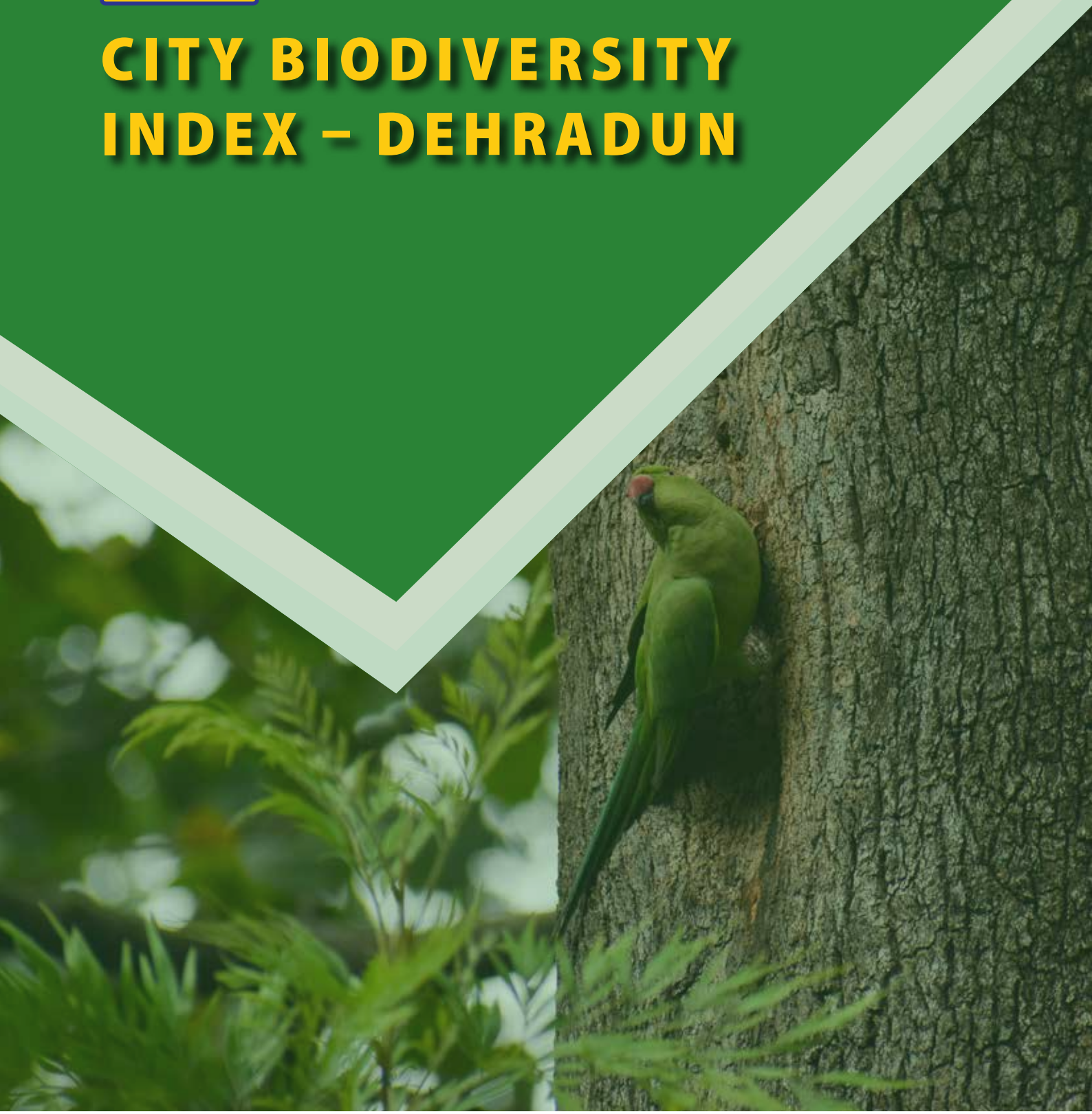
नगर निगम देहरादून

CITY BIODIVERSITY INDEX – DEHRADUN



भारतीय वन्यजीव संस्थान
Wildlife Institute of India

ICLEI
Local Governments for Sustainability

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Acronyms

ABS	Access and Benefit Sharing
AMRUT	Atal Mission for Rejuvenation and Urban Transformation
BMU	Federal Ministry for the Environment, Nature Conservation, and Nuclear Safety
BSI	Botanical Survey of India
CBI	City Biodiversity Index
CBSE	Central Board of Secondary Education
CoP	Conference of Parties
CSR	Corporate Social Responsibility
DEAL	Defence Electronics Application Laboratory
DSCL	Dehradun Smart City Private Limited
EbA	Ecosystem-based Adaptation
FRI	Forest Research Institute
ICLEI South Asia	ICLEI-Local Governments for Sustainability, South Asia
ICSE	Indian Certificate of Secondary Education
IGNFA	Indira Gandhi National Forest Academy
IIRS	Indian Institute of Remote Sensing
IKI	International Klimate Initiative
IMA	Indian Military Academy
INTERACT-Bio	Integrated subnational action for biodiversity: Supporting implementation of National Biodiversity Strategy and Action Plans through the mainstreaming of biodiversity objectives across city-regions
IRDE	Instruments Research and Development Establishment
IUCN	International Union for Conservation of Nature
MDDA	Mussoorie Dehradun Development Authority
NBSAP	National Biodiversity Strategy and Action Plan
NGO	Non Governmental Organisation
PCCF	Principal Chief Conservator of Forests
RIMC	Rashtriya Indian Military College
SBB	State Biodiversity Board
SCBD	Secretariat for the Convention on Biological Diversity
SEZ	Special Economic Zone
STPI	Software Technology Parks of India
WII	Wildlife Institute of India
ZSI	Zoological Survey of India

Background

The City Biodiversity Index (CBI), also known as the Singapore Index was developed after the ninth meeting of the Conference of Parties (CoP) in 2008, when it was acknowledged that cites and local bodies have a role to play in the implementation of a country's National Biodiversity Strategy and Action Plan (NBSAP). The pupose of the index was to consolidate the available biodiversity-related indicators at the local level, which could then help cities to evaluate and benchmark their biodiversity conservation efforts.

The CBI scoring is quantitative in nature. A total of 23 indicators make up the index, measuring a city's native biodiversity, the ecosystem services provided and biodiversity governance. Scores range between zero to four points for each indicator, with a maximum overall score of 92. The index is meant to allow the city to visualize their progress in conserving biodiversity with every application of the index. The first year is considered the baseline against which cities can then chart their subsequent progress.

According to the Secretariat for the Convention on Biological Diversity (SCBD)[1], some of the benefits that cities derived from the application of the index include "a) the process facilitated capacity-building in biodiversity conservation, b) the indicators also function as biodiversity conservation guidelines, and c) assistance in setting priorities for conservation actions and budget allocation through quantitative scoring".

In October 2019, a 'National Outreach Event for Awareness Generation on Urban Biodiversity' was conducted in Dehradun by the Wildlife Institute of India (WII), in collaboration with ICLEI-Local Governments for Sustainability, South Asia (ICLEI South Asia). This workshop was organized under the Integrated subnational action for biodiversity: Supporting implementation of National Biodiversity Strategy and Action Plans through the mainstreaming of biodiversity objectives across city-regions or INTERACT-Bio project. The INTERACT-Bio project is funded by The Federal Ministry for the Environment, Nature Conservation, and Nuclear Safety, (BMU) through the International Klimate Initiative (IKI). 51 participants from various National, State and City Governments attended the workshop at the Wildlife Institute of India Campus in Dehradun. The outreach workshop appraised the participants about the ongoing issues and trends in biodiversity conservation, policy and legislative framework, impacts of urban expansion on biodiversity and ecosystem services, tools for assessment of urban biodiversity such as the CBI, and Ecosystem-based Adaptation (EbA)/ Nature-based solutions to climate change.

At this workshop, the city of Dehradun, represented by Shri Sunil Uniyal Gama, Mayor, Nagar Nigam Dehradun, expressed an interest for the application of the index as a tool to assess the status of biodiversity, ecosystem services and biodiversity governance in the city. The Dehradun City Biodiversity Index 2020, thus, has been prepared jointly by WII and ICLEI South Asia, based on the SCBD endorsed user manual for CBI updated in 2014[2].

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1. https://www.cbd.int/subnational/partners-and-initiatives/city-biodiversity-index. Accessed online on 20 April 2020.
2. Secretariat of the Convention on Biological Diversity. (2014). User's manual on the Singapore Index on Cities' Biodiversity (also known as the city biodiversity index). Available at: http://www.cbd.int/en/subnational/partners-and-initiatives/city-biodiversity-index. Accessed online on 22 November 2019.

Summary of the Scores

The city scored a total of 31 out of 72 for 18 indicators. Since this was the baseline year the indicators 4-8 were not considered in the analysis, thus reducing the maximum possible score to 72.

- The first section on "Native Biodiversity in the City", contributed to an average score of 16 out of 20 as only 5 indicators were taken into consideration. This score is mainly because of the natural history of the city and the fact that a significant proportion of the city's native biodiversity receives protection through large and well maintained institutional campuses as well as from forests under the jurisdiction of the forest department.
- Indicators 11-14 which relate to "Ecosystem Services Provided by Biodiversity in the City" have minimally contributed to the overall score, scoring 4 out of a possible 16 points. This section is linked with the first section and reflects the biodiversity health of the city. Although historically, Dehradun was labelled as 'Green City', rampant urbanization and construction activities over the last two decades has resulted in degradation and fragmentation of natural areas and proportionate loss of natural areas. This has impacted ecosystem services within the city. Awareness on the benefits provided by urban nature can help to improve the score in this section.
- Indicators 15-23 which correspond to "Governance and Management of Biodiversity in the City" received a low score of 11 out of 36 points. The reason behind this is the fact that open green spaces and other biodiverse regions within the city are not actively administered by the municipal corporation. The district authority plays a significant role. This score also points towards the fact that since biodiversity considerations are not highlighted in Master Plan and other city plans, it is not adequately prioritized. Absence of a Local Biodiversity Strategy and Action Plan also highlights the same.

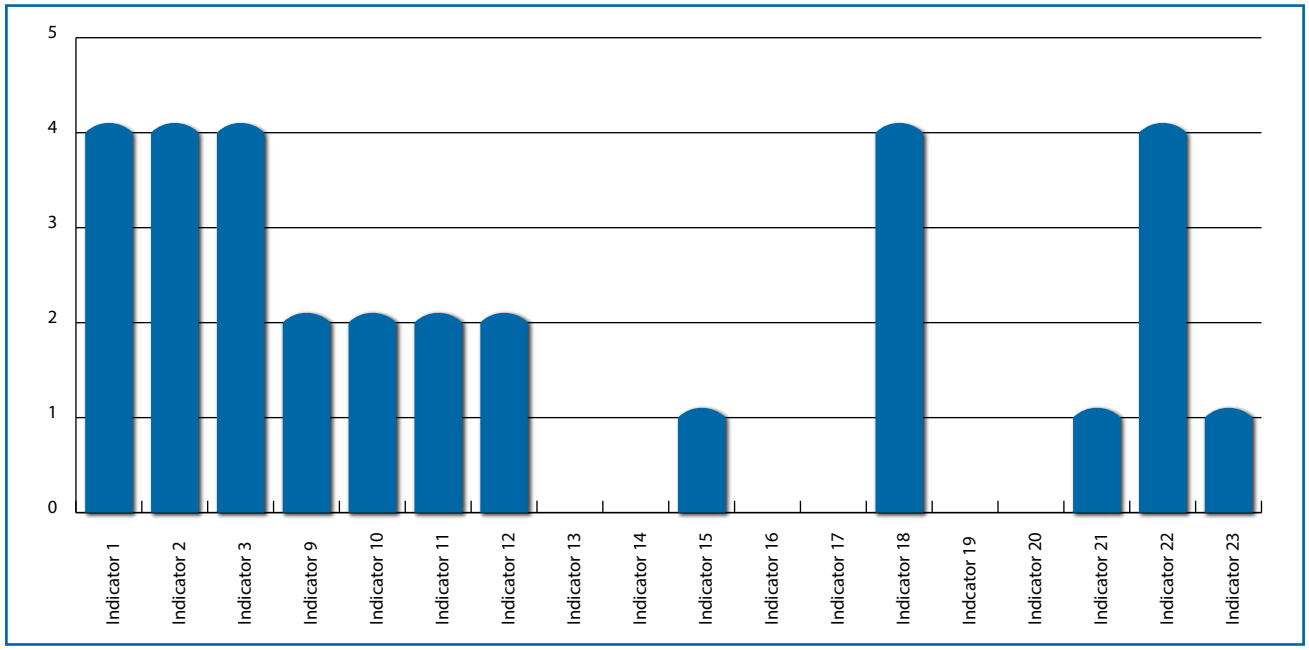

Figure 1: City Biodiversity Index of Dehradun (2020) at a glance

PART 1 – Dehradun City Profile

Location

Dehradun is the capital city of Uttarakhand, situated at the foothills of the Himalayas, in the Doon Valley. It is situated at the foothills of the Himalayas, lying between northern latitudes 30°13′ 38″ and 30°25′ 01″ and eastern longitudes 77°55′ 51″ and 78°8′ 23″ in the Doon valley of Dehradun district. To the east of the city is the River Song, to the west is the River Tons, the Himalayan ranges are in the north and in the south are the Lachiwala ranges and Sal forests[3]. Dehradun enjoys a pleasant climate due to its location in the hilly part of the state. During the summer months, the temperature ranges between 36°C and 16.7°C while the winter months are colder with the maximum and minimum temperatures touching 23.4°C and 5.2°C, respectively[4]. During the monsoon season, Dehradun experiences heavy to moderate showers during late-June to mid-August. Most of the annual rainfall of about 2,865 mm in the city is received during the months from June to September, July and August being the rainiest months in the season[3].

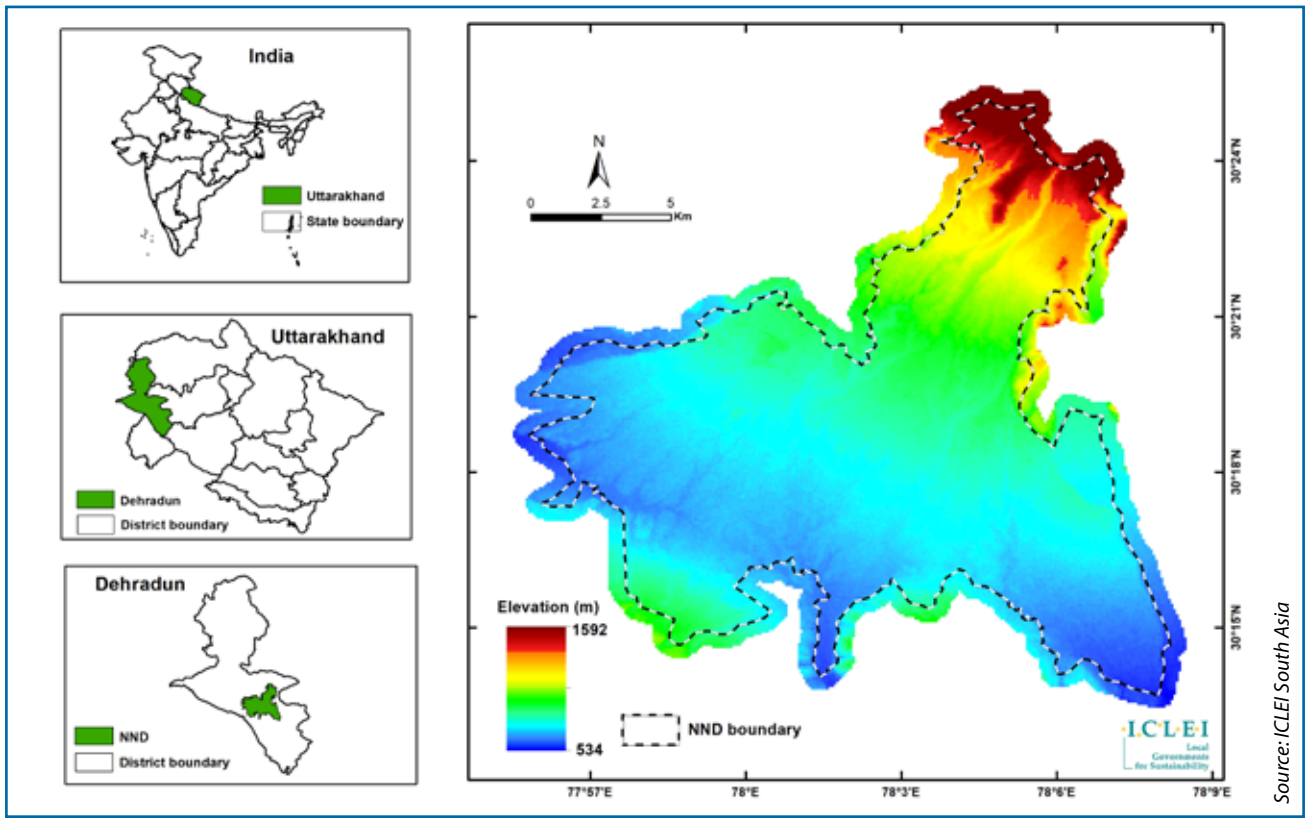

Figure 2: Location Map of Dehradun showing the municipal boundary of the city

3. ICLEI South Asia. (n.d). City Resilience Strategy of Dehradun. Prepared under Asian Cities for Climate Change Resilience Network Project. New Delhi.

4. Government of Uttarakhand. (2007). City Development Plan: Dehradun Revised. Prepared under Jawaharlal Nehru National Urban Renewal Mission, Urban Development Department, Government of Uttarakhand. http://udd.uk.gov.in/files/CDP_DDUN.PDF Accessed online on 20 April 2020.

Geophysical Characteristics

The city of Dehradun is located in a wide intermontane depression, known as Doon Valley within the Shivalik basin of Garhwal Himalaya[5]. The city is at a varying heights, ranging from 410 m at Clement Town to above 700 m at Malsi, which is 15 km from the city. However, the average elevation is 640 m (2,100 ft) above mean sea level.

A number of streams dissect the city in the north-south direction[6]. The high hills in the east and north and Shivaliks in the south give an interesting topographical setting to the city. All the hill ranges around Dehradun (except the Shivaliks) are rich in lime stone reserves.

Demography

The population of Dehradun city and its outgrowths in 2011 was 578,420 with a male and female population of 303,411 and 275,009, respectively[7]. The sex ratio of the city is 906 per 1,000 males. The number of children under six years in Dehradun city is 59,180 as per the 2011 Census report6. There are 31,600 boys and 27,580 girls. Child sex ratio of girls is 873 per 1,000 boys.

Literacy is an important indicator of social development, having effects on demographic characteristics and participation in labour force. The number of literates in Dehradun city is 463,791 out of which 251,832 are males and 211,959 are females. The average literacy rate of Dehradun city is 89.32 percent, whereas male literacy and female literacy rates are 92.65 and 85.66 percent, respectively[6].

As per the Census 2011, major religious groups that constitute the city of Dehradun are Hindus (83.98%), Muslims (11.91%), Sikhs (2.15%), Christians (0.79%) and others including Jains and Buddhists (1.17%). The major language spoken in Dehradun, according to Census 2011 is Hindi (including Garhwali 80.83%), which is also the official language. Other languages spoken in the region include English, Bengali, Punjabi, Nepali and Tibeto-Burman[6].

Economy

Dehradun is the administrative centre of the hill region of Uttarakhand and the capital of the new hill state that was carved out of Uttar Pradesh in the year 2000. The normalized value of per capita income for the city of Dehradun is 0.36, which is close to INR 180,000[3, 8]. It has witnessed strong economic growth in the last 20 years. Dehradun has experienced a commercial and information technology upswing, amplified by the establishment of software technology parks of India (STPI) and SEZs (Special Economic Zones) throughout. A number of manufacturing units are present in the Selaqui area.

The dominant sector of the economy of Dehradun is the tertiary sector. Being the gateway to the Himalayan region of the state, and the last rail head in the state, Dehradun attracts a large number of tourists on their onward journeys to different hill regions of the state. Due to its soothing micro-climate and scenic beauty, Dehradun also has a booming tourism industry, contributing significantly to the local economy[9]. Dehradun is also the whole sale trading centre for the entire state.

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5. Mahajan, A. K., Slob, S., Ranjan, R., Sporry, R., Champati Ray P. K., and van Westen, C. J. (2007). Seismic microzonation of Dehradun City using geophysical and geotechnical characteristics in the upper 30 m of soil column. J Seismol, 11:355-370.
6. Gupta, K. (2013). Unprecedented Growth of Dehradun Urban Area: A Spatio – Temporal Analysis. International Journal of Advancement in Remote Sensing, GIS and Geography. IJARSGG 1(2):47-56
7. Census of India. (2011). Dehradun City Census 2011 data. http://censusindia.gov.in /2011census/dchb/0505_PART_B_DCHB_DEHRADUN.pdf. Accessed online on 22 November 2019.
8. Gupta, S. (2014). Modeling district level economic disparities across Uttarakhand, India. IOSR Journal of Humanities and Social Sciences. IOSR-JHSS 19(2):84-90
9. Nagar Nigam Dehradun. (2020). https://nagarnigamdehradun.com/about-dehradun.php. Accessed online on 3 April 2020

The city of Dehradun also hosts prominent educational and training institutions of national importance including the Indian Military Academy (IMA), Indira Gandhi National Forest Academy (IGNFA), Zoological Survey of India (ZSI), Botanical Survey of India (BSI), Survey of India, WII, Indian Institute of Remote Sensing (IIRS) and Forest Research Institute (FRI). It is home to renowned public schools like The Doon School and Rashtriya Indian Military College (RIMC) and national establishments such as the Ordnance Factory Dehradun, Instruments Research and Development Establishment (IRDE), Defence Electronics Application Laboratory (DEAL) and other defence establishments.

In the past, Dehradun city was widely known for its litchis and the world's finest basmati rice. However, this has declined drastically in recent times, owing to rapid land use land cover changes in the city[10].

Biodiversity

Dehradun is known for its lush green environment and pleasant climate, making it a thriving 'Green City'. To further visualize the areas in the city that provide natural habitats for a variety of biodiversity, a natural asset map (as shown in Figure 3) was developed as part of the CBI process. Litchi orchards, tea gardens, mixed forest, green cover in prominent academic institutions such as WII, FRI, institutional areas such as IMA, IGNFA, ZSI, BSI, and public open spaces are the major biodiversity habitats of Dehradun. Other important habitats of the city include agricultural lands, open grasslands, hilly slopes, home gardens, bushes, scrubs and hilly streams[11].

An analysis of the Natural Asset Map of Dehradun, illustrates the city's heterogenous land use ranging from tea gardens, agricultural farms, forest, sparse vegetation to litchi and mango orchards. As a result of the distinct geo-physical features giving rise to mixed landuse, Dehradun encompasses a peculiar landscape unlike most Indian cities and has been home to exclusive range of both plant and animal species. Due to this distinctive topographical setting, the flora and fauna of the city is diverse[11]. However, due to uncontrolled growth, the city of Dehradun has marked serious negative changes in its overall biodiversity[10].

Flora: Although the city of Dehradun is bestowed with natural resources and is rich in vegetation, comprehensive inventories of flora are distinctly absent. However, several resources are present for the district and the Doon Valley area. The history of documentation of plants goes back to the 18th century[11].

There are four major types of forests occurring in different localities of the Doon Valley[13, 14]

1. Moist Shiwalik Sal Forest
2. Moist Bhabar Doon Sal Forest
3. West Gangetic Moist Deciduous Forest
4. Dry Shiwalik Sal Forest

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10. Bhat P.A., ul Shafiq, M., Mir, A.A., and Ahmed, P. (2017). Urban Sprawl and its impact on landuse/landcover dynamics of Dehradun City, India. International Journal of Sustainable Built Environment. 6:513–521
11. Saklani, A., Naithani, S., and Saini, K.S. (2018). Effects of Urbanization in Birds Diversity: A Case of Doon Valley. J Biodivers Manage Forestry 7:3
12. Negi, P.S. (2006). A Contribution to the Woody Plant Diversity of Doon Valley, Uttaranchal (North-West Himalaya). The Indian Forester. 1. 429-455.
13. Mandal, G., and Joshi, S.P. (2014). Analysis of vegetation dynamics and phytodiversity from three dry deciduous forests of Doon Valley, Western Himalaya, India. Journal of Asia-Pacific Biodiversity, 7:292-304
14. Tyagi, B.K., and Veer, V. (2016). Entomology in the Doon Valley (Garhwal Himalaya). Published by Scientific Publishers (India).

The main dominant species of these forests are *Shorea robusta*, commonly known as Sal, *Mallotus phillipensis*, *Syzygium cumini* and *Ehretia laevis*[12]. Heavy disturbances of various sites also exemplified by the establishment and spread of alien invasive species such as *Lantana camara* and *Solanum torvum*[12].

Post the 1950s, one of the most comprehensive documentation of the herbaceous flora of Dehradun district was carried out by Babu (1977)[15]. He identified 1230 species, distributed over 115 families. Out of 1230 species, 239 have been reported as exotic, 936 are native and origin of 55 species is unknown. In a publication on the Alien Flora of the Doon Valley[16], 308 woody and 128 herbaceous exotic species have been identified. Another publication chronicled[17] the total floral diversity as being represented by 674 taxa, 92 families, and 368 genera. These included 591 trees, 35 shrubs, 12 climbers, 15 palms and 21 bamboos.

In terms of city level studies, a comprehensive study of the floral diversity within the WII campus is available. The campus harbours 605 species of plants (94% wild and 6% planted), of which 13% are trees, 12% shrubs, 48% herbs, 10% climbers, 15% grasses and 2% ferns[18]. 376 of these plant species are medicinal. This accounts for 48% of the total wild herbaceous flora of Dehradun district recorded by Babu (1977)[15].

