LONG-TERM BIRD MONITORING PROJECT, GOA: LESSONS FROM COTIGAO WILDLIFE SANCTUARY.

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GOA FOREST DEPARTMENT

In association with

GBCN
For Goa's Birds!

GOA BIRD CONSERVATION NETWORK

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(for Goa Bird Conservation Network)

Project Summary

Long-term Bird Monitoring Program has been initiated jointly by Goa Forest Department and Goa Bird Conservation Network. The first phase has been implemented in Cotigao Wildlife Sanctuary, situated in Cancona taluka of Goa. The monitoring program has been implemented as a set of three surveys covering three distinct seasons of the state viz. Post-Monsoon, Winter and Pre-Monsoon. Surveys were conducted on 22 & 23 October 2016- 1st survey (post-monsoon season), 18 & 19 February 2017- 2nd survey (winter season) and 20 & 21 May 2017- 3rd survey (pre-monsoon season). 45 volunteers from Goa Bird Conservation Network and all Forest Department officials from Cotigao Wildlife Sanctuary took part in these surveys.

A checklist of Birds of Cotigao Wildlife Sanctuary, Survey Manual for Birds of Cotigao Wildlife Sanctuary (includes picture guide for bird identification), Training Workshop Report and three Interim Reports were developed during this program.

From the three survey efforts, a total of 167 species have been reported from Cotigao Wildlife Sanctuary. Crimson-backed Sunbird (Small Sunbird) *Leptocoma minima* and Greater Racket-tailed Drongo *Dicrurus paradiseus* are the two-resident species which have been seen across all the transects and are evenly distributed across all seasons with 100% frequency of being reported. 26 migrant species have been reported from the surveys which includes three local migrants.

Nadke beat was identified as very important in terms of high species diversity and having maximum unique species hence indicating presence of diverse habitats and niches which supports high diversity.

The next protected area where the monitoring program must be ideally implemented is Bhagwan Mahavir Wildlife Sanctuary (BMWLS) and Mollem National Park (MNP), starting from the pre-monsoon season of 2018.

Introduction

Goa, India's smallest state, is located at the western coast of the country, with the Arabian Sea to the west and the Western Ghats in the east. The state's area is just 3,702 sq. km, that is represented by three major landscapes (Rodgers *et al.* 2000) (**Fig. 1**), which can be classified as coastal plains (coast), mid highlands (Malabar plains), and the Western Ghats. The coastal plain is a narrow low-lying stretch of land, extending approximately three to five kilometres inland along Goa's 110 km long coastline. This zone however, extends further inland- up to 17 km in the deltaic region of the state's two major rivers, Mandovi, and Zuari. The coastal plain has a mosaic of habitats which include, sandbars, tidal mudflats, creeks, riverine islands, estuarine mangroves, rocky headlands, and Goa's famous sandy beaches. This zone also contains various land-use types like saltpans, marshlands, paddy fields and plantations of coconut palms. An important and biodiversity rich land-use type in this zone is the *Khazan* lands, which are saline floodplains managed extensively for agriculture and pisciculture. Also of importance are the fragile mangrove ecosystems dotting the estuarine regions of the state, extending inland along major river banks. Mid highland is an intermediate zone between coastal planes and Western Ghats. In this zone, lateritic plateau is a characteristic and dominant feature. These plateaus are zones of high floral endemism which are naturally covered with various ephemeral grass and herb species that have growth season between monsoon and post-monsoon period of the year. In many places cashew *Anacardium occidentale* trees have been planted on these plateaus and on the slopes. The slopes and bases of these plateaus naturally have moist-deciduous, and semi-evergreen vegetation, which sustains rich biodiversity. An important man-made feature of this zone are the many tanks, which were historically constructed to store monsoon waters for irrigation. Water stored in these tanks are used for irrigation of the winter paddy crop along partially reclaimed riverbeds in what is known as the *Vaingan* agriculture. These tanks and the adjoining inundated fields are important wintering grounds for all types of migratory waterbirds in Goa and these tanks heavily depend on local water management systems. The Western Ghats, in Goa, extends in a north–south direction along the entire eastern boundary of the state for 125 km. The southern portion of the Ghats in Goa, protrudes out towards the Arabian Sea, at Cabo de Rama, and then curves back inland. The northern portion of Goa's Ghats comprise formations of the 'Deccan Trap' type, like those in southern Maharashtra (Watve 2013) and are characterised by a horizontal top and vertical slopes—often referred to as tabletops. The central- and southern regions of the Goa's Ghats have rounded peaks, and in the southern regions, are covered with grass, with densely forested slopes like those in Uttar Kannada District (Karnataka). This diverse amalgamation of various landscapes and land-use types makes Goa a very biodiverse state.

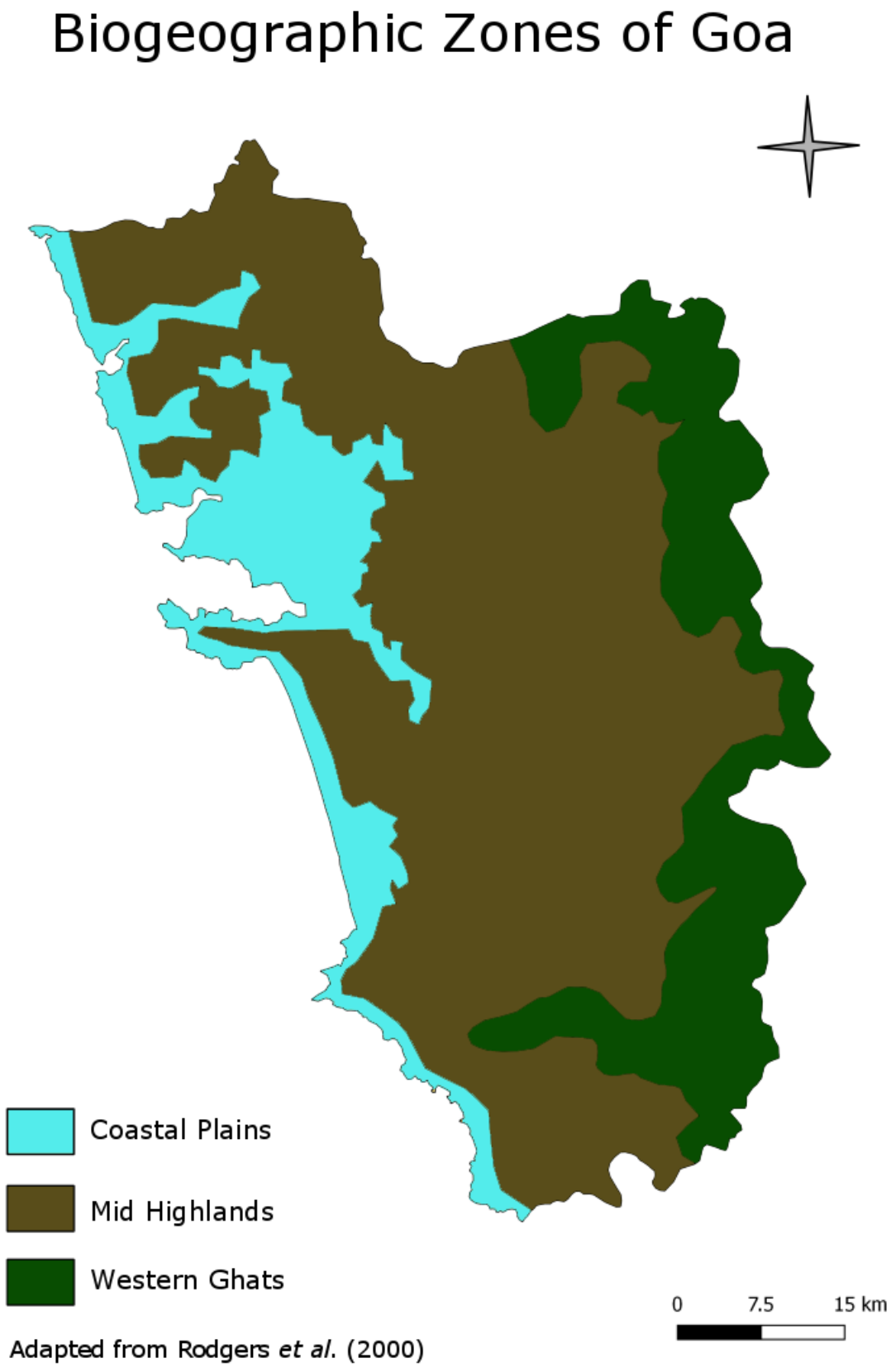

Fig. 1 Biogeographic zones of Goa showing the distribution of coastal plains, mid highlands and Western Ghats.

Goa has a unique distinction of having the maximum area under official protection as a proportion to its total area in comparison to any other state, with 22% of the state's area declared legally as protected areas. Goa has one national park and six wildlife sanctuaries (**Fig.2**) viz. Mollem National Park, Bhagwan Mahavir Wildlife Sanctuary, Bondla Wildlife Sanctuary, Cotigao Wildlife Sanctuary, Dr.Salim Ali Bird Sanctuary, Mhadei Wildlife Sanctuary and Netravali Wildlife Sanctuary encompassing an area of 769 sq. km.

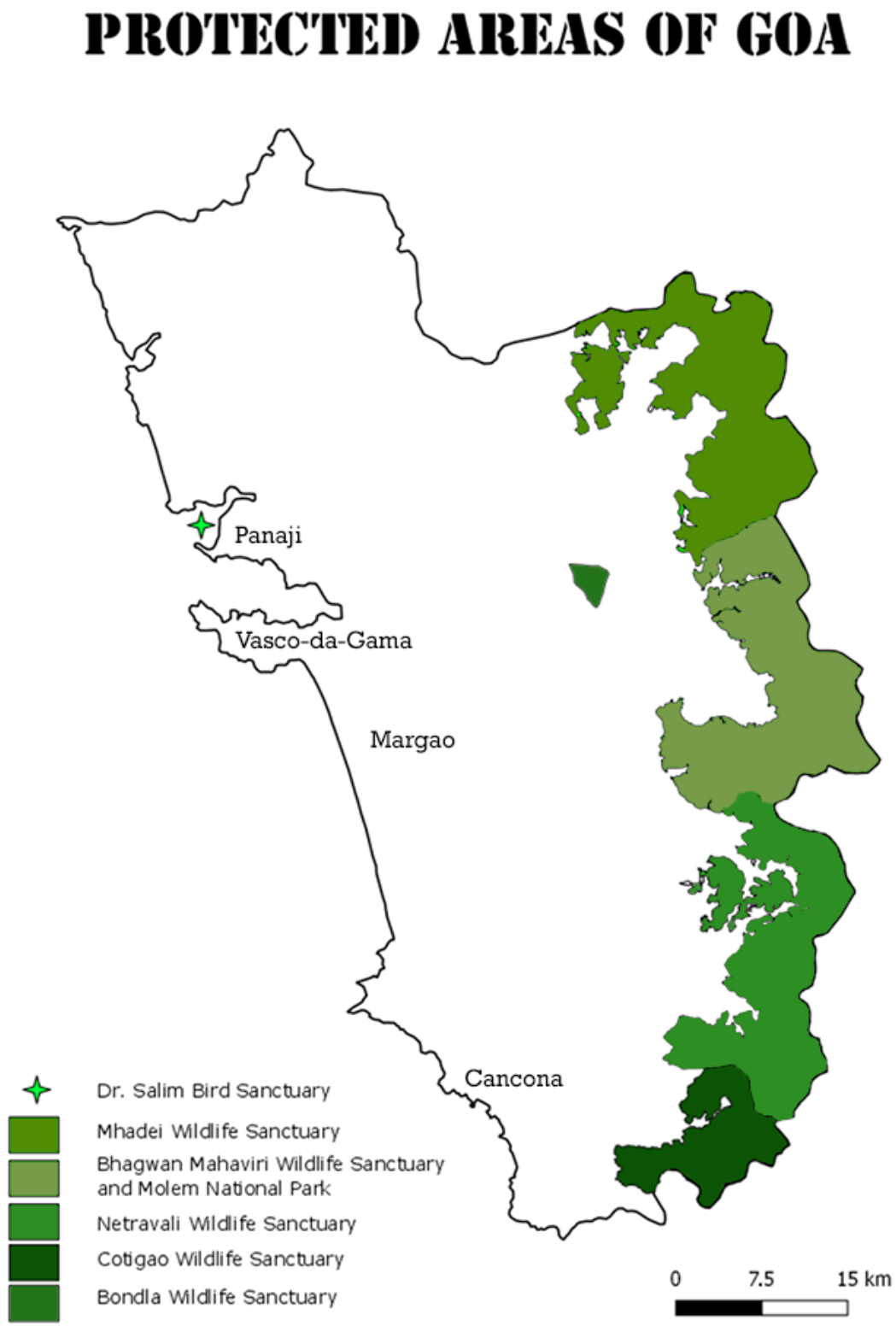

Fig.2: Protected area network of Goa

Cotigao Wildlife Sanctuary is located at the southern end of Goa in Cancona taluka. Established in 1969, it is one of the older protected areas of the state. The sanctuary is spread over an area of 88 sq. km, and is home to about 4000 people who live within it. While most hamlets fall outside the boundaries of the protected area, the hamlets of *Nadkem, Keri and Endrem* are situated within the protected area's boundary. The western end of the boundary is situated about 9 km away from the coast of Arabian sea at the fringes of which *Tirwal* village is located. The southern and south-eastern areas are contiguous with the *Kali* Tiger reserve, while the northern boundary is contiguous with *Netravali* wildlife sanctuary. Elevation of the sanctuary varies from 50 m at the western boundary to 843 m at the eastern boundary (Fig. 3a), the highest peak being *Ravan Dongr.* The river *Talpona* arises from the catchment areas of *Ravan Dongor* and flows west-wards for about 12 km before joining the Arabian sea at Cancona, while the *Galgibag* river gets fed by smaller streams from the southern ranges within the Sanctuary which meets the Arabian sea at *Mashem* village. The sanctuary is divided into seven beats (Fig. 3b) for administrative purposes as *Tirwal, Bella, Endrem, Nadkem, Kuskem, Edda and Zambolem* beats.

