth and infrastructure development, has profound consequences on biodiversity and ecosystems. This explores the effects of urbanization on bird populations in Mumbai and Navi Mumbai, focusing on the potential hazards posed by bird-aircraft collisions in these urban environments. Urbanization in Mumbai Metropolitan Region in past few decades led to alterations in the natural landscape, resulting in habitat fragmentation. As green spaces shrink and concrete expanses expand, the avian inhabitants face multiple challenges.

1. **Habitat Fragmentation and Loss**:

Urbanization often leads to the fragmentation and loss of natural habitats for birds. This disrupts breeding and nesting patterns, forcing birds to adapt to new environments or migrate, putting additional stress on their populations (Smith et al. 2019).

2. Pollution and Climate Change:

Urban areas are notorious for high levels of pollution, including air and noise pollution. Birds are highly sensitive to these environmental changes, and exposure can lead to respiratory issues and altered reproductive behaviors. Additionally, the urban heat island effect exacerbates climate change impacts, affecting bird migration patterns and food availability success (Gupta et al. 2018).

3. Altered Food Sources:

Urbanization results in changes to the availability and distribution of food sources for birds. Natural habitats are replaced by built structures, leading to the decline of insect populations and altering the foraging behavior of birds. This can have cascading effects on the entire ecosystem (Gupta et al. 2018).

4. Light and Noise Pollution:

Urban environments are characterized by excessive artificial lighting and noise, which can disrupt avian behavior. Birds rely on natural light cues for navigation, and excessive artificial lighting can lead to disorientation, affecting their migratory patterns and daily activities. Noise pollution can interfere with bird communication, breeding, and feeding behaviors (Smith et al. 2019).

The Navi Mumbai region has diverse habitat types such as mangroves, mudflats, saltpans, creek, grasslands, and agricultural fields and is home to various bird species, including several migrant species that visit the area. As the Chhatrapati Shivaji Maharaj International Airport has reached its saturation, there is a need for the construction of a second international airport to ensure availability of airport capacity for the population of MMR. The urbanization in MMR is generating tremendous pressure upon the already declining natural habitats, especially on the mangroves, mudflats, saltpans, other wetlands and remnant patches of the natural forests which would eventually impact the biodiversity (Nagendra et al. 2012).The current phase of assessment involves grid sampling of habitat and fixed-radius point count surveys to study the habitat wise bird abundance and richness within 10 KM of NMIA site. Wetland and Creek Total Count surveys within the study area is also conducted to note the water birds and their abundance. To get an overall idea regarding the modification of birds and their habitation in and around NMIA site during its construction and operational phase, we will investigate the spatial and temporal (within and between year) patterns in the population and community dynamics of the bird species and the habitat covariates that are affecting the

Table 9.1 Common bird species and their collision characteristics

Bird Species	Urbanization Effects	Collision Characteristics
Common Sparrow	Nesting site loss, reduced green spaces	Low risk, primarily affected by urbanization
Indian Cormorant	Habitat alteration, pollution	Limited risk, potential for collisions near water bodies
Asian Koel	Noise disruption during breeding	Low risk, behavioral changes due to noise pollution
Black Kite	Collisions with structures	Moderate risk during navigation through urban landscapes
House Crow	Adaptation to urban environment	Low risk, may contribute to competition for resources
Raptors (e.g., Eagles)	Scavenging near airports, soaring flight	High risk during takeoff and landing phases
Waterfowl	Vulnerable during migration	High risk due to large size and flocking behavior
Gulls and Terns	Coastal attraction, proximity to runways	High risk, especially in coastal airports
Migratory Songbirds	Seasonal and altitude-specific risk	Variable risk depending on timing and altitude during migration

9.2 Bird species Involved in Bird-Aircraft Collisions:

1. Black Kites and Eagles:

Behavioral Risks: Large raptors, including Black Kites and Eagles, are at risk during takeoff and landing due to their soaring flight patterns. The risk is heightened when they scavenge near airports. (Brown & Johnson 2021).

2. Waterfowl (Ducks, Geese):

Risk During Migration: Waterfowl, especially during migration, are vulnerable to collisions at various altitudes. Their large size and flocking behavior increase the likelihood of impacting aircraft (Brown & Johnson 2021).

3. Gulls and Terns:

Proximity to Coastal Areas: Coastal airports face challenges with gulls and terns, attracted to coastal habitats. The birds' presence near runways poses a significant risk during critical flight phases (Kumar & Singh 2020).

4. Migratory Songbirds:

Timing and Altitude Factors: Some songbirds, particularly during migration, are at risk during specific times of the year and at various altitudes.

Bird strikes need to be accessed using standardized, scientific process to improve flight safety and reduce economic losses (Hu et al. 2020). Multiple bird risk factors affect the aircraft safety and various research results have shown different sets of risk factors system (Qiao et al. 2019). Bird management can be divided into long term and short-term actions, each airport has its own specific bird hazard problems and hence a single management plan applied to all airports is not possible (Sodhi 2002). A sound ornithological understanding is needed for long term management solutions of this problem. As birds provide the inspiration to build aircrafts, a detailed understanding of their biology is needed to reduce bird-aircraft collisions (Sodhi 2002).

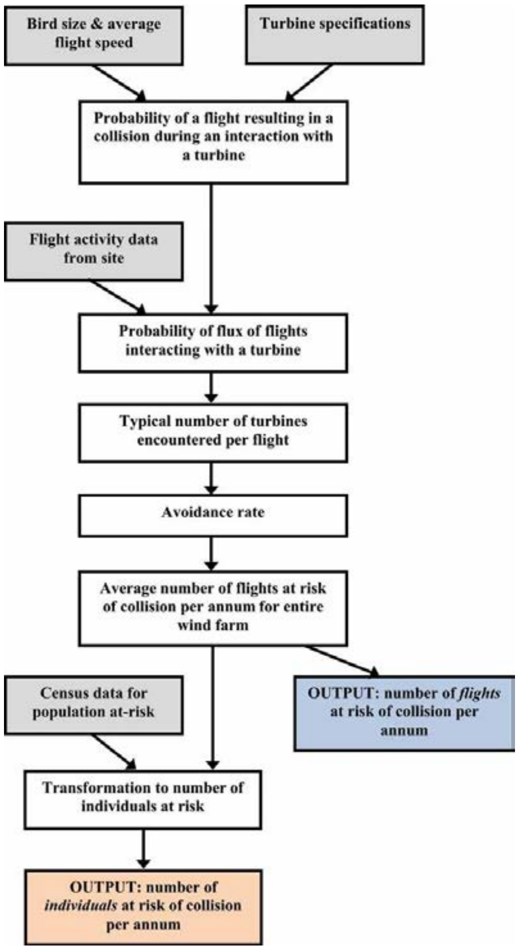


Figure 9.3 Overview of the collision risk model that quantifies risk to birds of colliding with wind turbines by Smales et al. 2013

Methodology

The severity scale will depend on the animal's size and tendency to flock or congregate. The heavier the animal and the flock size, the higher the severity of the strike. Flocking behaviour can multiply the impacts or increase the probability of a strike.

If there are no data regarding the severity caused by a species is available, then the severity can be calculated by the mass multiplied by the type of flock.

Severity of a strike = Body mass value x Flock size value

Flock size	Examples	Flock value
Usually solitary or widely spaced	Big birds of prey, Sparrows	1
Often in loose flocks	Pigeons, Large gulls	2
Often in tight flocks	Starlings	4

Note – Generic data.

Table 9.2. Bird categorization based on body mass

Body mass	Examples	Body Mass value
<50 g	Sparrows	2
51-200 g	Starlings	4
201-1000 g	Pigeons	8
1-5 kg	Large gulls	16
>5 kg	Birds of prey	32

Table 9.3. Bird categorization based on flock size

	Severity category				
	Very high	**High**	**Moderate**	**Low**	**Very low**
Severity value (mass category value x flock category value)	32-128	16	8	4	2

Table 9.1. Shows the severity categorization based on severity value

If the severity value of any bird species lies between the range of 32-128 it will be considered as a species that can cause very high severity when a strike takes place, if the value is 16 it will be a high-severity species, if the value is 8 then it will be moderate severity species, if the value is 4 then it will be low severity causing species, and if the value is low it will be very low severity causing species.

52% of the bird species observed in and around NMIA area constitute very low to low severity category, 22% of moderate and 36% are of high to very high category (fig 9.4)

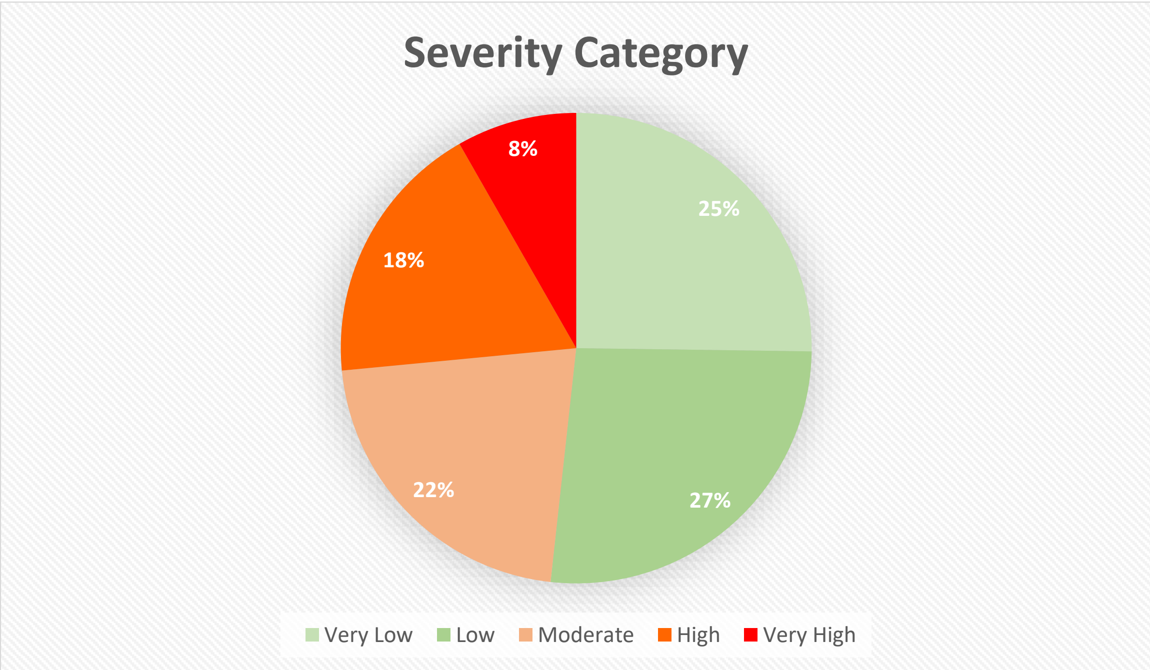


Fig 9.4 Severity Category of all the recorded birds in and around NMIA

Table 9.5 provides details of severity of a bird strike with Aircraft categorization based on severity Body Mass, Flock Size and Severity value in and around NMIA.