Fauna: The city of Dehradun has a unique ecosystem owing to its varied geographic and climatic conditions. Being a part of the Doon Valley in the Himalayan foothills, Dehradun, hosts a conservative natural habitat inhabited by thousands of animal species, many of them native to the valley[13]. The district of Dehradun contains a number of protected areas such as Rajaji National Park, Benog Wildlife Sanctuary and Asan Conservation Reserve, which are home to elephants and migratory birds. Vertebrate diversity of the district of Dehradun is represented by all the five vertebrate classes (741 species), viz., Pisces (86 species), Amphibia (18 species), Reptilia (46 species), Aves (533 species) and Mammalia (58 species)[19].

Butterflies and birds constitute a major proportion of the local biodiversity of Dehradun. About 30 percent (407 species) of the total number of butterfly species found in India occur in the state of Uttarakhand[20]. A study of the butterflies of Garhwal, Uttarakhand yielded 307 species[19]. Although there is lack of formal publication of butterflies found in the city of Dehradun, lepidopteran experts of the region such as Mr. Sanjay Sondhi, Founder Trustee of the Titli Trust and Mr. Debanjan Sarkar, a scholar from WII were consulted with. Their personal documentation and observations have been compiled in Table 9 in Annexure 2 based on the list provided in Singh and Sondhi (2016)[20].

Of the 533 species of birds recorded in the state[18], 414 are found in Dehradun city (personal communication with Dr. Dhananjai Mohan, IFS, Director, WII, Mr. Debanjan Sarkar, a scholar from WII and Mr. Rohan Chakravarty, a wildlife cartoonist and bird enthusiast). The list of birds found in the city can be found in Table 8 in Annexure 2.

In the local (city) context, a number of independent studies carried out within the campus area of WII yields data of different groups and sub-groups of animals. One such individual study, revealed a total of 102 species of spiders belonging to 78 genera and 23 families in the campus[21].

15. Babu, C.R. (1977). Herbaceous Flora of Dehradun. CSIR Publications, New Delhi.
16. Negi, P.S., and Hajra, P.K. (2007). Alien Flora of Doon Valley, Northwest Himalaya. Current Science 92(7)
17. Negi, P. (2006). A Contribution to Woody Plant Diversity of Doon Valley, Uttaranchal (North-West Himalaya). Indian Forester, 132(4), 429-455.
18. Adhikari, B.S., Babu, M.M., Saklani, P.L. and Rawat, G.S. (2010). Medicinal Plants Diversity and their Conservation Status in Wildlife Institute of India (WII) Campus, Dehradun. Ethnobotanical Leaflets 14: 46-83.
19. Rizvi, A.N., Tak, P.C., and Kumar, P. (2017). Faunal Diversity of Dehradun District: An Overview. Zoological Survey of India, 1-16
20. Singh, A.P., and Sondhi, S. (2016). Butterflies of Garhwal, Uttarakhand, Western Himalaya, India. Journal of Threatened Taxa, 8(4):8666-8697
21. Gupta, N., and Siliwal, M. (2012). A Checklist of Spiders (Arachnida: Araneae) of Wildlife Institute of India Campus, Dehradun, Uttarakhand, India. Indian Journal of Arachnology, 1(2):073

Like butterflies, moths are abundantly found in the city of Dehradun. A study[22] of the moths found in the campus of WII, another in Dehradun, Mussoorie and Devalsari in Garhwal, Uttarakhand[23], as well as records[24] from the Titli trust from their surveys between 2017-2019 yield a total of 326 species of moths that occur within the city of Dehradun. These have been compiled in Table 11 in Annexure 2. Inputs from Dr. Pritha Dey, a scholar at IISc have also contributed to the list.

A study on snakes conducted in the premises of WII, reported 14 species of snakes belonging to 3 families[25]. The species identified in the study constitute almost 35% of snakes found in the state of Uttarakhand and 4% of total snake diversity of India. The list of snakes found in the city has been compiled with the assistance of Dr. Abhijit Das of WII, in Table 10 in Annexure 2.

Amphibians play an important role in nature as both prey and predators. In the Doon valley ten species, eight genera and four families[26] of amphibians have been recorded. The species documented in the region fall under a single order and are categorized as 'Least Concern' in the IUCN Red List of Threatened Species.

Dehradun district has vast reserves of forests and wildlife. To obtain a comprehensive knowledge about the local plants and animals of the city, the city needs to develop a complete biodiversity profile, identifying major flora and fauna found within its limits. This would support the management and monitoring of biodiversity in the city.

Natural Asset Map: A natural asset map of Dehradun city (area under the jurisdiction of Nagar Nigam Dehradun) has been developed by WII and ICLEI South Asia (Figure 3). Table 1 provides details of each land class. Further details are mentioned in Annexure 1.

22. Dey, P., Joshi, K. and Uniyal, V.P. (2018). Common Moths of WII. WII, Dehradun.
23. Sondhi, Y. and Sondhi, S. (2016). A partial checklist of moths (Lepidoptera) of Dehradun, Mussoorie and Devalsari in Garhwal, Uttarakhand, India. Journal of Threatened Taxa 8(5): 8756– 8776.
24. Sondhi, S. (2020). Titli Trust National Moth Week Surveys, 2017-2019. Sondhi, S., Y. Sondhi, P. Roy and K. Kunte (eds.). Moths of India, v. 2.00. Indian Foundation for Butterflies. https://www.mothsofindia.org/home
25. Das, A., Krishna, M.K.S. and Nigam, P. (2015). Knowing Campus Snakes: A Pictorial Guide. Published by Wildlife Institute of India.
26. Husain, A. (2015). Amphibians of Doon Valley (Dehradun, Uttarakhand) with their Systematics, Distribution, Ecology, Conservation Status and Threats. Aquatic Ecosystem: Biodiversity, Ecology and Conservation.

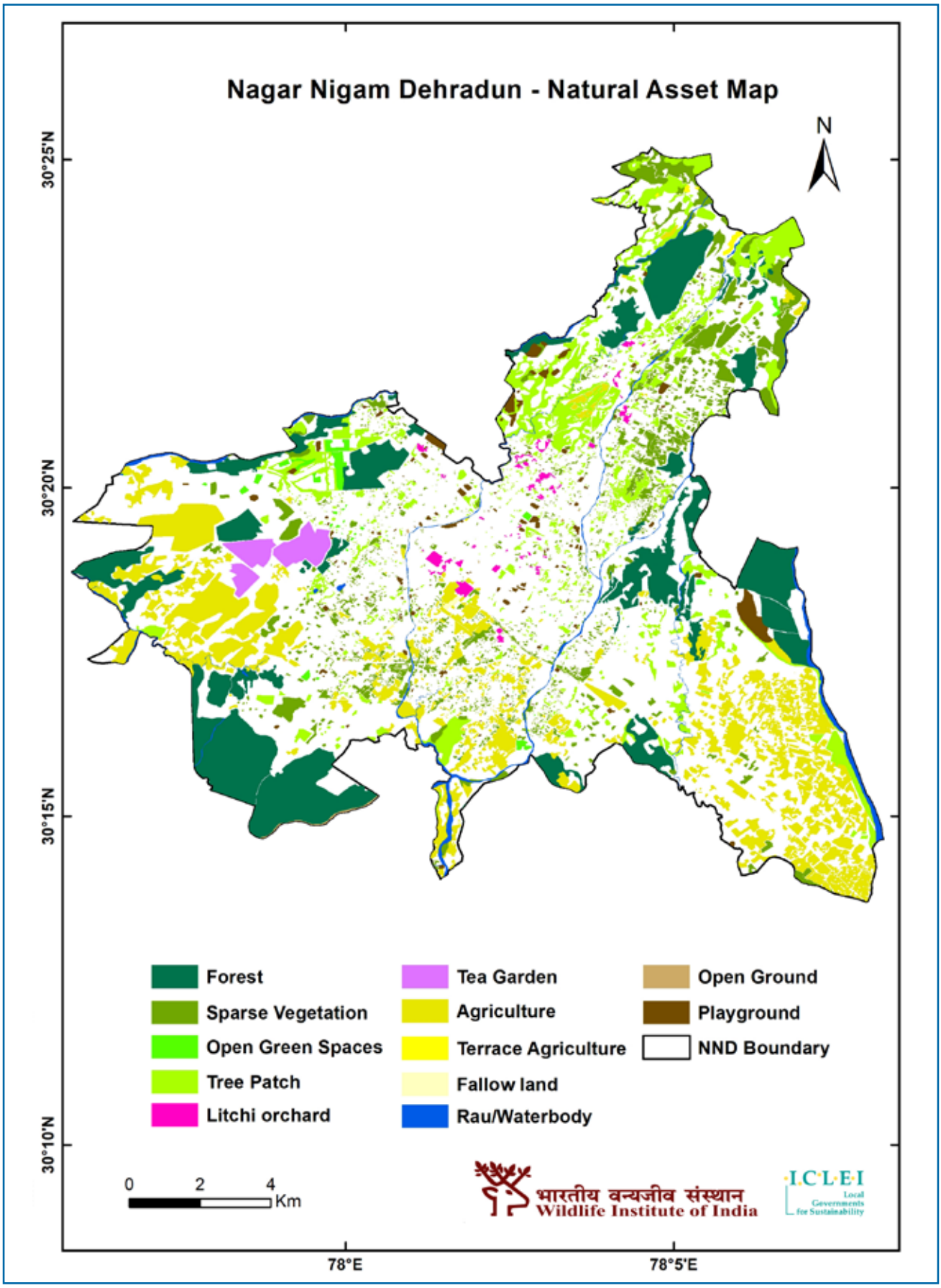


Figure 3: Natural Asset Map of Dehradun

Table 1: Area wise distribution of natural assets of Dehradun city

Sl. No.	Land Class	Area (in ha)	Area (in sq.km)
1	Agriculture	2,425	24.25
2	Fallow Land	10	0.10
3	Litchi Orchard	84	0.84
4	Open Green Space	91	0.91
5	Open Ground	14	0.14
6	Playground	212	2.12
7	Sparse Vegetation/Scrub Forest	1,282	12.82
8	Tea Garden	210	2.10
9	Terrace Agriculture	14	0.14
10	Tree Patch	1,590	15.9
11	Forest	2,563	25.63
12	Rau/Seasonal River	277	2.77
13	Waterbody	5	0.05
	Total	8,777	87.77

Administration of Biodiversity

In India, there are five commonly employed models of biodiversity governance[27] which can be broadly classified into state driven and community-based conservation. State driven conservation models include protected areas and territorial forests while community-based conservation includes models like autonomous community efforts, co-management of forests and decentralized governance of biodiversity.

The city of Dehradun does not enclose a protected area network. However, since Dehradun is nestled between the Doon valley with Malsi Reserve Forest present at its northern limits and Rajaji National Park and Tiger Reserve forming the southern peripheral territory, the city is a biodiverse region. In Dehradun city, the Malsi Reserve Forest and parts of the WII and FRI campuses which host reserve forest, fall within the territorial forest model of governance. There is no protected area within the jurisdiction of the city, neither is there any community based conservation such as sacred groves, jointly managed forests or biodiversity heritage sites.

At the administrative level, the following agencies/institutions at the state and city levels are responsible for biodiversity related activities. Although there are a number of NGOs and academic institutions working on various aspects of biodiversity, these have not been detailed below as they are not involved in the administration.

Uttarakhand State Forest Department: This department is headed by the Principal Chief Conservator of Forests (Head of Forest Force), who is assisted by other Principal Chief Conservator of Forests (PCCFs), Additional PCCFs, Chief Conservators of Forests and other officials. The department is concerned with responsibilities like production, conservation and protection of forests, development of working plans, budget, planning and policy-making, eco-development and tribal welfare, forest management information

27. Krishnan, P., Ramakrishnan, R., Saigal, S., Nagar, S., Faizi, S., Panwar, H.S., Singh, S. and Ved, N. (2012). Conservation Across Landscapes: India's Approaches to Biodiversity Governance. United Nations Development Programme, New Delhi, India.

systems, vigilance and administration. The Forest Department is also responsible for managing Malsi Reserve Forest and Rajaji National Park. For more information please visit www.forest.uk.gov.in

Uttarakhand State Biodiversity Board (SBB): The function of the SBBs is to advise the State Government, on any guidelines issued by the Central Government, on matters relating to the conservation of biodiversity, sustainable use of its components and equitable sharing of the benefits arising out of the utilization of biological resources. At the local level, the SBB also supports BMCs in the development of the People's Biodiversity Register. For more information please visit: http://www.sbb.uk.gov.in/

Agriculture Department, Government of Uttarakhand: The Agriculture Department of Uttarakhand is responsible for food and nutritional security within the state. The department supports farmers through various agricultural schemes, soil testing, distribution and guidelines on seeds and pesticides as well as information on agricultural machinery. For more information please visit: http://agriculture.uk.gov.in/

Mussoorie Dehradun Development Authority (MDDA): The MDDA is responsible for the planning and development of the Dehradun Urban Agglomeration, Mussoorie municipal area and the surrounding 185 Revenue Villages of Dehradun district. MDDA primarily works to implement the Master Plan, acquire land to implement various schemes, enforce plans and development schemes and take up measures for protection of natural environment in the development area. Thus a number of biodiversity related activities within the city such as plantation work and maintenance of some parks, is taken up by this body. For more information please visit: http://mddaonline.in/

Nagar Nigam Dehradun: This is the urban local body and is responsible for urban planning and urban management functions including construction and redevelopment of parks. Currently, Nagar Nigam Dehradun has been planning the construction of Chidonwali Park and rejuvenation of Gandhi Park, Tilak Park and Lala Lajpat Rai Park, ensuring environment-friendly developmental activities for the benefit of the local residents of the city. For more information please visit: https://nagarnigamdehradun.com

Dehradun Smart City Limited (DSCL): This city agency aims to drive economic growth and improve the quality of life of people by enabling technology that leads to smart and sustainable outcomes. As part of the Smart City Plan, DSCL has proposed to plant trees in different parts of the city to increase the green cover and enhance the surrounding environment. Other relevant projects proposed by the DSCL include construction of an Integrated Green Building which will be a sustainable building, designed to alleviate the environmental impacts. For more information please visit: http://smartcitydehradun.uk.gov.in/about-dscl

PART II: Indicators of the Index on Cities' Biodiversity

Native Biodiversity

Indicator 1: Proportion of Natural Areas in the City

According to the Singapore Index Manual, natural areas are defined as "Natural areas comprise predominantly native species and natural ecosystems, which are not, or no longer, or only slightly influenced by human actions, except where such actions are intended to conserve, enhance or restore native biodiversity."

Methodology

As per the CBI user manual

Principle for calculation of the indicator
(Total area of natural, restored and naturalised areas) ÷ (Total area of city) × 100%

Scoring Range: (based on the CBI user manual)
0 point: <1.0%
1 point: 1.0% - 6.9%
2 points: 7.0% - 13.9%
3 points: 14.0% - 20.0%
4 points: > 20.0%

City Data and Calculations
TThe definition of natural areas in the Singapore Index manual is difficult to strictly apply within the context of Indian cities where the ground realities are significantly different. Income inequality, a high population density, and limited infrastructural outreach means that while there are native and natural ecosystems, public access to these areas cannot be completely restricted.

To calculate the proportion of natural areas in the city, a natural asset map (Figure 3) of Dehradun was prepared and referred to. Table 1 below shows the various classes of natural assets identified within the natural asset map of Dehradun. Anthropogenically created land classes such as litchi orchard, fallow land, agriculture, tea garden, tree patch, open green spaces, open ground and playground were not considered in the calculation of this indicator. For more information regarding the classification schemes used for the generation of the Natural Asset Map, please refer Annexure 1.

The main land use classes that have been considered (Table 2) under natural areas are sparse vegetation, forest, rau/seasonal river, waterbody (lake). It is important to note that the river at various points within the city hosts informal settlements. Since it was difficult to exclude these areas in the area calculation of this land class, the entire area was considered. The waterbody considered in this calculation is the lake located within nature trail on the premises of WII where human interference is minimal.

Table 2: Area wise distribution of natural assets applicable to Indicator 1

Sl. No.	Land Class	Area in sq. km.
1.	Sparse Vegetation	12.82
2.	Forest	25.63
3.	Rau/Seasonal River	2.77
4.	Waterbody	0.05
	Total	41.27

Total area of natural, restored and naturalised areas = 41.27 sq. km.

Total area of the city = 196.48 sq. km.

RESULT: 21%

SCORE: 4

Recommendations to Improve Score

Dehradun city can maintain their score under this indicator by developing a city level LBSAP which will help to protect, improve and monitor these natural areas. A large contribution to the score of this indicator comes from well maintained and administrated institutional areas of the city. This needs to be recognized by the city administration who should take these stakeholders into cognizance during the development of the LBSAP.

Indicator 2: Connectivity Measures or Ecological Networks to Counter Fragmentation

Methodology

As per the CBI user manual

Principle for calculation of the indicator

$$\frac{1}{A_{total}} * \left(A_1^2 + A_2^2 + A_3^2 + \ldots + A_n^2\right)$$

Where:

- A_{total} is the total area of all natural areas
- A_1 to A_n are areas that are distinct from each other (i.e. more than or equal to 100m apart)
- $_n$ is the total number of connected natural areas

This measures effective mesh size of the natural areas in the city. A1 to An may consist of areas that are the sum of two or more smaller patches which are connected. In general, patches are considered as connected if they are less than 100m apart.

Scoring Range: (based on the CBI user manual)

0 point:	< 200 ha
1 point:	201 - 500 ha
2 points:	501 - 1000 ha
3 points:	1001 - 1500 ha
4 points:	> 1500 ha

City Data and Calculations

The patches associated with the land classes used to calculate indicator 1 i.e. forest, river, lake and sparse vegetation, have been considered in this calculation. In reality, manmade landscapes represented in Dehradun by the land classes- litchi orchard, fallow land, agriculture, tea garden, tree patch, open green spaces, also form a part of the ecological network to counter fragmentation for several species. However, these have not been considered following the guidelines of the CBI manual[2].

1,243 polygons (patches) were merged with the land class Rau/seasonal river and considered a single unit, as per the 100m proximity rule. Therefore, the total area of this big patch (A_1) was determined as 3,436.14 ha (refer in Annexure 3, Table 14).

There are 1,101 polygons (patches) which are outside the 100m buffer of this big patch. As per the 100m proximity rule, these 1,101 patches are inter-merged into 276 patches (A_2 – A_{277}). The total number of patches is as shown in Table 14.

A_{total} = 4121.77 ha

As per the final calculation,

Indicator 2 = 1/4121.77 ha X (11837184.58 ha^2) = 2871.87 ha

RESULT: 2871.87

SCORE: 4

Recommendations to Improve Score

The city can work towards the maintenance of this score by supporting restoration around natural areas and providing them with some form of protection. Local NGOs can help in securing community support for the same. A cohesive vision for the same can come through the LBSAP.

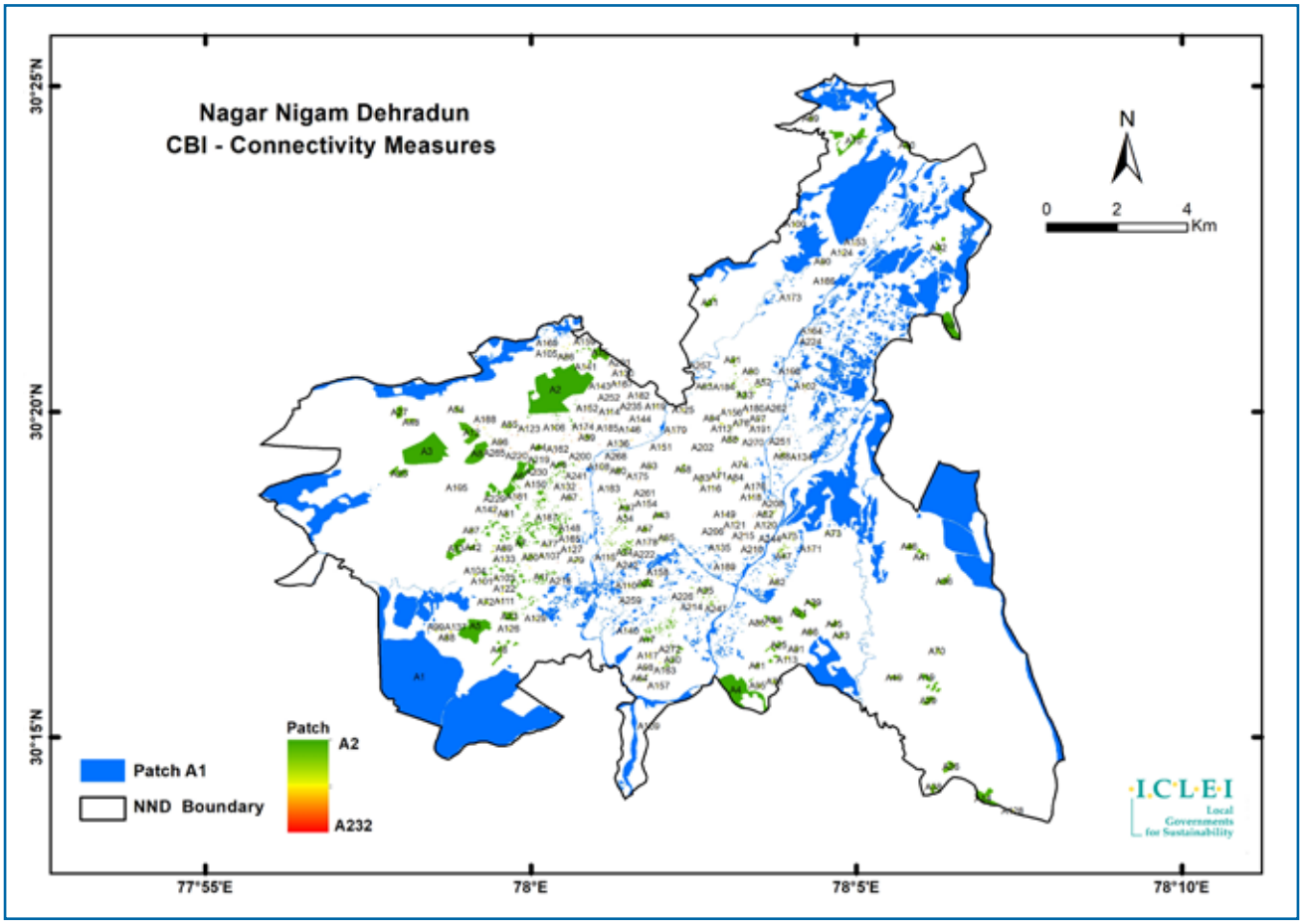


Figure 4: Patches of natural areas within the boundary of Nagar Nigam Dehradun

Indicator 3: Native Biodiversity in Built Up Areas (Bird Species)

Methodology

How to calculate indicator

Number of native bird species in built up areas where built up areas include impermeable surfaces like buildings, roads, drainage channels, etc., and anthropogenic green spaces like roof gardens, roadside planting, golf courses, private gardens, cemeteries, lawns, urban parks, etc. Areas that are counted as natural areas in indicator 1 should not be included in this indicator.

Scoring Range: (based on the CBI user manual)

0 point: < 19 bird species
1 point: 19 - 27 bird species
2 points: 28 - 46 bird species
3 points: 47 - 68 bird species
4 points: > 68 bird species

City Data and Calculations

For the purpose of calculating Indicator 3, sightings recorded on the citizen's science platform developed by Cornell Lab of Ornithology, eBird (2019)[28] was referred to. A district level list was refined into a city level list by consulting birding experts as recorded in part 1 (refer Table 12 in Annexure 2 for details). The list was then categorized into residents and migrants. Resident birds sighted within the municipal corporation limits were considered. Sightings from those areas considered in indicator 1 were not taken into account for the calculation of this indicator. This type of exclusion of sightings is possible using e-bird's mapping tools. Furthermore, the list was also checked for common urban birds by birding experts. It is important to note that in a heterogeneous landscape like Dehradun, there may be greater bird diversity than recorded for this indicator.

The total number of bird species (resident) identified for the purpose of this indicator is 97. The list of the birds considered for this indicator is provided in Annexure 2, Table 10.

RESULT: 97 Species

SCORE: 4

Recommendations to Improve Score

In order to sustain this score, the city needs to ensure the maintenance of its natural and agricultural spaces which provide a heterogeneous mosaic of habitats and resources for birds of the city.

28. eBird, (2019). The Cornell Lab of Ornithology https://ebird.org/region/IN-KL-ER/hotspots?yr=all&m Accessed on March 9, 2020.

Indicator 4 - 8: Change in Number of Native Species

Methodology

How to calculate indicator

The change in number of native species is used for indicators 4 to 8. The three core groups are:

- Indicator 4 : vascular plants
- Indicator 5 : birds
- Indicator 6 : butterflies

These groups have been selected as data are most easily available and to enable some common comparison.

Cities can select any two other taxonomic groups for indicators 7 and 8 (e.g., bryophytes, fungi, amphibians, reptiles, freshwater fish, molluscs, dragonflies, beetles, spiders, hard corals, marine fish, seagrasses, sponges, etc.)

The above data from the first application of the Singapore Index would be recorded in Part I: Profile of the City as the baseline.

Net change in species from the previous survey to the most recent survey is calculated as:

Total increase in number of species (as a result of re-introduction, rediscovery, new species found, etc.) minus number of species that have gone extinct.

Scoring Range: (based on the CBI user manual)

0 point:	Maintaining or a decrease in the number of species
1 point:	1 species increase
2 points:	2 species increase
3 points:	3 species increase
4 points:	4 species or more increase

City Data

Apart from isolated studies compiled by organisations, there has not been a comprehensive compilation of the biodiversity of Dehradun city.

For the purpose of the indicators 4-8, studies carried out within the city and its surrounds as detailed in Part 1, were considered. Taxa experts were consulted with, at the final stage of the list development. Annexure 2 has details of the species lists that have been considered for indicators 4-8 (Tables 11-.15).

For indicators 7 and 8, the taxonomic groups chosen are reptiles and moths, respectively. These lists will form the baseline for comparison when the index is revisited by the city, after 5 years.

RESULT: Since this is the baseline year for the species count, the city will not receive a score on the indicators 4-8 and it will be excluded from the overall calculation.