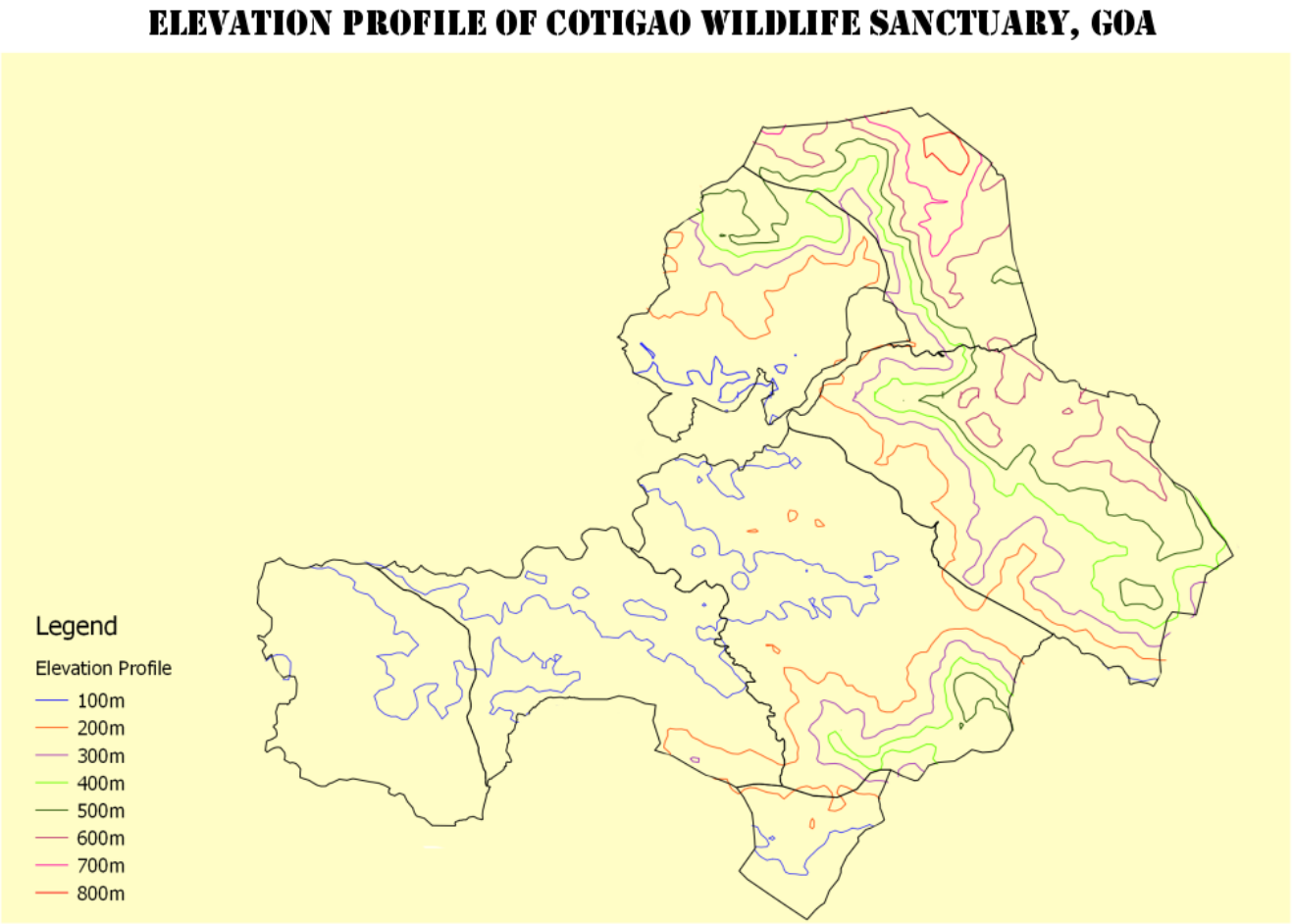

Fig. 3a: Elevation profile of Cotigao Wildlife Sanctuary. Elevation varies from 50 m to 800m and beyond culminating at 846 m.

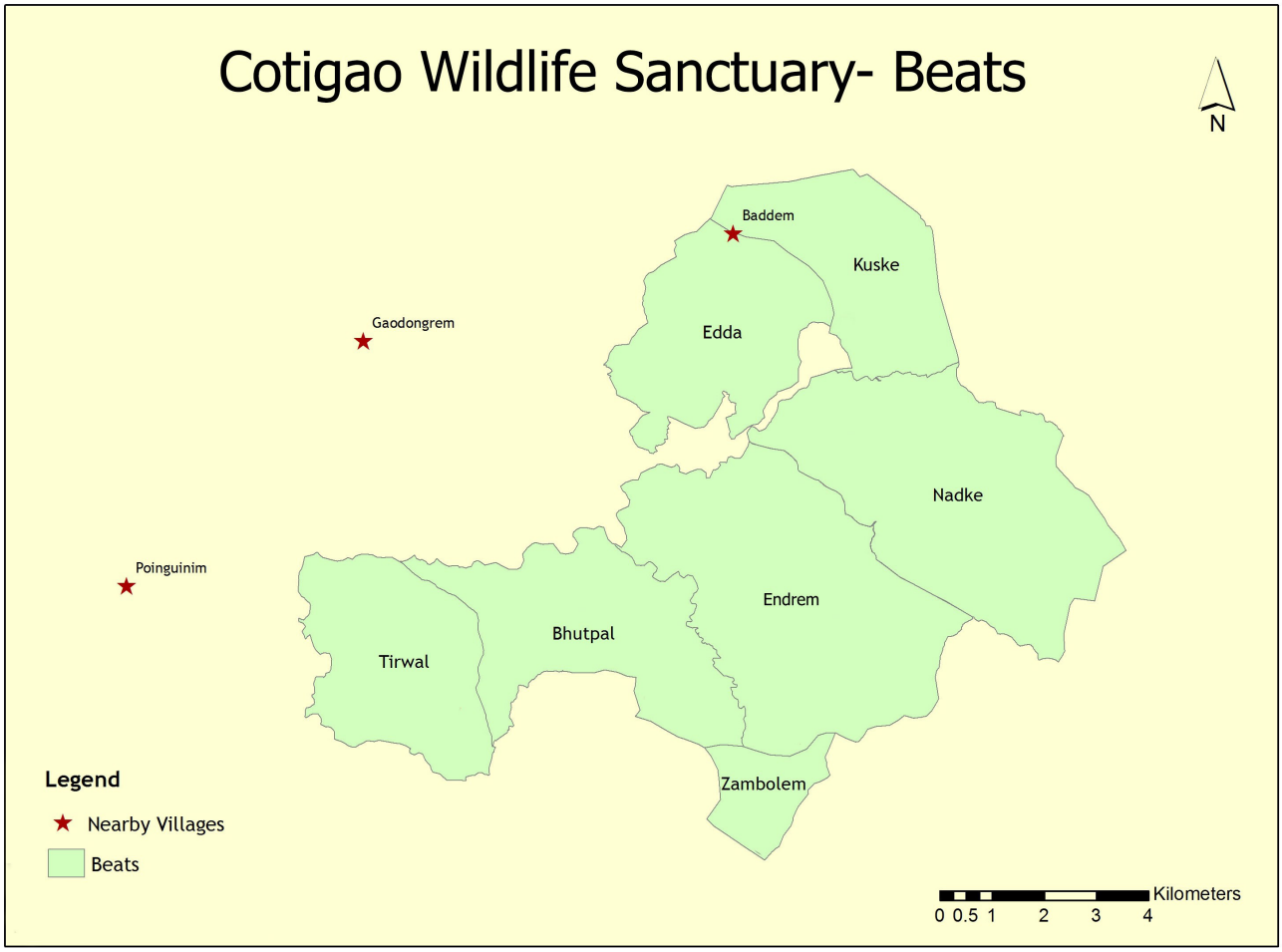

Fig. 3b: Beats within Cotigao Wildlife Sanctuary

The major forest types in the sanctuary include Moist Deciduous, Semi Evergreen and Wet Evergreen forests while zones with plantations and grasslands are classified separately as per BIS- dataset of Indian Institute of Remote Sensing Dehradun, India. Majority of the sanctuary is covered by Moist Deciduous and Semi Evergreen forest types with, pockets of Wet Evergreen forests on slopes which receive high rainfall (Fig.4).

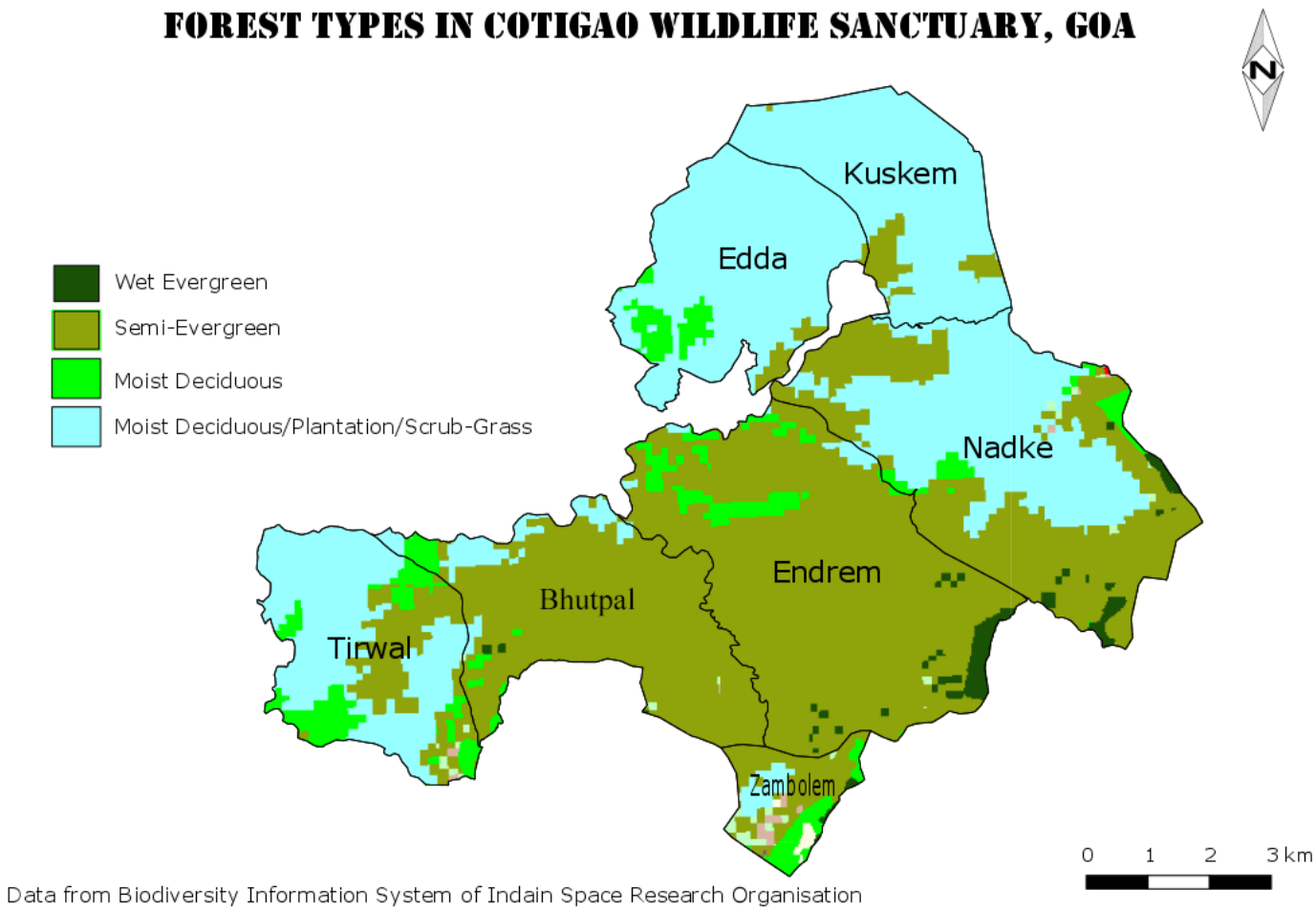

Fig.4: Forest Types in Cotigao Wildlife Sanctuary

Such multitude of habitat types within the sanctuary, makes this a very good area for diverse array of fauna which is sustained by well protected flora. Leopards Panthera pardus [1] are the top predators of these forests and it may not be surprising if a Tiger Panthera tigris from Kali tiger reserve has Cotigao within its home range. Sloth Bears Melursus ursinus are also sighted in the sanctuary especially during fruiting season. Gaurs Bos gaurus [2] are the large herbivores in this region, followed by Spotted Deer Axis axis, Sambar Deer Rusa unicolor and Indian Muntjac Muntiacus muntjak. Small mammals include Asian Palm Civet Paradoxurus hermaphroditus, Brown Palm Civet Paradoxurus jerdoni, Indian Crested Porcupine Hystrix indica, Indian Pangolin Manis crassicaudata, Indian Giant Squirrel Ratufa indica [3], Indian Giant Flying Squirrel Petaurista philippensis and Malabar Gray Slender Loris Loris lydekkerianus malabaricus [4]. The sanctuary also has a very good population of reptiles especially Hump-nosed Pit Viper Hypnale hypnale [5], Malabar Pit Viper Trimeresurus malabaricus and amphibians like the Malabar Gliding Frog Rhacophorus malabaricus, Bombay Bushfrog Raorchestes bombayensis and Amboli Bushfrog Pseudophilautus amboli [6].

Cotigao wildlife sanctuary however is known across the country as an excellent bird habitat. Estimated to be home to 224 species of birds, this sanctuary has been identified as an Important Bird and Biodiversity (IBA) by BirdLife International. Historical information on birds of Cotigao wildlife sanctuary come from notes of Goa based ornithologist, Heinz Lainer from his various trips to the sanctuary from early 1980's and surveys by Zoological Survey of India (Saha & Dasgupta 1992). Cotigao since the early 80's was known to be an im-

portant breeding habitat of the Malayan Night Heron *Gorsachius melanolophus* and Spot-bellied Eagle Owl *Bubo nipalensis*, while there are several historical records of scarcely recorded species like the Rosy Minivet *Pericrocotus roseus*, Black Baza *Aviceda leuphotes*, Dollarbird *Eurystomus orientalis* and Eurasian Woodcock *Scolopax rusticola* which have been evaluated recently (Baidya & Bhagat 2018).

LEOPARD 	SLENDER LORIS 
GAUR 	MALABAR GIANT SQUIRREL 
HUMP NOSED PIT VIPER 	AMBOLI BUSH FROG 

All information on the birdlife from Cotigao wildlife sanctuary where till recent, "snapshot" in nature, arising from short trips and visits by local and visiting birdwatchers, with information uploaded on eBird (Fig. 5), an online database of bird observations providing scientists, researchers and amateur naturalists with real-time data about bird distribution and abundance. However, a concrete database on the birds of the sanctuary which would not only address the fundamental question of how many species are present in the sanctuary but also answer more intriguing questions like, which bird species are common and which rare, which species does one have a higher probability of seeing in the winter in comparison to pre-monsoon months, how does the population of birds vary with seasons and answers to questions which will help the Forest Department make planning and policy decisions like, which beat has the highest population and diversity of birds, which beat has more concentration of endemic and threatened birds etc. was absent till recently.

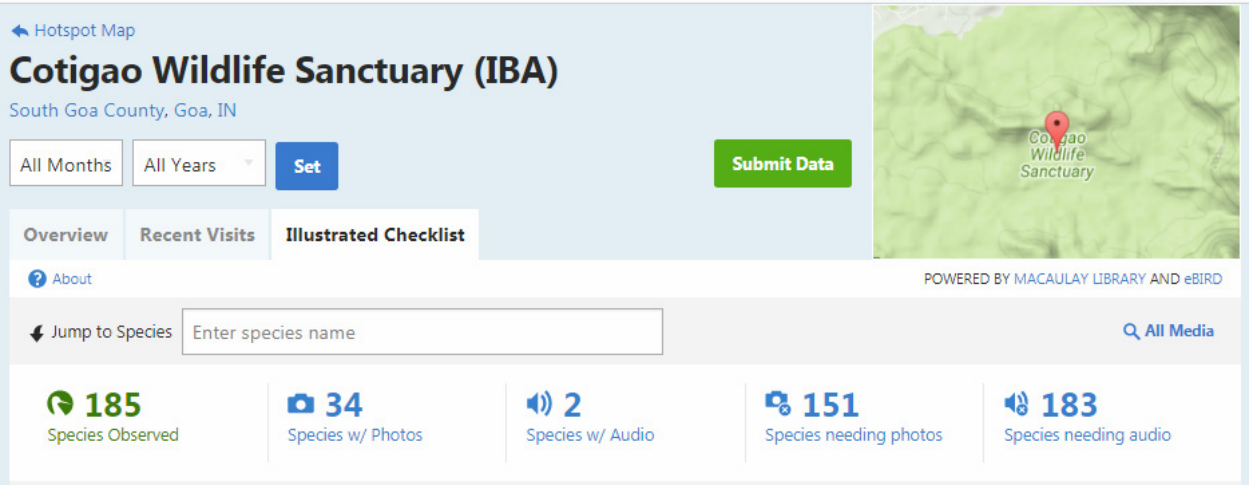

Fig. 5: 185 species reported on eBird from Cotigao Wildlife Sanctuary

In early December 2015, after a lot of brainstorming and discussions about the need for initiating a program which would build a robust database on birds from Goa's protected areas, the then President and Vice President of Goa Bird Conservation Network, Parag Rangnekar and Pronoy Baidya met the Principal Chief Conservator of Forests/ Chief Wildlife Warden of Goa Forest Department Shri. Ajai Saxena on 21 December 2015 with a proposal for conducting "Long Term Bird Monitoring" in the state's protected areas. The present technical report is a result of a year's hard work by officials from Goa Forest Department, Managing Committee of Goa Bird Conservation Network (GBCN), members of GBCN and various survey volunteers who have braved tough conditions and harsh terrain to put into place Goa's first robust annual bird monitoring data.