Table 9.5: Severity of a bird strike with Aircraft categorization based on severity Body Mass, Flock Size and Severity value

Sl.No.	Family	Scientific Name	Common Name	Body Mass	Body Mass Value	Flock Value	Severity Value	Severity Category
1	Accipitridae	*Tachyspiza badia*	Shikra	131.2	4	1	4	low
2		*Tachyspiza virgata*	Besra	117	4	1	4	low
3		*Spilornis cheela*	Crested Serpent-eagle	597.7	4	1	4	low
4		*Elanus caeruleus*	Black-winged kite	259.8	8	1	8	moderate
5		*Milvus migrans*	Black kite	734.1	8	1	8	moderate
6		*Haliastur indus*	Brahminy Kite	529	8	1	8	moderate
7		*Circus aeruginosus*	Western Marsh-harrier	704.1	8	1	8	moderate
8		*Haliaeetus leucogaster*	White-bellied sea-eagle	2827	16	1	16	high
9		*Clanga hastata*	Indian spotted eagle	1359.4	16	1	16	high
10		*Clanga clanga*	Greater spotted eagle	2154.3	16	1	16	high
11		*Elanus axillaris*	Black-shouldered kite	270.1	8	1	8	moderate
12		*Accipiter trivirgatus*	Crested Goshawk	265	8	1	8	moderate
13		*Hieraaetus pennatus*	Booted Eagle	823.8	8	1	8	moderate
14		*Butastur teesa*	White-eyed Buzzard	325	8	1	8	moderate
15		*Pernis ptilorhynchus*	Oriental Honey-Buzzard	1141.1	16	1	16	high
16		*Circus melanoleucos*	Pied Harrier	336.3	8	1	8	moderate
17	Acrocephalidae	*Acrocephalus dumetorum*	Blyth's Reed-Warbler	11.2	2	1	2	very low
18		*Iduna caligata*	Booted Warbler	8.9	2	1	2	very low
19		*Acrocephalus stentoreus*	Clamorous Reed-Warbler	24.2	2	1	2	very low
20	Alaudidae	*Eremopterix griseus*	Ashy-crowned Sparrow-lark	16	2	1	2	very low
21		*Ammomanes phoenicura*	Rufous-tailed lark	25.6	2	1	2	very low
22		*Galerida malabarica*	Malabar Lark	38.2	2	1	2	very low
23	Alcedinidae	*Halcyon smyrnensis*	White-breasted Kingfisher	91.4	4	1	4	low

24		*Ceryle rudis*	Pied Kingfisher	84.4	4	1	4	low
25		*Halcyon pileata*	Black capped Kingfisher	84	4	1	4	low
26		*Alcedo atthis*	Common Kingfisher	31.1	2	1	2	very low
27	Anatidae	*Dendrocygna javanica*	Lesser Whistling duck	519.6	8	4	32	very high
28		*Anas poecilorhyncha*	Indian Spot-billed duck	1000	8	2	16	high
29		*Spatula clypeata*	Northern Shoveler	612.6	8	2	16	high
30		*Anas acuta*	Northern Pintail	944.6	8	2	16	high
31		*Spatula querquedula*	Garganey	325.6	8	2	16	high
32		*Mareca strepera*	Gadwall	915.6	8	2	16	high
33		*Anas crecca*	Common Teal	341.9	8	2	16	high
34		*Mareca penelope*	Eurasian Wigeon	770	8	2	16	high
35		*Tadorna ferruginea*	Ruddy Shelduck	1235	16	2	32	very high
36		*Sarkidiornis melanotos*	African comb duck	2610	16	2	32	very high
37		*Tadorna tadorna*	Common shelduck	1146.8	16	2	32	very high
38		*Nettapus coromandelianus*	Cotton pygmy-goose	391.3	8	2	16	high
39		*Anas platyrhynchos*	Mallard	843.4	8	2	16	high
40	Apodidae	*Apus affinis*	Little swift	22.6	2	2	4	low
41		*Cypsiurus balasiensis*	Asian palm Swift	9.1	2	2	4	very low
42	Ardeidae	*Ardeola grayii*	Indian Pond Heron	253	8	1	8	moderate
43		*Ardea cinerea*	Grey Heron	1443	16	1	16	high
44		*Ardea purpurea*	Purple Heron	1064.5	16	1	16	high
45		*Butorides virescens*	Green-backed Heron	201.5	8	1	8	moderate
46		*Nycticorax nycticorax*	Black crowned Night Heron	810	8	1	8	moderate
47		*Ardea alba*	Great White Egret	871.3	8	1	8	moderate
48		*Ardea intermedia*	Intermediate Egret	458.8	8	1	8	moderate
49		*Egretta garzetta*	Little Egret	312	8	1	8	moderate
50		*Egretta gularis*	Western Reef Egret	312	8	1	8	moderate

51		*Bubulcus ibis*	Cattle Egret	366	8	1	8	moderate
52		*Ixobrychus flavicollis*	Black Bittern	321	8	1	8	moderate
53		*Ixobrychus cinnamomeus*	Cinnamon Bittern	126.5	4	1	4	low
54	Artamidae	*Artamus fuscus*	Ashy Woodswallow	39.8	2	1	2	very low
55		*Pericrocotus speciosus*	Scarlet Minivet	23.3	2	2	4	low
56	Campephagidae	*Pericrocotus cinnamomeus*	Small Minivet	8.6	2	2	4	low
57	Bucerotidae	*Ocyceros birostris*	Indian Grey Hornbill	375	8	1	8	moderate
58	Caprimulgidae	*Caprimulgus asiaticus*	Indian Nightjar	42	2	1	2	very low
59		*Caprimulgus affinis*	Savanna Nightjar	58.7	4	1	4	low
60	Charadriidae	*Vanellus indicus*	Red-wattled Lapwing	181	4	1	4	low
61		*Vanellus malabaricus*	Yellow-wattled Lapwing	140	4	1	4	low
62		*Pluvialis fulva*	Pacific Golden Plover	134.9	4	1	4	low
63		*Pluvialis squatarola*	Grey Plover	250	8	1	8	moderate
64		*Charadrius dubius*	Little ringed Plover	38.7	2	2	4	very low
65		*Charadrius alexandrinus*	Kentish Plover	42.3	2	2	4	very low
66		*Charadrius hiaticula*	Common Ringed Plover	64	4	2	8	low
67		*Charadrius leschenaultii*	Greater Sandplover	74.8	4	4	16	high
68		*Charadrius mongolus*	Lesser Sandplover	64	4	4	16	high
69	Ciconiidae	*Mycteria leucocephala*	Painted Stork	3180	16	4	64	very high
70		*Ciconia nigra*	Black Stork	2926	16	1	16	high
71		*Anastomus oscitans*	Asian Openbill	1590	16	1	16	high
72		*Ciconia episcopus*	Asian woollyneck	2061	16	1	16	high
73	Cisticolidae	*Prinia inornata*	Plain Prinia	7	2	1	2	very low
74		*Prinia socialis*	Ashy Prinia	8	2	1	2	very low
75		*Prinia sylvatica*	Jungle Prinia	16.1	2	1	2	very low
76		*Orthotomus sutorius*	Common Tailorbird	7.5	2	1	2	very low
77		*Prinia hodgsonii*	Grey-breasted Prinia	7.5	2	1	2	very low

78	Columbidae	*Columba livia*	Rock Dove	354.2	8	2	16	high
79		*Spilopelia senegalensis*	Laughing Dove	82.1	4	2	8	moderate
80		*Spilopelia chinensis*	Western Spotted Dove	159	4	2	8	moderate
81		*Streptopelia orientalis*	Oriental Trutle-dove	232.9	8	2	16	high
82		*Treron phoenicoptera*	Yellow footed green pigeon	212	8	2	16	high
83	Coraciidae	*Coracias benghalensis*	Indian Roller	157.5	4	1	4	low
84	Corvidae	*Corvus splendens*	House crow	292.6	8	1	8	moderate
85		*Corvus macrorhynchos*	Indian Jungle crow (large billed)	513.1	8	1	8	moderate
86		*Dendrocitta vagabunda*	Rufous Treepie	100	4	1	4	low
87	Cuculidae	*Centropus sinensis*	Greater Coucal	280.7	8	1	8	moderate
88		*Eudynamys scolopaceus*	Western Koel	194.9	4	1	4	low
89		*Clamator jacobinus*	Jacobin Cuckoo	79.4	4	1	4	low
90		*Hierococcyx varius*	Common Hawk-cuckoo	103	4	1	4	low
91		*Cacomantis passerinus*	Grey billed Cuckoo	25.3	2	1	2	very low
92	Dicaeidae	*Dicaeum erythrorhynchos*	Pale-billed flowerpecker	6.3	2	1	2	very low
93		*Dicaeum agile*	Thick-billed flowerpecker	9	2	1	2	very low
94	Dicruridae	*Dicrurus macrocercus*	Black Drongo	48.3	2	1	2	very low
95		*Dicrurus leucophaeus*	Ashy Drongo	37.6	2	1	2	very low
96		*Dicrurus aeneus*	Bronzed Drongo	26	2	1	2	very low
97		*Dicrurus caerulescens*	White-bellied Drongo	40	2	1	2	very low
98	Estrildidae	*Amandava amandava*	Red Avadavat	9	2	2	4	low
99		*Lonchura punctulata*	Scaly-breasted Munia	13.6	2	2	4	low
100		*Lonchura malacca*	Tricoloured Munia	12.6	2	2	4	low
101		*Euodice malabarica*	Indian Silverbill	12	2	2	4	low
102		*Lonchura striata*	White-rumped Munia	12.3	2	2	4	low
103	Falconidae	*Falco peregrinus*	Peregrine Falcon	760	8	1	8	moderate
104		*Falco amurensis*	Amur Falcon	141.9	4	1	4	low

105	Fringillidae	*Carpodacus erythrinus*	Common Rosefinch	24	2	1	2	very low
106	Glareolidae	*Glareola maldivarum*	Oriental Pratincole	75.2	4	1	4	low
107	Hirudinidae	*Hirundo rustica*	Barn Swallow	17.9	2	1	2	very low
108		*Hirundo smithii*	Wire-tailed Swallow	12.4	2	1	2	very low
109		*Ptyonoprogne concolor*	Dusky Crag Martin	13	2	1	2	very low
110	Irenidae	*Aegithina tiphia*	Common Iora	12	2	1	2	very low
111	Jacanidae	*Metopidius indicus*	Bronze-winged jacana	155	4	1	4	low
112	Laniidae	*Lanius schach*	Long-tailed Shrike	51.5	4	1	4	low
113		*Lanius cristatu*	Brown Shrike	32.2	2	1	2	very low
114	Laridae	*Larus heuglini*	Heuglin's Gull	1360	16	2	32	very high
115		*Chroicocephalus brunnicephalus*	Brown-headed Gull	569.3	8	2	16	high
116		*Chroicocephalus ridibundus*	Black-headed Gull	284	8	2	16	high
117		*Chroicocephalus genei*	Slender-billed Gull	281	8	2	16	high
118		*Gelochelidon nilotica*	Common Gull-billed Tern	218.3	8	4	32	very high
119		*Hydroprogne caspia*	Caspian Tern	655	8	4	32	very high
120		*Sterna hirundo*	Common Tern	129.2	4	4	16	very high
121		*Sternula albifrons*	Little Tern	57	4	4	16	very high
122		*Chlidonias hybrida*	Whiskered Tern	83.7	4	4	16	very high
123		*Sterna aurantia*	River Tern	209	8	4	32	very high
124		*Rynchops albicollis*	Indian Skimmer	164	4	4	16	very high
125	Leiotrichidae	*Turdoides striata*	Jungle Babbler	66	4	4	16	high
126	Megalaimidae	*Megalaima zeylanica*	Brown-headed Barbet	119	4	1	4	low
127		*Megalaima haemacephala*	Coppersmith Barbet	44.5	2	1	2	very low
128	Meropidae	*Merops orientalis*	Asian Green Bee-eater	14.8	2	4	8	moderate
129		*Merops philippinus*	Blue-tailed Bee-eater	34	2	4	8	moderate
130	Monarchinae	*Terpsiphone paradisi*	Indian Paradise-flycatcher	19.2	2	1	2	very low