Indicator 9: Proportion of Protected Natural Areas

Methodology

How to calculate indicator
(Area of protected or secured natural areas) ÷ (Total area of the city) × 100%

Scoring Range: (based on the CBI user manual)
0 point: < 1.4%
1 point: 1.4% - 7.3%
2 points: 7.4% - 11.1%
3 points: 11.2% - 19.4%
4 points: > 19.4%

City Data and Calculations
As detailed in Part 1 of the index, the governance models for biodiversity in India are of 5 types, which fall under two main streams- State driven conservation and Community based conservation. Within Dehradun city, natural areas that receive protection are currently those that fall under the State driven conservation stream are Territorial Forests. These include:

- Malsi Reserve Forest = 2.52 sq.km.
- Reserve forest in the WII Campus = 1.8 sq.km.
- Reserve forest in the FRI Campus = 4.5 sq.km.
- Forest under Asarori and Chandrabani Grant = 7.69 sq.km.

The total protected or secured natural area = 16.51 sq.km.

Total area of the city = 196.48 sq. km.

RESULT: 8.40%

SCORE: 2

Recommendations to Improve Score

The city can improve its score for this indicator by increasing protection of its natural areas. The score for this indicator is based primarily on state driven conservation efforts. The city can encourage more community based conservation initiatives, through the Biodiversity Management Committee, which needs to be established on priority.

Indicator 10: Proportion of Invasive Alien Species

Methodology

How to calculate indicator
(Number of invasive alien species) ÷ (Number of native species) × 100%

Scoring Range: (based on the CBI user manual)
0 point: > 30.0%
1 point: 20.1% - 30.0%
2 points: 11.1% - 20.0%
3 points: 1.0% - 11.0%
4 points: < 1.0%

City Data and Calculations
In India, the most well documented taxa in terms of alien species are terrestrial plants. The definition which has been considered for this indicator in the CBI is "one whose introduction and/or spread threatens biological diversity (For the purpose of the present guiding principles, the term "invasive alien species" shall be deemed the same as "alien invasive species" in accordance with Decision V/8 of the CoP to the Convention on Biological Diversity)".

The flowering plant taxa was selected for the purpose of calculation of indicator 10. For the purpose of calculation of this indicator, a list of flowering plants that could be found in the city was compiled and vetted by experts in WII. This list comprises of the plants that are found within the campus of WII since no list of the city is available. This can be found in Table 11 in Annexure 2. The species were then classified into native and exotic species, using sources such as Negi and Hajra (2007)[16], Sekhar *et al.* (2012)[29] and information on http://www.flowersofindia.net[30]. Exotic species were further refined into alien invasive species using the critieria in Sekhar *et al.* (2012)[24], which is provided in Table 16 in Annexure 2.

Out of 612 flowering plant species found in Dehradun city, 451 were identified as native, 161 were identified as exotic of which 63 were classified as invasive alien species.

Number of invasive alien species = 63

Number of native species = 451

RESULT: 13.97%

SCORE: 2

29. Sekar, K. C., Manikandan, R., and Srivastava, S. K. (2012). Invasive alien plants of Uttarakhand Himalaya. Proceedings of the National Academy of Sciences, India Section B: Biological Sciences, 82(3), 375-383.

30. Flowers of India. http://www.flowersofindia.net Accessed online on April 13 2020

Recommendations to Improve Score

It is important that a risk assessment of the alien invasive species, be conducted. The risk assessment will enable an understanding of which species are high, medium, low and insignificant with regard to their impacts on local ecosystems. This will help to further refine the present score. Once the risk assessment has been carried out, strategies that can be taken up by city authorities in partnership with academic institutions, NGOs and state authorities can be identified in the LBSAP.

It would also be worthwhile to produce maps that delineate areas occupied by alien invasive flora especially Lantana. These maps will help to develop site specific restoration plans for removal of alien species.

Indicator 11: Regulation of Quantity of Water

Methodology

How to calculate indicator
(Total permeable area) ÷ (Total terrestrial area of the city) × 100%

Scoring Range: (based on the CBI user manual)
0 point: < 33.1%
1 point: 33.1% - 39.7%
2 points: 39.8% - 64.2%
3 points: 64.3% - 75.0%
4 points: > 75.0%

City Data and Calculations

Since, no published data is available on impermeable/permeable surfaces of Dehradun, the Natural Asset Map (Figure 3) was used to calculate the proportion of all permeable areas. The land classes considered in the calculation are Agriculture, Terrace Agriculture, Tea Garden, Litchi Orchard, Fallow Land, Forest, Open Green Spaces, Playground, Rau/Seasonal River, Sparse vegetation, Tree patch and Waterbody (Table 3). Playgrounds in the city are both paved and unpaved. Therefore, for the purpose of calculation of the indicator, based on some amount of ground truthing that was carried out, it was decided that 80% of the total playground area would be considered.

Table 3: Natural asset classes used in the calculation for Indicator 11

Sl. No.	Classes	Area (in sq. km)
1	Forest	25.63
2	Sparse vegetation/ Scrub Forest	12.82
3	Tree patch	15.90
4	Agriculture	24.25
5	Rau/River	2.77
6	Waterbody	0.05
7	Terrace Agri	0.14
8	Tea Garden	2.10
9	Open Green Space	0.91
10	Litchi Orchard	0.84
11	Fallow Land	0.10
12	80% of Playground	1.69
	Total	**87.20**

Total permeable area = Area of Agriculture + Terrace Agriculture + Tea Garden + Litchi Orchard + Fallow Land + Mixed Forest + Open Green Spaces + 80% of Playground + Rau/Seasonal River + Sparse vegetation + Tree patch + Waterbody = 87.2 sq. km.

Total terrestrial area of the city = 193.66 sq. km.

RESULT: 45.03%

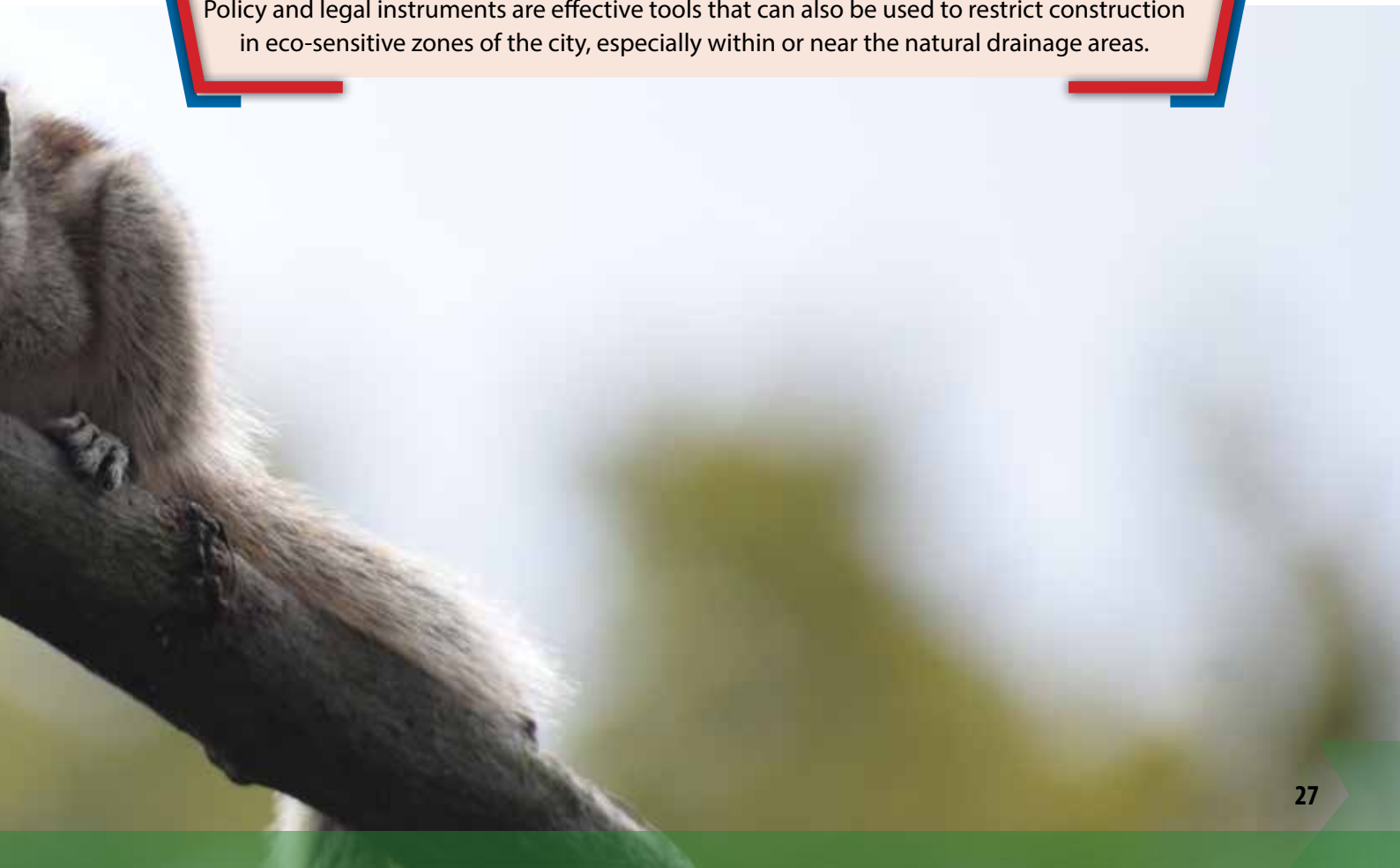
SCORE: 2

Recommendations to Improve Score

The city's river ecosystem and its drainage is extremely fragile3, owing to limited and ill maintained grey infrastructure, informal settlements, encroachments, limited outreach of solid waste management services and poor public civic sense. This has significant repercussions on the regulation of the quantity of water through the urban landscape.

The city should look into Nature based Solutions or a mix of grey and green infrastructure that can improve the percolation of rainwater into the ground within feasible built-up areas. Encouraging citizens to install rainwater harvesting structures can also improve capture of rainwater and reduce run-off. Increasing the proportion of vegetated (trees, herbs, shrubs) surface areas in the city through greening will also support the regulation of water.

Policy and legal instruments are effective tools that can also be used to restrict construction in eco-sensitive zones of the city, especially within or near the natural drainage areas.



Indicator 12: Climate Regulation: Carbon Storage and Cooling Effect of Vegetation

Methodology

How to calculate indicator
(Tree canopy cover) ÷ (Total terrestrial area of the city) × 100%

Scoring Range: (based on the CBI user manual)
0 point: < 10.5%
1 point: 10.5% - 19.1%
2 points: 19.2% - 29.0%
3 points: 29.1% - 59.7%
4 points: > 59.7%

City Data and Calculations
Indicator 12 measures the tree cover within the city and is used as a proxy for larger functions of climate regulation and carbon storage.

This indicator is calculated based on the Natural Asset Map (Figure 3), taking into account the land use classes of Forest, Tree Patch, Litchi Orchard and Open Green Spaces (Table 4).

Table 4: Land use classes which comprise predominately trees which have a role in carbon storage and cooling

Sl. No.	Land Class	Tree Cover (in sq.km)
1	Forest	25.63
2	Tree Patch	15.90
3	Litchi Orchard	0.84
4	Open Green Spaces	0.91
	Total	43.28

The total tree cover in the city of Dehradun is 43.28 sq. km.

The total terrestrial area of the city is 193.66 sq. km

RESULT: 22.35%

SCORE: 2

Recommendations to Improve Score

The city can improve their score for this indicator through a mix of activities related to conservation and restoration of its green spaces. Plantation of native tree species should be actively taken up by Nagar Nigam Dehradun. Community participation is critical for ensuring the success of programmes and strategies towards the same.

Indicator 13: Recreational Services

Methodology

How to calculate indicator
(Area of parks with natural areas and protected or secured natural areas)/1000 persons

Scoring Range: (based on the CBI user manual)
0 point: < 0.1 ha/1000 persons
1 point: 0.1 - 0.3 ha/1000 persons
2 points: 0.4 - 0.6 ha/1000 persons
3 points: 0.7 - 0.9 ha/1000 persons
4 points: > 0.9 ha/1000 persons

City Data and Calculations

For the city of Dehradun, parks with protected or secured natural areas, a list of the parks and their areas within the city was sourced from the Nagar Nigam. Additionally, parks not under the jurisdiction of the Nagar Nigam but that of the MDDA were delineated and their areas were calculated, as per list sourced online. This includes all the major parks of Dehradun such as Gandhi Park, MDDA Park- Rajpur, B.R Ambedkar Stadium, Vijay Park, Kandoli Park. Malsi Deer Park, Survey of India Park, and Parks of FRI were also delineated and their areas calculated from the map. The parks and their areas are listed in Table 5.

Table 5: Parks in Dehradun

Sl. No.	Name of the Park	Area (in ha)
1	Gandhi Park	5.89
2	MDDA Park – Rajpur	2.25
3	B.R Ambedkar Stadium	0.86
4	Vijay Park	0.26
5	Kandoli Park	0.54
6	Malsi Deer Park	6.84
7	Survey of India Park	1.79
8	Parks in FRI	23.88
9	Lala Lajpat Rai Park	1.56
10	Tilak Park	0.49
11	Central Park	2.33
12	Salawala Park	0.12
13	Mayur Vihar Park	0.27
14	Indira Nagar Colony Park	4.79
15	Old Nehru Colony Park	0.29
16	Vasant Vihar Park	0.16
17	Patel Park	0.07
18	Buddha Park	0.03
19	Shyama Mukherjee Park	0.3
20	Araghar Park	0.01

Sl. No.	Name of the Park	Area (in ha)
21	Ram Vihar Ballupur Park	0.24
22	Kailashpuri Park	0.02
23	Alkapuri Park	0.06
24	Manjuganj Park	0.08
25	Doon Vihar Park	0.79
26	Muslim Colony Park	0.23
27	Patel Nagar East Park	0.3
28	Patel Nagar West Park	3.74
29	Nehru Colony H-Block Park	0.94
30	Nehru Colony Park Project	0.53
31	Rajendra Nagar A-Block Park	0.24
32	Rajendra Nagar B-Block Park	0.08
33	Vidya Vihar Park	0.2
34	Pandit Deen Dayal Park	0.23
35	Nehrupuram Park, MDDA Colony	0.11
36	Indirapuram, MDDA Colony	1
37	Lohiapuram Park	0.03
38	Dalanwala MDDA Colony Park	0.04
39	Defence Colony Park	0.6
40	Siddarth Vihar Park	0.04
41	Kedarpuram Park	0.1
	Total	**62.33**

Total area of parks with natural areas = 62.33 ha

(Area of parks with natural areas) / 1000 persons = 62.33/ 1000 = 0.062 ha

RESULT: 0.062 ha

SCORE: 0

Recommendations to Improve Score

To improve this score, the city needs to set aside more green space for public access and recreation. Presently, the parks in the city are maintained either by the Nagar Nigam or by MDDA. Therefore, the two agencies can partner together to identify feasible sites for natural recreation spaces and develop these. Support of local NGOs and RWAs can also be solicited for in the maintenance of parks. The Nagar Nigam can also tie with corporates and private agencies (through CSR funds) for development and maintenance of parks and the recreational facilities in them.

The development of the Chidonwali Park by the Nagar Nigam is a step in the right direction and will help to improve this score.

Indicator 14: Educational Services

Methodology

How to calculate indicator
Average number of formal educational visits per child below 16 years to parks with natural areas or protected or secured natural areas per year

Scoring Range: (based on the CBI user manual)
0 point: 0 formal educational visit/year
1 point: 1 formal educational visit/year
2 points: 2 formal educational visits/year
3 points: 3 formal educational visits/year
4 points: > 3 formal educational visits/year

City Data
Data gathered from the records of three Government schools and 10 private schools shows that on an average one educational visit per year takes place to a park and other natural areas. However, these visits are at the discretion of the school and are not mandated within the curriculum by educational boards.

Therefore for this indicator, it was identified that no formal educational visit to natural areas takes place in schools of Dehradun.

RESULT: No formal educational visit

SCORE: 0

Recommendations to Improve Score

Dehradun city administration does not have an influence on the curriculum of the various boards followed by schools in the city. However, the city administration can give a directive to all schools to include such visits in their curriculum.

The various school boards responsible for curriculum development should consider including mandatory practical aspects and educational visits to support theoretical frameworks within themes of biodiversity education in curricula. The city administration should send a request in this regard to all the school boards, through the state government.

Indicator 15: Budget Allocated to Biodiversity

Methodology

How to calculate indicator
(Amount spent on biodiversity related administration) ÷ (Total budget of city) × 100%

Scoring Range: (based on the CBI user manual)
0 point: < 0.4%
1 point: 0.4% - 2.2%
2 points: 2.3% - 2.7%
3 points: 2.8% - 3.7%
4 points: > 3.7%

City Data and Calculations
For the calculation of this indicator, the financial commitment of the city government through the annual municipal budget (2019-2020) and schemes like Atal Mission for Rejuvenation and Urban Transformation (AMRUT), which are applied for and implemented directly by the city administration, were taken into consideration. State level funding which also contributes to biodiversity related administration, was not factored into the calculation, as that does not constitute the city budget and will rather form part of the state budget.

The calculation of this indicator was therefore from the various direct budget allocations (in INR) made to biodiversity related activities, by Dehradun city in 2019- 2020, and some projects under the AMRUT scheme (Sector: Urban green space) which directly fit into biodiversity administration and protection. The following are as listed below:

Budget Allocation (in INR) towards biodiversity related activites under AMRUT:
- Rejuvenation of Lala Lajpat Rai Park – INR 2.5 million
- Rejuvenation of Tilak Park – INR 2.5 million
- Development of Children Park at Gandhi Park - INR 10.5 million

Budget allocation (in INR) made to biodiversity related activites by Nagar Nigam Dehradun:
- Development of Chidonwali Park – INR 2.9 million

Amount spent on biodiversity related administration = INR 18,400,000

Total Municipal Budget = INR 1,952,931,600

Total AMRUT Budget = INR 1,328,000,000

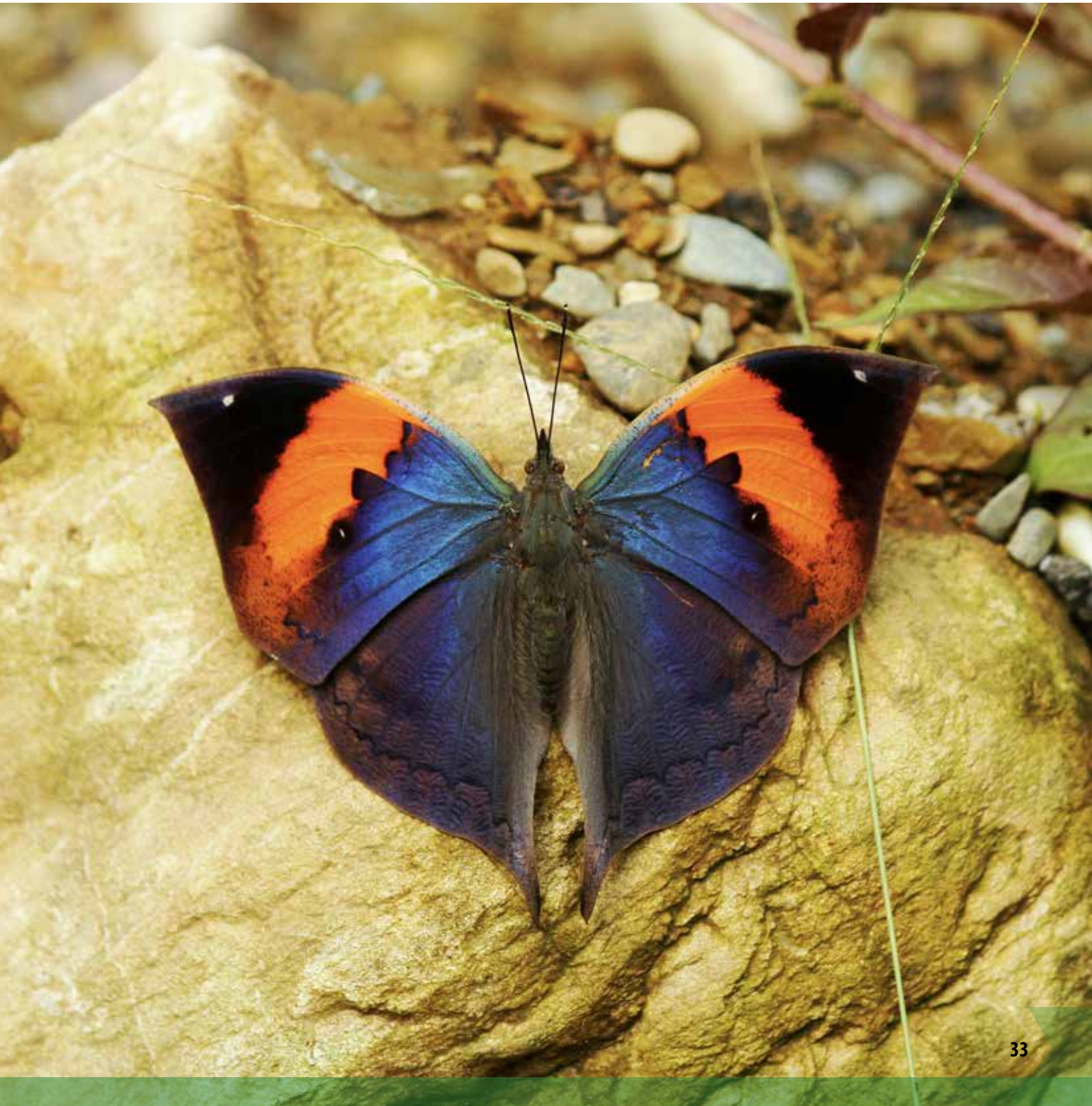
Overall Total = INR 3,280,931,600

RESULT: 0.56%

SCORE: 1

Recommendations to Improve Score

The city should take up more active role in biodiversity governance, by developing its LBSAP and incorporating the financial commitment in the annual municipal budget for initiatives proposed in the LBSAP. This will on one hand help to improve this score, and the other hand it will help to improve the overall quality of life in the city.



Indicator 16: Number of Biodiversity Projects Implemented by the City Annually

Methodology

How to calculate indicator
Number of programmes and projects that are being implemented by the city authorities, possibly in partnership with private sector, NGOs, etc. per year.

In addition to submitting the total number of projects and programmes carried out, cities are encouraged to provide a listing of the projects and to categorise the list into projects that are:
1. Biodiversity related
2. Ecosystems services related

Scoring Range: (based on the CBI user manual)
0 point: < 12 programmes/projects
1 point: 12 - 21 programmes/projects
2 points: 22 - 39 programmes/projects
3 points: 40 - 71 programmes/projects
4 points: > 71 programmes/projects

City Data and Calculations
This indicator is calculated based on the number of biodiversity related projects and programmes that the city authorities are involved in, either as the main player or in partnership with NGOs and the private sector, where the city is a key collaborator.

The city of Dehradun is in the course of implementation of various projects funded by government agencies linked to the Smart City Proposal like park rejuvenation, water supply and sewerage, viable and electric public transport facilities. The city is also partnering with NGOs like Waste Warriors and Him Foundation for undertaking tree plantation activities and promoting organic farming through vocational and training programmes

RESULT: < 12

SCORE: 0

Recommendations to Improve Score

The Nagar Nigam's limited involvement in biodiversity administration and governance in Dehradun impacts its score for this indicator.

The city should develop its LBSAP where it can identify suitable partnerships and take up activities identified therein.

Indicator 17: Policies, Rules and Regulations – Existence of Local Biodiversity Strategy and Action Plan

Methodology

How to calculate indicator
Status of LBSAP (or any equivalent plan); number of associated CBD initiatives.

Scoring Range: (based on the CBI user manual)

0 point:	No LBSAP*
1 point:	LBSAP not aligned with NBSAP
2 points:	LBSAP incorporates elements of NBSAP, but does not include any CBD initiatives**
3 points:	LBSAP incorporates elements of NBSAP, and includes one to three CBD initiatives
4 points:	LBSAP incorporates elements of NBSAP, and includes four or more CBD initiatives

* LBSAP or equivalent.
** The thematic programmes of work and cross-cutting issues of the CBD are listed in http://www.cbd.int/programmes/. The Strategic Plan for Biodiversity (2011-2020), including the Aichi Biodiversity Targets can also be used as a reference framework (http://www.cbd.int/sp/default.shtml).

City Data
There is no LBSAP developed for the city of Dehradun.

RESULT: NO LBSAP

SCORE: 0

Recommendations to Improve Score

Several scores within this index for Dehradun city can be improved with the development of an LBSAP, which will help the city better plan and administer the local biodiversity. The initiative in this regard should be taken up on priority basis by the Nagar Nigam.

Indicator 18 : Institutional Capacity - Essential Biodiversity Related Functions

Methodology

How to calculate indicator

Number of essential biodiversity related functions* that the city uses.

* The functions could include the following: biodiversity centre, botanical garden, herbarium, zoological garden or museum, insectarium, etc.

Scoring Range: (based on the CBI user manual)

0 point: No functions
1 point: 1 function
2 points: 2 functions
3 points: 3 functions
4 points: > 3 functions

City Data and Calculations

There are a number of essential biodiversity related functions within the city's jurisdiction, primarily because of the research institutions present. The following are the various biodiversity related functions present in the city.

- Dehradun Zoo, earlier referred to as Malsi Deer Park
- Regional Science Centre or Vigyan Dham
- Botanical Museum at FRI
- Herbarium at FRI and WII
- Insectarium at FRI
- Bambusetum at FRI
- Nature Trail at WII

RESULT: 8

SCORE: 4

Recommendations to Improve Score

Since a large number of essential biodiversity related functions are housed within research institutions in Dehradun, the Nagar Nigam should look into partnerships with these institutions which will help to maintain and upgrade these facilities.

The city in association with the Education Boards and Universities should encourage educational visits from local schools and colleges which will support practical understanding of biodiversity-related concepts.

Indicator 19 : Institutional Capacity - Inter-Agency Co-Operation

Methodology

How to calculate indicator

Number of city or local government agencies involved in inter-agency co-operation pertaining to biodiversity matters.

Scoring Range: (based on the CBI user manual)

0 point: 1 or 2 agencies* cooperate on biodiversity matters
1 point: 3 agencies cooperate on biodiversity matters
2 points: 4 agencies cooperate on biodiversity matters
3 points: 5 agencies cooperate on biodiversity matters
4 points: > 5 agencies cooperate on biodiversity matters

* Agencies could include departments or authorities responsible for biodiversity, planning, water, transport, development, finance, infrastructure, etc.