This technical report will provide detailed information regarding, how his project was conceptualised and implemented on ground following protocols based on scientific methodologies along with results arising from robust analysis of data using latest and well-established techniques which not only answers questions of a curious mind, but also provides various technical information for policy makers.GBCN is a non-profit, membership based society registered under the Societies Registration Act of 1860. Based in Goa, the Network's mandate is to work towards documenting birds of the State through scientific methods and citizen science approach while advocating protection of their habitats by generating information about the importance of such regions for the benefit of policy and decision makers, government departments and other non-governmental organizations in the state of Goa. GBCN started off in 2006 when a group of enthusiastic birdwatchers under the umbrella of Indian Bird Conservation Network, which was then headed by noted ornithologist and wildlife artist, Late Carl D'Silva, met and decided to form a network of likeminded birdwatchers and provide a platform for other novice bird watchers to grow and share information. What started as an informal group soon turned serious and to have the desired impact locally, GBCN registered itself as a non-profit society in 2015.

Concept Development

It is well documented in scientific literature that long term monitoring programs are essential to formulate management programs for the conservation of habitats. Long term monitoring programs have a distinction of being able to assess the outcomes of various management programs and provide a chance to implement adaptive management practices. Birds in particular have been a focus taxon for long term monitoring activities because they are highly diverse, easy to detect, better known than other vertebrate groups and are the best available indicators of overall habitat quality

Estimation of population sizes and status is one of the first and most basic step towards developing any kind of management and conservation strategy for a bio-diverse area and Goa being part of the mega-diverse Western Ghats still did not have a region-wide monitoring program for the protected areas, that can provide data on the status of endemic, resident and migratory species of forest birds to infer whether conservation efforts in the protected areas meet their needs as of 2015.

Looking at this huge lacuna of information on the bird life from Goa's protected areas, a need for long term region-wide monitoring program was felt, to assess the gaps in protection, evaluate strategies for addressing threats, improving implementation of management plans in protected areas, understanding migration patterns and population trends related to ongoing and expected impacts of environmental changes. It was envisaged that developing such a program would require a coordinated effort to design a common protocol for monitoring forest birds throughout the various habitat types, train volunteers and especially forest guards in the field, devising monitoring techniques, funding to implement and sustain the program in the long term.

Hence, with this understanding and background information, the working committee members of GBCN's research committee, went about designing a robust monitoring program which included training for the forest staff and survey volunteers, development of a scientific survey protocol, pilot surveys, GIS analysis, survey design, logistics and planning all of which were done in conjunction with the Goa Forest Department and specific goals and objectives were set.

Goals and Objectives

The long-term bird monitoring project's first intent was to quantitatively survey the bird population of Cotigao Wildlife Sanctuary and create a robust database. This would be achieved initially by using help of volunteer birdwatchers from Goa and eventually build capacity and confidence within the local community and forest guards of the Goa Forest Department to monitor bird populations and thus collect data that can be used to direct management programs within protected areas in the long run.

Another objective was to engage local communities who are located at the perimeter of the protected areas and have potentially more stake involved in such monitoring programs, by conducting various outreach activities in panchayats and schools around the protected area with the aim of getting them involved in the monitoring program.

What GBCN did differently to achieve these Goals?

- Conducted workshops to build skills and confidence among forest guards and local volunteers for surveys of long term bird monitoring programs, so that the surveys can happen in a cost-effective way, in future.

- Developed the monitoring program with inputs from experts of other nationally acclaimed organizations and agencies.

- The results from the program were presented in an easily interpretable set of three interim reports to the Goa Forest Department with added information on bird populations beat-wise.

- Used eBird (www.ebird.org) as a central repository to archive all quantitative data obtained by the survey.

- Used GBCN's website (www.birdsofgoa.org) to maintain a permanent repository of qualitative data like photographs, audio recordings and videos of birds.

- Provided, updates on the status of the project on GBCN's social media page at regular intervals.

- Have conducted outreach workshops and capacity building activities for local school children living at the perimeters of protected areas to infuse within the youths a sense of responsibility towards the forests of Goa and ensure their active participation in all planning and monitoring activities in the future as a part of pre-Bird Festival event.

Development of Project Methodology and Execution

The entire project was structured in four modules as below:

Module 1: a) Formation of a working group and assigning tasks to responsible individuals.

b) Development of survey methodology/ protocols in collaboration with Goa Forest Department and other agencies of national repute.

Module 2: a) Preparation of manuals for the program b) Conducting training workshops for capacity and confidence building amongst forest guards of GFD, volunteers and local communities.

Module 3: Pilot implementation of monitoring program at Cotigao Wildlife Sanctuary to assess the robustness of the methodology and address lacuna in the survey protocol and/or other practical difficulties.

Module 4: a) Gradual scale up and implementation of the monitoring program at all protected areas of Goa with real-time updation and analysis of data generated b) Submission of detailed annual reports to the Goa Forest Department.

Module 1:

Task	Process	Indicators of Success	Completion date
Formation of working group	Discussion with officials of GFD and members of GBCN	Identifying and assigning individuals for respective tasks.	February 2016
Development of survey methodology	Development of protocol by discussions with scientists, researchers, ornithologists and decision makers from GBCN, BCI, IBCN, WI and GFD	Survey strategy developed and circulated for review.	June 2016

Module 2:

Task	Process	Indicators of Success	Completion date
Preparation of manauls	1) Designing of two picture manuals of birds with a system of codes a) forest birds b) wetland birds. 2) Designing survey protocol manuals	Printing	April 2016
Conducting training workshops	Planning and designing workshops for 1) forest guards of GFD 2) survey volunteers 3) bird camps for schools in the vicinity of protected areas	Approval of workshop plans and notification of workshop dates	July-August 2016

Module 3:

Task	Process	Indicators of Success	Start date
Pilot implementation at Cotigao WLS	One year pilot implementation of survey protocol, data analysis, interpretation and real-time updation. Assessment of data quality and performance by forest guards and volunteers	Finding voids in the protocol, manual, analysis, interpretation and updation. Identification of practical difficulties. Initiation of rectification and review process.	October 2016

Module 4:

Task	Process	Indicators of Success	Completion date
Gradual scale-up in implementation of program	Conducting and monitoring efficiency of survey, data analysis, interpretation and real-time updation of data.	Reviews from experts on data and results. Use of data by GFD for management decisions.	From October 2017 to 2021

THE PROJECT IS CURRENTLY IN MODULE 4, AND SET FOR IMPLEMENTATION IN BHAGWAN MAHAVIR WILDLIFE SANCTUARY AND MOLLEM NATIONAL PARK FROM PRE-MONSOON SEASON OF 2018.

List of documents that have been developed to aid this project:

1. Checklist of Birds of Goa [7]
2. Checklist of Birds of respective protected areas (Cotigao Wildlife Sanctuary)
3. Picture manual for birds (booklet format) [8]
4. Survey protocol manual
5. Workshop report
6. Interim report (three reports submitted till date) [9]
7. Annual technical report [10]

7. Checklist of Birds of Goa, published in Indian BIRDS Journal.

8. Picture manual for Birds of Cotigao Wildlife Sanctuary.

9. Interim Reports submitted to Goa Forest Department.

10. Annual Technical Report.

Time Series of project

- Working proposal for implementation of "Long Term Bird Monitoring" in the state's protected areas submitted to Principal Chief Conservator of Forests/ Chief Wildlife Warden of Goa Forest Department Shri. Ajai Saxena on 21 December 2015.
- In the Annual General Body Meeting of GBCN held on 27 May 2016, a working group was formed with responsibilities for individual tasks delegated between members.
- On 8 July 2016 final structure of sub-committees and details of working group was charted.
- On 8 August 2016, five members of the working group responsible for designing survey methodology and protocols visited Range Forest Officer (RFO) of Cotigao Wildlife Sanctuary, Shri. Vikramaditya Naik Gaonkar to discuss with him logistics and procure information about beats and ranges within the sanctuary along with other preliminary ground information. On the same day the working group also procured beat and range maps of the sanctuary from the RFO's office for digital mapping and planning of the survey using GIS.
- On 21 August 2016, four members of the working group responsible for reconnaissance survey and ground truthing visited five potential transects within *Tirwal* and *Bhutpal* beats of the sanctuary.
- On 24 August 2016, an initial map of Cotigao Wildlife Sanctuary including beats and ranges was developed based on the information procured from the RFO's office and the initial reconnaissance survey.
- On 14 September 2016, a final map of Cotigao Wildlife Sanctuary with all potential transects was made available.
- On 15 September 2016, final work on designing of "Birds of Cotigao Wildlife Sanctuary" a survey manual designed especially for the forest staff and volunteers of the survey was initiated.
- On 20 September 2016, protocol to be followed for the surveys was finalized and it was decided that a modified version of the MacKinnon's listing will be used.
- On 28 September 2016, two picture manuals were printed and deemed ready for use.
- On 29 September 2016, members of the working group, responsible for conducting training workshop for forest staff of Cotigao Wildlife Sanctuary decided the structure and overall flow of the workshop.
- On 30 September 2016, training workshop for forest staff of Cotigao Wildlife Sanctuary was conducted and report submitted on 10 October 2016.
- On 22 & 23 October 2016, 1st survey (post-monsoon season) was conducted at Cotigao Wildlife Sanctuary and interim report submitted on 15 January 2017.
- On 18 & 19 February 2017, 2nd survey (winter season) was conducted at Cotigao Wildlife Sanctuary and interim report submitted on 15 July 2017.
- On 20 & 21 May 2017, 3rd survey (pre-monsoon season) was conducted at Cotigao Wildlife Sanctuary and interim report submitted on 12 August 2017.

Planning of Survey, Identification and Mapping of Transects in Cotigao Wildlife Sanctuary

Between 8 and 24 August 2016, the reconnaissance and mapping team of GBCN, visited Cotigao Wildlife Sanctuary and conducted a series of pilot bird surveys to ascertain potential transects to conduct the monitoring surveys. Transects were chosen keeping in mind, logistics and equal habitat representation while ensuring that all beats were also properly represented. To achieve this, all motorable internal roads were marked using GPS to help in planning logistics for the survey. Next, based on the pilot surveys along marked roads and tracks, 12 transects were identified for surveys on map (Fig. 6).

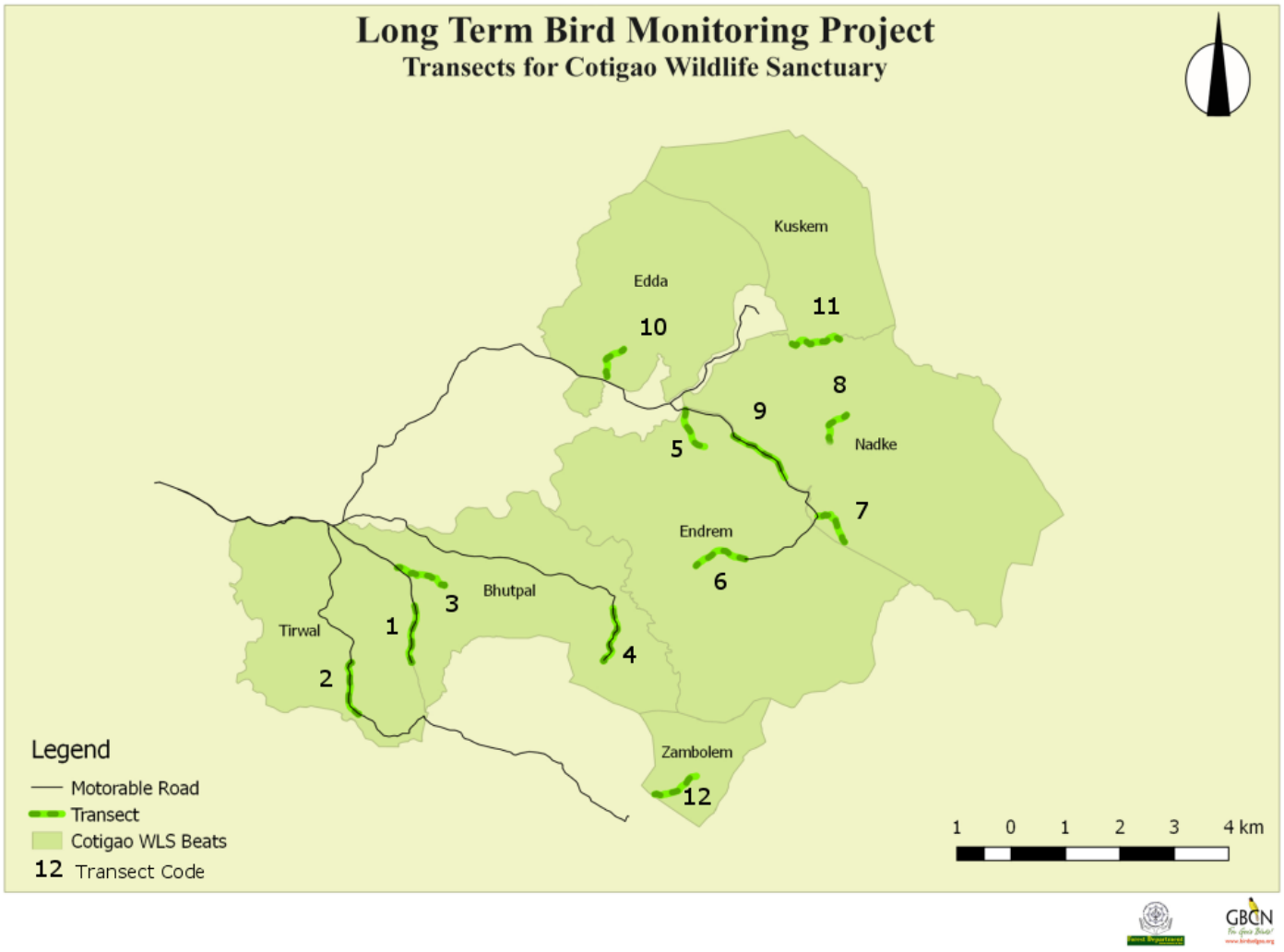

Fig. 6: Transects identified in Cotigao Wildlife Sanctuary for three season survey of birds

Training Workshop for Forest Staff of Cotigao Wildlife Sanctuary

30 September 2016, members of Goa Bird Conservation Network, conducted training workshop for forest staff of Cotigao Wildlife Sanctuary. This workshop was aimed to create excitement within the forest staff of the sanctuary towards birds/ bird watching and generate interest in them to take up bird watching actively so that it can translate to a long-term monitoring effort. The workshop was structured into two sessions- morning session which was indoor and evening session which was outdoors.

Morning session comprised of five interactive discussion and lecture series as listed below:

- Introduction to the workshop and workshop members— Parag Rangnekar
- Introduction to birds of Cotigao Wildlife Sanctuary— Prasanna Parab [14]
- Using bird calls to identify birds— Pankaj Lad [13]
- Importance of monitoring and understanding survey protocol for Cotigao Wildlife Sanctuary— Pronoy Baidya
- Do's & don'ts while bird watching— Omkar Dharwadkar

Throughout these sessions, it was ensured that there was constant interaction with the forest staff and all possible efforts were made to make the entire exercise engaging.