131	Motacillidae	*Motacilla flava*	Western Yellow Wagtail	17.7	2	1	2	very low
132		*Motacilla cinerea*	Grey Wagtail	17.2	2	1	2	very low
133		*Motacilla alba*	White Wagtail	23.9	2	1	2	very low
134		*Anthus rufulus*	Paddyfield Pipit	20.4	2	1	2	very low
135		*Motacilla maderaspatensis*	White-browed Wagtail	30.5	2	1	2	very low
136		*Anthus godlewskii*	Blyth's Pipit	25.3	2	1	2	very low
137		*Dendronanthus indicus*	Forest Wagtail	16.4	2	1	2	very low
138	Muscicapidae	*Saxicoloides fulicatus*	Indian Robin	16.6	2	1	2	very low
139		*Copsychus saularis*	Oriental Magpie-robin	36	2	1	2	very low
140		*Oenanthe deserti*	Desert Wheatear	19.8	2	1	2	very low
141		*Monticola solitarius*	Blue Rock Thrush	53.7	4	1	4	low
142		*Saxicola rubicola*	Common Stonechat	14.1	2	1	2	very low
143		*Cyornis tickelliae*	Tickell's Blue-flycatcher	16.2	2	1	2	very low
144		*Luscinia svecica*	Bluethroat	17.2	2	1	2	very low
145		*Phoenicurus ochruros*	Black Redstart	16.5	2	1	2	very low
146		*Muscicapa latirostris*	Asian Brown flycatcher	16	2	1	2	very low
147		*Oenanthe isabellina*	Isabelline Wheater	29.4	2	1	2	very low
148	Nectariniidae	*Leptocoma zeylonica*	Purple-rumped Sunbird	8.8	2	2	4	low
149		*Cinnyris asiaticus*	Purple Sunbird	8.1	2	2	4	low
150		*Aethopyga vigorsii*	Sahyadri Sunbird	6.7	2	2	4	low
151		*Cinnyris lotenius*	Loten's Sunbird	8.8	2	2	4	low
152	Oriolidae	*Oriolus kundoo*	Indian Golden Oriole	65.6	4	1	4	low
153		*Oriolus percivali*	Western Black-headed Oriole	49	2	1	2	very low
154		*Oriolus xanthornus*	Black-hooded Oriole	56.3	4	1	4	low
155	Pandionidae	*Pandion haliaetus*	Osprey	1483.2	16	1	16	high
156	Passeridae	*Passer domesticus*	House Sparrow	26.5	2	1	2	very low
157	Pellorneidae	*Pellorneum ruficeps*	Puff-throated babbler	26	2	1	2	very low

158	Phalacrocoracidae	*Microcarbo niger*	Little Cormorant	427	8	1	8	moderate
159		*Phalacrocorax carbo*	Great Cormorant	2529	16	1	16	high
160		*Phalacrocorax fuscicollis*	Indian Cormorant	706	8	1	8	moderate
161	Phasianidae	*Galloperdix spadicea*	Red Spurfowl	359.1	8	2	16	high
162		*Coturnix coturnix*	Common Quail	96.3	4	1	4	low
163		*Pavo cristatus*	Indian Peafowl	4154.8	16	2	32	very high
164		*Perdicula asiatica*	Jungle Bush-quail	68.4	4	1	4	low
165	Phoenicopteridae	*Phoenicopterus roseus*	Greater Flamingo	3031.6	16	4	64	very high
166		*Phoeniconaias minor*	Lesser Flamingo	1500	16	4	64	very high
167	Phylloscopidae	*Phylloscopus trochiloides*	Greenish Warbler	8.1	2	1	2	very low
168		*Phylloscopus collybita*	Common Chiffchaff	8.3	2	1	2	very low
169	Ploceinae	*Ploceus philippinus*	Baya Weaver	28.2	2	4	8	moderate
170	Podicipedidae	*Tachybaptus ruficollis*	Little Grebe	169.4	4	2	8	moderate
171	Psittaculidae	*Psittacula krameri*	Rose-ringed Parakeet	116.1	4	4	16	high
172		*Psittacula eupatria*	Alexandrine Parakeet	214	8	4	32	very high
173		*Psittacula cyanocephala*	Plum-headed Parakeet	66	4	4	16	high
174	Pycnonotidae	*Pycnonotus leucotis*	White-eared Bulbul	27.1	2	2	4	low
175		*Pycnonotus luteolus*	White-browed Bulbul	34.7	2	2	4	low
176		*Pycnonotus cafer*	Red-vented Bulbul	42.9	2	2	4	low
177		*Pycnonotus jocosu*	Red-whiskered Bulbul	29.5	2	2	4	low
178	Rallidae	*Amaurornis phoenicurus*	White-breasted Waterhen	180	4	1	4	low
179		*Porphyrio porphyrio*	Purple Swamphen	773.9	8	2	16	high
180		*Gallinula chloropus*	Common Moorhen	339.6	8	1	8	moderate
181		*Fulica atra*	Eurasian Coot	717.1	8	1	8	moderate
182		*Hydrophasianus chirurgus*	Pheasant-tailed Jacana	160	4	1	4	low
183	Recurvirostridae	*Himantopus himantopus*	Black-winged Stilt	176.8	4	4	16	high
184		*Recurvirostra avosetta*	Pied Avocet	304	8	2	16	high

185	Rhipidurinae	*Rhipidura aureola*	White-browed Fantail	11.2	2	2	4	low
186		*Rhipidura albogularis*	White-spotted Fantail	12.9	2	2	4	low
187	Rostratulidae	*Rostratula benghalensis*	Greater Painted-Snipe	121	4	1	4	low
188	Scolopacidae	*Calidris pugnax*	Ruff	131.7	4	1	4	low
189		*Gallinago gallinago*	Common Snipe	112.9	4	1	4	low
190		*Numenius phaeopus*	Whimbrel	364.6	8	1	8	moderate
191		*Numenius arquata*	Eurasian Curlew	803	8	1	8	moderate
192		*Calidris alpina*	Dunlin	51.9	4	4	16	high
193		*Arenaria interpres*	Ruddy Turnstone	136	4	1	4	low
194		*Limosa limosa*	Black-tailed Godwit	288.4	8	1	8	moderate
195		*Limosa lapponica*	Bar-tailed Godwit	291.7	8	1	8	moderate
196		*Tringa nebularia*	Common Greenshank	187	4	1	4	low
197		*Tringa totanus*	Common Redshank	129	4	1	4	low
198		*Tringa stagnatilis*	Marsh Sandpiper	77.5	4	4	16	high
199		*Calidris ferruginea*	Curlew Sandpiper	58.1	4	4	16	high
200		*Tringa glareola*	Wood Sandpiper	62.1	4	1	4	low
201		*Xenus cinereus*	Terek Sandpiper	78.8	4	1	4	low
202		*Actitis hypoleucos*	Common Sandpiper	48	2	1	2	very low
203		*Tringa ochropus*	Green Sandpiper	71.4	4	1	4	low
204		*Limicola falcinellus*	Broad-billed Sandpiper	37.1	2	4	8	moderate
205		*Calidris minuta*	Little Stint	21.1	2	4	8	moderate
206		*Calidris temminckii*	Temminck's Stint	23	2	1	2	low
207	Strigidae	*Athene brama*	Spotted Owlet	112	4	2	8	moderate
208	Sturnidae	*Acridotheres tristis*	Common Myna	116.4	4	2	8	moderate
209		*Acridotheres fuscus*	Jungle Myna	82.8	4	2	8	moderate
210		*Gracupica contra*	Asian Pied Starling	84	4	4	16	high
211		*Sturnia malabarica*	Chestnut-tailed Starling	39.6	2	4	8	moderate

212		*Sturnia pagodarum*	Brahminy Starling	48.9	2	4	8	moderate
213		*Pastor roseus*	Rosy Starling	73	4	4	16	high
214	Sylviidae	*Chrysomma sinense*	Yellow-eyed Babbler	17.2	2	2	4	low
215		*Sylvia curruca*	Lesser Whitethroat	11.4	2	1	2	very low
216		*Cisticola juncidis*	Zitting Cisticola	6.8	2	4	8	very low
217	Threskiornithidae	*Threskiornis melanocephalus*	Black-headed Ibis	1303	16	1	16	high
218		*Pseudibis papillosa*	Red-naped Ibis	823	8	1	8	moderate
219		*Plegadis falcinellus*	Glossy Ibis	626.6	8	1	8	moderate
220		*Platalea leucorodia*	Eurasian Spoonbill	1868	16	2	32	very high
221	Turdidae	*Geokichla citrina*	Orange-headed Thrush	53.3	4	2	8	moderate
222		*Myophonus horsfieldii*	Malabar Whistling Thrush	117	4	1	4	low
223	Turnicidae	*Turnix tanki*	Yellow-legged Buttonquail	52.8	4	1	4	low
224		*Turnix suscitator*	Barred Buttonquail	49.1	2	1	2	very low
225	Tytonidae	*Tyto alba*	Common Barn-Owl	403.3	8	1	8	moderate
226	Upupidae	*Upupa epops*	Common Hoopoe	66.9	4	1	4	low
227	Vangidae	*Tephrodornis pondicerianus*	Common Woodshrike	20.2	2	1	2	very low
228	Zosteropidae	*Zosterops palpebrosus*	Indian White-eye	8.6	2	4	8	moderate

Table 9.6 Severity of a bird strike with Aircraft categorization based on severity Body Mass, Flock Size and Severity value

Sr No.	Very Low		Low		Moderate		High		Very High	
	Scientific Name	**Common Name**	**Scientific Name**	**Common Name**	**Scientific Name**	**Common Name**	**Scientific Name**	**Common Name**	**Scientific Name**	**Common Name**
1	*Acrocephalus dumetorum*	Blyth's Reed-Warbler	*Tachyspiza badia*	Shikra	*Elanus caeruleus*	Black-winged kite	*Haliaeetus leucogaster*	White-bellied sea-eagle	*Dendrocygna javanica*	Lesser Whistling duck
2	*Iduna caligata*	Booted Warbler	*Tachyspiza virgata*	Besra	*Milvus migrans*	Black kite	*Clanga hastata*	Indian spotted eagle	*Tadorna ferruginea*	Ruddy Shelduck
3	*Acrocephalus stentoreus*	Clamorous Reed-Warbler	*Spilornis cheela*	Crested Serpent-eagle	*Haliastur indus*	Brahminy Kite	*Clanga clanga*	Greater spotted eagle	*Sarkidiornis melanotos*	African comb duck
4	*Eremopterix griseus*	Ashy-crowned Sparrow-lark	*Halcyon smyrnensis*	White-breasted Kingfisher	*Circus aeruginosus*	Western Marsh-harrier	*Pernis ptilorhynchus*	Oriental Honey-Buzzard	*Tadorna tadorna*	Common shelduck
5	*Ammomanes phoenicura*	Rufous-tailed lark	*Ceryle rudis*	Pied Kingfisher	*Elanus axillaris*	Black-shouldered kite	*Anas poecilorhyncha*	Indian Spot-billed duck	*Mycteria leucocephala*	Painted Stork
6	*Galerida malabarica*	Malabar Lark	*Halcyon pileata*	Black capped Kingfisher	*Accipiter trivirgatus*	Crested Goshawk	*Spatula clypeata*	Northern Shoveler	*Larus heuglini*	Heuglin's Gull
7	*Alcedo atthis*	Common Kingfisher	*Apus affinis*	Little swift	*Hieraaetus pennatus*	Booted Eagle	*Anas acuta*	Northern Pintail	*Gelochelidon nilotica*	Common Gull-billed Tern
8	*Cypsiurus balasiensis*	Asian palm Swift	*Ixobrychus cinnamomeus*	Cinnamon Bittern	*Butastur teesa*	White-eyed Buzzard	*Spatula querquedula*	Garganey	*Hydroprogne caspia*	Caspian Tern
9	*Artamus fuscus*	Ashy Woodswallow	*Pericrocotus speciosus*	Scarlet Minivet	*Circus melanoleucos*	Pied Harrier	*Mareca strepera*	Gadwall	*Sterna hirundo*	Common Tern
10	*Caprimulgus asiaticus*	Indian Nightjar	*Pericrocotus cinnamomeus*	Small Minivet	*Ardeola grayii*	Indian Pond Heron	*Anas crecca*	Common Teal	*Sternula albifrons*	Little Tern