City Data and Calculations

There are two main local government agencies which are involved in matters pertaining to biodiversity in Dehradun city. They are:

1. Nagar Nigam Dehradun
2. DSCL

RESULT: 2

SCORE: 0

Recommendations to Improve Score

In order to improve the score of this indicator, it is important that the city prioritises setting up its Biodiversity Management Committee as per the Biological Diversity Act, 2002. This committee will be responsible for documenting local biodiversity, its sustainable use and dealing with Access and Benefit Sharing (ABS) issues.

Indicators 20 : Participation and Partnership - Formal or Informal Public Consultation

Methodology

How to calculate indicator

Existence and state of formal or informal public consultation process pertaining to biodiversity related matters.

Scoring Range: (based on the CBI user manual)

0 point: No routine formal or informal process
1 point: Formal or informal process being considered as part of the routine process
2 points: Formal or informal process being planned as part of the routine process
3 points: Formal or informal process in the process of being implemented as part of the routine process
4 points: Formal or informal process exists as part of the routine process

City Data and Calculations

No routine formal or informal process exists for biodiversity related matters, however some informal consultations are carried out.

RESULT: No Routine Formal or Informal Processes

SCORE: 0

Recommendations to Improve Score

The city needs to incorporate a formal public consultation process not just in biodiversity related matters, but also other sectors which have impacts on the biodiversity of the city, especially sanitation and solid waste management. This will improve public participation, public ownership and transparency. The BMC, once formed can spearhead this process of public consultation.

Indicators 21 : Participation and Partnership - Institutional Partnership

Methodology

How to calculate indicator

Number of agencies/private companies/NGOs/academic institutions/international organisations with which the city is partnering in biodiversity activities, projects and programmes.

Instances of inter-agency co-operation listed in Indicator 19 should not be listed here again.

Scoring Range: (based on the CBI user manual)

0 point:	No formal or informal partnerships
1 point:	City in partnership with 1-6 other national or subnational agencies/private companies/ NGOs/academic institutions/international organisations
2 points:	City in partnership with 7-12 other national or subnational agencies/private companies/ NGOs/academic institutions/international organisations
3 points:	City in partnership with 13-19 other national or subnational agencies/private companies/ NGOs/academic institutions/international organisations
4 points:	City in partnership with 20 or more other national or subnational agencies/private companies/NGOs/academic institutions/international organisations

City Data and Calculations

The following are the agencies with whom the city is partnering with in terms of biodiversity related activities, projects and programmes:

- Waste Warriors for undertaking tree plantation activities
- Him Foundation for undertaking tree plantation activities and promoting organic farming through vocational and training programmes
- Mussoorie Dehradun Development Authority (MDDA) for undertaking riverside and other plantations

RESULT: 3

SCORE: 1

Recommendations to Improve Score

There are over 500 NGOs working on social welfare and other activities in Dehradun. There are several academic institutions of repute which have their campuses in the city. Nagar Nigam Dehradun can easily improve their score for this indicator by reaching out to and partnering with some of these institutions and NGOs who are working on biodiversity related matters. State and district level agencies like the Agriculture and Horticulture departments can also yield valuable partnerships to improve the biodiversity health of the city.

Indicators 22: Education and Awareness - Is Biodiversity or Nature Awareness included in the School Curriculum

Methodology

How to calculate indicator
Is biodiversity or nature awareness included in the school curriculum (e.g. biology, geography, etc.)?

Scoring Range: (based on the CBI user manual)

0 point:	Biodiversity or elements of it are not covered in the school curriculum
1 point:	Biodiversity or elements of it are being considered for inclusion in the school curriculum
2 points:	Biodiversity or elements of it are being planned for inclusion in the school curriculum
3 points:	Biodiversity or elements of it are in the process of being implemented in the school curriculum
4 points:	Biodiversity or elements of it are included in the school curriculum

City Data and Calculations

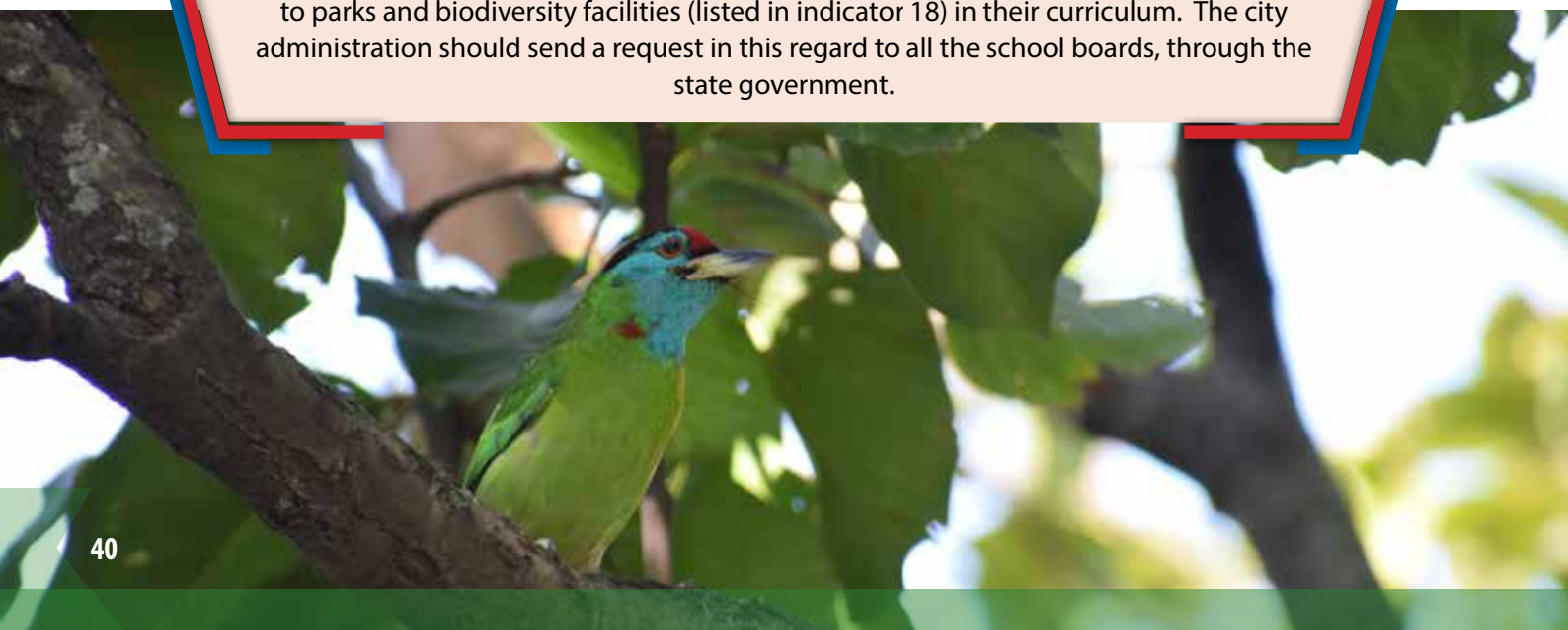
The schools within the city follow the curriculum of various boards such as the Uttarakhand State Board, Central Board of Secondary Education (CBSE) and Indian Certificate of Secondary Education (ICSE). All of these boards have included biodiversity and nature awareness in various subjects like Biology, Geography, and Environmental Sciences. Therefore, biodiversity or elements of it are included in the school curriculum.

RESULT: Yes

SCORE: 4

Recommendations to Improve Score

It should be noted here that this indicator which measures the theoretical aspects of biodiversity education receives the highest score possible whereas indicator 14 which measures practical aspects of biodiversity education received the lowest score possible. This highlights that environmental education not just in Dehradun, but in the country at large needs to strike the right balance between theory and practice. In order to address the same the city administration can give a directive to all schools to include visits to parks and biodiversity facilities (listed in indicator 18) in their curriculum. The city administration should send a request in this regard to all the school boards, through the state government.



Indicators 23: Education and Awareness - Number of Outreach or Public Awareness Events

Methodology

How to calculate indicator
Number of outreach or public awareness events held in the city per year.

Scoring Range: (based on the CBI user manual)
0 point: 0 outreach events/year
1 point: 1 - 59 outreach events/year
2 points: 60 -149 outreach events/year
3 points: 150-300 outreach events/year
4 points: > 300 outreach events/year

City Data and Calculations
Nagar Nigam Dehradun celebrates World Environment Day. There are also some public outreach programmes on sanitation and health conducted under the aegis of the Swachh Bharat Mission which have impact on the biodiversity of the city. The number of programmes and events organised per year falls within the range of 1-59.

RESULT: 1 - 59

SCORE: 1

Recommendations to Improve Score

There are certain informal fora such as 'Been There Doon That' and 'Doon Nature Club' in Dehradun which conduct walks and activities that connect citizens with their heritage and environment. The city administration can easily take ownership of these by bringing them under a common banner and recognising various players.This will improve the score on indicator 21 as well.

Table 6: Dehradun's score indicator-wise for the CBI

	Maximum Score	Dehradun City's score
Component – Native Biodiversity in the City		
Indicators		
1. Proportion of Natural Areas in the City	4 points	4 points
2. Connectivity Measures	4 points	4 points
3. Native Biodiversity in Built Up Areas (Bird Species)	4 points	4 points
4. Change in Number of Vascular Plant Species	4 points	N/A as baseline year
5. Change in Number of Bird Species	4 points	N/A as baseline year
6. Change in Number of Mammal Species	4 points	N/A as baseline year
7. Change in Number of Moth Species	4 points	N/A as baseline year
8. Change in Number of Fish Species	4 points	N/A as baseline year
9. Proportion of Protected Natural Areas	4 points	2 points
10. Proportion of Invasive Alien Species	4 points	2 points
Component – Ecosystem Services provided by Biodiversity		
Indicators		
11. Regulation of Quantity of Water	4 points	2 points
12. Climate Regulation: Carbon Storage and Cooling Effect of Vegetation	4 points	2 points
13. Recreation and Education: Area of Parks with Natural Areas	4 points	0 points
14. Recreation and Education: Number of Formal Education Visits per Child Below 16 Years to Parks with Natural Areas per Year	4 points	0 points
Component – Governance and Management of Biodiversity		
Indicators		
15. Budget Allocated to Biodiversity	4 points	1 point
16. Number of Biodiversity Projects Implemented by the City Annually	4 points	0 points
17. Existence of Local Biodiversity Strategy and Action Plan	4 points	0 points
18. Institutional Capacity: Number of Biodiversity Related Function	4 points	4 points
19. Institutional Capacity: Number of City or Local Government Agencies Involved in Inter-agency Cooperation Pertaining to Biodiversity Matters	4 points	0 points
20. Participation and Partnership: Existence of Formal or Informal Public Consultation Process	4 points	0 points
21. Participation and Partnership: Number of Agencies/Private Companies/NGOs/Academic Institutions/International Organisations with which the City is Partnering in Biodiversity Activities, Projects and Programmes	4 points	1 point
22. Education and Awareness: Is Biodiversity or Nature Awareness Included in the School Curriculum	4 points	4 points
23. Education and Awareness: Number of Outreach or Public Awareness Events Held in the City per Year	4 points	1 point
Native Biodiversity in the City (Sub-total for indicators 1-10)		**16/20***
Ecosystem Services provided by Biodiversity (Sub-total for indicators 11-14)		**4/16**
Governance and Management of Biodiversity (Sub-total for indicators 15-23)		**11/36**
Total		**31/72**

*as this is the baseline year, the score will only be applicable for five indicators out of ten

Reflections and Discussion on the Process of Calculating the CBI

The international protocol set out in the User's Manual on the Singapore index on cities' biodiversity was closely followed while calculating the CBI of Dehradun. However, there is scope to re-visit some of the indicators and explore whether they can be contextualized on a regional basis rather than generalized for all countries.

Indicator 1: The definition of natural areas - "Natural areas comprise predominantly native species and natural ecosystems, which are not, or no longer, or only slightly influenced by human actions, except where such actions are intended to conserve, enhance or restore native biodiversity", as already stated, cannot be strictly applied to Indian cities. Although large cities like Mumbai, Thane, Hyderabad, Kochi have protected natural areas within their boundaries, these rarely remain undisturbed because they are found in population dense areas. Further, within cities, these areas act as zones for recreation, being frequented by morning walkers etc. Smaller cities like Dehradun, Gangtok, have patches of natural areas which are found around zones of inhabitation or within institutions which again, do not fall in the definition set out in the CBI.

Indicator 2: According to Hilty *et al.* (2006)[31] "Corridor is any space, usually linear in shape that improves the ability of organisms to move among patches of their habitat". However, ecological corridors as defined with the CBI solely look at natural patches of land. In a country like India, the reality of ecological corridors is not just limited to natural spaces. It extends into naturalised habitats and also agricultural areas. An agricultural corridor or a farm corridor[32] while only potentially measuring hundreds of meters in width, will enhance movement of localized wildlife and pollinators.

Therefore, to further refine the indicator, it would help to define what types of patches can be considered and to clarify the logic behind the 100 meter assumption.

Indicator 3: It is extremely difficult to segregate out birds into those occupying anthropogenic spaces and those that only use natural ones in a country like India. This is especially true of smaller cities in India which have extremely heterogeneous or mixed landscapes such as Dehradun and Gangtok. For example, the Himalayan Griffon, which is not a common urban bird, is frequently seen nesting within urbanised neighbourhoods of Dehradun city, which ordinarily would not have been the case in a different city with a more conventional landuse type. This indicator needs to be revisited with possibility of inclusion of all birds sighted in the city for the calculation.

Indicator 10: In the case of most cities, alien species which were introduced over time, have naturalized in their environment. In the case of Dehradun, it is estimated that nearly a third of the Doon valley flora comprises of recently introduced exotics. Others may have naturalized long ago and they are now part of naturalized flora. Several species of trees introduced in Doon Valley support different components of

31. Hilty, J. A., Lidicker, W. Z. and Merenlender, A. M. (2006). Corridor Ecology: The science and practice of linking landscapes for biodiversity conservation. Washington, DC, USA: Island Press.

32. USDA NRCS. (1999). Conservation Corridor Planning at the Landscape Level: Managing for Wildlife Habitat. United States Department of Agriculture, Natural Resources Conservation Service.

biodiversity (birds, bees, butterflies) e.g., species of figs, Syzygium jambolanum, Terminalia myriocarpa, Eucalyptus sp. etc. It would be worthwhile to include such parameters (role of naturalised flora) while calculating the CBI.

Indicator 11: This indicator is currently based on the logic that vegetation has "a significant effect in reducing the rate of flow of water through the urban landscape" in terms of climate change and its influence on precipitation. The indicator mentions permeability of the areas as being vegetated areas or areas identified in indicator 1 plus other parks, roadside, etc. but excluding artificial permeable surfaces.

There are a few facets to this indicator which cannot be measured solely by the permeability proxy. If the indicator is a measure of flood protection, then it also needs to take into account topographical factors and the density of the vegetation. If the indicator is measuring water percolation, then it needs to take into account the permeability of the soil or the soil type/geological structure in the landscape. Irrespective of whether an area is unpaved, if the soil profile of that area is clayey such as areas in Bihar and West Bengal, then water will not be able to move into the ground to recharge aquifers.

Indicator 12: For this indicator, canopy cover is used as a proxy for carbon storage and cooling effects of vegetation. This is only part of the picture since different types of vegetation, even in manmade landscapes assist in carbon storage. Furthermore, it is a well known fact that soils hold 80% of the carbon in terrestrial ecosystems which the indicator does not take into account. The IPCC accepted methodology on calculation of carbon sequestration takes into account above ground and below ground carbon. The same needs to be looked into for revising the calculations for this indictaor.

Additionally, the indicator is just representative of the extent of canopy cover, which would impact the scores of cities with grasslands and those in extremely arid as well as in cold desert landscapes.

Indicators 14 and 22: Both these indicators measure some form of education and awareness on biodiversity. Indicator 14 on education services measures the practical application of biodiversity education as a proxy for ecosystem services. Indicator 22 measures the theoretical base for biodiversity education as an aspect of biodiversity governance. Both indicators represent two sides of the same coin and need to feed into each other. In the case of all Indian cities, there is more emplasis on the theoretical aspects of education rather than the practical. Therefore, cities across the board will score high on indicator 22 and low on indicator 14. This necessitates a different mechanism to measure the educational services of biodiversity or the establishment of a connection between both indicators.

Indicator 15: It would be helpful to also include the expenditure against the budget heads so that an apt comparison can be made as to the amount that is actually being spent.

Indicator 19: In India, not all of the urban services within a city are the responsibility of the city administration. In most cities, state or para-statal bodies are also responsible for the infrastructure and service delivery of water supply, sewerage management, transportation and electricity. Therefore, "Number of city or local government agencies involved in inter-agency co-operation pertaining to biodiversity matters" will need to include state and para-statal agencies involved in urban infrastructure and service delivery as well.

Annexure 1 - Detailed Note on Classification Scheme used for the Generation of the Natural Asset Map of Dehradun

For the generation of Natural Asset Map of Dehradun, following methodology was used:

1. Data used

a) A software, Google Earth Pro was used to digitize the natural assets of the city of Dehradun. High resolution satellite imagery in Google Earth dated, January 23rd, 2020 (as shown in Figure 5) was used as the background layer to delineate land class features.

b) Dehradun Ward boundary map image obtained from Nagar Nigam Dehradun was used to digitize the city corporation boundary. The JPEG map image was geo-referenced in ArcGIS 10 and overlaid on Google Earth Pro to digitize the city boundary in .kml file format. The natural assets covered under the city boundary were further delineated in .kml file format layer.

c) The city corporation boundary along with other natural asset class layers in (.kml) file format were later exported to ArcGIS 10 in (.shp) file format. The obtained shapefile layers were then converted from geographic coordinate system (WGS 1984) to projected coordinate system (Universal Transverse Mercator (UTM), Zone 44 N) to compute areas under each class.

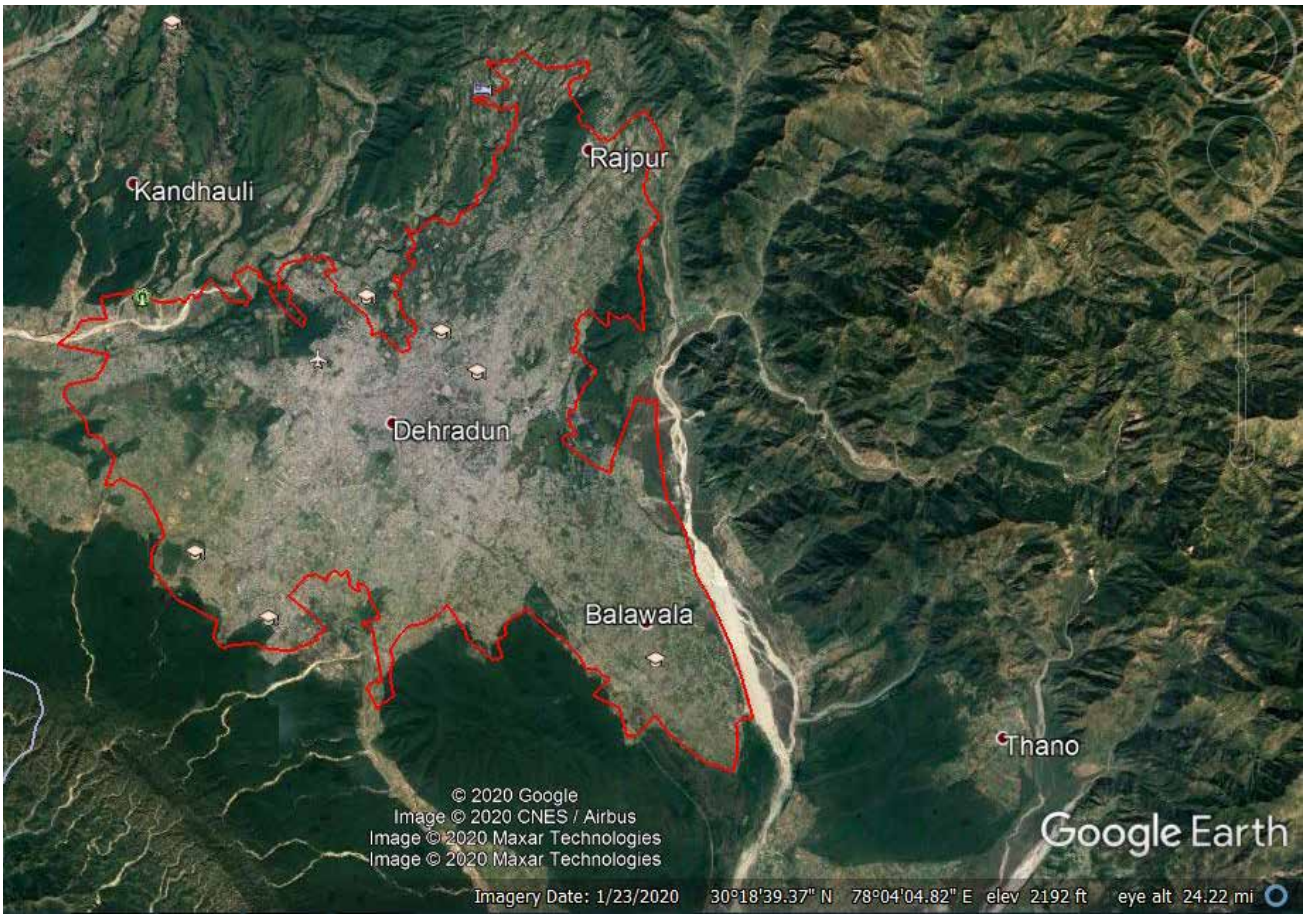


Figure 5: A screenshot of Google Earth satellite imagery

2. Accuracy Assessment

To assess the thematic accuracy of the map, the error matrix was generated (Table 7). About 64 samples of reference data acquired from field were used for accuracy assessment. Acceptable values of overall classification accuracy (92 %) and kappa coefficient (92.18) were retrieved for the datasets.

Table 7: Accuracy assessment

Classes	Producer's Accuracy	User's Accuracy
Forest	100%	100%
Sparse Vegetation	100%	50%
Open Green Space	82%	100%
Tree Patch	100%	92%
Litchi Orchard	100%	100%
Tea Garden	71.4%	100%
Agriculture	100%	100%
Terrace Agriculture	100%	100%
Fallow Land	100%	100%
Rau/Seasonal River	100%	100%
Waterbody	100%	100%
Playground	94%	89%
Open Ground	100%	100%

3. Visual Interpretation Key

Natural assets in a high resolution Google Earth imagery (natural colour) were identified with the help of interpretation elements such as size, shape, colour, pattern, geographic location (prior local knowledge) as shown in Table 8. Manual visual interpretation technique was used for the delineation of the asset classes at 1:2500 mapping scale.

Table 8: Visual Interpretation Key used in the Natural Asset Map of Dehradun

Class Names	Size	Shape	Colour	Pattern	Location
Forest	✓		✓		✓
Sparse Vegetation		✓	✓		✓
Open Green Space		✓			✓
Tree Patch	✓		✓		✓
Litchi Orchard	✓	✓	✓	✓	✓
Tea Garden		✓	✓	✓	✓
Agriculture		✓	✓	✓	
Terrace Agriculture		✓	✓	✓	✓
Fallow Land		✓	✓	✓	
Rau/Seasonal River		✓			✓
Waterbody		✓			✓
Playground		✓	✓		✓
Open Ground		✓		✓	✓

4. Natural Asset Classification Scheme

Given below is the classification scheme and definition of different land classes:

Table 9: Classification scheme with area-wise distribution

Sl. No.	Class Names	Area (in sq. km)
1	Forest	25.63
2	Sparse Vegetation / Scrub Forest	12.82
3	Open Green Space	0.91
4	Tree Patch	15.90
5	Litchi Orchard	0.84
6	Tea Garden	2.10
7	Agriculture	24.25
8	Terrace Agriculture	0.14
9	Fallow Land	0.10
10	Rau/Seasonal River	2.77
11	Water body	0.05
12	Playground	2.12
13	Open Ground	0.14

Forest: A forest is a large area dominated by trees. In this case, it refers to a patch of trees appearing to be dark green in colour and covering an area of more than 1 ha to 200 ha. Sal forests surrounding the campus of Wildlife Institute of India, Forest Research Institute, Malsi Reserve Forest is classified under this class.

Sparse Vegetation: An area of land where plant growth may be sparse and in some cases, stunted mainly due to unhealthy soil and environmental conditions. Sparse vegetation appearing to be irregular in shape, pale yellow to brown in colour including vegetation in vacant residential plots and along railway tracks, scrub vegetation in surrounding hills and riverside vegetation is classified under this class.

Open Green Space: A piece of land meant for recreational purposes appearing to be regular in shape and size, devoid of any built-up structure and is accessible to the public. Such spaces include tree cover, green lawns, gardens and walking pavements. City parks such as Gandhi Park, MDDA Park is classified under this class.

Tree Patch: Sporadic and discontinuous occurrence of a number of trees in a given land area usually less than 1 ha (0.01 sq. km). A patch of tree, not meant for recreational purposes, appearing to be green in colour and surrounded by built up structures, roadside and avenue plantations are classified under this class. This also includes trees, not necessarily fruit trees that are present in government-owned land, private land with restricted entry.

Litchi Orchard: An area of land that is green in colour, with a distinct pattern and well-defined edges, where cultivation of fruit trees i.e. litchi, is carried out. Such fruit orchards are commonly found in Dehradun. However, it is difficult to distinguish such orchards from other tree cover class such as 'tree patch' and therefore, ground truthing is key to their identification.

Tea Garden: A piece of land appearing to form a checkerboard pattern and specially designated for growing tea plantations, mainly meant for commercial purposes. In this case, it refers to Harbanswala – Arcadia tea estate located in the western periphery of the Dehradun city.

Agriculture: This refers to a land use system where both growing of crops and raising of livestock is done simultaneously. In this case, this may also refer to growing two or more crops at a time. Such land use system are characteristic of forming a checkerboard pattern possessing a definite boundary while their colour appearing to range from pale yellow to different shades of green. Agricultural farms in Patthri Bagh, Balawala is classified under this class.