During the evening session, the forest staff along with the workshop members from GBCN went on one of the transects marked for the survey where a hands-on demonstration on how to use birdcalls to identify birds, how to use binoculars, how to perform the survey, how to enter data in the datasheet during surveys and other nuances of the monitoring program were explained in detail [15, 16].

11 . Range Forest Officer Shri. Vikramaditya Naik Gaonkar inaugurating the workshop.

12. Participants of Workshop listening to introductory session.

13. Pankaj Lad conducting session on how to recognize bird calls

14. Prasanna Parab conducting session on Birds of Cotigao Wildlife Sanctuary

15. Parag Rangnekar explaining field protocols

16. Workshop organisers and participants

Logistic planning of Survey and Marking of Transects in Cotigao Wildlife Sanctuary

Members of the survey planning team of GBCN, visited Cotigao Wildlife Sanctuary multiple times between 1 and 20 October 2016, and long with forest officials of Cotigao Wildlife Sanctuary planned logistics of the survey and physically mark transects on ground using paint so that the transects are marked permanently.

17. Transects being marked in Bhutpal beat by forest guards

18. GBCN Planning team members along with forest officials searching for source of a mysterious bird call in Kuskem beat while transect marking

19. Transects being marked in Zambolem beat

Survey Methodology

Every survey participant/ volunteer was assigned to a particular transect which had been marked to carry out the survey. The survey method was a modified version of MacKinnon's listing. Detailed instructions for carrying out the survey and to fill the datasheets are explained below.

Survey:

Walk at a slow but constant pace. **DO NOT** spend a lot of time at a single place unless you encounter very high bird activity at a particular point on the transect.

Record all birds that you can see 50 meters on either side of the transect including birds in flight (raptors). Include those species too which you are able to identify through calls but are not able to see.

DO NOT guess the identity of a species and report it. In case you are not sure about the identity of the species **DO NOT** include it in the list.

Data Sheet:

The Data sheet in which sightings must be recorded with an explanation about the fields is below:

Long-term Bird Monitoring Project- Goa

Data Sheet No. : ___

Sanctuary Name: **Cotigao Wildlife Sanctuary**; Beat Name:_____; Transect No. : __

Date:	Start Time:	End Time:	Sample No. :
Weather Condition:			
S.No.	Species	Number of Individuals (Use statistic marks)	Total
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
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15			

Data Sheet No. : This is nothing but the serial number of the page.

Beat Name: This is the name of the beat within the sanctuary where the transect is marked. Ask organizers/ Forest Dept. staff for details on this and enter in the data sheet.

Transect No. : Each Transect has a number. Ask organizers/ Forest Dept. staff for details on this and enter in the data sheet.

Date: Date in DD/MONTH/YYYY format on which survey is done eg. 24/November/2016.

Start Time: Time at which entry is started.

End Time: Time at which entry is completed.

Sample Number: Table number, ie: there will be many such tables with 15 rows each in the data sheet. Table number would mean how many such tables you are using to enter data (more details in section below).

Species: Name of the Bird.

Number of Individuals (Use Statistic Mark): Whenever you see a bird say you saw one House sparrow, use a "|" symbol to note it. If you saw three birds, use the symbol "|||", if you saw five birds use "𝍸". Tally symbols of numbers up to ten are given below:

1	|	6	𝍸 |
2	||	7	𝍸 ||
3	|||	8	𝍸 |||
4	||||	9	𝍸 ||||
5	𝍸	10	𝍸 𝍸

Total: Add up all the tally marks to represent the total number of birds recorded from that list.

Entering Data:

Before starting to observe birds, write down all relevant information in the sheet like Date, Start Time, Sample Number and Weather Condition. Under Weather, describe briefly if the sky was clear & sunny/cloudy/ drizzling with mention about the wind conditions and humidity.

When you start observing birds, start listing species as you encountered them in the order of your encounter. For example, if Red-whiskered Bulbul is the first bird that you observed write it besides S.No. 1. If you saw one individual of the Red-whiskered Bulbul, under the "Number of Individuals" column write "|" which means one. Your datasheet should look as below after entering this:

Date: 24/November/2016	Start Time: 6.15 am	End Time: 6.45 am	Sample No. : 1
Weather Condition: Sunny, with mild wind. Humidity medium			
S.No.	Species	Number of Individuals (Use statistic marks)	Total
1	Red-whiskered Bulbul	|	
2			
3			

Suppose the next bird that you encounter is the Jungle Myna and you have seen six of them, input data as below:

Date: 24/November/2016	Start Time: 6.15 am	End Time: 6.45 am	Sample No. : 1
Weather Condition: Sunny, with mild wind. Humidity medium			
S.No.	Species	Number of Individuals (Use statistic marks)	Total
1	Red-whiskered Bulbul	|	
2	Jungle Myna	𝍸 |	
3			

Suppose you observe another Red-whiskered Bulbul after the Jungle Myna, do not enter it again in row three (S. No. 3), and instead just add another "|" in row one (S. No. 1) itself as below:

Date: 24/November/2016	Start Time: 6.15 am	End Time: 6.45 am	Sample No. : 1
Weather Condition: Sunny, with mild wind. Humidity medium			
S.No.	Species	Number of Individuals (Use statistic marks)	Total
1	Red-whiskered Bulbul	||	
2	Jungle Myna	𝍸 |	
3			

Keep repeating this procedure until you have noted down fifteen birds. When this happens, note the time and enter it. Your list should look as below upon entering all fifteen species:

Date: 24/November/2016	Start Time: 6.15 am	End Time: 6.45 am	Sample No. : 1
Weather Condition: Sunny, with mild wind. Humidity medium			
S.No.	Species	Number of Individuals (Use statistic marks)	Total
1	Red-whiskered Bulbul	𝍸 ||||	9
2	Jungle Myna	𝍸 |	6
3	Orange Minivet	||||	4
4	Oriental Magpie Robin	||	2
5	Tickell's Blue Flycatcher	||	2
6	Purple Sunbird	|||	3
7	White-cheeked Barbet	||||	4
8	Indian Paradise Flycatcher	||	2
9	White-rumped Shama	|	1
10	Malabar Trogon	||	2
11	Grey-breasted Prinia	||	2
12	Black-rumped Flameback	||	2
13	Grey-fronted Green Pigeon	𝍸 𝍸 𝍸 𝍸 ||||	39
14	Common Tailorbird	|||	3
15	Black-naped Monarch	||	2

After you have noted down fifteen birds in the first table, start this process again in a new table. In the new table, you can enter birds that you had entered in the previous table too. In short, you can enter the same bird species in different tables but **cannot** repeat the same bird species in one table.

Date: 24/November/2016	Start Time: 6.45 am	End Time: 7.05 am	Sample No. : 2
Weather Condition: Sunny, with mild wind. Humidity medium			
S.No.	Species	Number of Individuals (Use statistic marks)	Total
1	Red-whiskered Bulbul	𝍸 𝍸 ||||	14
2	Nilgiri Flowerpecker	||	2
3	Tickell's Blue Flycatcher	|	1
4	Black-naped Monarch	|	1
5	Crimson-backed Sunbird	||||	4
6	Malabar Pied Hornbill	|||	3
7	Oriental Honey Buzzard	|	1
8	Malabar Barbet	||	2
9	Indian Paradise Flycatcher	|	1
10	Oriental Magpie Robin	|	1
11	Purple-rumped Sunbird	|	1
12	Grey-breasted Prinia	||	2
13	Yellow-browed Bulbul	||||	4
14	Malabar Parakeet	𝍸 |	6
15	Rose Finch	𝍸 ||||	9

An entire filled data sheet will look as shown below.

Long-term Bird Monitoring Project- Goa

Data Sheet No. : 1

Sanctuary Name: **Cotigao Wildlife Sanctuary**; Beat Name: Edda Beat ; Transect No. : 1

Date: 24/November/2016	Start Time: 6.15 am	End Time: 6.45 am	Sample No. : 1
Weather Condition: Sunny, with mild wind. Humidity medium			
S.No.	Species	Number of Individuals (Use statistic marks)	Total
1	Red-whiskered Bulbul	𝍸 ||||	9
2	Jungle Myna	𝍸 |	6
3	Orange Minivet	||||	4
4	Oriental Magpie Robin	||	2
5	Tickell's Blue Flycatcher	||	2
6	Purple Sunbird	|||	3
7	White-cheeked Barbet	||||	4
8	Indian Paradise Flycatcher	||	2
9	White-rumped Shama	|	1
10	Malabar Trogon	||	2
11	Grey-breasted Prinia	||	2
12	Black-rumped Flameback	||	2
13	Grey-fronted Green Pigeon	𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 ||||	39
14	Common Tailorbird	|||	3
15	Black-naped Monarch	||	2
Date: 24/November/2016	Start Time: 6.45 am	End Time: 7.05 am	Sample No. : 2
Weather Condition: Sunny, with mild wind. Humidity medium			
S.No.	Species	Number of Individuals (Use statistic marks)	Total
1	Red-whiskered Bulbul	𝍸 𝍸 ||||	14
2	Nilgiri Flowerpecker	||	2
3	Tickell's Blue Flycatcher	|	1
4	Black-naped Monarch	|	1
5	Crimson-backed Sunbird	||||	4
6	Malabar Pied Hornbill	|||	3
7	Oriental Honey Buzzard	|	1
8	Malabar Barbet	||	2
9	Indian Paradise Flycatcher	|	1
10	Oriental Magpie Robin	|	1
11	Purple-rumped Sunbird	|	1
12	Grey-breasted Prinia	||	2
13	Yellow-browed Bulbul	||||	4
14	Malabar Parakeet	𝍸 |	6
15	Rose Finch	𝍸 ||||	9

Name of Volunteers: Omkar Dharwadkar, Prasanna Parab, Pronoy Baidya

Ensure that you hand over the datasheets to the survey coordinator upon the completion of the survey.

Snapshots from Three Surveys

Survey 1 (22 & 23 October 2016- Post-Monsoon Season)

20. Parag Rangnekar briefing survey volunteers on do's and don'ts while staying in Cotigao Wildlife Sanctuary

21. Survey volunteers and participants standing for a group photograph before commencement of the survey

22. Pronoy Baidya instructing and assigning volunteers to their respective transects

23. Transect in *Bhutpal* Beat

24. Survey at *Nadke* beat in progress

25. Post survey validation of data with survey volunteers

115 species have been recorded from the 12 transects. Of the 115 species, the Crimson-backed Sunbird *Leptocoma minima* was found to be the most abundant with 200 individuals counted and evenly distributed species in the sanctuary being observed in all 12 transects, followed by the Yellow-browed Bulbul *Iole indica* and Greater Racket-tailed Drongo *Dicrurus paradiseus* all of which are resident birds. Among the migrant birds, Ashy Drongo *Dicrurus leucophaeus*, Green Warbler *Phylloscopus nitidus* and Greenish Warbler *Phylloscopus trochiloides* were the most dominant and evenly distributed species. Of the 115 species recorded, 21 were migrant species whereas 94 were resident species. A very interesting and encouraging observation was the record of Malabar Grey Hornbill *Ocyceros griseus* from 11 transects. A total of 83 individuals were counted in three visits. Hornbills are considered as indicators of ecosystem health, and sightings of good numbers of this species indicate towards the good state of the forests.

Survey 2 (18 & 19 February 2017- Winter Season)

26. Survey volunteers and forest officials in a group photograph

27. Transect in *Endrem* beat

28. Rajiv D'Silva photographing the elusive Srilanka Frogmouth *Batrachostomus moniliger*

29. *Tulshimol* waterhole in *Bhutpal* beat.

142 species have been recorded from the 12 transects. Of the 142 species, the Crimson-backed Sunbird *Leptocoma minima* was found to be the most abundant and evenly distributed species in the sanctuary being observed in all 12 transects, followed by the Malabar Barbet (Crimson-throated Barbet) *Psilopogon malabaricus* and Malabar Grey Hornbill *Ocyceros griseus* all of which are resident birds. Among the migrant birds, Ashy Drongo *Dicrurus leucophaeus*, Green Warbler *Phylloscopus nitidus* and Greenish Warbler *Phylloscopus*

trochiloides were the most dominant and evenly distributed species. Of the 142-species recorded, 20 were migrant species whereas 122 were resident species.

Survey 3 (20 & 21 May 2017- Pre-Monsoon Season)

105 species have been recorded from the 12 transects. Of the 105 species, Asian Fairy-bluebird - *Irena puella*, Bronzed Drongo - *Dicrurus aeneus*, Crimson-backed Sunbird (Small Sunbird) - *Leptocoma minima*, Greater Racket-tailed Drongo - *Dicrurus paradiseus*, Malabar Barbet (Crimson-throated Barbet) - *Psilopogon malabaricus*, Malabar Grey Hornbill - *Ocyceros griseus* and Nilgiri Flowerpecker - *Dicaeum concolor* were recorded from all transects. Of these Crimson-backed Sunbird and Nilgiri Flowerpecker were the top two abundant species with 131 and 106 individuals recorded respectively. Among the migrant birds only Ashy Drongo - *Dicrurus leucophaeus* and Asian Brown Flycatcher - *Muscicapa dauurica* were recorded. While the Asian Brown Flycatcher could be passage individuals on their return migration, Ashy Drongos are known to leave very late in the season.

30. Survey Volunteers listening to calls of nocturnal birds during night survey

31. Post survey data validation by survey leads

32. Transect in *Nadke* Beat

33. Survey volunteers take a break and try to get a glimpse of the Speckled Piculet *Picumnus innominatus*

Results

From the three survey efforts, a total of 167 species (165 species as per treatment in Baidya & Bhagat 2018) representing 15 Orders and 52 families have been reported from Cotigao Wildlife Sanctuary (Appendix 1). Species richness was highest in winter survey with 142 species being counted from the 12 transects (Fig.7). This is expected since, the resident bird population is supplemented by migrant species. Of the 142-species counted in winter survey, 20 species were migrants (long distance migrants and local migrants). Of the 20 species, Ashy Drongo and Green Warbler were the most frequently encountered species which were also recorded from all the transects in winter.

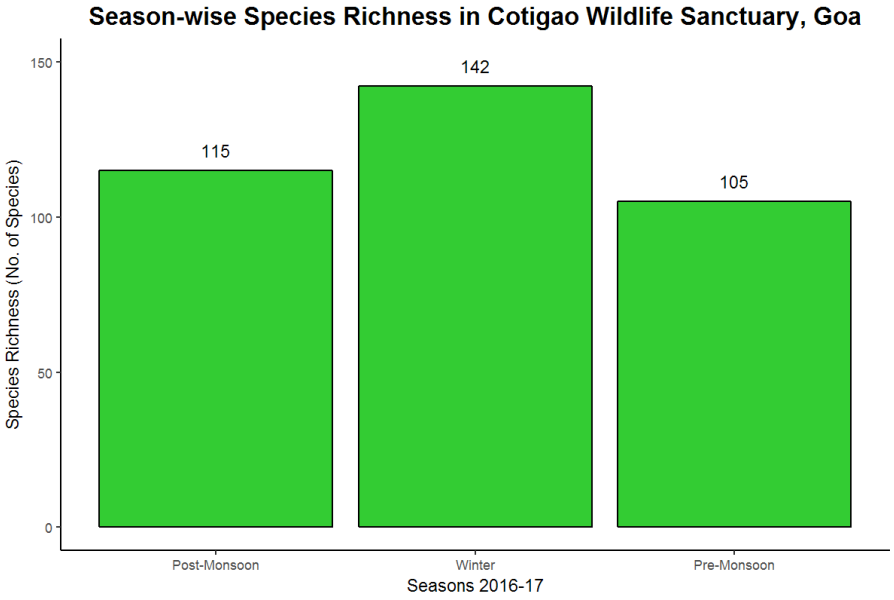


Fig.7: Season-wise cumulative species richness in Cotigao Wildlife Sanctuary

The number of migrant species rose and fell as expected, across the three seasons with maximum migrants being recorded from winter season (Fig.8), which is the peak migratory season preceded by post-monsoon season when most of the passage migrants and early arriving migrants were recorded. A total of 26 migratory species were recorded from this survey cumulatively, which includes three local migrants, which are known to evade monsoons in Goa viz. Black Kite *Milvus migrans*, Indian Golden Oriole *Oriolus kundoo* and Indian Paradise-Flycatcher *Terpsiphone paradise*. Two species of migrants- Ashy Drongo and Asian Brown Flycatcher *Muscicapa dauurica* and two local migrants- Indian Golden Oriole *Oriolus kundoo* and Indian Paradise-Flycatcher *Terpsiphone paradise* were recorded in all the three surveys. The local migrants are known to leave just before the start of monsoons and arrive shortly after monsoon concluded in Goa. Ashy Drongo is known to be an early arriving migrant most individuals probably in passage, while leaves late in the season. The Asian Brown Flycatchers also could follow similar patterns, however very less information exists to ascertain this.