11	*Charadrius dubius*	Little ringed Plover	*Caprimulgus affinis*	Savanna Nightjar	*Butorides virescens*	Green-backed Heron	*Mareca penelope*	Eurasian Wigeon	*Chlidonias hybrida*	Whiskered Tern
12	*Charadrius alexandrinus*	Kentish Plover	*Vanellus indicus*	Red-wattled Lapwing	*Nycticorax nycticorax*	Black crowned Night Heron	*Nettapus coromandelianus*	Cotton pygmy-goose	*Sterna aurantia*	River Tern
13	*Prinia inornata*	Plain Prinia	*Vanellus malabaricus*	Yellow-wattled Lapwing	*Ardea alba*	Great White Egret	*Anas platyrhynchos*	Mallard	*Rynchops albicollis*	Indian Skimmer
14	*Prinia socialis*	Ashy Prinia	*Pluvialis fulva*	Pacific Golden Plover	*Ardea intermedia*	Intermediate Egret	*Ardea cinerea*	Grey Heron	*Pavo cristatus*	Indian Peafowl
15	*Prinia sylvatica*	Jungle Prinia	*Charadrius hiaticula*	Common Ringed Plover	*Egretta garzetta*	Little Egret	*Ardea purpurea*	Purple Heron	*Phoenicopterus roseus*	Greater Flamingo
16	*Orthotomus sutorius*	Common Tailorbird	*Coracias benghalensis*	Indian Roller	*Egretta gularis*	Western Reef Egret	*Charadrius leschenaultii*	Greater Sandplover	*Phoeniconaias minor*	Lesser Flamingo
17	*Prinia hodgsonii*	Grey-breasted Prinia	*Dendrocitta vagabunda*	Rufous Treepie	*Bubulcus ibis*	Cattle Egret	*Charadrius mongolus*	Lesser Sandplover	*Psittacula eupatria*	Alexandrine Parakeet
18	*Cacomantis passerinus*	Grey billed Cuckoo	*Eudynamys scolopaceus*	Western Koel	*Ixobrychus flavicollis*	Black Bittern	*Ciconia nigra*	Black Stork	*Platalea leucorodia*	Eurasian Spoonbill
19	*Dicaeum erythrorhynchos*	Pale-billed flowerpecker	*Clamator jacobinus*	Jacobin Cuckoo	*Ocyceros birostris*	Indian Grey Hornbill	*Anastomus oscitans*	Asian Openbill		
20	*Dicaeum agile*	Thick-billed flowerpecker	*Hierococcyx varius*	Common Hawk-cuckoo	*Pluvialis squatarola*	Grey Plover	*Ciconia episcopus*	Asian woollyneck		
21	*Dicrurus macrocercus*	Black Drongo	*Amandava amandava*	Red Avadavat	*Spilopelia senegalensis*	Laughing Dove	*Columba livia*	Rock Dove		
22	*Dicrurus leucophaeus*	Ashy Drongo	*Lonchura punctulata*	Scaly-breasted Munia	*Spilopelia chinensis*	Western Spotted Dove	*Streptopelia orientalis*	Oriental Trutle-dove		
23	*Dicrurus aeneus*	Bronzed Drongo	*Lonchura malacca*	Tricoloured Munia	*Corvus splendens*	House crow	*Treron phoenicoptera*	Yellow footed		

								green pigeon		
24	*Dicrurus caerulescens*	White-bellied Drongo	*Euodice malabarica*	Indian Silverbill	*Corvus macrorhynchos*	Indian Jungle crow (large billed)	*Chroicocephalus brunnicephalus*	Brown-headed Gull		
25	*Carpodacus erythrinus*	Common Rosefinch	*Lonchura striata*	White-rumped Munia	*Centropus sinensis*	Greater Coucal	*Chroicocephalus ridibundus*	Black-headed Gull		
26	*Hirundo rustica*	Barn Swallow	*Falco amurensis*	Amur Falcon	*Falco peregrinus*	Peregrine Falcon	*Chroicocephalus genei*	Slender-billed Gull		
27	*Hirundo smithii*	Wire-tailed Swallow	*Glareola maldivarum*	Oriental Pratincole	*Merops orientalis*	Asian Green Bee-eater	*Turdoides striata*	Jungle Babbler		
28	*Ptyonoprogne concolor*	Dusky Crag Martin	*Metopidius indicus*	Bronze-winged jacana	*Merops philippinus*	Blue-tailed Bee-eater	*Pandion haliaetus*	Osprey		
29	*Aegithina tiphia*	Common Iora	*Lanius schach*	Long-tailed Shrike	*Microcarbo niger*	Little Cormorant	*Phalacrocorax carbo*	Great Cormorant		
30	*Lanius cristatu*	Brown Shrike	*Megalaima zeylanica*	Brown-headed Barbet	*Phalacrocorax fuscicollis*	Indian Cormorant	*Galloperdix spadicea*	Red Spurfowl		
31	*Megalaima haemacephala*	Coppersmith Barbet	*Monticola solitarius*	Blue Rock Thrush	*Ploceus philippinus*	Baya Weaver	*Psittacula krameri*	Rose-ringed Parakeet		
32	*Terpsiphone paradisi*	Indian Paradise-flycatcher	*Leptocoma zeylonica*	Purple-rumped Sunbird	*Tachybaptus ruficollis*	Little Grebe	*Psittacula cyanocephala*	Plum-headed Parakeet		
33	*Motacilla flava*	Western Yellow Wagtail	*Cinnyris asiaticus*	Purple Sunbird	*Gallinula chloropus*	Common Moorhen	*Porphyrio porphyrio*	Purple Swamphen		
34	*Motacilla cinerea*	Grey Wagtail	*Aethopyga vigorsii*	Sahyadri Sunbird	*Fulica atra*	Eurasian Coot	*Himantopus himantopus*	Black-winged Stilt		
35	*Motacilla alba*	White Wagtail	*Cinnyris lotenius*	Loten's Sunbird	*Numenius phaeopus*	Whimbrel	*Recurvirostra avosetta*	Pied Avocet		

36	*Anthus rufulus*	Paddyfield Pipit	*Oriolus kundoo*	Indian Golden Oriole	*Numenius arquata*	Eurasian Curlew	*Calidris alpina*	Dunlin		
37	*Motacilla maderaspatensis*	White-browed Wagtail	*Oriolus xanthornus*	Black-hooded Oriole	*Limosa limosa*	Black-tailed Godwit	*Tringa stagnatilis*	Marsh Sandpiper		
38	*Anthus godlewskii*	Blyth's Pipit	*Coturnix coturnix*	Common Quail	*Limosa lapponica*	Bar-tailed Godwit	*Calidris ferruginea*	Curlew Sandpiper		
39	*Dendronanthus indicus*	Forest Wagtail	*Perdicula asiatica*	Jungle Bush-quail	*Limicola falcinellus*	Broad-billed Sandpiper	*Gracupica contra*	Asian Pied Starling		
40	*Saxicoloides fulicatus*	Indian Robin	*Pycnonotus leucotis*	White-eared Bulbul	*Calidris minuta*	Little Stint	*Pastor roseus*	Rosy Starling		
41	*Copsychus saularis*	Oriental Magpie-robin	*Pycnonotus luteolus*	White-browed Bulbul	*Athene brama*	Spotted Owlet	*Threskiornis melanocephalus*	Black-headed Ibis		
42	*Oenanthe deserti*	Desert Wheatear	*Pycnonotus cafer*	Red-vented Bulbul	*Acridotheres tristis*	Common Myna				
43	*Saxicola rubicola*	Common Stonechat	*Pycnonotus jocosu*	Red-whiskered Bulbul	*Acridotheres fuscus*	Jungle Myna				
44	*Cyornis tickelliae*	Tickell's Blue-flycatcher	*Amaurornis phoenicurus*	White-breasted Waterhen	*Sturnia malabarica*	Chestnut-tailed Starling				
45	*Luscinia svecica*	Bluethroat	*Hydrophasianus chirurgus*	Pheasant-tailed Jacana	*Sturnia pagodarum*	Brahminy Starling				
46	*Phoenicurus ochruros*	Black Redstart	*Rhipidura aureola*	White-browed Fantail	*Pseudibis papillosa*	Red-naped Ibis				
47	*Muscicapa latirostris*	Asian Brown flycatcher	*Rhipidura albogularis*	White-spotted Fantail	*Plegadis falcinellus*	Glossy Ibis				

48	*Oenanthe isabellina*	Isabelline Wheater	*Rostratula benghalensis*	Greater Painted-Snipe	*Geokichla citrina*	Orange-headed Thrush			
49	*Oriolus percivali*	Western Black-headed Oriole	*Calidris pugnax*	Ruff	*Tyto alba*	Common Barn-Owl			
50	*Passer domesticus*	House Sparrow	*Gallinago gallinago*	Common Snipe	*Zosterops palpebrosus*	Indian White-eye			
51	*Pellorneum ruficeps*	Puff-throated babbler	*Arenaria interpres*	Ruddy Turnstone					
52	*Phylloscopus trochiloides*	Greenish Warbler	*Tringa nebularia*	Common Greenshank					
53	*Phylloscopus collybita*	Common Chiffchaff	*Tringa totanus*	Common Redshank					
54	*Actitis hypoleucos*	Common Sandpiper	*Tringa glareola*	Wood Sandpiper					
55	*Sylvia curruca*	Lesser Whitethroat	*Xenus cinereus*	Terek Sandpiper					
56	*Cisticola juncidis*	Zitting Cisticola	*Tringa ochropus*	Green Sandpiper					
57	*Turnix suscitator*	Barred Buttonquail	*Calidris temminckii*	Temminck's Stint					
58	*Tephrodornis pondicerianus*	Common Woodshrike	*Chrysomma sinense*	Yellow-eyed Babbler					
59			*Myophonus horsfieldii*	Malabar Whistling Thrush					
60			*Turnix tanki*	Yellow-legged Buttonquail					
61			*Upupa epops*	Common Hoopoe					

Chapter 10-Bird Strike Hazard Management and Recommendations

Birds and humans share the sky for the movement. Bird strike to aircraft is a serious hazard for both birds and aircraft. As there is an increase in the number of flights, the bird population undergoes changes, and the severity of the situation continues to increase. To prevent these bird strikes, strategies are fundamental in nature and should be strictly followed in airports to minimize bird hazards. Bird hazard management is challenging in India due to the diversity of bird species. There are legal restrictions on wildlife handling under the Wildlife Protection Act (1972)

A. General observations and recommendations

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

Probable bird hit prevention methods to be adopted at the airport site

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

1. Development of a system for proper disposal of garbage, especially waste, which attracts birds

2. Regulations to prevent feeding pigeons, crows, etc. in the vicinity of the airport

3. Preventing the rearing of pigeons (kabutar bazi) near airport areas is essential. Rearing pigeons in flocks within the aircraft's approach path or funnel area significantly increases the likelihood of bird strikes.

3. Installation of Barb wires and metal spikes to prevent the nesting of birds like pigeons on the airport premises

4. Strict regulation against unauthorized landfilling activities, especially of wetlands.

5. Distress calls/emergency calls/noise generators, played either via a fixed station or mobile units along the runways following a proper methodology

6. Use of flashlights and other methods to scare roosting birds on runways during night-time.

B. Overall recommendations to deter birds

1. The hangars should be made bird-free through use of metal spikes to make perching on/in hangars difficult. Bird scarers should be employed on the rolls to scare birds in the hangars regularly.
2. Ensuring the non-availability of kitchen wastes for birds in the aerodrome from canteens and households. A directive should also be given to staff, their families, and workmen not to put out food leftovers for birds or dogs.
3. Ensuring that water sources are protected from birds using nets.