Terrace Agriculture: A method of growing crops on sides of hills or mountains by planting on graduated terraces built into the slope. Terrace agriculture is a kind of subsistence agricultural system practiced by the locals in the surrounding hilly region of the city of Dehradun. Such land use system follows a distinctive wavy pattern along the slope of the hill and appears to be pale yellow, brown and green in colour.

Fallow Land: It is a farmland that has no growing crops, usually for a year or more, to recover its soil fertility. A piece of land adjoining agricultural farms appearing to be unusually barren and pale brown in colour.

Seasonal River: A river, also referred to as Rau in the Doon Valley, which exists only during monsoon season and otherwise remains dry throughout the year. Such features strikingly appear to be zig-zag in shape along the length and breadth of the covered area.

Waterbody: A body of water forming a physiographical feature with varying degrees of human interference, for example a lake, pond. In this case, it refers to a lake in the campus of the Wildlife Institute of India.

Playground: An open/bare ground meant for sports and other leisure activities. Private and government school (both unpaved and paved in the % ratio of 80:20, respectively) playgrounds that have definite boundaries are classified under this class.

Open Ground: A ground or an open area usually assigned as a parking space for cars and other vehicles. Such areas may be devoid of any vegetation and thus, is a combination of concrete ground and natural area showing regular pattern and having a definite shape.

Annexure 2 - Species Lists

Table 10: List of bird species used in the calculation of Indicator 3

Sl. No.	Common Name	Scientific Name	Status
1.	Alexandrine Parakeet	*Psittacula eupatria*	Resident
2.	Ashy Prinia	*Prinia socialis*	Resident
3.	Asian Barred Owlet	*Glaucidium cuculoides*	Resident
4.	Asian Koel	*Eudynamys scolopaceus*	Resident
5.	Bank Myna	*Acridotheres ginginianus*	Resident
6.	Barn Swallow	*Hirundo rustica*	Resident
7.	Black-chinned Babbler	*Stachyridopsis pyrrhops*	Resident
8.	Black-hooded Oriole	*Oriolus xanthornus*	Resident
9.	Black Bulbul	*Hypsipetes leucocephalus*	Resident
10.	Black Drongo	*Dicrurus macrocercus*	Resident
11.	Black Kite	*Milvus migrans*	Resident
12.	Blue-throated Barbet	*Psilopogon asiaticus*	Resident
13.	Blue Rock-Thrush	*Monticola solitaries*	Resident
14.	Blue Whistling-Thrush	*Myophonus caeruleus*	Resident
15.	Brahminy Starling	*Sturnia pagodarum*	Resident
16.	Bronzed Drongo	*Dicrurus aeneus*	Resident
17.	Brown-headed Barbet	*Psilopogon zeylanicus*	Resident
18.	Brown Rock Chat	*Oenanthe fusca*	Resident
19.	Cattle Egret	*Bubulcus ibis*	Resident
20.	Chestnut-tailed Starling	*Sturnia malabarica*	Resident
21.	Cinereous Tit	*Parus cinereus*	Resident
22.	Collared Owlet	*Glaucidium brodiei*	Resident
23.	Collared Scops-Owl	*Otus lettia*	Resident
24.	Common Tailorbird	*Orthotomus sutorius*	Resident
25.	Coppersmith Barbet	*Psilopogon haemacephalus*	Resident
26.	Crimson Sunbird	*Aethopyga siparaja*	Resident
27.	Dark-sided Flycatcher	*Muscicapa sibirica*	Resident
28.	Dusky Crag-Martin	*Ptyonoprogne concolor*	Resident
29.	Eurasian Collared-Dove	*Streptopelia decaocto*	Resident
30.	Eurasian Hoopoe	*Upupa epops*	Resident
31.	Gray-backed Shrike	*Lanius tephronotus*	Resident
32.	Gray Francolin	*Francolinus pondicerianus*	Resident
33.	Gray Treepie	*Dendrocitta formosae*	Resident
34.	Greater Coucal	*Centropus sinensis*	Resident
35.	Green Bee-eater	*Merops orientalis*	Resident
36.	Himalayan Black-lored Tit	*Machlolophus xanthogenys*	Resident
37.	Himalayan Bulbul	*Pycnonotus leucogenys*	Resident
38.	Himalayan Swiftlet	*Aerodramus brevirostris*	Resident
39.	House Crow	*Corvus splendens*	Resident

Sl. No.	Common Name	Scientific Name	Status
40.	House Sparrow	*Passer domesticus*	Resident
41.	Indian Gray Hornbill	*Ocyceros birostris*	Resident
42.	Indian Peafowl	*Pavo cristatus*	Resident
43.	Indian Pond-Heron	*Ardeola grayii*	Resident
44.	Indian Robin	*Copsychus fulicatus*	Resident
45.	Indian Scops-Owl	*Otus bakkamoena*	Resident
46.	Indian White-eye	*Zosterops palpebrosus*	Resident
47.	Jungle Babbler	*Argya striata*	Resident
48.	Jungle Myna	*Acridotheres fuscus*	Resident
49.	Large-billed Crow	*Corvus macrorhynchos*	Resident
50.	Laughing Dove	*Spilopelia senegalensis*	Resident
51.	Lineated Barbet	*Psilopogon lineatus*	Resident
52.	Little Cormorant	*Microcarbo niger*	Resident
53.	Little Swift	*Apus affinis*	Resident
54.	Long-tailed Shrike	*Lanius schach*	Resident
55.	Oriental Magpie-Robin	*Copsychus saularis*	Resident
56.	Oriental Turtle-Dove	*Streptopelia orientalis*	Resident
57.	Pale-billed Flowerpecker	*Dicaeum erythrorhynchos*	Resident
58.	Pied Bushchat	*Saxicola caprata*	Resident
59.	Plum-headed Parakeet	*Psittacula cyanocephala*	Resident
60.	Purple Sunbird	*Cinnyris asiaticus*	Resident
61.	Red-billed Blue-Magpie	*Urocissa erythroryncha*	Resident
62.	Red-billed Leiothrix	*Leiothrix lutea*	Resident
63.	Red-rumped Swallow	*Cecropis daurica*	Resident
64.	Red-vented Bulbul	*Pycnonotus cafe*	Resident
65.	Red-wattled Lapwing	*Vanellus indicus*	Resident
66.	Red-whiskered Bulbul	*Pycnonotus jocosus*	Resident
67.	Rock Pigeon	*Columba livia*	Resident
68.	Rose-ringed Parakeet	*Psittacula krameri*	Resident
69.	Rufous Treepie	*Dendrocitta vagabunda*	Resident
70.	Russet Sparrow	*Passer cinnamomeus*	Resident
71.	Scaly-breasted Munia	*Lonchura punctulata*	Resident
72.	Shikra	*Accipiter badius*	Resident
73.	Slaty-headed Parakeet	*Psittacula himalayana*	Resident
74.	Spotted Dove	*Spilopelia chinensis*	Resident
75.	Streaked Laughingthrush	*Trochalopteron lineatum*	Resident
76.	Thick-billed Flowerpecker	*Dicaeum agile*	Resident
77.	White-throated Fantail	*Rhipidura albicollis*	Resident
78.	Wire-tailed Swallow	*Hirundo smithii*	Resident

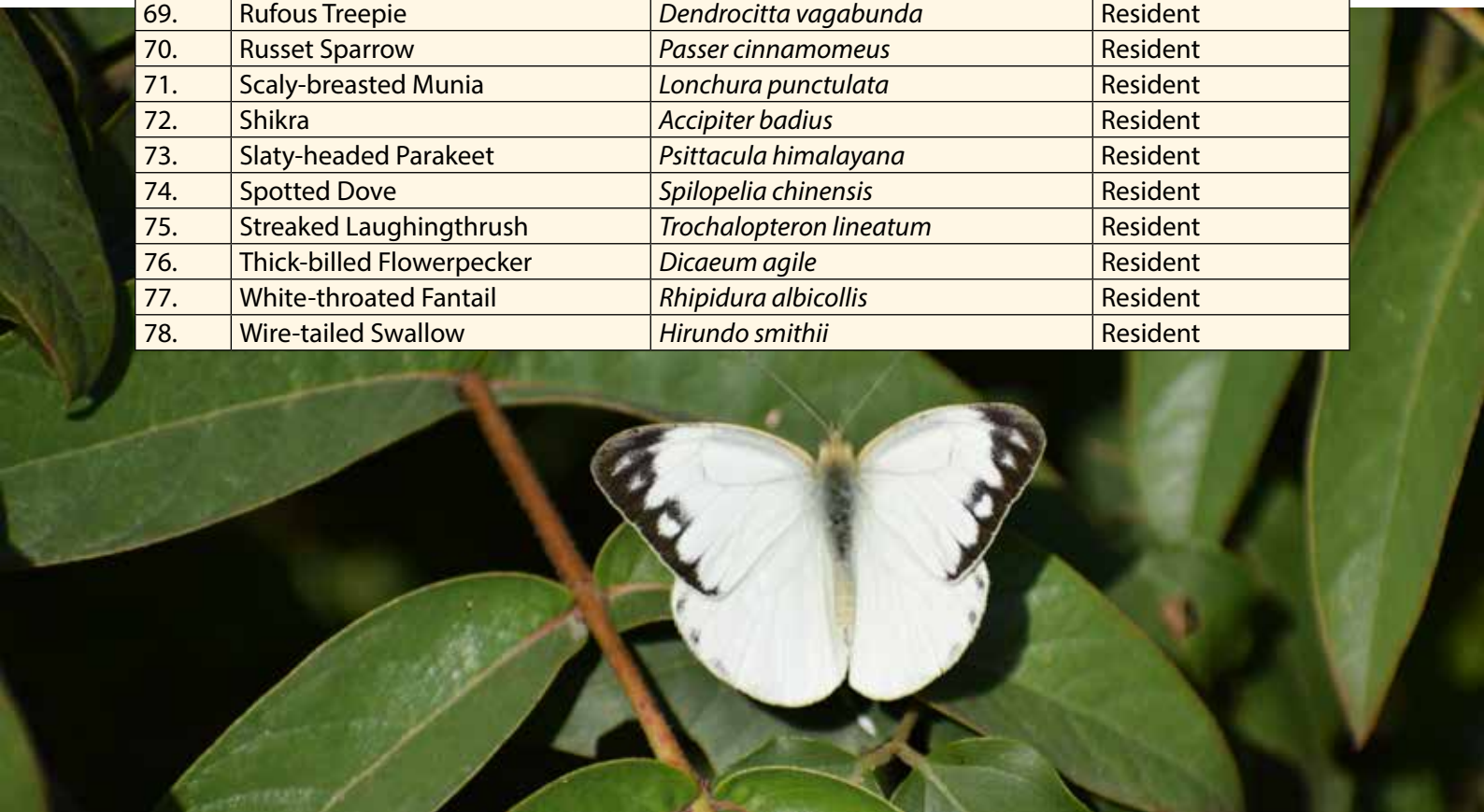


Table 11: List of flowering plants found in the city of Dehradun, used in the calculation of indicators 4 and 10

Sl. No.	Scientific Name	Habit	Native / Exotic
1	*Aechmanthera gossypina* Nees.	Herb	Native
2	*Barleria cristata* L.	Herb	Native
3	*Dichoriste erecta* (Burm.f.) Ktz.	Herb	Native
4	*Dicliptera bupleuroides* Nees.	Herb	Native
5	*Dicliptera paniculata* (Forsk.) Brum.	Herb	Native
6	*Hemigraphis hirta* T. Anders.	Herb	Native
7	*Hemigraphis rupestris* Heyne ex T. Anders.	Herb	Native
8	*Hygrophila auriculata* (Schum) Heine.	Herb	Native
9	*Hygrophila polysperma* (Roxb.) T.Anders.	Herb	Native
10	*Hygrophila salicifolia* (Vahl.) Nees.	Herb	Native
11	*Justicia adhatoda* L	Shrub	Native
12	*Justicia peploides* (Nees) Clarke.	Herb	Native
13	*Justicia simplex* D.Don.	Herb	Native
14	*Lepidagathis incurva* Buch-Ham ex D.Don.	Herb	Native
15	*Nelsonia canescens* (Lamk.)Spreng	Herb	Native
16	*Rostellularia quinquangularis* Nees.	Herb	Native
17	*Ruellia tweediana* (Nees) Griseb.	Herb	Exotic
18	*Rungia pectinata* (L.) Nees.	Herb	Native
19	*Strobilanthes auriculata* (Nees.)Bremek	Herb	Native
20	*Agave americana*	Herb	Exotic
21	*Mollugo pentaphylla* L.	Herb	Native
22	*Trianthema portulaccastrum* L.	Herb	Native
23	*Achyranthes aspera* Watt.	Herb	Native
24	*Aerva sanguinolenta* (L) BL.	Herb	Native
25	*Aerva scandens* Wall ex Mog.	Herb	Native
26	*Alternanthera pugens* HBK.	Herb	Exotic
27	*Alternanthera ficoides* (L.) R.Br.	Herb	Exotic
28	*Alternanthera philoxeroides* (Mast.)Griseb.	Herb	Exotic
29	*Alternanthera polygonoides* (L.) R.Br.	Herb	Exotic
30	*Alternanthera sessilis* (L.) R.Br. ex DC.	Herb	Exotic
31	*Amaranthus lividus* Linn.	Herb	Exotic
32	*Amaranthus spinosus* L.	Herb	Exotic
33	*Amaranthus tricolor* L.	Herb	Native
34	*Amaranthus viridis* L.	Herb	Native
35	*Celosia argentea* L.	Herb	Exotic
36	*Gomphrena celosioides* Mart.	Herb	Exotic
37	*Lannea coromandelica* (Houtt.) Merr.	Tree	Native
38	*Mangifera indica* Linn.	Tree	Native
39	*Miliusa velutina* Hk.f.& Th.	Tree	Native
40	*Centella asiatica* (L) Urb.	Herb	Native
41	*Cyclospermum leptophyllum* F. Muell ex Benth.	Herb	Exotic
42	*Hydrocotyle sibthorpioides* Lamk.	Herb	Native
43	*Alstonia scholaris* (L.)Br.	Tree	Native
44	*Carissa spinarum* Stapf.	Shrub	Native
45	*Holarrhena antidysenterica* Wall.	Shrub	Native
46	*Ichnocarpus frutescens* Br.	Herb	Native

Sl. No.	Scientific Name	Habit	Native / Exotic
47	*Plumeria rubra* Linn.	Tree	Exotic
48	*Rauwolfia serpentina* Benth.	Shrub	Native
49	*Tabernaemontana divaricata* (L.) R.Br.	Shrub	Exotic
50	*Thevetia peruviana K. Schum*	Tree	Exotic
51	*Vallaris solanacea* (Roth).Kutze.	Herb	Native
52	*Wrightia arborea Roem & Sch.*	Tree	Native
53	*Arisaema helleborifolium* Scholt.	Herb	Native
54	*Arisaema tortuosum* (Wall.)Scholt.	Herb	Native
55	*Colocasia antiquorum* Schult.	Herb	Native
56	*Epipremnum pinnatum*	Herb	Exotic
57	*Sauromatum venosum* (W.Ait) Kunth.	Herb	Native
58	*Scindapsus officinalis* (Roxb.) Schott.	Herb	Native
59	*Calamus tenuis* Roxb.	Shrub	Native
60	*Phoenix acaulis Buch.*	Shrub	Native
61	*Asclepias curassavica L.*	Herb	Exotic
62	*Calotropis procera* (Willd) *Dry & Ait.*	Herb	Exotic
63	*Cryptolepis buchanani Roem & Sch.*	Herb	Native
64	*Gongronema nepalense* DC.	Herb	Exotic
65	*Marsdenia tenacissima* W.&A.	Herb	Native
66	*Telosma pallida* (Roxb) Craib.	Herb	Native
67	*Tylophora ovata* (Wall.) Wt. & Arn.	Herb	Native
68	*Acanthospermum hispidum* DC.	Herb	Exotic
69	*Ageratina adenophora* Spreng.	Herb	Exotic
70	*Ageratum conyzoides* L.	Herb	Exotic
71	*Ageratum houstonianum* Mill.	Herb	Exotic
72	*Artemisia nilagirica* (Cl.) Pamp.	Herb	Native
73	*Artemisia parviflora* Buch-Ham.	Herb	Native
74	*Bidens pilosa* L.	Herb	Exotic
75	*Blainvillea acmella* (L.) Philipson	Herb	Native
76	*Blumea oxyodonta* DC.	Herb	Native
77	*Blumea lacera* DC.	Herb	Exotic
78	*Caesulia axillaris* Roxb.	Herb	Native
79	*Centipeda minima* (L.) A.Br.& Asch.	Herb	Native
80	*Cirsium arvense* (L.)Scop.	Herb	Exotic
81	*Cirsium wallichii* DC.	Herb	Native
82	*Cotula hemispherica* Wall ex Benth & Hk.	Herb	Native
83	*Eclipta prostrata* (L.) L.	Herb	Native
84	*Elephantopus scaber L.*	Herb	Native
85	*Emilia sonchifolia* (L.) DC.	Herb	Exotic
86	*Enydra flactuans* Lour.	Herb	Native
87	*Erigeron karvinskianus* DC.	Herb	Exotic
88	*Galinsoga parviflora* Cav.	Herb	Exotic
89	*Gnaphalium polycaulon* Pers.	Herb	Native
90	*Gnaphalium pensylvanicum* Willd.	Herb	Exotic
91	*Inula cappa* (Buch-Ham ex D.Don) DC.	Shrub	Native
92	*Ixeris polycephala* Cass	Herb	Native

Sl. No.	Scientific Name	Habit	Native / Exotic
93	*Leucomeris spectabilis* D.Don	Herb	Exotic
94	*Parthenium hysterophorus* L.	Herb	Exotic
95	*Pentanema indicum* (L.) DC.	Herb	Native
96	*Saussurea heteromalla* (D.Don) Hand.-Maz.	Herb	Native
97	*Senecio nudicaulis Buch-Ham ex D.Don.*	Herb	Native
98	*Siegesbeckia orientalis* L.	Herb	Native
99	*Sonchus asper* (L.) Hill.	Herb	Exotic
100	*Spilanthes acmella* (L.) Murr.	Herb	Native
101	*Synedrella vialis*	Herb	Native
102	*Tridax procumbens L.*	Herb	Exotic
103	*Vernonia cinerea* (L.) Less.	Herb	Native
104	*Xanthium strumarium* L.	Herb	Exotic
105	*Youngia japonica* (L.) DC.	Herb	Exotic
106	*Campsis radicans*	Herb	Exotic
107	*Oroxylum indicum* (L.) Benth. ex Kurz.	Tree	Native
108	*Stereospermum suaveolens* DC.	Tree	Native
109	*Xylosma longifolium* Clos.	Tree	Native
110	*Bombax ceiba* L.	Tree	Native
111	*Cordia dichotoma Forst.f.*	Tree	Native
112	*Bothriospermum tenellum* Fisch & Mey.	Herb	Exotic
113	*Cynoglossum lanceolatum* Forsk.	Herb	Exotic
114	*Heliotropium strigosum* Willd.	Herb	Native
115	*Trichodesma indicum* R.Br.	Herb	Native
116	*Arabidopsis thaliana (L.) Heynch.*	Herb	Exotic
117	*Brassica juncea* (L.) Czern & Coss.	Herb	Exotic
118	*Capsella bursa-pastoris* Moen.	Herb	Exotic
119	*Cardamine hirsuta* Lin.	Herb	Exotic
120	*Cardamine scutata* L.	Herb	Native
121	*Coronopus didymus* (L.) Sm.	Herb	Exotic
122	*Eruca sativa* Mill.	Herb	Exotic
123	*Iberis amara* L.	Herb	Exotic
124	*Lepidium virginicum L.*	Herb	Exotic
125	*Rorippa dubia* (Pers) Hara.	Herb	Exotic
126	*Rorippa nasturtium-aquaticum* (L.) Hayek	Herb	Exotic
127	*Buddleja asiatica Lour.*	Shrub	Native
128	*Garuga pinnata Roxb.*	Tree	Native
129	*Campanula benthamii* Wall. ex Kit	Herb	Native
130	*Canabis sativa* L.	Herb	Exotic
131	*Capparis zeylanica L.*	Shrub	Native
132	*Arenaria serpyllifolia L.*	Herb	Exotic
133	*Drymaria cordata* (L.) Willd. ex Roem.	Herb	Native
134	*Silene conoidea* L.	Herb	Native
135	*Stellaria media (L.) Vill*	Herb	Native
136	*Celastrus paniculata* Willd.	Herb	Native
137	*Chenopodium album* L.	Herb	Exotic
138	*Chenopodium murale* L.	Herb	Exotic

Sl. No.	Scientific Name	Habit	Native / Exotic
139	*Dysphania ambrosioides* L.	Herb	Exotic
140	*Cleome viscosa* L.	Herb	Exotic
141	*Terminalia alata* Heyne ex Roth.	Tree	Native
142	*Terminalia bellirica* (Gaert.) Roxb.	Tree	Native
143	*Terminalia chebula* Retz.	Tree	Native
144	*Commelina benghalensis* L.	Herb	Native
145	*Commelina suffruticosa* Bl.	Herb	Native
146	*Commelina caroliniana* Cl.	Herb	Native
147	*Commelina diffusa Burm.f.*	Herb	Native
148	*Commelina longifolia Lamk.*	Herb	Native
149	*Cyanotis cristata* (L.) Schult.	Herb	Native
150	*Cynotis fasciculata* Schult.	Herb	Native
151	*Murdania scapiflora* (Roxb.)Royle	Herb	Native
152	*Murdannia nudiflora* (L.)Brenan	Herb	Native
153	*Convolvulus arvensis* L.	Herb	Exotic
154	*Evolvulus alsinoides* (L.) L.	Herb	Native
155	*Evolvulus nummularius* L.	Herb	Exotic
156	*Ipomoea dichroa* Choisy.	Herb	Native
157	*Ipomoea eriocarpa* R.Br.	Herb	Native
158	*Ipomoea hederifolia* L.	Herb	Exotic
159	*Ipomoea nil* (L) Roth.	Herb	Exotic
160	*Ipomoea pes-tigridis* L.	Herb	Native
161	*Ipomoea quamoclit* L.	Herb	Exotic
162	*Ipomoea triloba* L.	Herb	Exotic
163	*Ipomoea batatas* (L.) Lam.	Herb	Exotic
164	*Ipomoea cairica* (L.) Sw.	Herb	Exotic
165	*Ipomoea fistulosa* Mart ex Choisy (=I.carnea)	Shrub	Exotic
166	*Rivea laotica* Oost.	Herb	Native
167	*Bryophyllum pinnatum (Lamk.) Pers.*	Herb	Native
168	*Cucumis sativus* var hardwickii Royle	Herb	Native
169	*Luffa aegyptiaca* Mill.	Herb	Native
170	*Mormodica dioica* Roxb ex Willd.	Herb	Native
171	*Mukia maderaspatana* (L.)Merr.	Herb	Native
172	*Trichosanthes cucumerina L.*	Herb	Native
173	*Trichosanthes tricuspidata* Lour.	Herb	Native
174	*Zehneria scabra* (L.f.) Soud	Herb	Native
175	*Cuscuta chinensis* Lam.	Herb	Exotic
176	*Cuscuta reflexa* Roxb.	Herb	Exotic
177	*Carex sp.*	Herb	Native
178	*Cyperus alopecuroides* Rottb.	Herb	Native
179	*Cyperus alulatus* Kern.	Herb	Native
180	*Cyperus amabilis* Vahl.	Herb	Native
181	*Cyperus brevifolius* (Rottb.)Hassk.	Herb	Native
182	*Cyperus compressus* L.	Herb	Native
183	*Cyperus cyperoides* (L.) O.Ktz.	Herb	Native
184	*Cyperus cyperoides* (Retz.) Raynal	Herb	Native

Sl. No.	Scientific Name	Habit	Native / Exotic
185	*Cyperus difformis* L.	Herb	Exotic
186	*Cyperus iria* L.	Herb	Exotic
187	*Cyperus kylligia* Endl.	Herb	Native
188	*Cyperus nutans* Vahl.	Herb	Native
189	*Cyperus pangorei* Rottb.	Herb	Native
190	*Cyperus paniceus* (Rottb.)Boeck.	Herb	Native
191	*Cyperus procerus* Rottb.	Herb	Native
192	*Cyperus pumilus* L.	Herb	Native
193	*Cyperus rotundus* L.	Herb	Native
194	*Cyperus sanguinolentus* Vahl.	Herb	Native
195	*Cyperus squarossus* L.	Herb	Native
196	*Cyperus triceps* Endl.	Herb	Native
197	*Fimbristylis acicularis* R.Br.	Herb	Native
198	*Fimbristylis complanata* (Retz.)Link.	Herb	Native
199	*Fimbristylis dichotoma* (L.) Vahl.	Herb	Native
200	*Fimbristylis quincuangularis* (Vahl.) Kunth.	Herb	Native
201	*Fimbristylis quinquangularis* (L.)Vahl.	Herb	Native
202	*Fimbristylis tomentosa* Vahl.	Herb	Native
203	*Scleria levis* Retz.	Herb	Native
204	*Dillenia indica* Linn.	Tree	Native
205	*Dioscorea bulbifera* L.	Herb	Native
206	*Dioscorea belophylla* Voigt. ex Haine.	Herb	Native
207	*Dioscorea hispida* Dennst.	Herb	Native
208	*Dioscorea pentaphylla* L.	Herb	Native
209	*Shorea robusta* Gaert. f.	Tree	Native
210	*Diospyros peregrina* (Gaertn.)	Tree	Native
211	*Diospyros montana Roxb.*	Tree	Native
212	*Ehretia acuminata* R.Br.	Tree	Native
213	*Ehretia laevis* Roxb.	Tree	Native
214	*Acalypha australis* L.	Herb	Exotic
215	*Antidesma acidum* Retz.	Herb	Native
216	*Baliospermum montanum* (Willd.)Muell.-Arg.	Herb	Native
217	*Bridelia retusa* Spreng.	Tree	Native
218	*Drypetes roxburghii* (Wall.) Hurus.	Tree	Native
219	*Euphorbia emodi* Hook.f.	Herb	Native
220	*Euphorbia heterophylla* Orteg	Herb	Exotic
221	*Euphorbia hirta* L.	Herb	Exotic
222	*Euphorbia hypericifolia* L.	Herb	Exotic
223	*Euphorbia prostrata* Orteg	Herb	Exotic
224	*Euphorbia tirucalli* Linn.	Tree	Exotic
225	*Jatropha curcas* DC.	Shrub	Exotic
226	*Mallotus philippensis* Muell-Arg.	Tree	Native
227	*Phyllanthus emblica Linn.*	Tree	Native
228	*Phyllanthus fraternus Webster*	Herb	Native
229	*Phyllanthus urinaria* L.	Herb	Exotic
230	*Phyllanthus velutinus* Wight	Tree	Native