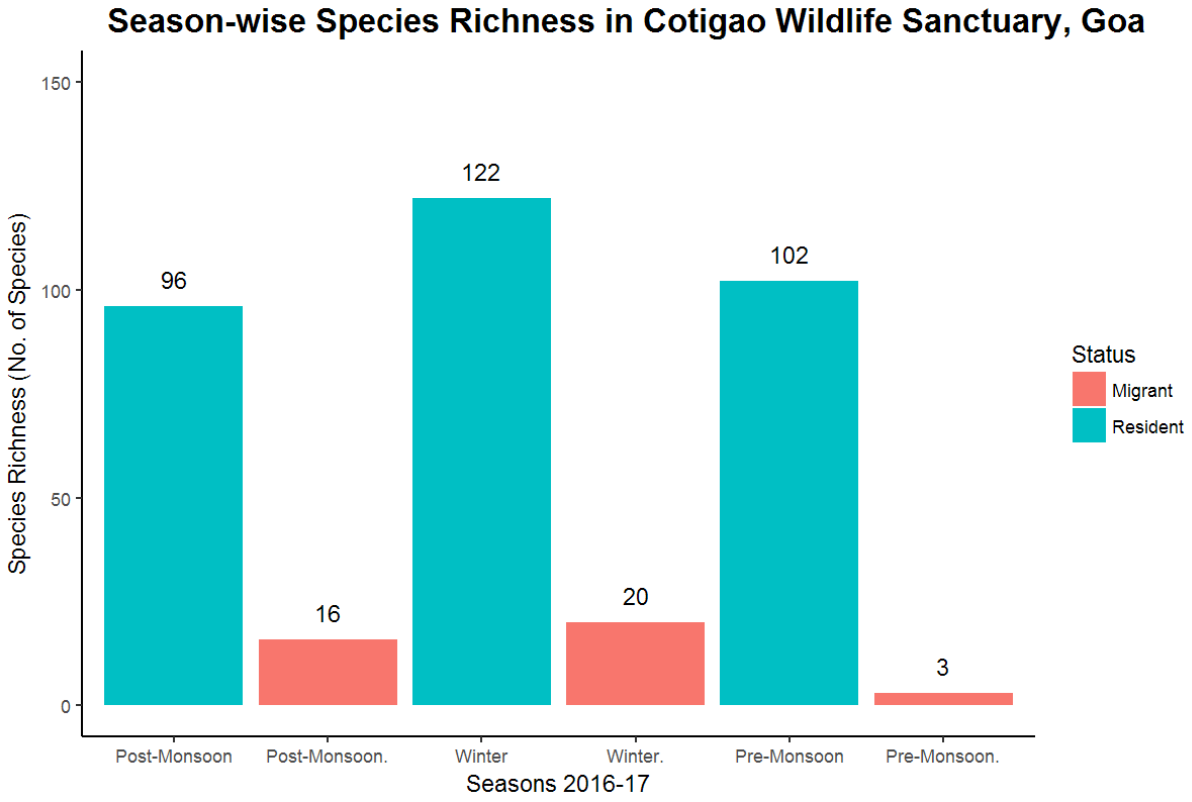


Fig.8: Season-wise resident/migrant species richness in Cotigao Wildlife Sanctuary

Of the 167-species recorded, 77 species were recorded across all the three seasons (Fig.9), of which 73 were resident species (Fig.10). It is interesting to note that in the winter season survey, 24 unique species (not recorded in other two surveys) of resident birds were recorded. This includes six species from the swift-swallow-martin group, four species of raptors, and four species of nocturnal birds while the rest of the species are habitat restricted residents of Goa (wetland birds), species which make seasonal elevational movements like Square-tailed (Black) Bulbul *Hypsipetes ganeesa* and in general rare species like Yellow-crowned Woodpecker *Dendrocopos mahrattensis*.

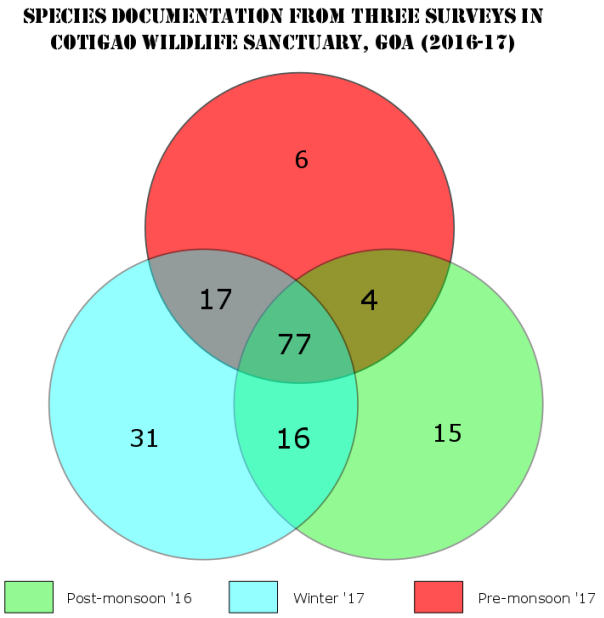


Fig.9: Cumulative species documentation from Cotigao Wildlife Sanctuary showing number of unique and consistently recorded species across all surveys

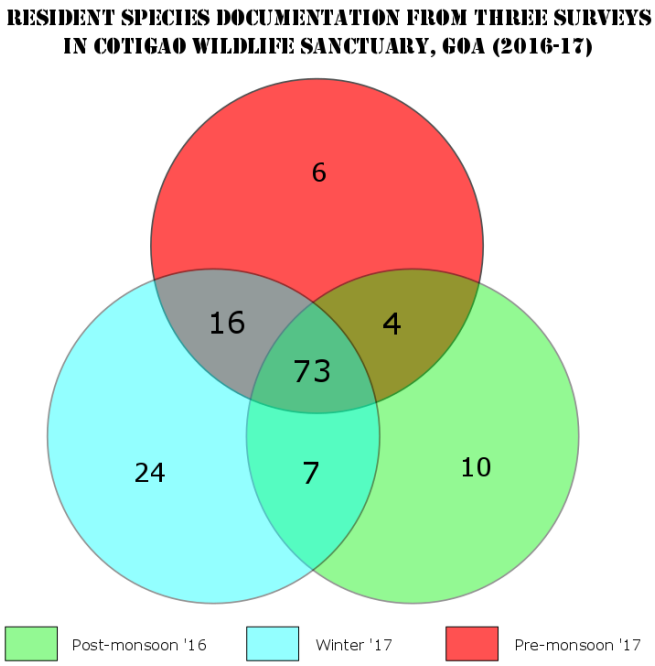


Fig.10: Cumulative species documentation from Cotigao Wildlife Sanctuary showing number of unique and consistently recorded resident species across all surveys

Crimson-backed Sunbird (Small Sunbird) *Leptocoma minima* [34] and Greater Racket-tailed Drongo *Dicrurus paradiseus* [35] are the two-resident species which have been seen across all the transects and are evenly distributed across all seasons with 100% frequency of being reported.

34. Crimson-backed Sunbird (Small Sunbird)

35. Greater Racket-tailed Drongo

Number of individuals counted (based on high counts of each species from every transect) across seasons also varied considerably (Fig.11). Maximum number of individuals were counted in winter season survey which can be attributed to the migratory species boosting the population of birds in the sanctuary, which is followed by individuals counted during pre-monsoon survey. In comparison to post-monsoon season of 2016 where 16 species of migratory birds were recorded, only three species were recorded in the pre-monsoon survey of 2017 but still number of individuals counted in pre-monsoon season of 2017 survey was higher than that in post-monsoon survey of 2016. This can be explained by the breeding cycles of resident birds. In the month of May, when the survey of pre-monsoon 2017 was conducted, most resident birds would have completed breeding or would be in breeding/ courtship stage. This makes detection and hence counting of birds very easy leading to more number of individuals being counted. This count would also possibly involve many juvenile birds who would have just fledged.

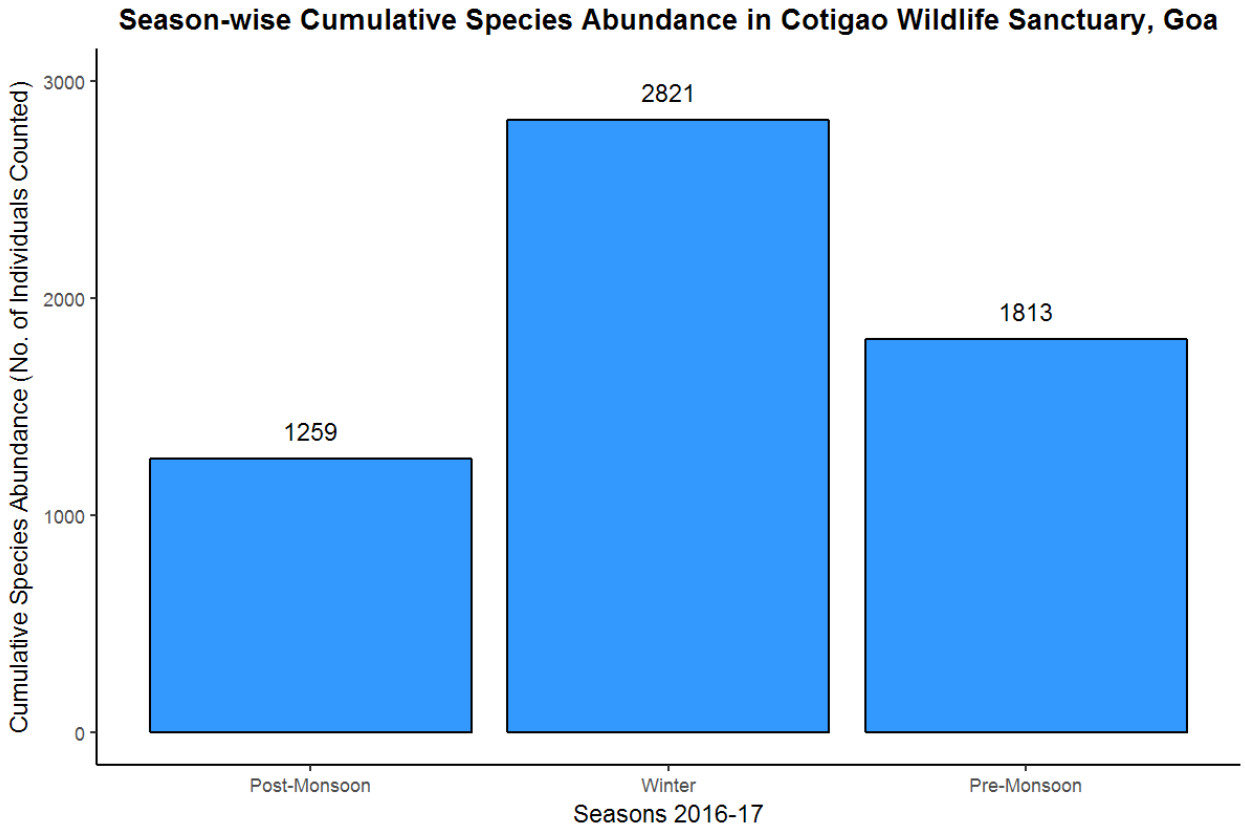


Fig.11: Number of individuals (based on high counts from a transect out of three visits) counted during the surveys

An analysis of species recorded per unit effort expended (unit of effort is a sample, which is a list of 15 species, refer survey methodology for more details) shows that 260 samples yielded 167 species and a graph plotted between species accumulation and effort (Fig.12) shows that the species accumulation curve had just begun to slow down and plateau between sample 200 and 260. Increasing the number of transects, hence the number of samples would have led to plateauing of the species accumulation curve, however the effort expenditure was limited due to logistical constraints.