4. Ensuring the absence of dumpsites in (and around) the complex.
5. Ensure the absence of fruit and nectar bearing speciesin the immediate surrounds of the aerodrome. Fruiting trees such as mango, guava, sapota/chickoo, and jamun should not be planted.
6. Regarding dumpsites and waste disposal in general, the authorities should use the provisions of the Central Government Act of Section 91 in The Aircraft Rules, 1937, as per which the slaughter and skinning of animals, and dumping of food or other wastes and pollutants that would attract birds and animals are not permitted within a radius of 10 km of the aerodrome.
7. Ideally, fish and meat markets should be concentrated in large, designated areas within municipal or gram panchayat limits. The scattered distribution of meat and fish shops across cities creates significant challenges in solid waste collection and disposal. Consolidating these markets into larger, single areas will allow local governing bodies to better manage the waste generated and reduce the related bird and animal problems like increased food availability for crows and kites, dogs and rats. It is essential for all local governing bodies to designate such areas and ensure that suitable larger plots are made available for these markets.

C. Overall recommendations for habitat management

1. Ideally, the entire expanse of all airports/aerodromes — and all its immediate surroundings — should comprise only one habitat type, i.e., grassland (the vegetation of the runway shoulders). With only a single habitat type, managing bird hazards in the airport/aerodrome becomes simpler and easier with fewer bird species to deal with. This is because the lesser the habitat diversity, the lesser the habitat structure/make-up and food/prey sources, thus resulting in fewer bird species. However, given the location of this airport in an area that is rich in wetlands, mangroves, mudflats, forests, etc, this would not be possible. As for the management of the grassland of runway shoulders, the grassland should comprise only one grass species (whether short or tall grass) to reduce the species and also, the structural diversity of the grassland habitat, thereby reducing the diversity of food and prey species for birds, and correspondingly, bird species. As for the issue of a short vs. tall grass policy, the pros and cons of these are discussed under issue of grass management in runway shoulders.
2. The Height of the grass cover should be maintained <cm. Grass species with larger grain size (e.g., *Dicanthium spp*.) should be eliminated.
3. Water flows associated with irrigation and open canals/ stagnant water through or near the airfield should be covered with nets~~.~~

D. Bird species-wise recommendations

There are several factors that attract the bird species to come in and around the complex, which mainly include Food, Water, roosting, nesting, resting and here are a few species-wise recommendations for the species which are common n and around the NMIA site.

- Prinia Family (ashy prinia, Plain Prinia): A small and secretive species that does not venture out of its habitat, so not a potential threat to aircraft. Maintaining short grass (< 30 cm) would keep the species away from the airfield area.

- Cattle Egret: – Cattle egrets are mainly an insectivorous species. They were seen foraging in the shoulders along the runway. An appropriate deterrent for this species would be to keep the grass height short and well-maintained at all times of the year.
- Indian Pond Heron: A small waterbird that forages at the edges of water bodies and in waterlogged areas, either solitary or in small groups. Deterrent measures as recommended for others, besides ensuring proper drainage within the airfield and netting of water channels in and around the NMIA.
- Black Kite :- The Black Kite is a serious threat to aircraft and is one of the most common causes of bird strikes in Indian airfields. The primary reasons for this is its soaring activity, and the habit of sitting on shoulders and even runways of airfields especially to dry after rains or to get rid of ticks by sunning. The main deterrent measures for this species would be proper disposal of edible wastes from canteens and households, discards from slaughterhouses and meat shops, and ensuring the absence of carcass and dump yards in the vicinity of the airfield. Since the species is an adept flier using thermals to travel long distances, such mitigation measures should extend well beyond the airfield, up to 5 to 10 kilometres or more. Being commensal with humans, its populations have proliferated due to the availability of food at carcass and dump yards. Thousands of kites can be seen in and around the Kanjur Marg dumping ground and on the transmission lines and towers that criss-cross Thane Creek.
- Blue Rock Pigeon: The Rock Pigeon is commensal with humans, and nests in available sites in houses and other buildings. It also feeds on grass seeds available at the shoulder of airfields. These attributes make it a serious threat to aircraft, and additionally, it has a tendency of flying as large flocks. Deterrent measures would include making nesting sites in buildings of the airfield areas and surrounding areas inaccessible for them through 'pigeon-proofing' with mesh/nests or through use of metal spikes in the buildings. This may necessitate the modification of building permissions issued by the Planning Authorities. This species, like the Red-wattled Lapwing avoids uniform tall grass areas, so grass height should be around 30 cm tall and also uniform in growth.
- Crow Family: The primary deterrent measure to keep the House crow from visiting the airfield is to ensure that the premises of the air station and surrounding areas are free of food waste. Being commensal with humans, its populations have proliferated in towns and cities due to the availability of food resources. The jungle crow species is more predatory and less commensal with humans, the shoulders of runways and areas bordering the airfield should be made as 'sterile' as possible to check on the populations of small prey like frogs, snails, crabs on which the Jungle Crow feeds on.
- House Sparrow: House sparrows nest in crevices in urban structures. A suggested deterrent for this species would be to no nesting place is available such as cracks and crevices, spaces between electrical wiring, open and non functional electrical boards in the buildings.

- Lapwing: Lapwings being ground nesting birds, appropriate short grass cover should be developed and maintained preferably 15-20 cm height, inside the airfield. Regular patrolling must be carried out within the airside area to identify and map resting and nesting sites.

E. Urbanisation and management of existing high-tide roosting sites

The eight critical high tide roosting sites we monitored in this study are either threatened by urbanisation or mismanagement. For instance, except in Mankhurd (23.36% built-up cover), the built-up area around sites (2.5 km radius circle) had increased more than 24% in the last four and half decades — peaking at NRI (48.87%) and TSC (48.30%; Kulavmode et al. 2021). The waders prefer low water level (10–25cm deep), and increasing tree cover around wetland reduce their visibility, besides, it provides shelter to dogs and avian predators.

Similarly, the huge urbanisation pressure on Panje wetland can be inferred by a jump in the built-up area around the wetland from 27% to 42% in the last 16 years (2002–2018; Kulavmode et al. 2021). It is a large wetland (~157 ha), supports a big congregation of shorebirds (~50,000 individuals in peak wintering season), is owned by a private company and will be going for the commercial development (Gadgil, 2019). The BSP saltpans — one of the richest sites that supports 48 species of shorebirds— are under the looming threat of the electric transmission line (Jadhav 2021). Many saltpans in BPS were abandoned in the last two years, perhaps due to the proposed transmission line work. In addition, behavioural analysis results exhibited that most species had strong negative impacts due to the presence of vehicles, predators and human disturbances (please refer to Chapter 7 for more details).

The satellite telemetry and resighting data indicated that all the high-tide roosting sites are strongly connected with each other and Thane Creek (please refer to Chapter 6 for more details)

We recommend the following actions to conserve the high-tide roosting sites.
- The high-tide roosting sites should be included in or made legally associated with Thane Creek Flamingo Sanctuary for better protection of the shorebirds.
- Landfilling, excavation, recreational and commercial development in and around DPS, Kharghar, Mankhurd, Panje, BPS and Belpada-wetlands and saltpans should be controlled strictly prohibited while looking at the scarcity of high-quality roosting sites, roost fidelity, and annual return rates of shorebirds (Prabhu et al., 2022).
- The proposed and ongoing electric transmission lines passing through Thane Creek and its adjacent mangroves, mudlflats, salt pansand other wetlands or near high-tide roosting sites should be placed underground or insulated to avoid bird electrocution.
- The beautification actions to improve the aesthetic value of high-tide roosting sites must be prevented, and any habitat alternation in these sites should be undertaken with shorebird expert opinion and advice.

- Fishing, salt farming, blocking tidal water movement, bird watching and photography can co-exist with shorebirds with simple management practices such as minimising disturbance around high tide hours (at least two hours before and after hide tide), part of the wetland can be used for fishing, maintaining the water level below 10–20 cm in whole wetland or at least in its periphery, and regulating the number of birdwatchers, photographers and enthusiasts, especially during spring migration (Prabhu et al., 2022).

F. Creating new high-tide roosting sites

Tracking data of the flamingos and the godwit indicated that, in addition to the high-roosting sites mentioned above, the shorebirds use numerous wetlands inside the mangrove, forests, mudlflats, and salt pans or close to the creek. We identified eight such areas (Table 10.1) which, with little management actions, can be turned into safe high-tide roosting sites in the long run.

Table 10.1. Details of high-tide roosting sites used by satellite-tagged birds.

Site	Central GPS locations	Size (ha)	Surrounding habitat
Deonar-Ghatkopar-Vikhroli Wetlands	19.074319°N, 72.943032°E	432	Mangrove
Vikhroli Wetland	19.102725°N, 72.943661°E	71	Mangrove
Kanjurmarg Wetland	19.131780°N, 72.944939°E	13	Mangrove and built-up area
Vashi Holding Pond	19.081612°N, 72.992634°E	16	Mangrove and built-up area
Vashi Wetland	19.088954°N, 72.998716°E	26	Mangrove and built-up area
Kopar Khairane Wetland 1	19.107261°N, 72.987257°E	8	Mangrove
Kopar Khairane Wetland 2	19.105822°N, 72.981665°E	6	Mangrove
Ghansoli Wetland	19.117684°N, 72.981145°E	8	Mangrove

Deonar-Ghatkopar-Vikhroli Wetlands:

It is the largest and contiguous chain of wetlands interspersed with mangrove patches (Table 10.1, Fig. 10.1). They are situated east of Deonar dumping ground, east of Ghatkopar, south of Vikhroli, and west of transect no. 18 to 20. All the tagged birds used this site intensively, highlighting the importance of this site. It is surrounded by mangroves, mudlflats, salt pans and has a network of wetlands that make it a relatively safe roosting place for the birds. The farthest wetland is located less than 2.5 km from the creek, thus, birds can spend less energy moving between this roosting site and the creek. The variable size of wetlands and the wide range of their depts allow a variety of shorebirds to roost, from small waders to flamingos.

Figure 10.1. Google satellite map of Deonar-Ghatkopar-Vikhroli Wetlands, including part of mudflats (lightbrown) and Vashi Bridge (pink).

Vikhroli Wetland:

This wetland is located east of Vikhroli, 750m north of Deonar-Ghatkopar-Vikhroli wetlands and west of transect no. 16 and 17. It is about 1.5 km from the nearest mudflat and is surrounded by mangroves and mudflts. It is a moderate-sized wetland (Table 10.1, Fig. 10.2).

Kanjurmarg Wetland:

It is a small wetland (Table 10.1, Fig. 10.3) east of Kanjurmarg, close to the Eastern Express Highway. Except for the northwestern side of the wetland, flanked by the highway, the rest of the wetland is surrounded by mangroves mudlflats, and salt pans.

Fig. 10.2. Google satellite map of Vikhroli Wetland.

Fig. 10.3. Google satellite map of Kanjurmarg Wetland.

Vashi Holding Pond:

It is a small holding pond (Table 10.1, Fig. 10.4) situated west of sector 10 in Vashi and east of transect no. 35 and 36. The wetland is relatively deep and surrounded by a jogging track. It is utilised by lesser flamingos. It is embedded in mangroves, except for the dense built-up area on the east. The closest mudflat is less than half a kilometre from the wetland.

Vashi Wetland:

The wetland is located adjacent (300 m north) to Vashi Holding Pond and east of transect no. 36 (Table 10.1, Fig. 10.4). The surrounding habitat of Vashi Wetland is similar to Vashi Holding Pond, but in contrast, it is a shallow wetland sprinkled with thin mangrove patches—ideal for shorebird roosting.

Fig. 10.4. Google satellite map of Vashi Wetland (above) Holding Pond (below).

Kopar Khairane Wetland 1 and 2:

These wetlands are situated west of sector 1 in Kopar Khairane and east of transect no. 38. They are very small wetlands (Table 10.1, Fig. 10.5), adjacent to each other, separated by 350 m mangrove stripe, and surrounded by thick mangroves. They are less than 1.25 km away from the nearest mudflat.

Ghansoli Wetland:

It is also a small wetland located 900m north of Kopar Khairane Wetlands, east of transect no. 39 and 40, and west of sector 11 in Ghansoli (Table 10.1, Fig. 10.6). The habitat features are similar to that of Kopar Khairane Wetlands. The nearest mudflat is less than 200m away.