Sl. No.	Scientific Name	Habit	Native / Exotic
231	*Phyllanthus virgatus* Retz. (syn. P. simplex)	Herb	Native
232	*Putranjiva roxburghii* Wall.	Tree	Native
233	*Ricinus communis* Linn.	Shrub	Exotic
234	*Securinega virosa* (Roxb) Ball.	Shrub	Native
235	*Triadica sebifera* Roxb.	Tree	Exotic
236	*Abrus pulchellus* Wall ex Thw.	Herb	Native
237	*Acacia sp.*	Tree	Native
238	*Aeschynomene indica* L.	Shrub	Exotic
239	*Albizia chinensis* (Osb.) Merril	Tree	Native
240	*Albizia procera* Benth.	Tree	Native
241	*Albizia odoratissima* (L.f.) Benth.	Tree	Native
242	*Alysicarpus bupleurifolius* (L.) DC.	Herb	Native
243	*Alysicarpus rugosus* (Willd) DC.	Herb	Native
244	*Alysicarpus vaginalis* (L) DC.	Herb	Native
245	*Bauhinia purpurea* Linn.	Tree	Exotic
246	*Bauhinia racemosa* Lamk.	Tree	Native
247	*Bauhinia variegata* L.	Tree	Exotic
248	*Butea monosperma* (Lamk) Tamb.	Tree	Native
249	*Cajanus scarabaeoides* (L.) Benth.	Herb	Native
250	*Cassia occidentalis* L.	Shrub	Native
251	*Cassia tora* L.	Herb	Exotic
252	*Cassia absus* L.	Shrub	Exotic
253	*Cassia fistula* L.	Tree	Native
254	*Chamaecrista pumila* Lam.	Herb	Native
255	*Codariocalyx motorius* (Houtt) Merr.	Herb	Native
256	*Crotalaria albida* Heyne.	Herb	Native
257	*Crotalaria bialata* Schrank.	Herb	Native
258	*Crotalaria calycina* Schrank.	Herb	Native
259	*Crotalaria prostrata Rottl ex Willd.*	Herb	Native
260	*Crotalaria sericea* Retz.	Herb	Native
261	*Dalbergia latifolia* Roxb.	Tree	Native
262	*Dalbergia sissoo* Roxb.	Tree	Native
263	*Delonix regia* Raf.	Tree	Exotic
264	*Desmodium pulchellum* (L.) Benth.	Herb	Native
265	*Desmodium triangualre* (Retz.)Merr.	Shrub	Native
266	*Desmodium concinnum* DC.	Herb	Native
267	*Desmodium gangeticum* (L.) DC.	Herb	Native
268	*Desmodium heterocarpon*	Herb	Native
269	*Desmodium laxiflorum* D.C.	Herb	Native
270	*Desmodium microphyllum* (Thunb) DC.	Herb	Native
271	*Desmodium oojeinense* (roxb.)Hoc.	Tree	Native
272	*Desmodium triflorum* (L.) DC.	Herb	Native
273	*Dolichos uniflorus Lamk.*	Herb	Native
274	*Flemingia macrophylla* Willd & Ktze.	Herb	Native
275	*Flemingia strobilifera* (L.) R.Br.	Herb	Native
276	*Indigofera atropurpurea* Buch-Ham ex Hornem.Na	Herb	Native

Sl. No.	Scientific Name	Habit	Native / Exotic
277	*Indigofera cassioides* Rottl. ex DC.	Herb	Native
278	*Indigofera linifolia* (L.f.) Retz.	Shrub	Exotic
279	*Indigofera prostrata* Willd.	Herb	Native
280	*Lathyrus sphaericus* Retz.	Herb	Exotic
281	*Lathyrus aphaca L.*	Herb	Exotic
282	*Lens culinaris* Medik.	Herb	Native
283	*Lespedeza juncea* var. sericea	Shrub	Native
284	*Medicago polymorpha* L. var. apiculata Van Ooststr. & Reichg	Herb	Exotic
285	*Medicago polymorpha* L. var. polymorpha	Herb	Exotic
286	*Melilotus alba* Medik.	Herb	Exotic
287	*Melilotus indica* (L.) All.	Herb	Native
288	*Milletia extensa* (Benth.)Baker	Herb	Native
289	*Mimosa pudica* L.	Herb	Exotic
290	*Mimosa rubicaulis* Lamk.	Shrub	Native
291	*Mucuna nigricans* Steud.	Herb	Native
292	*Neptunia triquetra* Benth.	Herb	Native
293	*Pueraria phaseoloides* (Roxb.)Benth.	Herb	Native
294	*Pueraria tuberosa* DC.	Herb	Native
295	*Rhynchosia minima* (L.)D.C.	Herb	Native
296	*Sesbania bispinosa* L.	Herb	Exotic
297	*Sesbania sesban* (L.)Merr. ssp. sesban	Herb	Native
298	*Smithia conferta*	Herb	Native
299	*Spatholobus parviflorus* Roxb. (Syn. Spatholobus roxburghii Roxb.)	Herb	Native
300	*Tadehagi triquetrum* (L.) DC.	Herb	Native
301	*Tephrosia candida* (Roxb.)D.C.	Herb	Native
302	*Trifolium tomentosum* L.	Herb	Native
303	*Uraria neglecta* Prain.	Herb	Native
304	*Uraria picta* (Jacq) Desv.	Herb	Native
305	*Vicia sativa* L.	Herb	Native
306	*Vicia hirsuta* L.	Herb	Native
307	*Vicia tetrasperma* (L.) Moench.	Herb	Native
308	*Vigna radiata* (L.) Wilcz var. radiata	Herb	Native
309	*Vigna vexillata* (L.) A.Rich.	Herb	Native
310	*Zornia gibosa* Span.	Herb	Native
311	*Casearia elliptica willd.*	Tree	Native
312	*Casearia graveolens* Dalz.	Tree	Native
313	*Flacourtia indica Merr.*	Shrub	Native
314	*Fumaria indica* (Hassk) Pugs.	Herb	Exotic
315	*Canscora decussata Roxb.*	Herb	Native
316	*Exacum pedunculatum* L.	Herb	Native
317	*Gentiana pedicellata* (D.Don) Wall.	Herb	Native
318	*Geranium lucidum L.*	Herb	Native
319	*Ginkgo biloba*	Tree	Exotic
320	*Curculigo orchioides Gaertn.*	Herb	Native

Sl. No.	Scientific Name	Habit	Native / Exotic
321	*Hypoxis aurea* Lour.	Herb	Native
322	*Ajuga bracteosa* Wall ex Benth.	Herb	Native
323	*Anisomeles indica* (L.) O. Ktze.	Herb	Native
324	*Anisomeles ovata* R.Br.	Herb	Native
325	*Clinopodium umbrosum* (Beib.) Koch.	Herb	Native
326	*Colebrookea oppositifolia* J.E. Smith	Shrub	Native
327	*Elsholtzia ciliata* (Thunb.)Hyland	Herb	Native
328	*Leucas cephalotes* (Roth.) Spreng.	Herb	Native
329	*Leucas mollisima* Wall	Herb	Native
330	*Mosla dianthera* (Buch-Ham) Maxim	Herb	Native
331	*Nepeta graciliflora* Benth.	Herb	Native
332	*Nepeta hisdostana* (Roth) Haines	Herb	Native
333	*Ocimum bacillicum* Linn.	Herb	Native
334	*Orthosiphon rubicundus* Benth.	Herb	Native
335	*Perilla frutescems* (L.) Brott.	Herb	Native
336	*Platostoma hispidum* (L.) Nicols.	Herb	Native
337	*Plectranthus japonicus* (Burm.f.) Koidz	Herb	Exotic
338	*Pogostemon benghalense* O.Kuntze	Shrub	Native
339	*Salvia plebeia* R. Br.	Herb	Native
340	*Cinnamomum camphora* L.	Tree	Exotic
341	*Corypha sp.*	Tree	Native
342	*Litsea glutinosa* (Lour) Robins.	Tree	Native
343	*Litsea monopetala* (Roxb) Pers.	Tree	Native
344	*Persea odoratissima* Nees	Tree	Native
345	*Leea asiatica* (L.) Ridsdale.	Herb	Native
346	*Asparagus adscendens* Roxb.	Shrub	Native
347	*Gloriosa superba* L.	Herb	Native
348	*Linum usitatissimum* L.	Herb	Native
349	*Reinwardtia indica* Planch.	Shrub	Native
350	*Lagerstroemia speciosa* (L.)Pers.	Tree	Native
351	*Lawsonia alba* Lamk.	Shrub	Native
352	*Lawsonia inermis*	Shrub	Native
353	*Rotala rotundifolia* (Roxb.)Koenche	Herb	Native
354	*Woodfordia fruticosa* (L.) Kurz.	Shrub	Exotic
355	*Magnolia champaca* L.	Tree	Native
356	*Aspidopteris wallichii* Hk.f.	Herb	Native
357	*Hiptage benghalensis* (L.) Kurz.	Herb	Native
358	*Abelmoschus manihot* (L.) Med. ssp. tetraphyllus Borss.	Herb	Native
359	*Abelmoschus moschatus* Medic.	Herb	Native
360	*Abelmoschus var. pungens* (Roxb.) Hochr.	Herb	Native
361	*Kydia calycina* Roxb.	Tree	Native
362	*Malva parviflora* L.	Herb	Exotic
363	*Malvastrum coromandelianum* (L.) Garke.	Herb	Native
364	*Sida acuta Burm.*	Shrub	Exotic
365	*Sida cordata* (Burm.f.)Borss.	Herb	Native
366	*Sida cordifolia* L.	Herb	Native

Sl. No.	Scientific Name	Habit	Native / Exotic
367	*Sida humilis Willd.*	Herb	Native
368	*Sida rhombifolia* L. ssp. rhombifolia Borss.	Herb	Native
369	*Thespesia lampas* (Cav) Alex.	Herb	Native
370	*Urena lobata* L.	Shrub	Exotic
371	*Martynia annua* L.	Herb	Exotic
372	*Sonerila tenera* Royle.	Herb	Native
373	*Azadirachta indica* A.Juss.	Tree	Exotic
374	*Melia azeadarach* L.	Tree	Exotic
375	*Melia dubia* DC.	Tree	Native
376	*Toona ciliata* Roem.	Tree	Native
377	*Cissampelos pareira* L.	Herb	Native
378	*Cocculus hirsutus* (L.) Diels.	Herb	Native
379	*Tinospora sinensis* (Lour) Merill	Herb	Native
380	*Artocarpus lakoocha* Roxb.	Tree	Native
381	*Broussonetia papyrifera* Vent.	Tree	Exotic
382	*Ficus palmata* Forsk.	Tree	Native
383	*Ficus semicordata* Buch-Ham. ex JE Sm.	Tree	Native
384	*Ficus auriculata* Wall.	Tree	Native
385	*Ficus benghalensis* L.	Tree	Native
386	*Ficus benghalensis* var krishnae D.C.	Tree	Native
387	*Ficus hispida* L.	Tree	Native
388	*Ficus religiosa* L.	Tree	Native
389	*Ficus rumphii* Bl.	Tree	Native
390	*Ficus scandens* Roxb.	Herb	Native
391	*Ficus virens* Roxb.	Tree	Native
392	*Maclura cochinchinensis* (Lour)Corner	Shrub	Native
393	*Morus alba* Linn.	Tree	Exotic
394	*Ardisia solanacea* Roxb.	Shrub	Native
395	*Embelia tsjeriam-cottam* Roxb.	Shrub	Native
396	*Callistemon viminalis* Cheel.	Tree	Exotic
397	*Careya arborea* Roxb.	Tree	Native
398	*Psidium guajava* L.	Tree	Exotic
399	*Syzygium cumini* (L.) Skeels.	Tree	Native
400	*Syzygium cumini* L. var. caryophyllifolia	Tree	Native
401	*Syzygium operculatum* (Roxb.) Niedenzu	Tree	Native
402	*Boerhavia diffusa* L.	Herb	Native
403	*Nyctanthes arbor-tristis* L.	Shrub	Native
404	*Oenothera rosea* W . Ait.	Herb	Exotic
405	*Jasminum multiflorum* (Retz.)Willd.	Shrub	Native
406	*Ludwigia octovalvis* (Jacq.)Raven	Herb	Exotic
407	*Cymbidium macrorhizum* Lindl.	Herb	Exotic
408	*Eulophia sp.*	Herb	Native
409	*Habenaria plantaginea* Lindl.	Herb	Native
410	*Nervilia gammieana* (Hk.f.) Schlecht.	Herb	Native
411	*Rhynchostylis retusa* (L.)Bl	Herb	Native
412	*Zeuxine strateumatica* (L.) Schlecht.	Herb	Native

Sl. No.	Scientific Name	Habit	Native / Exotic
413	*Aeginetia indica* L.	Herb	Native
414	*Biophytum sensitivum* (L.) DC.	Herb	Native
415	*Oxalis corniculata L.*	Herb	Exotic
416	*Oxalis debillis* HBK. var. corymbosa (DC)Lourt.	Herb	Native
417	*Argemone mexicana L.*	Herb	Exotic
418	*Passiflora edulis Sims.*	Herb	Exotic
419	*Passiflora foetida L.*	Herb	Exotic
420	*Passiflora quadrangularis* L.	Herb	Exotic
421	*Passiflora suberosa* L.	Herb	Exotic
422	*Cedrus deodara*	Tree	Native
423	*Pinus roxburghii*	Tree	Native
424	*Peperomia pellucida* (L.) HBK.	Herb	Exotic
425	*Pittosporum napaulense* D.C. Rdl.	Shrub	Native
426	*Plantago major Linn.*	Herb	Exotic
427	*Plumbago zeylanica* L.	Herb	Native
428	*Alopecurus nepalensis* Trin.	Herb	Native
429	*Apluda mutica.* L.	Herb	Native
430	*Arthraxon prionodes* (Steud.) Dandy	Herb	Native
431	*Arthraxon lancifolius* (Trin) Hocl.	Herb	Native
432	*Arundinella bengalensis* (Spreng.) Druce.	Herb	Native
433	*Arundinella nepalensis* Trin.	Herb	Native
434	*Arundinella setosa* Trin.	Herb	Native
435	*Arundo donax* L.	Herb	Native
436	*Axonopus compressus (Sw..)P.Beauv.*	Herb	Native
437	*Bambusa vulgaris* var. vittata A.C. Riviere	Shrub	Exotic
438	*Bothriochloa intermedia* (R.Br.) A.Camus.	Herb	Native
439	*Bothriochloa pertusa (L.) A.Camus.*	Herb	Native
440	*Brachiaria ramosa* (L.) Stapf.	Herb	Native
441	*Capillipedium parviflorum* (R.Br.) Stapf.	Herb	Native
442	*Capillipedium assimile* (Steud.) A. Camus.	Herb	Native
443	*Chloris dolichostachya Lag.*	Herb	Native
444	*Chrysopogon serrulatus* Trin.	Herb	Native
445	*Coix lachryma-jobi* L.	Herb	Exotic
446	*Cymbopogon martinii* (Roxb) Wats.	Herb	Native
447	*Cynodon dactylon* (L.) Pers.	Herb	Native
448	*Cyrtococcum accrescems* (Trin) Stapf.	Herb	Native
449	*Dactyloctenium aegyptiacum* (L.) Willd.	Herb	Exotic
450	*Dendrocalamus sp.*	Shrub	Native
451	*Desmostachya bipinnata* Stapf.	Herb	Native
452	*Dichanthium annulatum* (Forsk) Stapf.	Herb	Native
453	*Digitaria timorensis* (Kunth.) Bal.	Herb	Native
454	*Digitaria sanguinalis* (L.) Scop.	Herb	Native
455	*Digitaria stricta* Roth ex Roem & Schult.	Herb	Native
456	*Digitaria violascens* Link.	Herb	Native
457	*Echinochloa colonum* L.	Herb	Exotic
458	*Eleusine indica* Gaertn.	Herb	Native

Sl. No.	Scientific Name	Habit	Native / Exotic
459	*Eragrostis stenophylla* Hochst. ex Miq.	Herb	Native
460	*Eragrostis uniloides* Nees	Herb	Native
461	*Eragrostis viscosa* Trin.	Herb	Native
462	*Eulalia leschenaultiana* (Decne) Ohwi.	Herb	Native
463	*Hackelochloa granularis* (L.) O. Ktze.	Herb	Native
464	*Hemarthria compressa* Kunth.	Herb	Native
465	*Heteropogon contortus* L.	Herb	Native
466	*Imperata cylindrica* (L.) Beauv	Herb	Exotic
467	*Ischaemum indicum*	Herb	Native
468	*Leersia hexandra Sw.*	Herb	Native
469	*Lolium temulentum* L.	Herb	Exotic
470	*Melocanna bambusoides* Trin.	Shrub	Native
471	*Microstegium ciliatum* (Trin.)A.Camus	Herb	Native
472	*Narenga porphyrocoma (Hans. ex Trim.) B*	Herb	Native
473	*Neyraudia arundinacea* (L.) Hen.	Herb	Exotic
474	*Oplismenus burmannii* Beauv	Herb	Native
475	*Oplismenus compositus Beauv*	Herb	Native
476	*Oryza sativa* L.	Herb	Native
477	*Panicum miliare Lamk.*	Herb	Native
478	*Panicum paludosum* Roxb.	Herb	Native
479	*Paspalidum flavidum* (Retz) A. Camus.	Herb	Native
480	*Paspalum distichum* L.	Herb	Exotic
481	*Paspalum scorbiculatum* L.	Herb	Native
482	*Paspalum vaginatum* Sw.	Herb	Exotic
483	*Perotis indica Retz.*	Herb	Native
484	*Phragmites karka* Trin.	Herb	Native
485	*Poa annua* L.	Herb	Native
486	*Pogonatherum crinitum Trin.*	Herb	Native
487	*Polypogon fugax* Nees ex steud.	Herb	Native
488	*Pseudosorghum* fasciculare (Roxb)A Camus	Herb	Native
489	*Rottboellia exaltata* L.f.	Herb	Native
490	*Saccharum bengalense Retz.*	Herb	Native
491	*Saccharum spontaneum* L.	Herb	Exotic
492	*Setaria palmifolia* (Koenig) Stapf.	Herb	Native
493	*Setaria verticillata* (L.)P.Beauv.	Herb	Exotic
494	*Setaria viridis* Beauv	Herb	Native
495	*Sorghum halepense* (L.) Pers.	Herb	Native
496	*Sporobolus diander* Beauv	Herb	Native
497	*Themeda arundinacea (Roxb.) Ridley*	Herb	Native
498	*Themeda gigantea* (Cav) Hack.	Herb	Native
499	*Thysanolaena latifolia* Ktze.	Herb	Native
500	*Vetiveria zizanioides* L. Nash.	Herb	Native
501	*Zoysia tenuifolia* Trin.	Herb	Exotic
502	*Polygala arvensis Willd.*	Herb	Native
503	*Polygonum barbatum* L.	Herb	Exotic
504	*Polygonum chinense* Linn.	Herb	Exotic

Sl. No.	Scientific Name	Habit	Native / Exotic
505	*Polygonum hydropiper* L.	Herb	Exotic
506	*Polygonum lapathifolium* L. var. lanatum (Roxb.) Steward	Herb	Exotic
507	*Polygonum monspeliense* Guss.	Herb	Native
508	*Polygonum plebejum* R.Br.	Herb	Native
509	*Rumex dentatus* L.	Herb	Native
510	*Rumex nepalensis* Spr.	Herb	Native
511	*Monochoria vaginalis* (Burm.f.) Pers.	Herb	Exotic
512	*Portulaca grandiflora* Hk.	Herb	Exotic
513	*Portulaca oleraceae* Linn.	Herb	Exotic
514	*Portulaca pilosa* Linn.	Herb	Native
515	*Anagalis arvensis* L.	Herb	Exotic
516	*Anagalis pumila* Sw.	Herb	Native
517	*Androsace umbellata* (Lour) Benth.	Herb	Native
518	*Lysimachia obovata* Buch-Ham.	Herb	Native
519	*Grevillea robusta* A. Cunn.	Tree	Exotic
520	*Clematis gouriana* Roxb.	Herb	Native
521	*Ranunculus arvensis* L.	Herb	Native
522	*Ranunculus muricatus* Tutin.	Herb	Native
523	*Ranunculus sceleratus* L. ssp. sceleratus Ttuin	Herb	Native
524	*Gouania leptostachya Lamk.*	Herb	Native
525	*Rhamnus virgata* Roxb.	Shrub	Native
526	*Ventilago denticulata* Tulasne.	Herb	Native
527	*Ziziphus mauritiana* Lamk.	Shrub	Native
528	*Duchesnia indica* (Andr) Forcke.	Herb	Native
529	*Potentilla sundaica* (Bl.) O.Kuntze	Herb	Native
530	*Pyrus pashia Buch-Ham ex D.Don.*	Shrub	Native
531	*Rosa multiflora* Tjunb.	Shrub	Exotic
532	*Rubus ellipticus* Smith.	Shrub	Native
533	*Rubus niveus Wall.*	Shrub	Native
534	*Borreria articularis* (L.f.) F.N. Will.	Herb	Native
535	*Catunaregam spinosa (Thunb.) Tiruv*	Shrub	Native
536	*Coffea benghalensis* Roxb.	Shrub	Native
537	*Galium aparine* L.	Herb	Exotic
538	*Knoxia mollis* R.Br.	Herb	Native
539	*Neolamarckia cadamba*	Tree	Native
540	*Oldenlandia corymbosa* Bakh.f.	Herb	Native
541	*Oldenlandia corymbosa* Hk. f.	Herb	Native
542	*Oldenlandia diffusa (Willd.) Roxb.*	Herb	Native
543	*Pavetta indica ssp. tomentosa* (Roxb. ex Sm.) Ben	Shrub	Native
544	*Randia tetrasperma* (Roxb) Benth.	Shrub	Native
545	*Rubia cordifolia* L.	Herb	Native
546	*Wendlandia heynei* (Roxb) DC.	Shrub	Native
547	*Glycosmis pentaphylla* Correa	Shrub	Native
548	*Murraya paniculata* (L) jack.	Shrub	Native
549	*Murraya koenigii* (L.) Spreng.	Shrub	Native
550	*Salix disperma* Roxb. ex D.Don	Tree	Native

Sl. No.	Scientific Name	Habit	Native / Exotic
551	*Cardiospermum halicacabum* Linn.	Herb	Native
552	*Schleichera oleosa* (Lour.)Oken	Tree	Native
553	*Bacopa monnieri (Linn.) Penn.*	Herb	Native
554	*Limnophila rugosa (Roth) Merr.*	Herb	Native
555	*Lindenbergia indica* (L.) O. Ktze.	Herb	Native
556	*Lindernia cordifolia* (Colsm) Merr.	Herb	Native
557	*Lindernia ciliata* (Colsm) Penn.	Herb	Native
558	*Lindernia crustacea* (L.) Muell.	Herb	Native
559	*Lindernia hookeri (Clarke) Wettst. Ssp. Kumaunensis Penn.*	Herb	Native
560	*Mazus pumilus* (Burm.f.) Stecnis.	Herb	Native
561	*Mecardonia procumbens* (Mill) Green.	Herb	Exotic
562	*Mimulus strictus* Benth.	Herb	Native
563	*Scoparia dulcis L.*	Herb	Exotic
564	*Veronica anagalis-aquatica* L.	Herb	Native
565	*Veronica persica* Poir.	Herb	Exotic
566	*Smilax wightii* DC.	Herb	Native
567	*Physalis angulata* L.	Herb	Exotic
568	*Physalis minima* L.	Herb	Exotic
569	*Physalis peruviana* L.	Herb	Exotic
570	*Solanum indicum* L.	Shrub	Exotic
571	*Solanum erianthum* D.Don	Shrub	Exotic
572	*Solanum hispidum* Pers.	Shrub	Exotic
573	*Solanum nigrum* L.	Herb	Exotic
574	*Solanum torvum* Sw.	Shrub	Exotic
575	*Solanum viarum* clarke.	Shrub	Exotic
576	*Solanum viarum Dunal*	Shrub	Exotic
577	*Solanum virginianum* Burm.f.	Shrub	Native
578	*Helicteres isora* L.	Shrub	Native
579	*Taxus wallichiana*	Tree	Native
580	*Corchorus aestuans L.*	Herb	Exotic
581	*Corchorus olitorius L.*	Herb	Exotic
582	*Grewia hirsuta* Vahl.	Shrub	Native
583	*Grewia elastica* var. vestita.	Tree	Native
584	*Grewia tiliaefolia* Vahl.	Tree	Native
585	*Triumfetta pilosa* Roth.	Herb	Native
586	*Triumfetta rhomboidea* Jacq.	Herb	Exotic
587	*Typha elephantina* Roxb.	Herb	Native
588	*Celtis tetrandra* Roxb.	Tree	Native
589	*Boehmeria scabrella* Gaud.	Shrub	Native
590	*Gonostegia pentandra* (Roxb) Benn.	Herb	Native
591	*Pouzolzia zeylanica* (L.) Benth.	Herb	Native
592	*Urtica parviflora* Roxb.	Herb	Native
593	*Urtica dioica* Linn.	Herb	Native
594	*Callicarpa macrophylla* Vahl.	Shrub	Native
595	*Clerodendrum indicum* (L.)Kntze.	Shrub	Native
596	*Clerodendrum infortunatum* Vent.	Shrub	Native