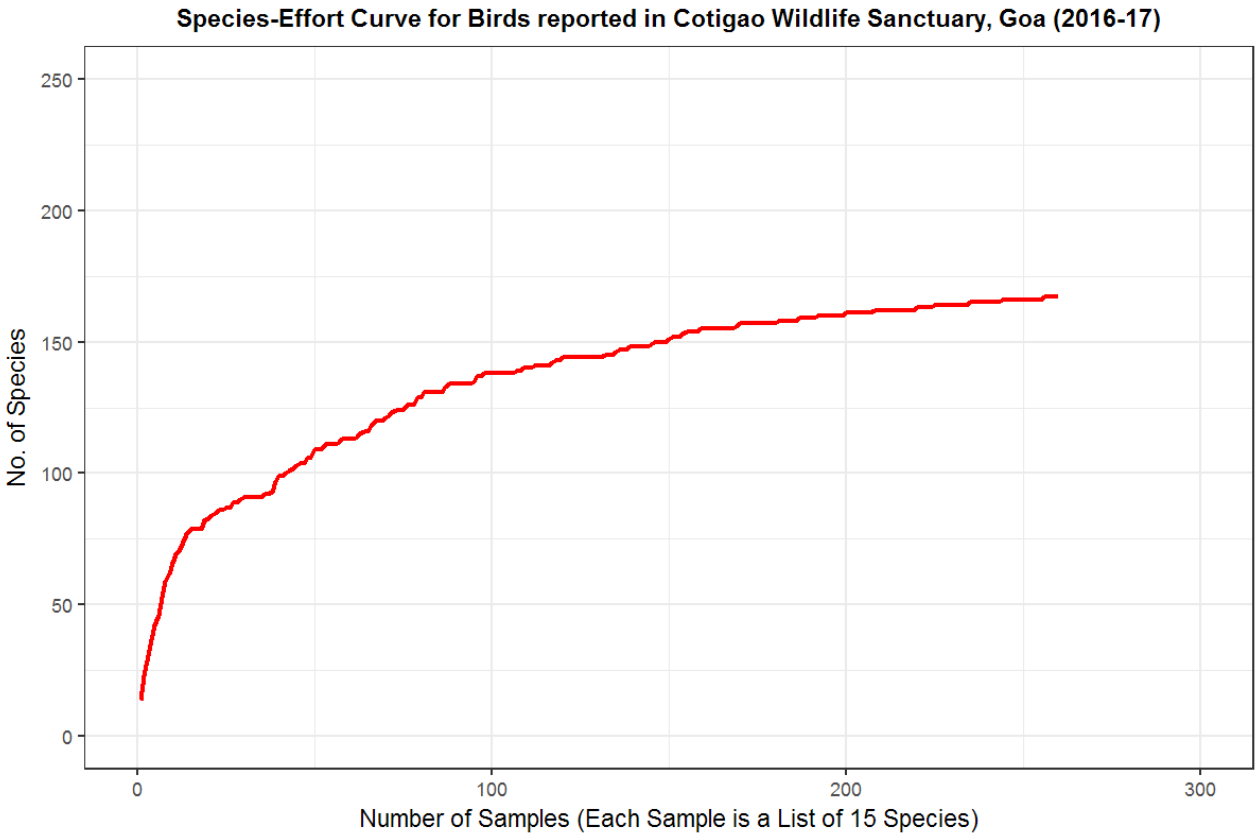
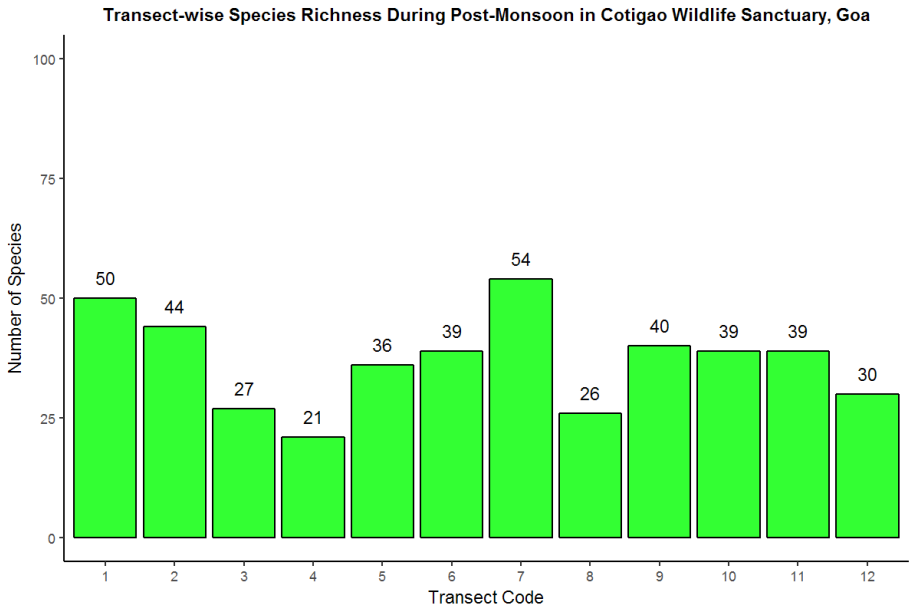
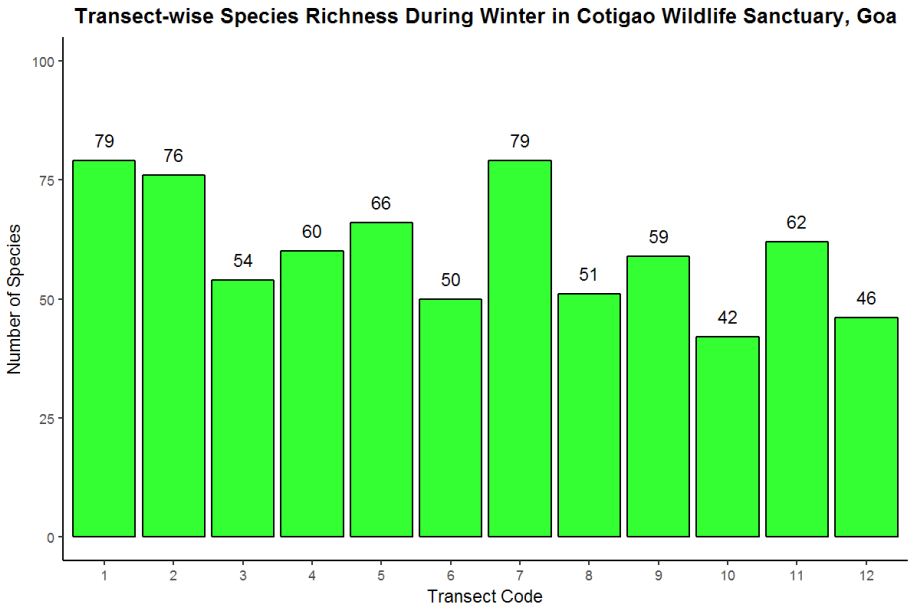


Fig.12: Species effort curve showing how species were detected as sampling effort kept increasing. The point at which species accumulation curve plateaus is the minimum amount of effort needed to record all possible species in the given area

It is important to however note that, Cotigao Wildlife Sanctuary is a very diverse habitat with varying habitat types and elevation profile which gives rise to very unique species assemblages. For example, species richness across different transects were not uniform and so is the case across seasons (Fig. 13, 14, 15), while similar trends were also observed for abundance (cumulative high counts) (Fig. 16, 17, 18).





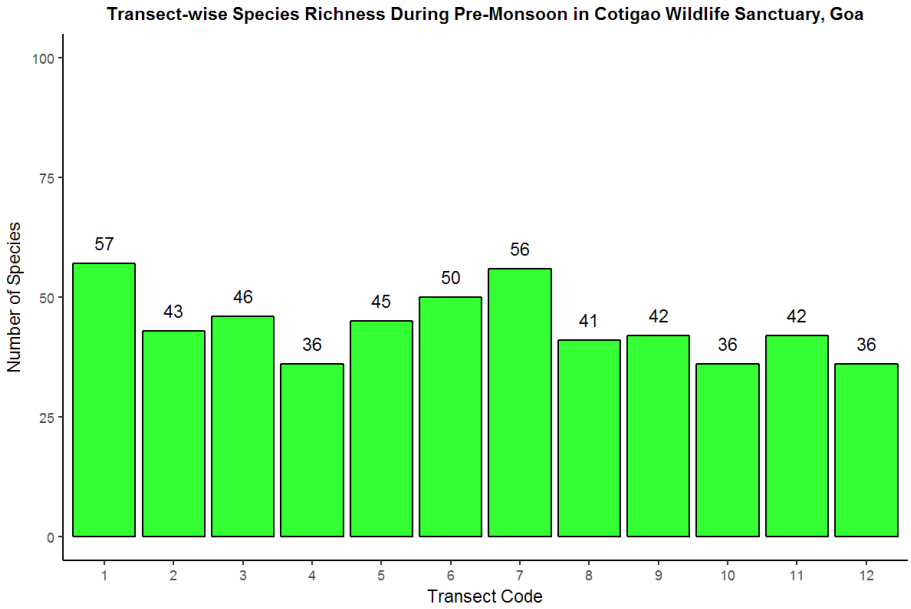
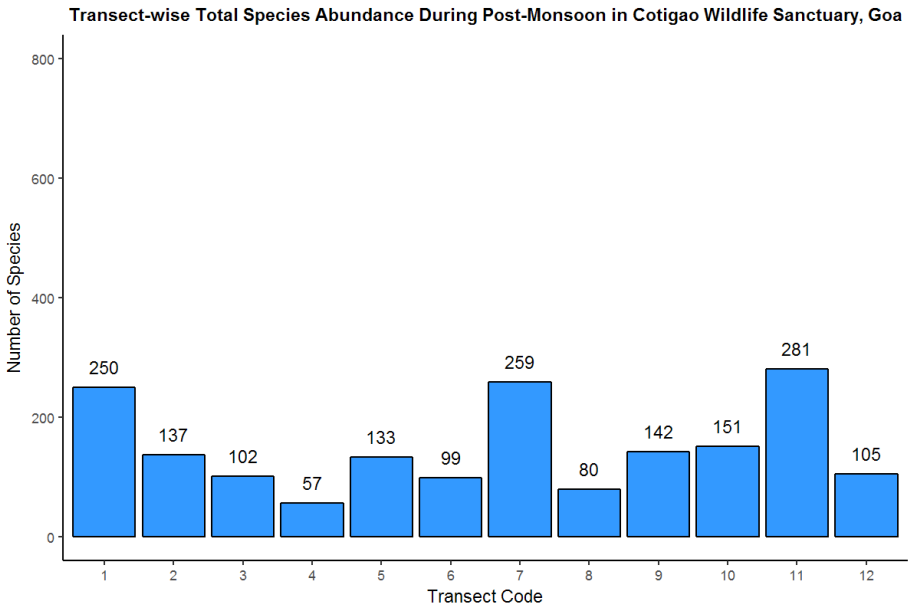
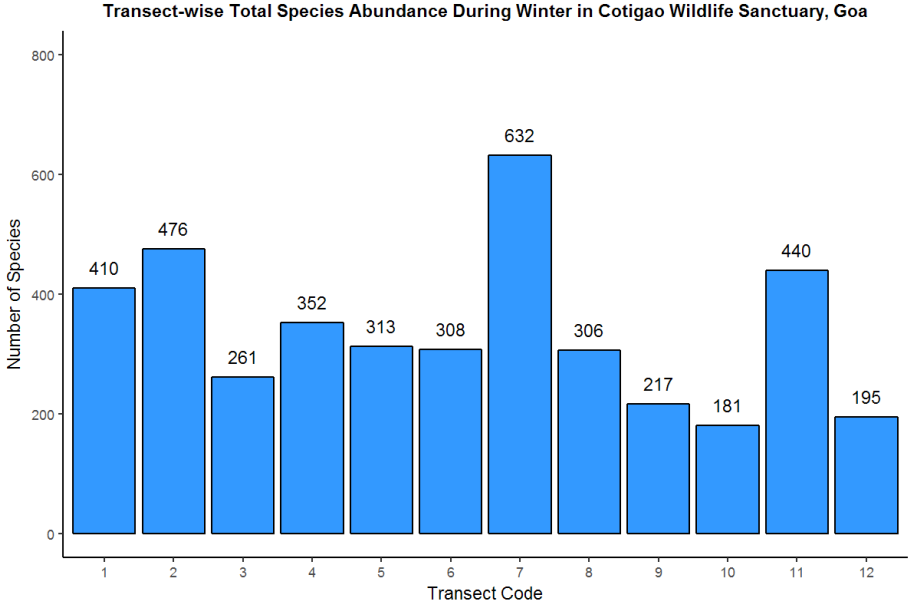


Fig. 13, 14, 15: Representing transect-wise species richness across different seasons





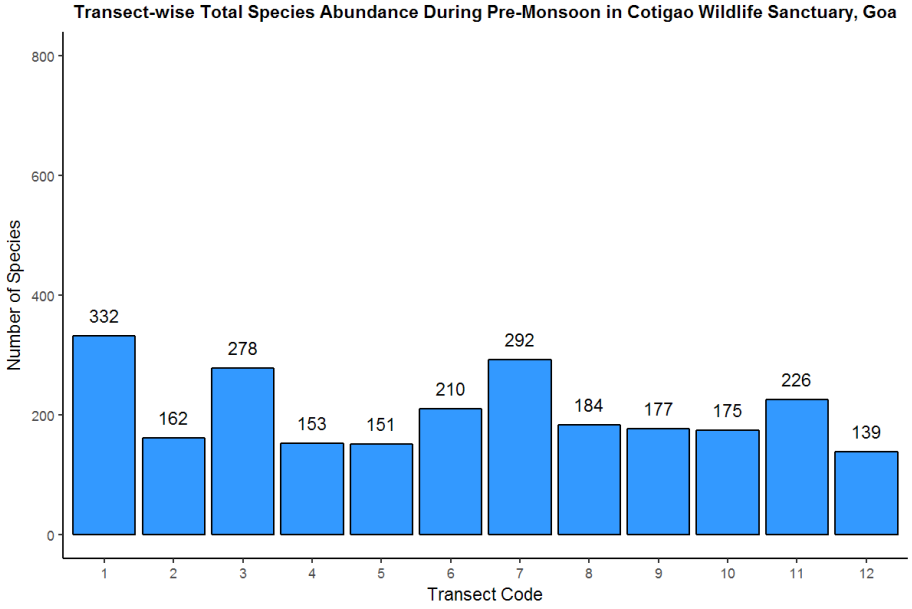


Fig. 16, 17, 18: Representing transect-wise individuals counted across different seasons

Species evenness also varied considerably across seasons in the sanctuary, while only two species were recorded from all 12 transects in post-monsoon season survey of 2016, ten and seven species were recorded from all 12 transects in winter and pre-monsoon surveys of 2017 respectively (Fig. 19, 20, 21).

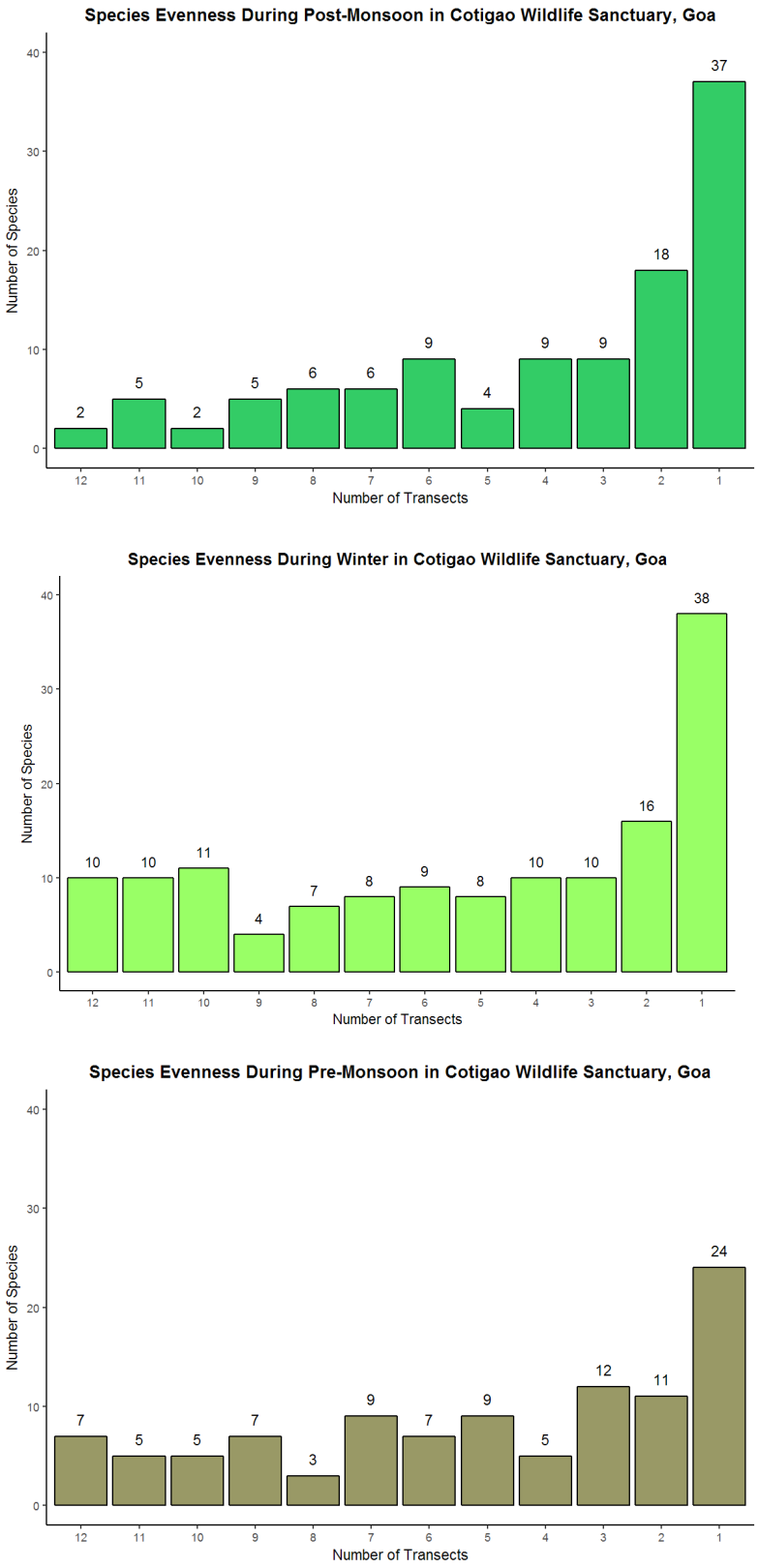
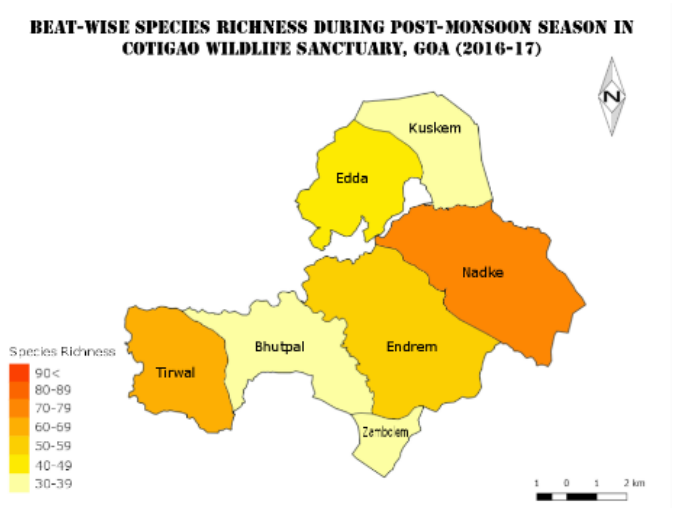
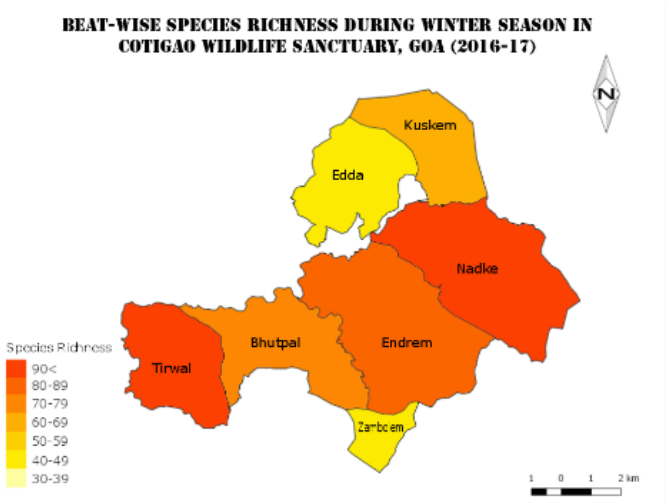