Fig. 10.5. Google satellite map of Kopar Khairane Wetland 1 (right) and Wetland 2(left).

Fig. 10.6. Google satellite map of Ghansoli Wetland.

We propose the following actions for long-term conservation of these wetlands:
- Among wetlands mentioned above, which are under the jurisdiction of the Forest Department, should be integrated with Thane Creek Flamingo Sanctuary. It would be highly advantageous if privately owned land in these wetlands would be acquired by the Forest Department. Even if not acquired, these wetlands should be kept undisturbed and no construction activity should be permitted.
- The effect of tidal water holding period and water depts on the shorebird roosting should be studied experimentally at some of the wetlands to optimise these water parameters to improve the quality of roosting sites.
- Though these wetlands are currently not suffering from some of the human disturbances mentioned in section 9.2 appropriate actions must be taken in advance to preserve the remaining wetlands. The wetlands that have been destroyed need to be restored.

G. Disturbances due to bridges and jetties

Three shorebird taxa (egrets, ducks and lesser flamingo) abundance models selected distance from the bridge and jetty as significant covariates that negatively influence the bird numbers. Similarly, satellite telemetry data showed that though flamingos approached jetties or bridges, their occurrences peaked 500 to 1000 m away from these structures, indicating they avoided the proximity to jetties or bridges. Flight altitude data revealed the low height preference of the flamingos (75% of observations were less than 6m and 90% were less than 17m), which suggests the construction of bridges put the species under stress to take high flights, leading to energy loss and could affect the species survival (please refer to Chapter 8 for details). In addition, perhaps an incidence like an invasion of mudflats by the mussel (M. strigata) is the outcome of change in mudflat properties due to dredging, drilling, cement usage and erosion from offshore construction sites. Besides habitat (mudflats) loss, the pillars can affect tidal water movement and alter the mud or sand deposition patterns, likely to influence the mudflats' faunal diversity.

We found that except for three species and two behaviour types that differ significantly between feeding and construction sites, the remaining behaviours did not differ significantly. For example, greater flamingos showed significantly higher vigilance at construction sites than at feeding sites, in contrast, Eurasian curlew had significantly lower vigilance at construction sites, and little stints had spent substantially more time resting at construction sites. Which perhaps suggests the habitat suitability at construction despite the disturbances. However, more data and different models may yield contrasting results (Please refer to Chapter 7 for more details).

The appropriate actions should be taken to minimise the impacts of bridges and jetties on shorebirds, such as:
- The old and under-construction bridges and jetties are already altering and fragmenting the shorebird habitats, and upcoming bridges only worsen this situation, therefore, we recommend the new jetties and bridges should be discouraged and construction must be avoided in areas with a high abundance of shorebirds such Thane Creek Flamingo Sanctuary, as well as the mudflats, saltpans and other wetlands

- Install the noise barriers along the bridge that either reflect or absorb the sound waves. The material used should be transparent but non-reflective. The top and joints between the panels, i.e., the frame should be made of metal and pained with contrasting colours, such as the top of the frame is red, and the sides are black.

- Affix plastic spikes onto the bridge barrier to repel the birds from landing or roosting. It reduces the bird strikes and discourages the bird of prey from perching on the bridge, which minimise the negative impact on prey species.

- Lighting should be limited to essential areas. Sheilds must be used to direct the light downwardv and away from bird habitats and prevent upward light spill. Warm colour LED lights with lowv wattage should be used, which reduces the brightness or intensity of light and is bird-friendly. Use of motion sensors and timers to activate light only when needed or turn off during off-peak hours may further minimise the negative impact of light pollution on the birds.
- Unnecessary crowding of people on jetties and bridges should be avoided, and behaviours such as making loud noises, feeding the birds and dumping waste in the creek must be prohibited.

H. Adaptive Management:

We highly recommend adaptive management practices. i.e., continuously monitor the effects of the NMIA and other human disturbances on bird populations and habitats and be willing to adjust mitigation measures based on new information.

Chapter 11-Observations at the Navi Mumbai International Airport Site (NMIA)

Due to the ongoing construction activities at NMIA site and large vehicular traffic movement, the inner field of NMIA site become inaccessible for the field work. We surveyed the border area of the construction site and adadditionally, we have surveyed the adjacent Panvel Creek area and its associated inlets to get aclear picture regarding the waterbirds present there which is just beside the construction site.

Some of the important observations during the ongoing construction activities in the NMIA site –

1) We observed Raptors like Black Kite and Western Marsh Harrier roosting and foraging at the aairport site and the adjacent creek area.
2) Grassbirds like Ashy Prinia, Plain Prinia, Rufous-tailed Lark and Common Stonechat were observed in remnant vegetation in the border of the NMIA site.
3) Numerous resident and migratory aquatic birds are still seen foraging and roosting in the adjacent mangrove patches next to the creek despite ongoing work at the airport site.
4) The total number of species decreased from 80 to 60.

Table 11.1: List of bird species observed at NMIA site

1	Ashy Prinia (*Prinia socialis*)	42	Indian Pond-Heron (*Ardeola grayii*)
2	Red-vented Bulbul (*Pycnonotus cafer*)	43	Indian Robin (*Saxicoloides fulicatus*)
3	Asian Green Bee-eater (*Merops orientalis*)	44	Indian Spotted Eagle (*Clanga hastata*)
4	Asian Palm-swift (*Cypsiurus balasiensis*)	45	Intermediate Egret (*Ardea intermedia*)
5	Asian Pied Starling (*Gracupica contra*)	46	Large-billed Crow (*Corvus macrorhynchos*)
6	Black Redstart (Phoenicurus ochruros)	47	Purple Sunbird (*Cinnyris asiaticus*)
7	Barn Swallow (*Hirundo rustica*)	48	Lesser Sandplover (*Charadrius mongolus*)
8	Baya Weaver (*Ploceus philippinus*)	49	Little Cormorant (*Microcarbo niger)*
9	Western Marsh-Harrier (Circus aeruginosus)	50	Little Egret (*Egretta garzetta*)
10	Black Drongo (*Dicrurus macrocercus*)	51	Little Stint (*Calidris minuta*)
11	Black Kite (*Milvus migrans*)	52	Long-tailed Shrike (*Lanius schach*)
12	Black-headed Gull (*Larus ridibundus*)	53	Oriental Magpie-robin (*Copsychus saularis*)
13	Black-headed Ibis (*Threskiornis melanocephalus*)	54	Oriental Honey-buzzard *(Pernis ptilorhynchus)*
14	Black-tailed Godwit (*Limosa limosa*)	55	Osprey (Pandion haliaetus)
15	Black-winged Kite (*Elanus caeruleus*)	56	Paddyfield Pipit (*Anthus rufulus*)
16	Black-winged Stilt (*Himantopus himantopus*)	57	Painted Stork (*Mycteria leucocephala*)
17	Blue Rock-thrush (*Monticola solitarius*)	58	Peregrine Falcon (Falco peregrinus)
18	Red-wattled Lapwing (*Vanellus indicus*)	59	White-breasted Kingfisher (*Halcyon smyrnensis*)
19	Blyth’s Reed-warbler (*Acrocephalus dumetorum*)	60	Plain Prinia (*Prinia inornata*)
20	Rufous-tailed Lark (*Ammomanes phoenicura*)		
21	Brown-headed Gull (*Larus brunnicephalus*)		

22	Caspian Tern (*Hydroprogne caspia*)		
23	Common Greenshank (*Tringa nebularia*)		
24	Common Gull-billed Tern (*Gelochelidon nilotica*)		
25	Common Myna (*Acridotheres tristis*)		
26	Common Redshank (Tringa totanus)		
27	Common Sandpiper (*Actitis hypoleucos*)		
28	Common Stonechat (*Saxicola torquatus*)		
29	Common Tailorbird (*Orthotomus sutorius*)		
30	Desert Wheatear (*Oenanthe deserti*)		
31	Dusky Crag Martin (*Ptyonoprogne concolor*)		
32	Greater Coucal (*Centropus sinensis*)		
33	Greater Spotted Eagle (*Clanga clanga)*		
34	Grey Heron (*Ardea cinerea*)		
35	House Crow (*Corvus splendens*)		
36	House Sparrow (*Passer domesticus*)		
37	India Spot-billed Duck (*Anas poecilorhyncha*)		
38	Indian Cormorant (*Phalacrocorax fuscicollis*)		
39	Indian Golden Oriole (*Oriolus kundoo*)		
40	Rock Dove (*Columba livia*)		
41	Rose-ringed Parakeet (*Psittacula krameri*)		

Abundance of bird species in the NMIA Airport site peripheral region

We have presented the top ten (10) most represented species in the airport site for all the consecutive seasons: Post-Monsoon, Winter & Summer. The highest abundance of Common Stonechat followed by Black Kite is observed in the Post-Monsoon season, highest abundance of Little Stint followed by Common Sandpiper in the Winter Season, & highest abundance of House Crow followed by Common Stonechat in the Summer Season.