Sl. No.	Scientific Name	Habit	Native / Exotic
597	*Lantana camara* L.	Shrub	Exotic
598	*Phyla nodiflora* (L.) Green.	Herb	Native
599	*Premna herbacea* Roxb.	Herb	Native
600	*Premna mollissima* Roxb.	Tree	Native
601	*Pseudocaryopteris* bicolor (D.Don) Robins.	Shrub	Native
602	*Rotheca serrata* (L.) Spreng.	Shrub	Native
603	*Vitex negundo* L.	Shrub	Exotic
604	*Duranta erecta* Linn.	Shrub	Exotic
605	*Duranta repens* var. variegata	Shrub	Exotic
606	*Viola betonicifolia* Sm.	Herb	Native
607	*Viola pilosa* Bl.	Herb	Native
608	*Ampelocissus latifolia* Planch.	Herb	Native
609	*Cayratia pedata Lam.*	Herb	Native
610	*Costus speciosus* (Koen. ex Retz) J.E.	Herb	Native
611	*Zingiber capitatum* Roxb.	Herb	Native
612	*Zingiber chrysanthum* Rosc.	Herb	Native

Table 12: List of bird species found in the city of Dehradun, which has been used for Indicator 5

Sl. No.	Common Name	Scientific Name	Resident/ Migrant
1.	Aberrant Bush Warbler	*Horornis flavolivaceus*	Migrant
2.	Alexandrine Parakeet	*Psittacula eupatria*	Resident
3.	Alpine Swift	*Tachymarptis melba*	Resident
4.	Ashy-crowned Sparrow-Lark	*Eremopterix griseus*	Resident
5.	Ashy-throated Warbler	*Phylloscopus maculipennis*	Migrant
6.	Ashy Bulbul	*Hemixos flavala*	Resident
7.	Ashy Drongo	*Dicrurus leucophaeus*	Migrant
8.	Ashy Prinia	*Prinia socialis*	Resident
9.	Ashy Woodswallow	*Artamus fuscus*	Resident
10.	Asian Barred Owlet	*Glaucidium cuculoides*	Resident
11.	Asian Brown Flycatcher	*Muscicapa dauurica*	Migrant
12.	Asian Emerald Dove	*Chalcophaps indica*	Resident
13.	Asian Koel	*Eudynamys scolopaceus*	Resident
14.	Asian Openbill	*Anastomus oscitans*	Resident
15.	Asian Palm-Swift	*Cypsiurus balasiensis*	Resident
16.	Asian Pied Starling	*Gracupica contra*	Resident
17.	Banded Bay Cuckoo	*Cacomantis sonneratii*	Resident
18.	Bank Myna	*Acridotheres ginginianus*	Resident
19.	Bar-headed Goose	*Anser indicus*	Migrant
20.	Bar-tailed Treecreeper	*Certhia himalayana*	Resident
21.	Bar-winged Flycatcher-shrike	*Hemipus picatus*	Resident
22.	Barn Owl	*Tyto alba*	Resident
23.	Barn Swallow	*Hirundo rustica*	Resident
24.	Bay-backed Shrike	*Lanius vittatus*	Resident
25.	Baya Weaver	*Ploceus philippinus*	Migrant
26.	Bearded Vulture	*Gypaetus barbatus*	Resident
27.	Bengal Bushlark	*Mirafra assamica*	Migrant
28.	Black-breasted Weaver	*Ploceus benghalensis*	Resident
29.	Black-chinned Babbler	*Stachyridopsis pyrrhops*	Resident
30.	Black-chinned Yuhina	Yuhina nigrimenta	Resident
31.	Black-crested Bulbul	*Pycnonotus flaviventris*	Resident
32.	Black-crowned Night-Heron	*Nycticorax nycticorax*	Resident
33.	Black-headed Cuckooshrike	*Lalage melanoptera*	Resident
34.	Black-headed Ibis	*Threskiornis melanocephalus*	Resident
35.	Black-headed Jay	*Garrulus lanceolatus*	Resident
36.	Black-hooded Oriole	*Oriolus xanthornus*	Resident
37.	Black-naped Monarch	*Hypothymis azurea*	Resident
38.	Black-rumped Flameback	*Dinopium benghalense*	Resident
39.	Black-throated Accentor	*Prunella atrogularis*	Migrant
40.	Black-throated Sunbird	*Aethopyga saturata*	Migrant
41.	Black-throated Thrush	*Turdus atrogularis*	Migrant
42.	Black-throated Tit	*Aegithalos concinnus*	Migrant
43.	Black-winged Cuckooshrike	*Lalage melaschistos*	Resident
44.	Black-winged Kite	*Elanus caeruleus*	Resident
45.	Black-winged Stilt	*Himantopus himantopus*	Resident
46.	Black Bulbul	*Hypsipetes leucocephalus*	Resident

Sl. No.	Common Name	Scientific Name	Resident/ Migrant
47.	Black Drongo	*Dicrurus macrocercus*	Resident
48.	Black Eagle	*Ictinaetus malaiensis*	Resident
49.	Black Francolin	*Francolinus francolinus*	Resident
50.	Black Kite	*Milvus migrans*	Resident
51.	Black Redstart	*Phoenicurus ochruros*	Resident
52.	Black Stork	*Ciconia nigra*	Migrant
53.	Blue-bearded Bee-eater	*Nyctyornis athertoni*	Resident
54.	Blue-capped Redstart	*Phoenicurus coeruleocephala*	Migrant
55.	Blue-capped Rock-Thrush	*Monticola cinclorhyncha*	Resident
56.	Blue-tailed Bee-eater	*Merops philippinus*	Resident
57.	Blue-throated Barbet	*Psilopogon asiaticus*	Resident
58.	Blue-throated Flycatcher	*Cyornis rubeculoides*	Resident
59.	Blue Rock-Thrush	*Monticola solitarius*	Resident
60.	Blue Whistling-Thrush	*Myophonus caeruleus*	Resident
61.	Bluethroat	*Luscinia svecica*	Migrant
62.	Blyth's Leaf Warbler	*Phylloscopus reguloides*	Resident
63.	Blyth's Reed Warbler	*Acrocephalus dumetorum*	Resident
64.	Bonelli's Eagle	*Aquila fasciata*	Resident
65.	Booted Eagle	*Hieraaetus pennatus*	Resident
66.	Brahminy Starling	*Sturnia pagodarum*	Resident
67.	Bronze-winged Jacana	*Metopidius indicus*	Resident
68.	Bronzed Drongo	*Dicrurus aeneus*	Resident
69.	Brown-capped Woodpecker	*Yungipicus nanus*	Resident
70.	Brown-fronted Woodpecker	*Dendrocoptes auriceps*	Resident
71.	Brown-headed Barbet	*Psilopogon zeylanicus*	Resident
72.	Brown Boobook	*Ninox scutulata*	Resident
73.	Brown Crake	*Amaurornis akool*	Resident
74.	Brown Dipper	*Cinclus pallasii*	Resident
75.	Brown Fish-Owl	*Ketupa zeylonensis*	Resident
76.	Brown Rock Chat	*Oenanthe fusca*	Resident
77.	Brown Shrike	*Lanius cristatus*	Migrant
78.	Brown Wood-Owl	*Strix leptogrammica*	Resident
79.	Brownish-flanked Bush Warbler	*Horornis fortipes*	Migrant
80.	Buff-barred Warbler	*Phylloscopus pulcher*	Migrant
81.	Cattle Egret	*Bubulcus ibis*	Resident
82.	Changeable Hawk-Eagle	*Nisaetus cirrhatus*	Resident
83.	Chestnut-bellied Nuthatch	*Sitta cinnamoventris*	Resident
84.	Chestnut-bellied Rock-Thrush	*Monticola rufiventris*	Migrant
85.	Chestnut-crowned Bush Warbler	*Cettia major*	Resident
86.	Chestnut-crowned Laughingthrush	*Trochalopteron erythrocephalum*	Resident
87.	Chestnut-eared Bunting	*Emberiza fucata*	Resident
88.	Chestnut-headed Bee-eater	*Merops leschenaulti*	Migrant
89.	Chestnut-headed Tesia	*Cettia castaneocoronata*	Resident
90.	Chestnut-tailed Starling	*Sturnia malabarica*	Resident
91.	Cinereous Tit	*Parus cinereus*	Resident
92.	Cinereous Vulture	*Aegypius monachus*	Migrant

Sl. No.	Common Name	Scientific Name	Resident/ Migrant
93.	Cinnamon Bittern	*Ixobrychus cinnamomeus*	Resident
94.	Citrine Wagtail	*Motacilla citreola*	Resident
95.	Coal Tit	*Parus ater*	Resident
96.	Collared Owlet	*Glaucidium brodiei*	Resident
97.	Collared Scops-Owl	*Otus lettia*	Resident
98.	Common Babbler	*Argya caudata*	Resident
99.	Common Buzzard	*Buteo buteo*	Migrant
100.	Common Chiffchaff	*Phylloscopus collybita*	Migrant
101.	Common Cuckoo	*Cuculus canorus*	Migrant
102.	Common Greenshank	*Tringa nebularia*	Migrant
103.	Common Hawk-Cuckoo	*Hierococcyx varius*	Migrant
104.	Common House-Martin	*Delichon urbicum*	Resident
105.	Common Iora	*Aegithina tiphia*	Resident
106.	Common Kingfisher	*Alcedo atthis*	Resident
107.	Common Myna	*Acridotheres tristis*	Resident
108.	Common Pochard	*Aythya ferina*	Migrant
109.	Common Rosefinch	*Carpodacus erythrinus*	Migrant
110.	Common Sandpiper	*Actitis hypoleucos*	Migrant
111.	Common Snipe	*Gallinago gallinago*	Migrant
112.	Common Tailorbird	*Orthotomus sutorius*	Resident
113.	Common Wood-Pigeon	*Columba palumbus*	Resident
114.	Common Woodshrike	*Tephrodornis pondicerianus*	Resident
115.	Coppersmith Barbet	*Psilopogon haemacephalus*	Resident
116.	Crested Bunting	*Emberiza lathami*	Resident
117.	Crested Goshawk	*Accipiter trivirgatus*	Resident
118.	Crested Kingfisher	*Megaceryle lugubris*	Resident
119.	Crested Serpent-Eagle	*Spilornis cheela*	Resident
120.	Crested Treeswift	*Hemiprocne coronata*	Resident
121.	Crimson Sunbird	*Aethopyga siparaja*	Resident
122.	Dark-sided Flycatcher	*Muscicapa sibirica*	Resident
123.	Demoiselle Crane	*Grus virgo*	Migrant
124.	Dollarbird	*Eurystomus glaucurus*	Resident
125.	Dusky Crag-Martin	*Ptyonoprogne concolor*	Resident
126.	Dusky Warbler	*Phylloscopus fuscatus*	Migrant
127.	Eastern Orphean Warbler	*Sylvia crassirostris*	Resident
128.	Egyptian Vulture	*Neophron percnopterus*	Resident
129.	Eurasian Collared-Dove	*Streptopelia decaocto*	Resident
130.	Eurasian Coot	*Fulica atra*	Resident
131.	Eurasian Crag-Martin	*Ptyonoprogne rupestris*	Resident
132.	Eurasian Griffon	*Gyps fulvus*	Resident
133.	Eurasian Hobby	*Falco subbuteo*	Resident
134.	Eurasian Hoopoe	*Upupa epops*	Resident
135.	Eurasian Kestrel	*Falco tinnunculus*	Resident
136.	Eurasian Marsh-Harrier	*Circus aeruginosus*	Migrant
137.	Eurasian Moorhen	*Gallinula chloropus*	Resident
138.	Eurasian Sparrowhawk	*Accipiter nisus*	Migrant

Sl. No.	Common Name	Scientific Name	Resident/ Migrant
139.	Eurasian Wigeon	*Mareca penelope*	Migrant
140.	Eurasian Woodcock	*Scolopax rusticola*	Migrant
141.	Eurasian Wryneck	*Jynx torquilla*	Migrant
142.	European Goldfinch	*Carduelis carduelis*	Migrant
143.	European Roller	*Coracias garrulus*	Migrant
144.	Ferruginous Duck	*Aythya nyroca*	Migrant
145.	Fire-breasted Flowerpecker	*Dicaeum ignipectus*	Migrant
146.	Fire-capped Tit	*Cephalopyrus flammiceps*	Migrant
147.	Fire-tailed Sunbird	*Aethopyga ignicauda*	Migrant
148.	Fork-tailed Drongo-Cuckoo	*Surniculus dicruroides*	Migrant
149.	Fulvous-breasted Woodpecker	*Dendrocopos macei*	Resident
150.	Gadwall	*Mareca strepera*	Migrant
151.	Garganey	*Spatula querquedula*	Migrant
152.	Glossy Ibis	*Plegadis falcinellus*	Resident
153.	Golden-fronted Leafbird	*Chloropsis aurifrons*	Resident
154.	Graceful Prinia	*Prinia gracilis*	Resident
155.	Gray-backed Shrike	*Lanius tephronotus*	Resident
156.	Gray-bellied Cuckoo	*Cacomantis passerinus*	Resident
157.	Gray-breasted Prinia	*Prinia hodgsonii*	Resident
158.	Gray-capped Woodpecker	*Yungipicus canicapillus*	Resident
159.	Gray-crowned Prinia	*Prinia cinereocapilla*	Resident
160.	Gray-headed Canary-Flycatcher	*Culicicapa ceylonensis*	Resident
161.	Gray-headed Swamphen	*Porphyrio poliocephalus*	Resident
162.	Gray-headed Woodpecker	*Picus canus*	Resident
163.	Gray-hooded Warbler	*Phylloscopus xanthoschistos*	Migrant
164.	Gray-sided Bush Warbler	*Cettia brunnifrons*	Migrant
165.	Gray-throated Martin	*Riparia chinensis*	Resident
166.	Gray-winged Blackbird	*Turdus boulboul*	Resident
167.	Gray Bushchat	*Saxicola ferreus*	Migrant
168.	Gray Francolin	*Francolinus pondicerianus*	Resident
169.	Gray Heron	*Ardea cinerea*	Resident
170.	Gray Nightjar	*Caprimulgus jotaka*	Resident
171.	Gray Treepie	*Dendrocitta formosae*	Resident
172.	Gray Wagtail	*Motacilla cinerea*	Migrant
173.	Graylag Goose	*Anser anser*	Migrant
174.	Great Barbet	*Psilopogon virens*	Migrant
175.	Great Cormorant	*Phalacrocorax carbo*	Resident
176.	Great Crested Grebe	*Podiceps cristatus*	Migrant
177.	Great Egret	*Ardea alba*	Resident
178.	Great Hornbill	*Buceros bicornis*	Resident
179.	Greater Coucal	*Centropus sinensis*	Resident
180.	Greater Flameback	*Chrysocolaptes guttacristatus*	Resident
181.	Greater Painted-Snipe	*Rostratula benghalensis*	Resident
182.	Greater Yellownape	*Chrysophlegma flavinucha*	Resident
183.	Green-backed Tit	*Parus monticolus*	Migrant
184.	Green-tailed Sunbird	*Aethopyga nipalensis*	Migrant

Sl. No.	Common Name	Scientific Name	Resident/ Migrant
185.	Green-winged Teal	*Anas carolinensis*	Migrant
186.	Green Bee-eater	*Merops orientalis*	Resident
187.	Green Sandpiper	*Tringa ochropus*	Migrant
188.	Greenish Warbler	*Phylloscopus trochiloides*	Migrant
189.	Hair-crested Drongo	*Dicrurus hottentottus*	Resident
190.	Hill Pigeon	*Columba rupestris*	Resident
191.	Himalayan Black-lored Tit	*Machlolophus xanthogenys*	Resident
192.	Himalayan Bluetail	*Tarsiger rufilatus*	Resident
193.	Himalayan Bulbul	*Pycnonotus leucogenys*	Resident
194.	Himalayan Buzzard	*Buteo burmanicus*	Migrant
195.	Himalayan Flameback	*Dinopium shorii*	Resident
196.	Himalayan Griffon	*Gyps himalayensis*	Resident
197.	Himalayan Rubythroat	*Calliope pectoralis*	Resident
198.	Himalayan Swiftlet	*Aerodramus brevirostris*	Resident
199.	House Crow	*Corvus splendens*	Resident
200.	House Sparrow	*Passer domesticus*	Resident
201.	Hume's Warbler	*Phylloscopus humei*	Migrant
202.	Immaculate Cupwing	*Pnoepyga immaculata*	Resident
203.	Indian Blue Robin	*Larvivora brunnea*	Migrant
204.	Indian Cormorant	*Phalacrocorax fuscicollis*	Resident
205.	Indian Cuckoo	*Cuculus micropterus*	Migrant
206.	Indian Golden Oriole	*Oriolus kundoo*	Migrant
207.	Indian Gray Hornbill	*Ocyceros birostris*	Resident
208.	Indian Nightjar	*Caprimulgus asiaticus*	Resident
209.	Indian Paradise-Flycatcher	*Terpsiphone paradisi*	Migrant
210.	Indian Peafowl	*Pavo cristatus*	Resident
211.	Indian Pitta	*Pitta brachyura*	Resident
212.	Indian Pond-Heron	*Ardeola grayii*	Resident
213.	Indian Robin	*Copsychus fulicatus*	Resident
214.	Indian Roller	*Coracias benghalensis*	Resident
215.	Indian Scops-Owl	*Otus bakkamoena*	Resident
216.	Indian Silverbill	*Euodice malabarica*	Resident
217.	Indian Spot-billed Duck	*Anas poecilorhyncha*	Resident
218.	Indian Thick-knee	*Burhinus indicus*	Resident
219.	Indian White-eye	*Zosterops palpebrosus*	Resident
220.	Intermediate Egret	*Ardea intermedia*	Resident
221.	Jungle Babbler	*Argya striata*	Resident
222.	Jungle Bush-Quail	*Perdicula asiatica*	Resident
223.	Jungle Myna	*Acridotheres fuscus*	Resident
224.	Jungle Owlet	*Glaucidium radiatum*	Resident
225.	Kalij Pheasant	*Lophura leucomelanos*	Resident
226.	Kashmir Flycatcher	*Ficedula subrubra*	Vagrant
227.	Knob-billed Duck	*Sarkidiornis melanotos*	Resident
228.	Large-billed Crow	*Corvus macrorhynchos*	Resident
229.	Large-billed Leaf Warbler	*Phylloscopus magnirostris*	Migrant
230.	Large-tailed Nightjar	*Caprimulgus macrurus*	Resident

Sl. No.	Common Name	Scientific Name	Resident/ Migrant
231.	Large Cuckooshrike	*Coracina macei*	Resident
232.	Large Gray Babbler	*Argya malcolmi*	Resident
233.	Laughing Dove	*Spilopelia senegalensis*	Resident
234.	Lemon-rumped Warbler	*Phylloscopus chloronotus*	Resident
235.	Lesser Coucal	*Centropus bengalensis*	Resident
236.	Lesser Racket-tailed Drongo	*Dicrurus remifer*	Resident
237.	Lesser Sand-Plover	*Charadrius mongolus*	Migrant
238.	Lesser Whistling-Duck	*Dendrocygna javanica*	Resident
239.	Lesser Whitethroat	*Sylvia curruca*	Migrant
240.	Lesser Yellownape	*Picus chlorolophus*	Resident
241.	Lineated Barbet	*Psilopogon lineatus*	Resident
242.	Little Cormorant	*Microcarbo niger*	Resident
243.	Little Egret	*Egretta garzetta*	Resident
244.	Little Forktail	*Enicurus scouleri*	Resident
245.	Little Grebe	*Tachybaptus ruficollis*	Resident
246.	Little Pied Flycatcher	*Ficedula westermanni*	Resident
247.	Little Ringed Plover	*Charadrius dubius*	Resident
248.	Little Stint	*Calidris minuta*	Migrant
249.	Little Swift	*Apus affinis*	Resident
250.	Long-legged Buzzard	*Buteo rufinus*	Migrant
251.	Long-tailed Minivet	*Pericrocotus ethologus*	Resident
252.	Long-tailed Shrike	*Lanius schach*	Resident
253.	Long-tailed Thrush	*Zoothera dixoni*	Resident
254.	Mallard	*Anas platyrhynchos*	Migrant
255.	Maroon Oriole	*Oriolus traillii*	Resident
256.	Marsh Sandpiper	*Oriolus traillii*	Migrant
257.	Mistle Thrush	*Turdus viscivorus*	Resident
258.	Mountain Bulbul	*Ixos mcclellandii*	Resident
259.	Mountain Hawk-Eagle	*Nisaetus nipalensis*	Resident
260.	Mountain Scops-Owl	*Otus spilocephalus*	Resident
261.	Mrs. Gould's Sunbird	*Aethopyga gouldiae*	Migrant
262.	Nepal House-Martin	*Delichon nipalense*	Resident
263.	Northern Pintail	*Anas acuta*	Migrant
264.	Northern Shoveler	*Spatula clypeata*	Migrant
265.	Olive-backed Pipit	*Anthus hodgsoni*	Migrant
266.	Orange-bellied Leafbird	*Chloropsis hardwickii*	Resident
267.	Orange-headed Thrush	*Geokichla citrina*	Resident
268.	Oriental Darter	*Anhinga melanogaster*	Resident
269.	Oriental Hobby	*Falco severus*	Resident
270.	Oriental Honey-buzzard	*Pernis ptilorhynchus*	Resident
271.	Oriental Magpie-Robin	*Copsychus saularis*	Resident
272.	Oriental Pied-Hornbill	*Anthracoceros albirostris*	Resident
273.	Oriental Scops-Owl	*Otus sunia*	Resident
274.	Oriental Skylark	*Alauda gulgula*	Migrant
275.	Oriental Turtle-Dove	*Streptopelia orientalis*	Resident
276.	Osprey	*Pandion haliaetus*	Migrant

Sl. No.	Common Name	Scientific Name	Resident/ Migrant
277.	Paddyfield Pipit	*Anthus rufulus*	Resident
278.	Painted Stork	*Mycteria leucocephala*	Resident
279.	Pale-billed Flowerpecker	*Dicaeum erythrorhynchos*	Resident
280.	Pale-footed Bush Warbler	*Urosphena pallidipes*	Resident
281.	Pale Sand Martin	*Riparia diluta*	Resident
282.	Peregrine Falcon	*Falco peregrinus*	Migrant
283.	Pheasant-tailed Jacana	*Hydrophasianus chirurgus*	Resident
284.	Pied Bushchat	*Saxicola caprata*	Resident
285.	Pied Cuckoo	*Clamator jacobinus*	Migrant
286.	Pied Kingfisher	*Ceryle rudis*	Resident
287.	Pine Bunting	*Emberiza leucocephalos*	Resident
288.	Pink-browed Rosefinch	*Carpodacus rodochroa*	Migrant
289.	Plain Mountain-Finch	*Leucosticte nemoricola*	Migrant
290.	Plum-headed Parakeet	*Psittacula cyanocephala*	Resident
291.	Plumbeous Redstart	*Phoenicurus fuliginosus*	Migrant
292.	Puff-throated Babbler	*Pellorneum ruficeps*	Resident
293.	Purple Heron	*Ardea purpurea*	Resident
294.	Purple Sunbird	*Cinnyris asiaticus*	Resident
295.	Rain Quail	*Coturnix coromandelica*	Resident
296.	Red-billed Blue-Magpie	*Urocissa erythroryncha*	Resident
297.	Red-billed Leiothrix	*Leiothrix lutea*	Resident
298.	Red-breasted Flycatcher	*Ficedula parva*	Migrant
299.	Red-breasted Parakeet	*Psittacula alexandri*	Resident
300.	Red-crested Pochard	*Netta rufina*	Migrant
301.	Red-headed Vulture	*Sarcogyps calvus*	Resident
302.	Red-naped Ibis	*Pseudibis papillosa*	Resident
303.	Red-rumped Swallow	*Cecropis daurica*	Resident
304.	Red-vented Bulbul	*Pycnonotus cafer*	Resident
305.	Red-wattled Lapwing	*Vanellus indicus*	Resident
306.	Red-whiskered Bulbul	*Pycnonotus jocosus*	Resident
307.	Red Avadavat	*Amandava amandava*	Resident
308.	Red Collared-Dove	*Streptopelia tranquebarica*	Resident
309.	Red Junglefowl	*Gallus gallus*	Resident
310.	Richard's Pipit	*Anthus richardi*	Migrant
311.	River Lapwing	*Vanellus duvaucelii*	Resident
312.	Rock Bunting	*Emberiza cia*	Resident
313.	Rock Pigeon	*Columba livia*	Resident
314.	Rose-ringed Parakeet	*Psittacula krameri*	Resident
315.	Rosy Minivet	*Pericrocotus roseus*	Migrant
316.	Rosy Pipit	*Anthus roseatus*	Migrant
317.	Ruddy-breasted Crake	*Porzana fusca*	Resident
318.	Ruddy Shelduck	*Tadorna ferruginea*	Migrant
319.	Rufous-bellied Niltava	*Niltava sundara*	Migrant
320.	Rufous-breasted Accentor	*Prunella strophiata*	Migrant
321.	Rufous-chinned Laughingthrush	*Ianthocincla rufogularis*	Resident
322.	Rufous-gorgeted Flycatcher	*Ficedula strophiata*	Migrant