Fig. 19, 20, 21: Distribution of species across different transects representing evenness of species distribution. Bars, represented by 12 on *X*- axis shows number of species that were represented in all 12 transects while bar represented by 1 on *X*- axis shows number of species that were recorded only from a single transect.

This information however gains more importance and gives more insights when collated according to beats. Beats are the fundamental units of administration within a protected area in Goa and hence for better interpretation results were also analysed based on beats.

An analysis of beat-wise species richness shows that *Nadke* beat is very diverse and species rich. This can be attributed to the diverse habitat and elevation profile of this beat. Transects which were identified in this beat equally represented all habitat types and partially represented elevation profile (higher elevation sites were logistically not feasible to be surveyed). Presence of semi-evergreen and moist-deciduous patches, historical fallow agricultural fields and cashew plantations along with an elevation gradient, makes this beat harbour a diverse set of bird species representative of all the above-mentioned habitat types. In contrast, *Zambolem* beat has low bird diversity, because this beat primarily has forest plantations. Species richness fluctuates seasonally as expected across the different beats (Fig. 22, 23, 24).





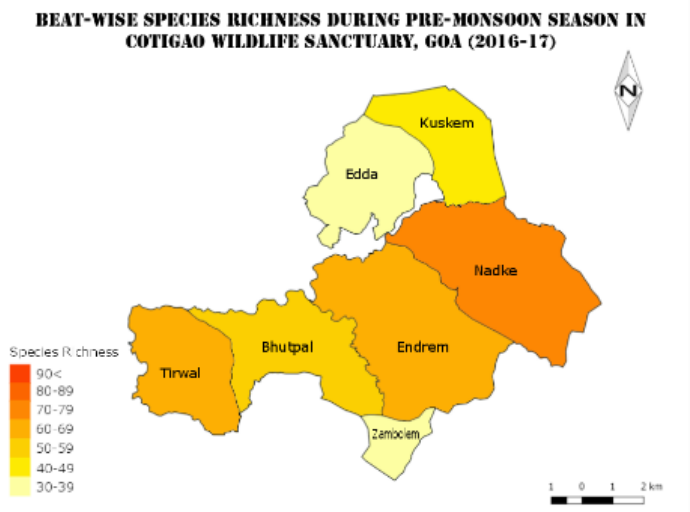


Fig. 22, 23, 24: Species richness is represented beat-wise within Cotigao Wildlife sanctuary to visualise season-wise beats with high species richness and diversity

The importance of *Nadke* beat in terms of high species diversity and having maximum unique species is further made clear by mapping unique species distributed across the seven beats (Fig. 25, 26, 27).

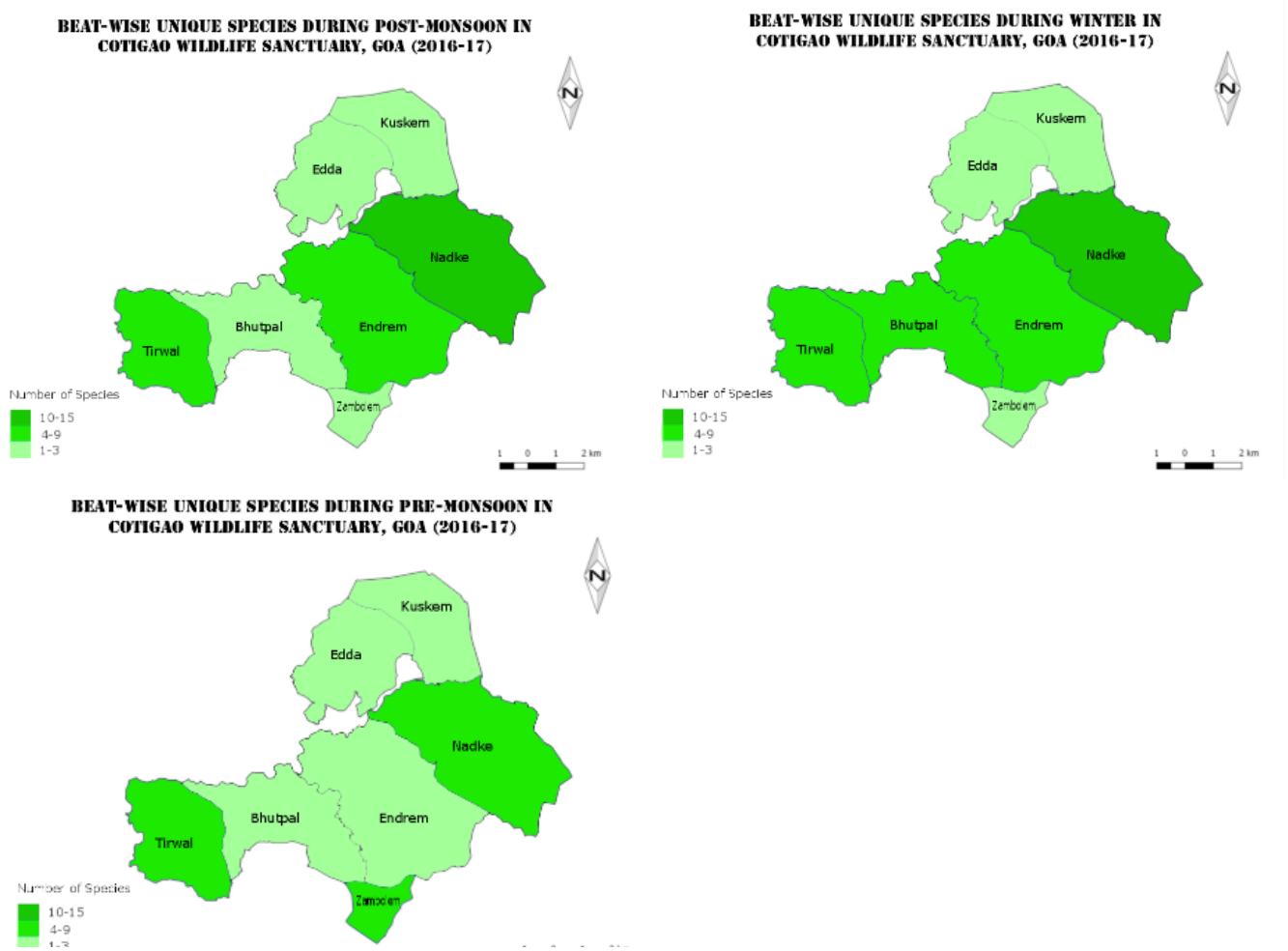
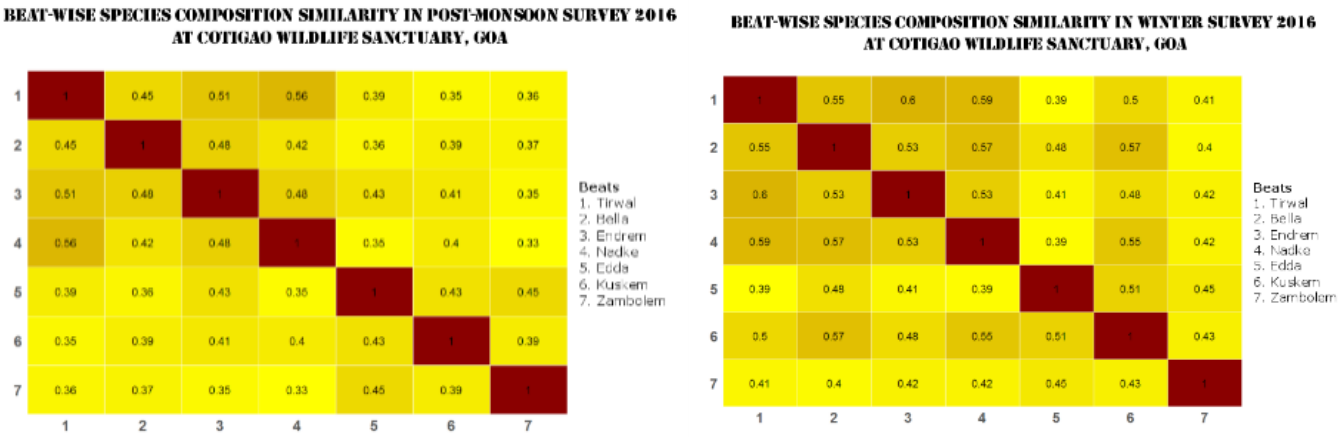


Fig. 25, 26, 27: Unique species distribution is represented beat-wise within Cotigao Wildlife sanctuary to visualise season-wise beats with unique species within them

This however does not, reduce the importance of other beats. In-fact the other beats with its own diverse and unique habitat types in unique ratios makes up the bird diversity of Cotigao Wildlife Sanctuary. An analysis of similarity using Jaccard's similarity index (Jaccard 1912) based on presence-absence of species from each beat was performed to understand how similar beats are to each other in different seasons (Fig. 28, 29, 30).



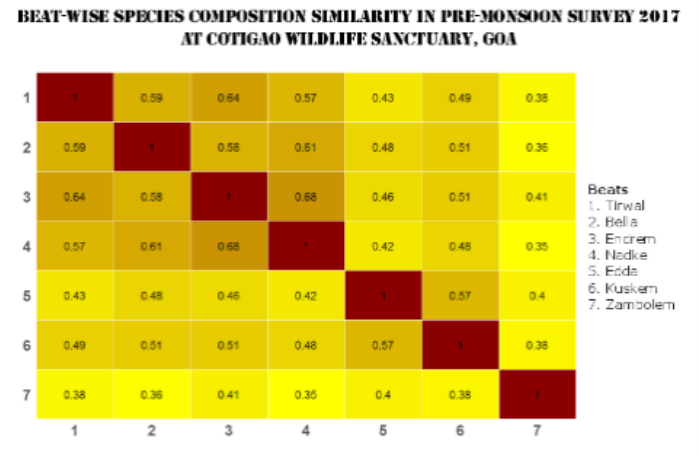


Fig. 28, 29, 30: Season-wise Jaccard's Similarity Matrix which shows how similar the bird species composition of a beat is in comparison to another. The darker the colour of a cell, the more similar the two beats that they represent. Values of Jaccard's index varies between 0-1. 0 represents no similarity and 1 represents no difference

It is very clear that, in winter and pre-monsoon season of 2017, species composition in *Tirwal, Bhutpal, Endrem, Nadke* and to an extent *Kuskem* beats were quite similar to each other and possibly indicates that the habitats in these beats are preferred by nesting resident bird species. This however can be ascertained with confidence by doing more detailed studies and performing occupancy/ ecological niche modelling.

The present report gives the first rigorous and scientific insight about the status of birds from any protected area in Goa made possible through simultaneous surveys conducted by volunteers. It should however be noted that, there might be certain degree of bias which could arise from difference in observer experience. This was tried and addressed by having three counts in a season which would help average out observer bias and distribute expertise across the samples. It should also be noted that the amount of analysis that can be performed with this data is limitless, however the intention of this technical report is to present information in a manner that is easily comprehendible by everyone and can be of use to managers and decision makers while planning management strategies within Cotigao Wildlife Sanctuary. From the results, few interpretations are easy to draw, for example the various habitat types in *Nadke* beat need to be preserved the way they are so that it can sustain diverse population of bird species unique to each habitat type. Open areas within this beat ie: historical fallow fields need to be maintained as habitats for grass-birds and species of open areas like pipits and larks. Forest plantations can be supplemented by trees which are important sources of food for birds like *Bombax ceiba, Caryota urens, Diospyros montana, Erythrina indica, Ficus glomerata, F. racemose, Grewia tiliifolia* and *Ziziphus mauritiana.* Understory vegetation needs to be maintained since they are important nesting and foraging zones for the endemic White-bellied Blue Flycatcher *Cyornis pallipes*.

Following microhabitats should be maintained and protected:

Forest openings: Important habitats for the Grey Junglefowl *Gallus sonneratii*, Red Spurfowl *Galloperdix spadicea* and Jungle Bush Quail *Perdicula asiatica* who use these habitats to feed on grass shoots, seeds and insects. Predatory birds like Shikra *Accipiter badius*, Besra *A. virgatus* and Crested Hawk *Nisaetus cirrhatus* use these areas as hunting grounds, making use of the dense edge vegetation to hide and stalk prey.

Flowering trees: Flowering trees like *Bombax ceiba*, *Butea monosperma* and other flowering species like *Moullava spicate,* native species of *Ixora* and *Calliandra haematocephala* are excellent food plants for all nectarivore birds like Sunbirds. These flowering trees and plants attract a lot of flies and bees towards them hence also becoming an important resource for insectivorous birds like Flycatchers, Bee-eaters and Drongos.

Fruiting trees: Fruiting trees of *Ficus* genus, *Terminalia bellirica*, *Caryota urens, Diospyros montana, Strychnos nux-vomica* etc. are important source of food for Hornbills, Parakeets, Pigeons and Bulbuls.

A dead, standing tree: Is a perfect resource and nesting habitat for many species of Woodpeckers and Barbets. These are also ideal foraging grounds for Bee-eaters and Flycatchers.

Streams: This is an important habitat for Flycatchers, Warblers, Babblers, Thrushes and other insectivorous birds who feed on insects that are found in abundance along the wet banks of the stream. Shallow areas of the streams also become important areas for birds to have bath.

Waterholes: These become very important resources and habitats especially in the drier months, when natural sources of water dwindle. Well maintained waterholes are good habitats and resources for Flycatchers, Raptors, Bulbuls Junglefowls etc. Many birds also use the waterholes for bathing.