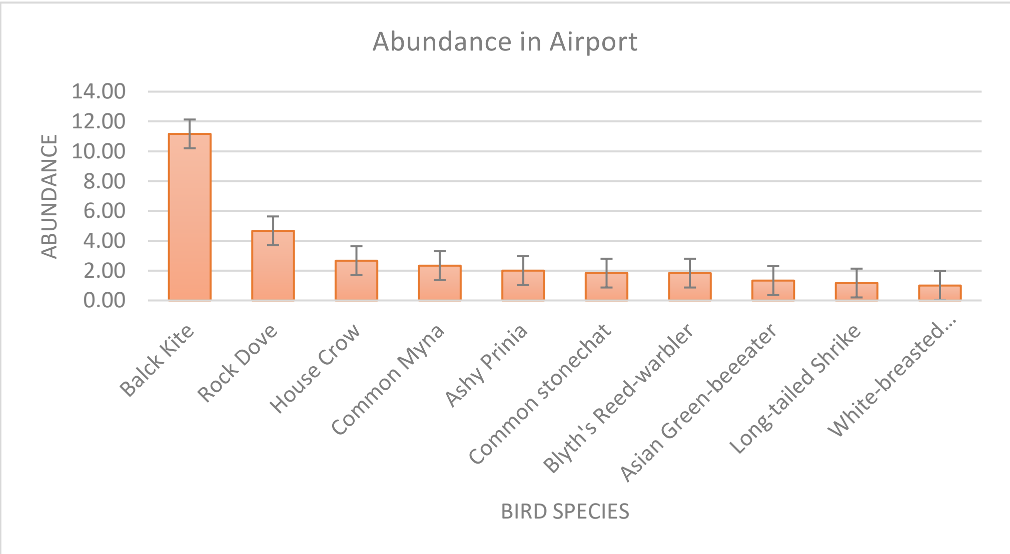


Figure 11.1: Bird abundance in Airport Site -Post -Monsoon Season

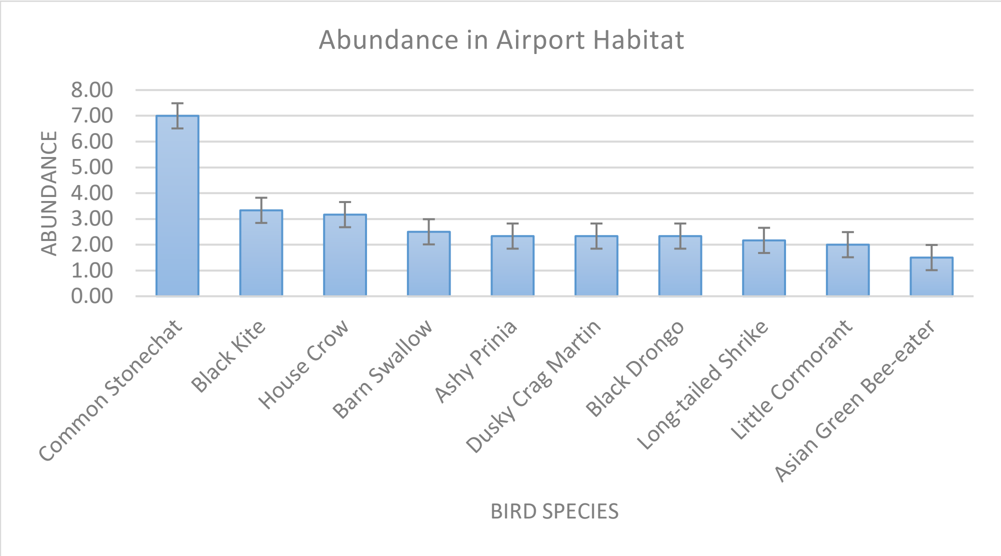


Figure11.2 : Bird abundance in Airport Site – Winter Season

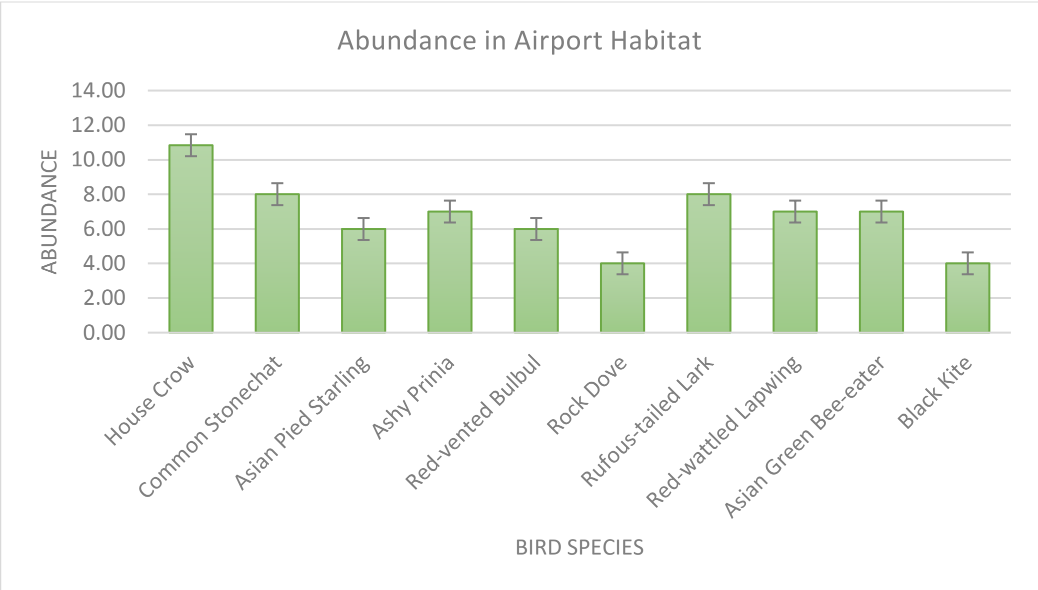


Figure11.3 : Bird abundance in Airport Site – Summer Season

Chapter 12-Garbage Dumps and Meat Shops in the study area

Presence of the garbage dumps in the close proximity of airports can result into Bird-Aircraft Strike Hazards (BASH). Ecologically it can create problematic situations of superabundant species, which can cause severe threats to the local fauna in the area.

The plenty of meat and fish shops throughout the city can create vast food availability for opportunistic predators and facultative scavengers (Kumar et al. 2014). In the previous reports (refer 3rd and 4th annual reports), we had provided all the necessary details of meat shops in and around NMIA site within the 10 km boundary by the systematic grid sampling across habitats.

The total number of garbage dumps and meat shops across all the habitat types were 39

The total number of meat shops across urban core areas were 66. The number of meat shops keeps changing, as many of them are makeshift type. The meat shops were of two types: Permanent (inside the building) and Temporary (in the open areas). Birds were mainly observed to be associated with the temporary shops or the big open market areas. The bird species mainly associated to the meat shops are Cattle Egret and House Crow. There are considerable meet shops and bird association in Kharghar, Khanda Colony, Old Panvel and Ulwe area. The considerably active bird association with meat shops are present in the following shops:

Table 12.1: Meat shops and bird association in the study area

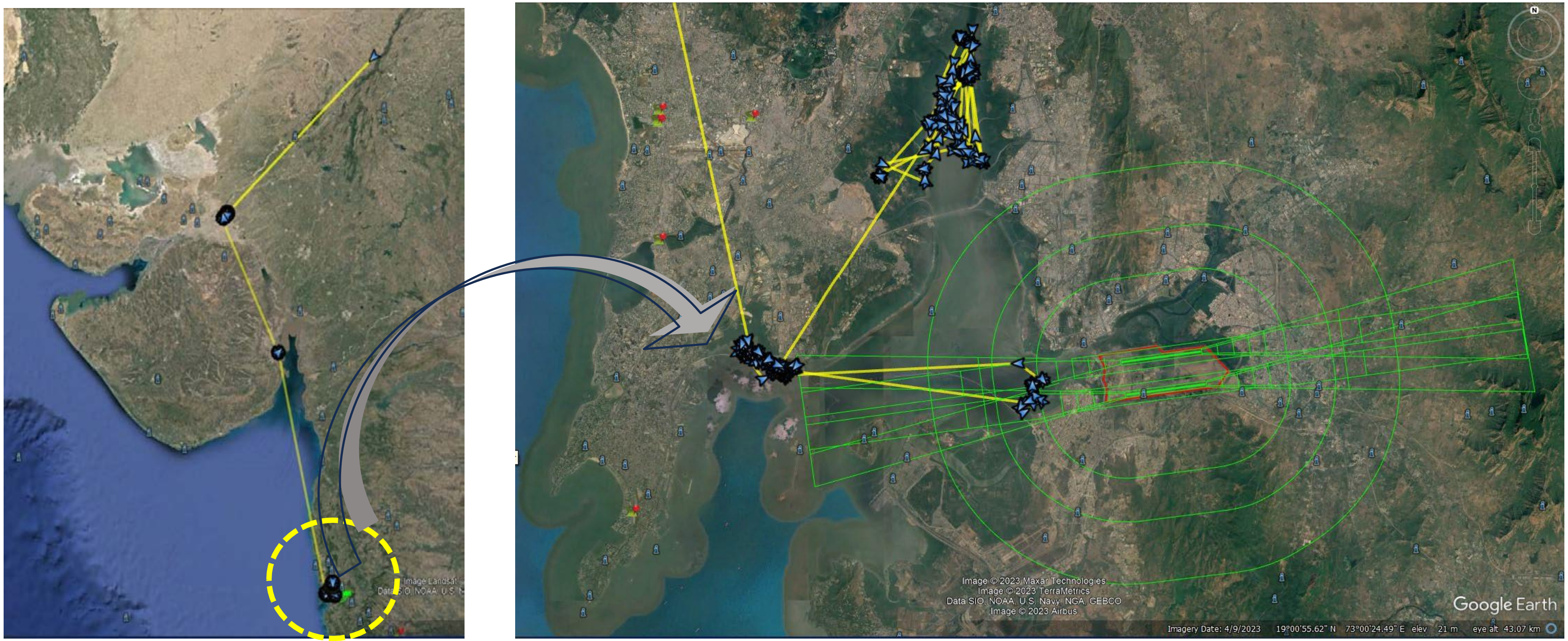
Sl. No.	Name	Area	Lattitude	Longitude	Types of Meat	Shop type	Bird Species
1	Manoj Vegetables Shop	Khanda Colony	19.00560246	73.11490048	Chicken and Mutton	Temporary	Cattle Egret
2	Near Laxmi Online	Old Panvel	18.99262107	73.11517364	Chicken	Temporary	House Crow
3	Untitled Shop	Ulwe	18.96868	73.017283	Chicken and Mutton	Temporary	House Crow
							Black Kite
4	Near Sai Ankit Residency	Ulwe	18.9750805	73.02839079	Chicken and Mutton	Temporary	House Crow
5	Near GOLDEN PAAN SHOP AND GENERAL	Ulwe	18.97823598	73.03235497	Chicken	Temporary	House Crow

Table 11.2 : List of birds observed near slaughter shops

SL. No.	Family	Common Name	Scientific Name	Resident/Migratory
1	Accipitridae	Black Kite	*Milvus migrans*	R
2	Ardeidae	Cattle Egret	*Bubulcus ibis*	R/LM
3	Corvidae	House Crow	*Corvus splendens*	R
4	Corvidae	Large billed-Crow	*Corvus culminates*	R

Annexure 1

BNHS – Bird Flight Data (5FBC2910 – 2022-12)



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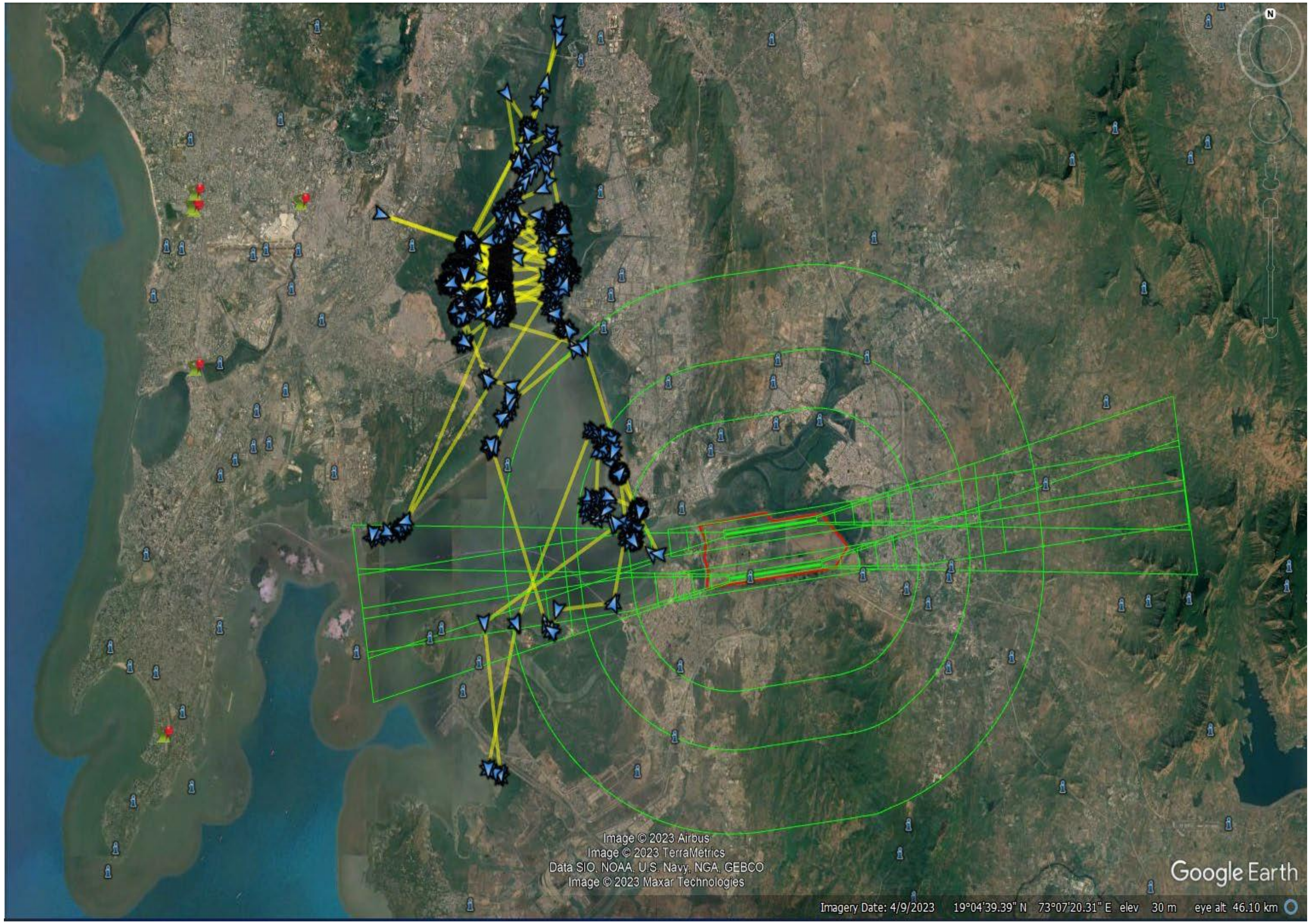