Future Directions

This year-long survey effort is just the beginning of the "long-term bird monitoring program". The effort needs to now spill over to other protected areas in a phased manner as envisaged in the proposal, while forest officials of Cotigao Wildlife Sanctuary with a skeletal survey team from GBCN keep monitoring efforts a continual process. The next step is to implement this monitoring program in Bhagwan Mahavir Wildlife Sanctuary (BMWLS) and Mollem National Park (MNP) from the pre-monsoon season of 2018. The area of BMWLS and MNP is many times that of Cotigao Wildlife Sanctuary, however the experience gained from planning and implementation of surveys in Cotigao, will ensure the smooth implementation of this project across all the protected areas across the state.

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Appendix 1. Checklist of Birds of Cotigao Wildlife Sanctuary based on Surveys from Long-term Bird Monitoring Program.

Sl.No.	Species	Endemic	IUCN	WPA Sch. 1	Status
	I.Galliformes				
	1. Phasianidae (partridges, pheasants, grouse)				
1	Indian Peafowl *Pavo cristatus*			X	R
2	Grey Junglefowl *Gallus sonneratii*				R
3	Red Spurfowl *Galloperdix spadicea*				R
	II. Columbiformes				
	2. Columbidae (pigeons)				
4	Nilgiri Wood Pigeon *Columba elphinstonii*	WG	VU		R
5	Spotted Dove *Streptopelia chinensis*				R
6	Pompadour Green Pigeon (Grey-fronted Green Pigeon) *Treron pompadora affinis*				R
7	Emerald Dove *Chalcophaps indica*				R
8	Green Imperial Pigeon *Ducula aenea*				R
9	Mountain Imperial Pigeon (Nilgiri Imperial Pigeon) *Ducula badia cuprea*	E			R
	III. Caprimulgiformes				
	3. Podargidae (frogmouths)				
10	Sri Lanka Frogmouth *Batrachostomus moniliger*			X	R
	4. Caprimulgidae (nightjars)				
11	Jerdon's Nightjar *Caprimulgus atripennis*				R
	5. Apodidae (swifts)				
12	Crested Treeswift *Hemiprocne coronata*				R
13	White-rumped Spinetail *Zoonavena sylvatica*				R
14	Brown-backed Needletail *Hirundapus giganteus*				R
15	Indian Swiftlet *Aerodramus unicolor*			X	R
16	Asian Palm Swift *Cypsiurus balasiensis*				R
17	Alpine Swift *Tachymarptis melba*				R
18	Pacific Swift (Blyth's Swift) *Apus pacificus*				M
19	Indian House Swift *Apus affinis*				R
	IV. Cuculiformes				
	6. Cuculidae (cuckoos)				
20	Greater Coucal *Centropus sinensis*				R
21	Pied Cuckoo *Clamator jacobinus*				M
22	Asian Koel *Eudynamys scolopaceus*				R
23	Banded Bay Cuckoo *Cacomantis sonneratii*				R
24	(Fork-tailed) Drongo Cuckoo *Surniculus lugubris dicruroides*				R
25	Common Hawk Cuckoo *Hierococcyx varius*				R
	V. Pelecaniformes				
	7. Ardeidae (herons)				
26	Malayan Night Heron *Gorsachius melanolophus*				R
27	Indian Pond Heron *Ardeola grayii*				R
28	Cattle Egret *Bubulcus ibis*				R
29	Little Egret Egretta garzetta				R

	8. Phalacrocoracidae (cormorants)				
30	Little Cormorant *Microcarbo niger*				R
	VI. Charadriiformes				
	9. Charadriidae (plovers & lapwings)				
31	Red-wattled Lapwing *Vanellus indicus*				R
	VII. Accipitriformes				
	10. Accipitridae (kites, hawks and eagles)				
32	Oriental Honey Buzzard *Pernis ptilorhynchus*			X	R
33	Crested Serpent Eagle *Spilornis cheela*			X	R
34	Changeable Hawk Eagle (Crested Hawk Eagle) *Nisaetus cirrhatus cirrhatus*			X	R
35	Rufous-bellied Eagle *Lophotriorchis kienerii*			X	R
36	Black Eagle *Ictinaetus malaiensis*			X	R
37	Booted Eagle *Hieraaetus pennatus*			X	M
38	Shikra *Accipiter badius*			X	R
39	Besra *Accipiter virgatus*			X	R
40	Brahminy Kite *Haliastur indus*			X	R
41	Black Kite *Milvus migrans*			X	LM
	VIII. Strigiformes				
	11. Strigidae (owls)				
42	Jungle Owlet *Glaucidium radiatum*				R
43	Oriental Scops Owl *Otus sunia*				R
44	Brown Wood Owl *Strix leptogrammica*				R
45	Spot-bellied Eagle Owl *Bubo nipalensis*				R
46	Brown Fish Owl *Ketupa zeylonensis*				R
	IX. Trogoniformes				
	12. Trogonidae (trogons)				
47	Malabar Trogon *Harpactes fasciatus*				R
	X. Bucerotiformes				
	13. Bucerotidae (hornbills)				
48	Great Hornbill *Buceros bicornis*		NT	X	R
49	Malabar Pied Hornbill *Anthracoceros coronatus*		NT	X	R
50	Malabar Grey Hornbill *Ocyceros griseus*	WG		X	R
	14. Upupidae (hoopoes)				
51	Common Hoopoe *Upupa epops*				R
	XI. Piciformes				
	15. Picidae (woodpeckers)				
52	Speckled Piculet *Picumnus innominatus*				R
53	Heart-spotted Woodpecker *Hemicircus canente*				R
54	Lesser Golden-backed Woodpecker *Dinopium benghalense*				R
55	Rufous Woodpecker *Micropternus brachyurus*				R
56	Lesser Yellow-naped Woodpecker *Picus chlorolophus*				R
57	White-bellied Woodpecker *Dryocopus javensis*				R
58	Greater Golden-backed Woodpecker *Chrysocolaptes lucidus*				R
59	Brown-capped Pygmy Woodpecker *Dendrocopos moluccensis*				R
60	Yellow-fronted Pied Woodpecker *Dendrocopos mahrattensis*				R

	16. Ramphastidae (toucans and barbets)		
61	Brown-headed Barbet *Psilopogon zeylanicus*		R
62	White-cheeked Barbet *Psilopogon viridis*		R
63	Malabar Barbet *Psilopogon malabaricus*	WG	R
64	Coppersmith Barbet *Psilopogon haemacephalus*		R
	XII. Coraciiformes		
	17. Meropidae (bee-eaters)		
65	Blue-bearded Bee-eater *Nyctyornis athertoni*		R
66	Green Bee-eater *Merops orientalis*		R
67	Chestnut-headed Bee-eater *Merops leschenaulti*		R
68	Blue-tailed Bee-eater *Merops philippinus*		M
	18. Alcedinidae (kingfisher)		
69	Blue-eared Kingfisher *Alcedo meninting*		R
70	Common Kingfisher *Alcedo atthis*		R
71	Stork-billed Kingfisher *Pelargopsis capensis*		R
72	White-throated Kingfisher *Halcyon smyrnensis*		R
73	Black-capped Kingfisher *Halcyon pileata*		R
	XIII. Falconiformes		
	19. Falconidae (falcons and caracaras)		
74	Common Kestrel *Falco tinnunculus*		R
	XIV. Psittaciformes		
	20. Psittaculidae (Old World parrots)		
75	Plum-headed Parakeet *Psittacula cyanocephala*		R
76	Malabar Parakeet *Psittacula columboides*	WG	R
77	Rose-ringed Parakeet *Psittacula krameri*		R
78	Vernal Hanging Parrot *Loriculus vernalis*		R
	XV. Passeriformes		
	21. Pittidae (pittas)		
79	Indian Pitta *Pitta brachyura*		R
	22. Campephagidae (minivets and cuckooshrikes)		
80	Small Minivet *Pericrocotus cinnamomeus*		R
81	Scarlet Minivet (Orange Minivet) *Pericrocotus flammeus*		R
82	Large Cuckooshrike *Coracina javensis*		LM
83	Black-headed Cuckooshrike *Lalage melanoptera*		R
	23. Oriolidae (orioles, figbirds and allies)		
84	Black-hooded Oriole *Oriolus xanthornus*		R
85	Indian Golden Oriole *Oriolus kundoo*		LM
86	Black-naped Oriole *Oriolus chinensis*		M
	24. Artamidae (woodswallows, Australian magpies and allies)		
87	Ashy Woodswallow *Artamus fuscus*		R
	25. Vangidae (vangas and helmet-shrikes)		
88	Bar-winged Flycatcher-shrike *Hemipus picatus*		R
89	Large Woodshrike (Malabar Woodshrike) *Tephrodornis virgatus sylvicola*	E	R
90	Common Woodshrike *Tephrodornis pondicerianus*		R
	26. Aegithinidae (ioras)		

91	Common Iora *Aegithina tiphia*		R
	27. Dicruridae (drongos)		
92	Black Drongo *Dicrurus macrocercus*		R
93	Ashy Drongo *Dicrurus leucophaeus*		M
94	White-bellied Drongo *Dicrurus caerulescens*		R
95	Bronzed Drongo *Dicrurus aeneus*		R
96	Hair-crested Drongo *Dicrurus hottentottus*		R
97	Greater Racket-tailed Drongo *Dicrurus paradiseus*		R
	28. Rhipiduridae (fantails)		
98	White-throated Fantail (Spot-breasted Fantail) *Rhipidura albicollis albogularis*		R
	29. Laniidae (shrikes)		
99	Brown Shrike *Lanius cristatuscristatus*		M
100	Long-tailed Shrike *Lanius schach*		M
	30. Corvidae (crows and jays)		
101	Rufous Treepie *Dendrocitta vagabunda*		R
102	House Crow *Corvus splendens*		R
103	Large-billed Crow (Indian Jungle Crow) *Corvus macrorhynchos culminatus*		R
	31. Monarchidae (monarchs and paradise-flycatchers)		
104	Black-naped Monarch *Hypothymis azurea*		R
105	Indian Paradise-flycatcher *Terpsiphone paradisi*		LM
	32. Dicaeidae (flowerpeckers)		
106	Thick-billed Flowerpecker *Dicaeum agile*		R
107	Pale-billed Flowerpecker *Dicaeum erythrorhynchos*		R
108	Plain Flowerpecker (Nilgiri Flowerpecker) *Dicaeum concolor concolor*	E	R
	33. Nectariniidae (sunbirds)		
109	Little Spiderhunter *Arachnothera longirostra*		R
110	Purple-rumped Sunbird *Leptocoma zeylonica*		R
111	Crimson-backed Sunbird *Leptocoma minima*	WG	R
112	Purple Sunbird *Cinnyris asiaticus*		R
113	Loten's Sunbird *Cinnyris lotenius*		R
	34. Irenidae (fairy-bluebirds and leafbirds)		
114	Asian Fairy-bluebird *Irena puella*		R
115	Golden-fronted Leafbird *Chloropsis aurifrons*		R
116	Jerdon's Leafbird *Chloropsis jerdoni*		R
	35. Estrildidae (waxbills)		
117	White-rumped Munia *Lonchura striata*		R
118	Scaly-breasted Munia *Lonchura punctulata*		R
119	Black-throated Munia *Lonchura kelaarti*		R
	36. Passeridae (sparrows, snowfinches and allies)		
120	Yellow-throated Sparrow *Gymnoris xanthocollis*		R
	37. Motacillidae (wagtails and pipits)		
121	Forest Wagtail *Dendronanthus indicus*		M
122	Western Yellow Wagtail *Motacilla flava*		M
	38. Stenostiridae (fairy-flycatcher and crested flycatchers)		
123	Grey-headed Canary-flycatcher *Culicicapa ceylonensis*		M

	39. Cisticolidae (cisticolas)			
124	Grey-breasted Prinia *Prinia hodgsonii*			R
125	Ashy Prinia *Prinia socialis*			R
126	Common Tailorbird *Orthotomus sutorius*			R
	40. Acrocephalidae (brush, reed and swamp warblers)			
127	Blyth's Reed Warbler *Acrocephalus dumetorum*			M
	41. Hirundinidae (swallows)			
128	Streak-throated Swallow *Petrochelidon fluvicola*			M
129	Red-rumped Swallow *Cecropis daurica*			R
130	Barn Swallow *Hirundo rustica*			M
	42. Pycnonotidae (bulbuls)			
131	(Square-tailed) Black Bulbul *Hypsipetes leucocephalus ganeesa*			R
132	Black-crested Bulbul (Flame-throated Bulbul) *Pycnonotus melanicterus gularis*	E		R
133	Red-whiskered Bulbul *Pycnonotus jocosus*			R
134	Red-vented Bulbul *Pycnonotus cafer*			R
135	White-browed Bulbul *Pycnonotus luteolus*			R
136	Grey-headed Bulbul *Brachypodius priocephalus*	WG	NT	R
137	Yellow-browed Bulbul *Acritillas indica*			R
	43. Phylloscopidae (Old World leaf warblers)			
138	Green Leaf Warbler *Seicercus nitidus*			M
139	Greenish Leaf Warbler *Seicercus trochiloides*			M
140	Large-billed Leaf Warbler *Seicercus magnirostris*			M
141	Western Crowned Leaf Warbler *Seicercus occipitalis*			M
	44. Sylviidae (Sylvia warblers, parrotbills and allies)			
142	Yellow-eyed Babbler *Chrysomma sinense*			R
	45. Zosteropidae (white-eyes and yuhinas)			
143	Oriental White-eye *Zosterops palpebrosus*			R
	46. Timaliidae (scimitar babblers and allies)			
144	Indian Scimitar Babbler *Pomatorhinus horsfieldii*			R
145	Dark-fronted Babbler *Rhopocichla atriceps*			R
146	Puff-throated Babbler *Pellorneum ruficeps*			R
	47. Pellorneidae (smaller babblers)			
147	Quaker Tit Babbler *Alcippe poioicephala*			R
	48. Leiothrichidae (babblers, laughingthrushes and allies)			
148	Jungle (Black-winged) Babbler *Turdoides striata somervillei*	E		R
	49. Sittidae (nuthatches, spotted creepers and wallcreeper)			
149	Velvet-fronted Nuthatch *Sitta frontalis*			R
	50. Sturnidae (starlings)			
150	Brahminy Starling *Sturnia pagodarum*			R
151	Chestnut-tailed Starling *Sturnia malabarica*			R
151a	Malabar Starling *Sturnia malabarica blythii*	E		R
152	Common Myna *Acridotheres tristis*			R
153	Jungle Myna *Acridotheres fuscus*			R
	51. Muscicapidae (chats and flycatchers)			
154	Oriental Magpie Robin *Copsychus saularis*			R

155	White-rumped Shama *Kittacincla malabarica*		R
156	Asian Brown Flycatcher *Muscicapa dauurica*		M
157	Brown-breasted Flycatcher *Muscicapa muttui*		M
158	White-bellied Blue Flycatcher *Cyornis pallidipes*	WG	R
159	Tickell's Blue Flycatcher *Cyornis tickelliae*		R
160	Verditer Flycatcher *Eumyias thalassinus*		M
161	Indian Blue Robin *Larvivora brunnea*		M
162	Malabar Whistling Thrush *Myophonus horsfieldii*		R
163	Taiga Flycatcher *Ficedula albicilla*		M
	52. Turdidae (thrushes)		
164	Orange-headed Thrush *Geokichla citrina*		
164a	Orange-headed Thrush *Geokichla citrina citrina*		M
164b	White-throated Ground Thrush *Geokichla citrina cyanota*		R
165	Indian Blackbird *Turdus simillimus*		R

R- Resident, M- Migrant, WG- Western Ghats Endemic, E-sub-species endemics treated as full species in Rasmussen and Anderton (2012) or del Hoyo *et al*. (2016). IUCN Threatened Species: VU- Vulnerable, NT- Near Threatened. WPA Sch. 1: Schedule 1 species under the Wildlife Protection Act of 1972.