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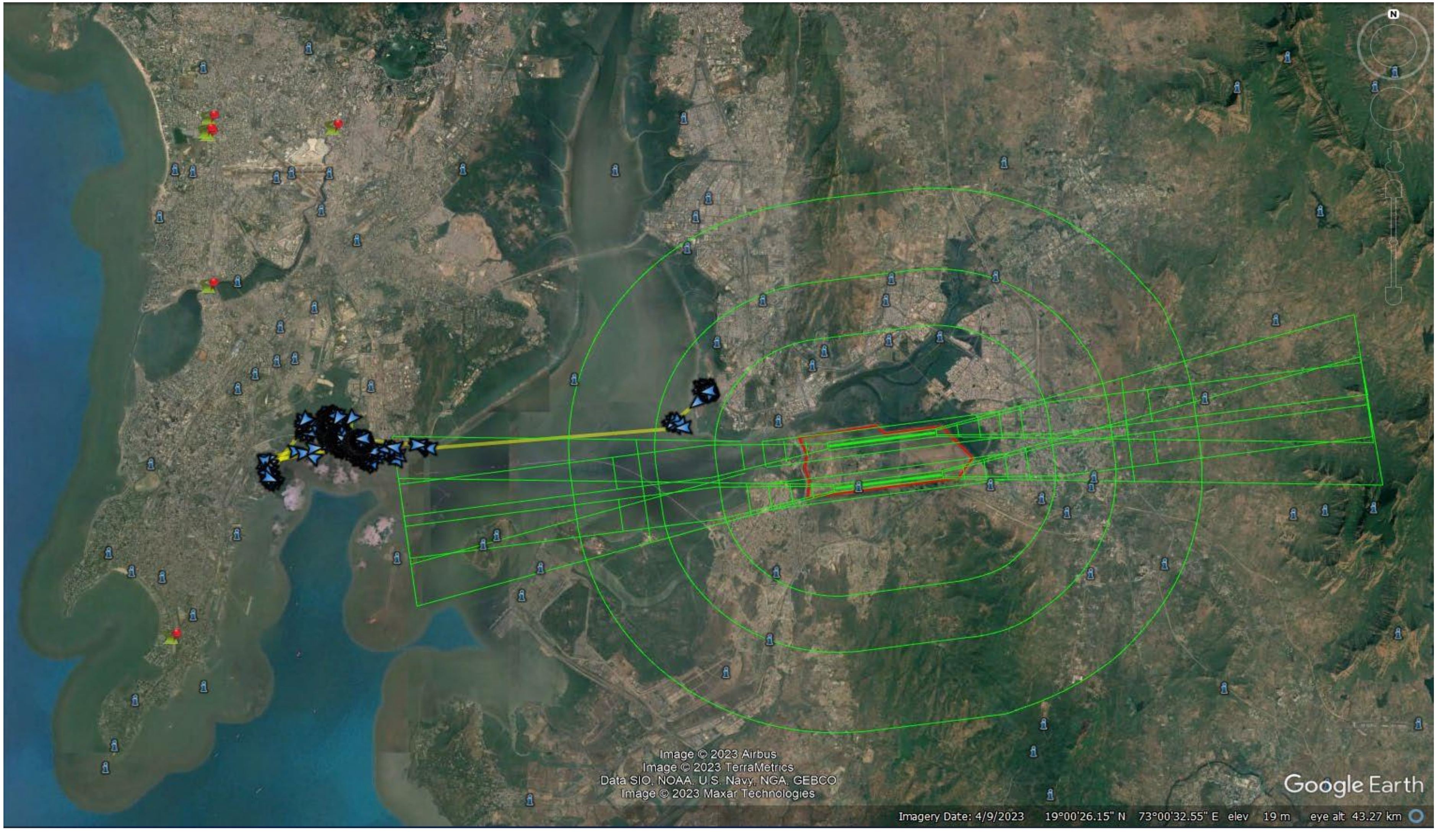

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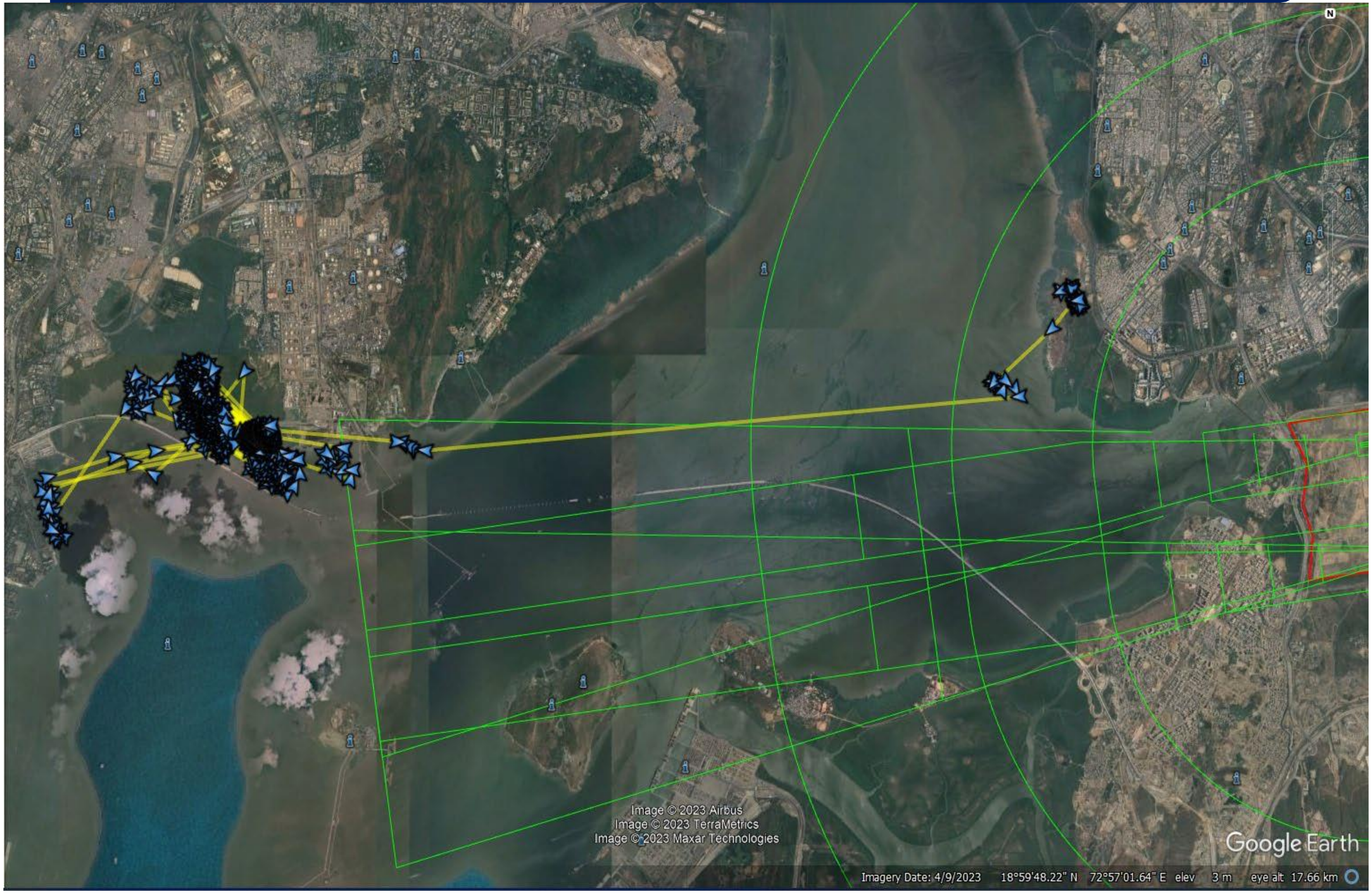

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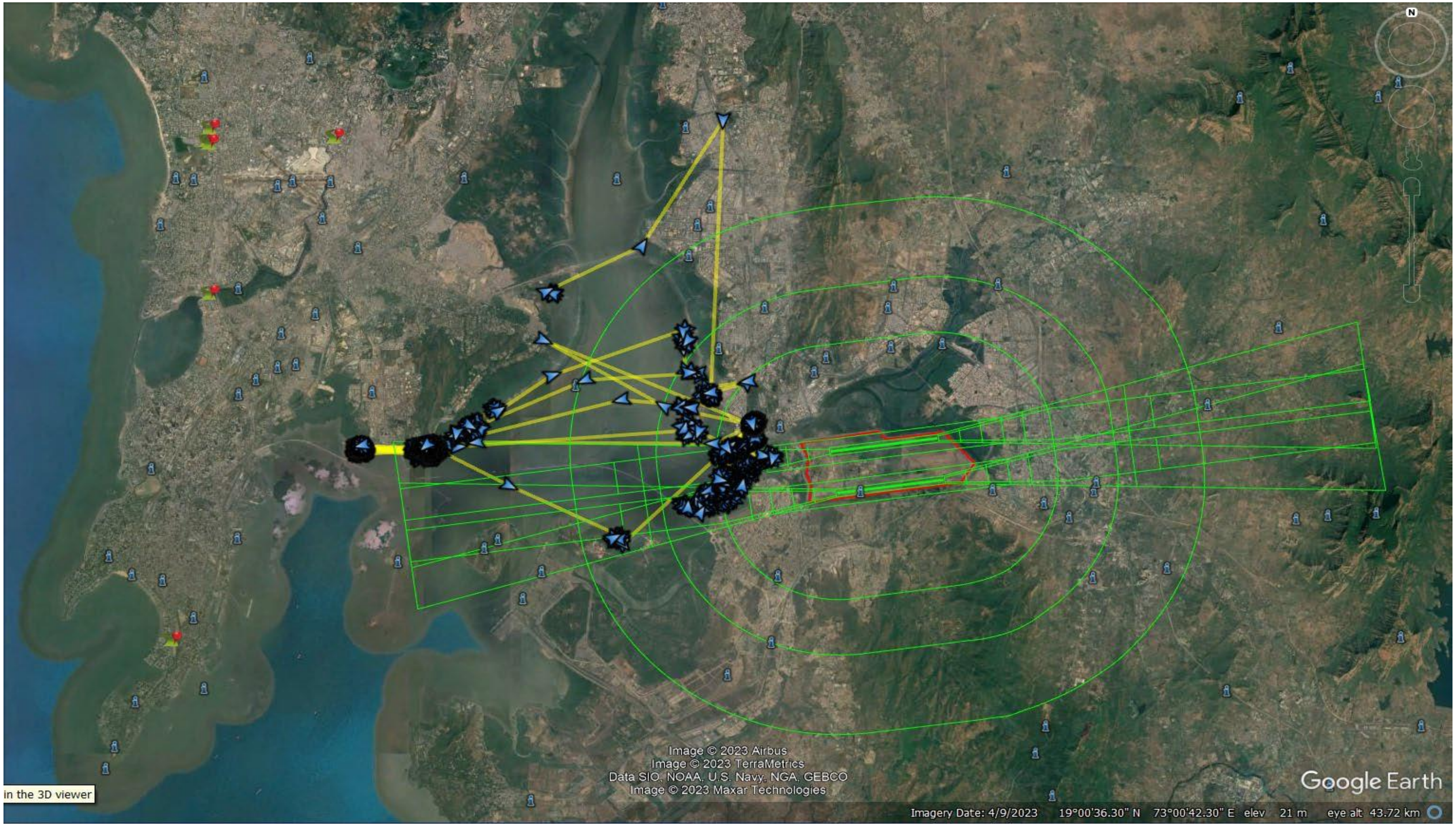

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