Sl. No.	Common Name	Scientific Name	Resident/ Migrant
323.	Rufous Sibia	*Heterophasia capistrata*	Migrant
324.	Rufous Treepie	*Dendrocitta vagabunda*	Resident
325.	Rufous Woodpecker	*Micropternus brachyurus*	Resident
326.	Russet Sparrow	*Passer cinnamomeus*	Resident
327.	Rusty-cheeked Scimitar-Babbler	*Pomatorhinus erythrogenys*	Resident
328.	Scaly-breasted Cupwing	*Pnoepyga albiventer*	Resident
329.	Scaly-breasted Munia	*Lonchura punctulata*	Resident
330.	Scaly Thrush	*Zoothera dauma*	Resident
331.	Scarlet Minivet	*Pericrocotus speciosus*	Resident
332.	Shikra	*Accipiter badius*	Resident
333.	Short-toed Snake-Eagle	*Circaetus gallicus*	Resident
334.	Siberian Rubythroat	*Calliope calliope*	Migrant
335.	Siberian Stonechat	*Saxicola maurus*	Migrant
336.	Sirkeer Malkoha	*Taccocua leschenaultii*	Resident
337.	Slaty-blue Flycatcher	*Ficedula tricolor*	Migrant
338.	Slaty-headed Parakeet	*Psittacula himalayana*	Resident
339.	Small Buttonquail	*Turnix sylvaticus*	Resident
340.	Small Minivet	*Pericrocotus cinnamomeus*	Resident
341.	Small Niltava	*Niltava macgrigoriae*	Resident
342.	Smoky Warbler	*Phylloscopus fuligiventer*	Resident
343.	Snowy-browed Flycatcher	*Ficedula hyperythra*	Migrant
344.	Speckled Piculet	*Picumnus innominatus*	Resident
345.	Speckled Wood-Pigeon	*Columba hodgsonii*	Resident
346.	Spot-winged Starling	*Saroglossa spilopterus*	Migrant
347.	Spotted Dove	*Spilopelia chinensis*	Resident
348.	Spotted Forktail	*Enicurus maculatus*	Resident
349.	Spotted Owlet	*Athene brama*	Resident
350.	Square-tailed Drongo-Cuckoo	*Surniculus lugubris*	Resident
351.	Steppe Eagle	*Aquila nipalensis*	Resident
352.	Stork-billed Kingfisher	*Pelargopsis capensis*	Resident
353.	Streak-throated Swallow	*Petrochelidon fluvicola*	Resident
354.	Streak-throated Woodpecker	*Picus xanthopygaeus*	Resident
355.	Streaked Laughingthrush	*Trochalopteron lineatum*	Resident
356.	Streaked Weaver	*Ploceus manyar*	Resident
357.	Striated Babbler	*Argya earlei*	Resident
358.	Striated Heron	*Butorides striata*	Resident
359.	Striated Laughingthrush	*Grammatoptila striatus*	Resident
360.	Striated Prinia	*Prinia crinigera*	Resident
361.	Stripe-throated Yuhina	*Yuhina gularis*	Resident
362.	Sulphur-bellied Warbler	*Phylloscopus griseolus*	Migrant
363.	Taiga Flycatcher	*Ficedula albicilla*	Migrant
364.	Tawny-bellied Babbler	*Dumetia hyperythra*	Resident
365.	Tawny Eagle	*Aquila rapax*	Resident
366.	Tawny Pipit	*Anthus campestris*	Migrant
367.	Thick-billed Flowerpecker	*Dicaeum agile*	Resident
368.	Tickell's Blue Flycatcher	*Cyornis tickelliae*	Resident

Sl. No.	Common Name	Scientific Name	Resident/ Migrant
369.	Tickell's Leaf Warbler	*Phylloscopus affinis*	Resident
370.	Tickell's Thrush	*Turdus unicolor*	Migrant
371.	Tree Pipit	*Anthus trivialis*	Migrant
372.	Tricolored Munia	*Lonchura malacca*	Resident
373.	Tufted Duck	*Aythya fuligula*	Migrant
374.	Ultramarine Flycatcher	*Ficedula superciliaris*	Migrant
375.	Upland Pipit	*Anthus sylvanus*	Resident
376.	Variegated Laughingthrush	*Trochalopteron variegatum*	Resident
377.	Velvet-fronted Nuthatch	*Sitta frontalis*	Resident
378.	Verditer Flycatcher	*Eumyias thalassinus*	Resident
379.	Wallcreeper	*Tichodroma muraria*	Migrant
380.	Wedge-tailed Green-Pigeon	*Treron sphenurus*	Resident
381.	West Himalayan Bush Warbler	*Locustella kashmirensis*	Vagrant
382.	Western Crowned Warbler	*Phylloscopus occipitalis*	Migrant
383.	Western Yellow Wagtail	*Motacilla flava*	Migrant
384.	Whiskered Yuhina	*Yuhina flavicollis*	Migrant
385.	Whistler's Warbler	*Phylloscopus whistleri*	Migrant
386.	White-bellied Drongo	*Dicrurus caerulescens*	Resident
387.	White-breasted Waterhen	*Amaurornis phoenicurus*	Resident
388.	White-browed Fantail	*Rhipidura aureola*	Migrant
389.	White-browed Scimitar-Babbler	*Pomatorhinus schisticeps*	Resident
390.	White-browed Wagtail	*Motacilla maderaspatensis*	Resident
391.	White-capped Bunting	*Emberiza stewarti*	Resident
392.	White-capped Redstart	*Phoenicurus leucocephalus*	Migrant
393.	White-crested Laughingthrush	*Garrulax leucolophus*	Resident
394.	White-eyed Buzzard	*Butastur teesa*	Resident
395.	White-naped Woodpecker	*Chrysocolaptes festivus*	Resident
396.	White-rumped Munia	*Lonchura striata*	Resident
397.	White-rumped Shama	*Copsychus malabaricus*	Resident
398.	White-tailed Stonechat	*Saxicola leucurus*	Migrant
399.	White-throated Fantail	*Rhipidura albicollis*	Resident
400.	White-throated Kingfisher	*Halcyon smyrnensis*	Resident
401.	White-throated Laughingthrush	*Pterorhinus albogularis*	Resident
402.	White Wagtail	*Motacilla alba*	Migrant
403.	Wire-tailed Swallow	*Hirundo smithii*	Resident
404.	Wood Sandpiper	*Tringa glareola*	Migrant
405.	Woolly-necked Stork	*Ciconia episcopus*	Vagrant
406.	Yellow-bellied Fairy-Fantail	*Chelidorhynx hypoxanthus*	Migrant
407.	Yellow-bellied Prinia	*Prinia flaviventris*	Vagrant
408.	Yellow-breasted Greenfinch	*Chloris spinoides*	Resident
409.	Yellow-eyed Babbler	*Chrysomma sinense*	Resident
410.	Yellow-footed Green-Pigeon	*Treron phoenicoptera*	Resident
411.	Yellow-throated Sparrow	*Gymnoris xanthocollis*	Resident
412.	Yellow-wattled Lapwing	*Vanellus malabaricus*	Resident
413.	Zitting Cisticola	*Cisticola juncidis*	Resident

Table 13: List of butterfly species found in the city of Dehradun, used for Indicator 6

Sl. No.	Common Name	Scientific Name
1	Spot Swordtail	*Graphium nomius*
2	Glassy Bluebottle	*Graphium cloanthus*
3	Common Bluebottle	*Graphium sarpedon*
4	Tailed Jay	*Graphium agamemnon*
5	Common Jay	*Graphium doson*
6	Common Rose	*Pachliopta aristolochiae*
7	Common Mime	*Papilio clytia*
8	Lime Butterfly	*Papilio demoleus*
9	Spangle	*Papilio protenor*
10	Common Mormon	*Papilio polytes*
11	Paris Peacock	*Papilio paris*
12	Indian Cabbage White	*Pieris canidia*
13	Large Cabbage White	*Pieris brassicae*
14	Great Blackvein	*Aporia agathon*
15	Bath White	*Pieris daplidice*
16	Pioneer	*Belenois aurota*
17	Common Gull	*Cepora nerissa*
18	Yellow Orange Tip	*Ixias pyrene*
19	White Orange Tip	*Ixias marianne*
20	Common Jezebel	*Delias eucharis*
21	Hill Jezebel	*Delias belladonna*
22	Striped Albatross	*Appias libythea*
23	Psyche	*Leptosia nina*
24	Small Orange Tip	*Colotis etrida* etrida
25	Common Wanderer	*Pareronia valeria*
26	Common Emigrant	*Catopsilia pomona*
27	Mottled Emigrant	*Catopsilia pyranthe*
28	Common Brimstone	*Gonepteryx rhamni*
29	Small Grass Yellow	*Eurema brigitta*
30	One Spot Grass Yellow	*Eurema andersonii*
31	Common Grass Yellow	*Eurema hecabe*
32	Three Spot Grass Yellow	*Eurema blanda*
33	Spotless Grass Yellow	*Eurema laeta*
34	Dark Clouded Yellow	*Colias fieldii*
35	Pale Clouded Yellow	*Colias erate*
36	Apefly	*Spalgis epeus*
37	Common Gem	*Poritia hewitsoni*
38	Angled Sunbeam	*Curetis dentata*
39	Acute Sunbeam	*Curetis acuta*
40	Common Acacia Blue	*Surendra quercetorum*
41	Large Oakblue	*Arhopala amantes*
42	Indian Oakblue	*Arhopala atrax*
43	Spangled Plushblue	*Flos asoka*
44	Yamfly	*Laxura atymnus*
45	Cornelian	*Deudorix epijarbas*
46	Peacock Royal	*Tajuria cippus*

Sl. No.	Common Name	Scientific Name
47	Common Silverline	*Spindasis vulcanus*
48	Common Shot Silverline	*Spindasis ictis*
49	Indigo Flash	*Rapala varuna*
50	Slate Flash	*Rapala manea*
51	Indian Red Flash	*Rapala iarbus*
52	Redspot	*Zesius chrysomallus*
53	Orchid Tit	*Hypolycaena othona*
54	Common Guava Blue	*Virachola isocrates*
55	Large Guava Blue	*Virachola perse*
56	Common Onyx	*Horaga onyx onyx*
57	Brown Onyx	*Horaga viola*
58	Plains Cupid	*Chilades pandava*
59	Indian Cupid	*Everes lacturnus*
60	Lime Blue	*Chilades lajus*
61	Tailed Cupid	*Everes (argiades) indica*
62	Common Hedge Blue	*Acytolepis puspa* gisca
63	Pale Hedge Blue	*Udara dilectus*
64	Margined Hedge Blue	*Celatoxia marginata*
65	Albocerulean	*Udara albocaerulea*
66	Dark Grass Blue	*Zizeeria karsandra*
67	Pale Grass Blue	*Pseudozizeeria maha*
68	Lesser Grass Blue	*Zizeeria oits*
69	Tiny Grass Blue	*Zizula hylax*
70	Forget–me–not Blue	*Catochrysops strabo*
71	Pea Blue	*Lampides boeticus*
72	Bright Babul Blue	*Azanus ubaldus*
73	Zebra Blue	*Leptotes plinius*
74	Gram Blue	*Euchrysops cnejus*
75	Dark Cerulean	*Jamides bochus*
76	Common Cerulean	*Jamides celeno*
77	Opaque Six-Lineblue	*Nacaduba beroe*
78	Common Lineblue	*Prosotas nora ardates*
79	Tailless Lineblue	*Prosotas dubiosa indica*
80	White–tipped Lineblue	*Prosotas noreia hampsonii*
81	Striped Pierrot	*Tarucus nara*
82	Common Pierrot	*Castalius rosimon* rosimon
83	Red Pierrot	*Talicada nyseus* nyseus
84	Himalayan Pierrot (Veined Pierrot)	*Tarucus venosus*
85	Sorrel Sapphire	*Heliophorus sena*
86	Lesser Grass Jewel	*Freyeria putli*
87	Grass Jewel	*Freyeria trochylus*
88	Common Quaker	*Neopithecops zalmora*
89	Malayan	*Megisba malaya sikkima*
90	Double–banded Judy	*Abisara bifasciata suffusa*
91	Dark Judy	*Abisara fylla*
92	Punchinello	*Zemeros flegyas gleygas*
93	Common Palmfly	*Elymnias hypermnestra undularis*

Sl. No.	Common Name	Scientific Name
94	Common Evening Brown	*Melanitis leda*
95	Dark Evening Brown	*Melanitis phedima*
96	Bamboo Treebrown	*Lethe europa*
97	Common Treebrown	*Lethe rohria*
98	Banded Treebrown	*Lethe confusa*
99	Darkbrand Bushbrown	*Mycalesis mineus*
100	Longbrand Bushbrown	*Mycalesis visala*
101	Common Bushbrown	*Mycalesis perseus*
102	Lepcha Bushbrown	*Telinga lepcha*
103	Hybrid Argus	*Callerebia hybrida*
104	Ringed Argus	*Callerebia annada*
105	Large Threering	*Ypthima nareda*
106	Common Fourring	*Ypthima huebneri*
107	Common Fivering	*Ypthima baldu*
108	Siren	*Hestina persimilis*
109	Black Rajah	*Charaxes solon*
110	Indian Nawab	*Charaxes bharata*
111	Angled Castor	*Ariadne ariadne*
112	Common Castor	*Ariadne merione*
113	Rustic	*Cupha erymanthis*
114	Common Leopard	*Phalanta phalantha*
115	Vagrant	*Vagrans egista*
116	Painted Courtesan	*Euripus consimilis*
117	Large Silverstripe	*Argynnis childreni*
118	Indian Fritillary	*Argynnis hyperbius*
119	Yellow Coster	*Acraea issoria*
120	Tawny Coster	*Acraea terpsicore*
121	Blue Pansy	*Junonia orithya*
122	Yellow Pansy	*Junonia hierta hierta*
123	Lemon Pansy	*Junonia lemonias*
124	Grey Pansy	*Junonia atlites*
125	Peacock Pansy	*Junonnia almana*
126	Blue Admiral	*Koniska canace*
127	Indian Red Admiral	*Vanessa Indica*
128	Painted Lady	*Vanesso cardui*
129	Indian Tortoiseshell	*Aglais caschmirensis*
130	Circe	*Hestinalis nama*
131	Common Jester	*Symbrenthia lilaea khasiana*
132	Danaid Eggfly	*Hypolimnas misippus*
133	Great Eggfly	*Hypolimnas bolina*
134	Orange Oakleaf	*Kallima inachus*
135	Common Map	*Cyrestis thyodamas*
136	Common Sailer	*Neptis hylas*
137	Pallas's Sailer (Rusty Sailer)	*Neptis sappho*
138	Creamy Sailer	*Neptis soma*
139	Short-banded Sailer	*Phaedyma columella*
140	Sullied Sailer	*Neptis clinia*

Sl. No.	Common Name	Scientific Name
141	Pale Green Sailer	*Neptis zaida*
142	Yellow Sailer	*Neptis ananta*
143	Common Lascar	*Pantoporia hordonia*
144	Extra lascar	*Pantoporia sandaka*
145	Common Sergeant	*Athyma perius*
146	Himalayan Sergeant	*Athyma opalina*
147	Staff Sergeant	*Athyma selenophora*
148	Studded Sergeant	*Athyma asura*
149	Orange Staff Sergeant	*Athyma cama*
150	Commander	*Moduza procris*
151	Gaudy Baron	*Euthalia lubentina*
152	Commodore	*Auzakia danava*
153	Baronet	*Euthalia nais*
154	Common Baron	*Euthalia aconthea*
155	Grey Count	*Tanaecia lepidea*
156	Tabby	*Pseudergolis wedah*
157	Popinjay	*Stibochiona nicea*
158	Club Beak	*Libythea myrrha*
159	Common Beak	*Libythea lepita*
160	Plain Tiger	*Danaus chrysippus*
161	Common Tiger	*Danaus genutia*
162	Dark Blue Tiger	*Tirumala septentrionis*
163	Blue Tiger	*Tirumala limniace*
164	Glassy Tiger	*Parantica aglea*
165	Chestnut Tiger	*Parantica sita*
166	Striped Blue Crow	*Euploea mulciber*
167	Common Crow	*Euploea core*
168	Common Banded Awl	*Hasora chromus*
169	Branded Orange Awlet	*Burara oedipodea*
170	Orange Awlet	*Burara jaina*
171	Fulvous Pied Flat	*Pseudocoladenia fatih*
172	Tri–colour Pied Flat	*Coladenia indrani*
173	Common Small Flat	*Sarangesa dasahara*
174	Spotted Small Flat	*Sarangesa purendra*
175	Common Spotted Flat	*Celaenorrhinus leucocera*
176	Yellow-banded Flat	*Celaenorrhinus dhanada*
177	Water Snow Flat	*Tagiades litigiosa*
178	Spotted Snow Flat	*Tagiades menaka*
179	Chestnut Angle	*Odontoptilum angulata*
180	Veined Scrub Hopper	*Aeromachus stigmatus*
181	Indian Skipper	*Spialia galba*
182	Grass Demon	*Udaspes folus*
183	Restricted Demon	*Notocrypta curvifascia*
184	Indian Palm Bob	*Suastus gremius*
185	Tree Flitter	*Hyarotis adrastus*
186	Palm Red–Eye	*Erionota thrax*
187	Common Red Eye	*Matapa aria*

Sl. No.	Common Name	Scientific Name
188	Himalayan Grass Dart	*Taractrocera danna*
189	Common Dartlet	*Oriens gola*
190	Himalayan Dart	*Taractrocera danna*
191	Pale Palm Dart	*Telicota colon*
192	Dark Palm Dart	*Telicota bambusae*
193	Great Swift	*Pelopidas assamensis*
194	Rice Swift	*Borbo cinnara*
195	Bevan's Swift (Lesser Rice Swift)	*Borbo bevani*
196	Straight Swift	*Parnara bada*
197	Large Branded Swift	*Pelopidas subochracea*
198	Small Branded Swift	*Pelopidas mathias*
199	Conjoined Swift	*Pelopidas conjuncta*
200	Yellowspot Swift	*Polytremis eltola*
201	Himalayan Swift	*Polytremis discreta*
202	Figure–of–8–Swift	*Baoris pagana*
203	Complete Paintbrush Swift	*Baoris farri*

Table 14: List of snakes found in the city of Dehradun, used for Indicator 7

Sl.No.	Common Name	Scientific Name
1	Common Krait	*Bungarus caeruleus*
2	Spectacled Cobra	*Naja naja*
3	Buff Striped Keelback	*Amphiesma stolatum*
4	Common Cat Snake	*Boiga trigonata*
5	Common Trinket Snake	*Coelognathus helena* helena
6	Common Wolf Snake	*Lycodon aulicus*
7	Yellow Speckled Wolf Snake	*Lycodon jara*
8	Common Kukri Snake	*Oligodon arnesis*
9	Indian Rat Snake	*Ptyas mucosa*
10	Cantor's Black-headed Snake	*Sibynophis sagittarius*
11	Checkered Keelback	*Xenochrophis piscator*
12	Brahminy Worm Snake	*Indotyphlops brahminus*
13	Python	*Python moluris*
14	Russell's Viper	*Vipera russelli*

Table 15: List of moths found in the city of Dehradun, used for Indicator 8

Sl. No.	Scientific Name
1	*Gunda ochracea*
2	*Abraxas cf. sylvata*
3	*Abraxas sp.*
4	*Achaea Janata*
5	*Acherontia Lachesis*
6	*Acherontia styx*
7	*Acosmeryx anceus*
8	*Acosmeryx pseudonaga*
9	*Actias selene*
10	*Aemene cf. taprobanis*
11	*Aethaloessa calidalis*
12	*Agathia carissima*
13	*Agathia cf quinaria*
14	*Agathia lycaenaria*
15	*Agrius convolvuli*
16	*Aloa lactinea*
17	*Altha subnotata*
18	*Amata bicincta*
19	*Amata cyssea*
20	*Amblychia angeronaria*
21	*Ambulyx liturata*
22	*Ambulyx sp.*
23	*Anambulyx elwesi*
24	*Anisoneura aleuco*
25	*Anomis flava*
26	*Antheraea frithi*
27	*Antheraea mylitta*
28	*Antheraea paphia*
29	*Antheua servula*
30	*Antitrygodes sp.*
31	*Aporandria specularia*
32	*Arctornis comma*
33	*Arctornis sp.*
34	*Areas galactina*
35	*Argina astrea*
36	*Arguda sp.*
37	*Artaxa cf. diagramma*
38	*Asota caricae*
39	*Asota ficus*
40	*Asota plaginota*
41	*Athetis bipuncta*
42	*Attacus atlas*
43	*Attatha ino*
44	*Auchmis inextricata*
45	*Bagada spicea*

Sl. No.	Scientific Name
46	*Barsine cf. maculifasciata*
47	*Barsine cf. orientalis*
48	*Barsine dharma*
49	*Barsine linga*
50	*Bastilla crameri*
51	*Benbowia virescens*
52	*Biston sp.*
53	*Biston suppressaria*
54	*Botyodes asialis*
55	*Bradina diagonalis*
56	*Brahmaea hearseyi*
57	*Buckleria paludum*
58	*Calesia dasypterus*
59	*Calesia haemorrhoa*
60	*Calliteara cf grotei*
61	*Calliteara sp.*
62	*Callopistria minuta*
63	*Callopistria rivularis*
64	*Callyna jugaria*
65	*Callyna monoleuca*
66	*Calyptra parva*
67	*Carea angulate*
68	*Cephonodes hylas*
69	*Chabula acamasalis*
70	*Chadisra bipars*
71	*Chasmina candida*
72	*Chasmina judicata*
73	*Cheromettia apicata*
74	*Chiasmia Eleonora*
75	*Chiasmia emersaria*
76	*Chiasmia xanthonora*
77	*Chrysocraspeda faganaria*
78	*Chrysocraspeda olearia*
79	*Chrysodeixis sp.*
80	*Cirrhochrista brizoalis*
81	*Cirrhochrista fumipalpis*
82	*Cleora fraternal*
83	*Clepsis sp.*
84	*Clostera cf restitura*
85	*Cnaphalocrocis medinalis*
86	*Comibaena cassidara*
87	*Comostola cf subtiliaria*
88	*Conogethes punctiferalis*
89	*Corymica arnearia*
90	*Cotachena pubescens*

Sl. No.	Scientific Name
91	*Creatonotos gangis*
92	*Creatonotos transiens*
93	*Cyana coccinea*
94	*Cyana gelida*
95	*Cyana guttifera*
96	*Cyana peregrina*
97	*Cyana puella*
98	*Cyclidia substigmaria*
99	*Cydalima laticostalis*
100	*Cypa cf. pallens*
101	*Dalima patularia*
102	*Daphnis nerii*
103	*Dasyboarmia subpilosa*
104	*Diaphania indica*
105	*Dichromia quadralis*
106	*Dierna strigata*
107	*Digama insulana*
108	*Dindica alaopis*
109	*Diomea lignicolora*
110	*Dysphania militaris*
111	*Ectropidia shoreae*
112	*Ectropis crepuscularia*
113	*Eilema sp.*
114	*Endocrossis flavibasalis*
115	*Eoophyla cf. peribocalis*
116	*Epiplema ruptaria*
117	*Episparis liturata*
118	*Episteme adulatrix*
119	*Erebus caprimulgus*
120	*Erebus ephesperis*
121	*Erebus hieroglyphica*
122	*Erebus macrops*
123	*Eressa confinis*
124	*Eterusia sp.*
125	*Eucyclodes albisparsa*
126	*Eucyclodes divapala complex*
127	*Eudocima homaena*
128	*Eudocima phalonia*
129	*Eumelea rosalia*
130	*Eumelea sp.*
131	*Eupanacra mydon*
132	*Euproctis plagiata*
133	*Euproctis sp.*
134	*Eupterote bifasciata*
135	*Eupterote fabia*
136	*Eupterote geminata*

Sl. No.	Scientific Name
137	*Eupterote undata*
138	*Fascellina chromataria*
139	*Fascellina plagiata*
140	*Fodina cuneigera*
141	*Fodina pallula*
142	*Fodina stola*
143	*Ganisa plana*
144	*Gastropacha cf pardalis*
145	*Gastropacha pardalis*
146	*Gastropacha sp.*
147	*Glyphodes bicolor*
148	*Glyphodes bivitralis*
149	*Grammodes geometrica*
150	*Gynautocera papilionaria*
151	*Hamodes propitia*
152	*Haritalodes derogata*
153	*Helicoverpa armigera*
154	*Hemithea constipunctata*
155	*Hemithea tritonaria*
156	*Herdonia gigantea*
157	*Herochroma cristata*
158	*Herpetogramma sp.*
159	*Heterostegane cf. urbica*
160	*Heterostegane subtessellata*
161	*Hippotion sp.*
162	*Histia flabellicornis*
163	*Homea clathrum*
164	*Hulodes caranea*
165	*Hyaloplaga pulchralis*
166	*Hyblaea puera*
167	*Hydatocapnia cf marginata*
168	*Hydriris ornatalis*
169	*Hyles livornica*
170	*Hymenia perspectalis*
171	*Hyperythra lutea*
172	*Hypocala rostrata*
173	*Hypomecis cineracea*
174	*Hypomecis transcissa*
175	*Hypopyra vespertilio*
176	*Hyposidra talaca*
177	*Hyposidra violescens*
178	*Idaea macrospila*
179	*Ischjya manlia*
180	*Kunugia cf. latipennis*
181	*Lamprosema commixta*
182	*Lamprosema tampiusalis*

Sl. No.	Scientific Name
183	*Leptomiza calcearia*
184	*Leucinodes orbonalis*
185	*Leucophlebia lineata*
186	*Loepa katinka*
187	*Lycene cf. obsoleta*
188	*Lycene sp.*
189	*Lyclene dharma*
190	*Lyclene near hollowai*
191	*Lymantria concolor*
192	*Lymantria incerta*
193	*Lymantria marginata*
194	*Lymantria mathura*
195	*Lymantria semicincta*
196	*Macdunnoughia tetragona*
197	*Macrobrochis gigas*
198	*Macrobrochis prasena*
199	*Macroglossum belis*
200	*Macroglossum cf. pyrrhoristica*
201	*Maliattha separata*
202	*Maliattha signifera*
203	*Maliattha tegulata*
204	*Mangina argus*
205	*Maruca vitrata*
206	*Marumba cf. dyras*
207	*Medasina albidaria*
208	*Metanastria hyrtaca*
209	*Metoeca foedalis*
210	*Miltochrista obsoleta*
211	*Miresa sp.*
212	*Mocis discios*
213	*Mocis frugalis*
214	*Mocis undata*
215	*Musotima suffusalis*
216	*Mythimnia sp.*
217	*Nagia linteola*
218	*Nausinoe geometralis*
219	*Nausinoe pueritia*
220	*Neocerura liturata*
221	*Nephele hespera*
222	*Notarcha aurolinealis*
223	*Nyctemera adversata*
224	*Nyctemera cenis*
225	*Ocinara albicolis*
226	*Olepa koslandana*
227	*Olepa ricini*
228	*Omiodes indicata*
229	*Ophiusa tirhaca*

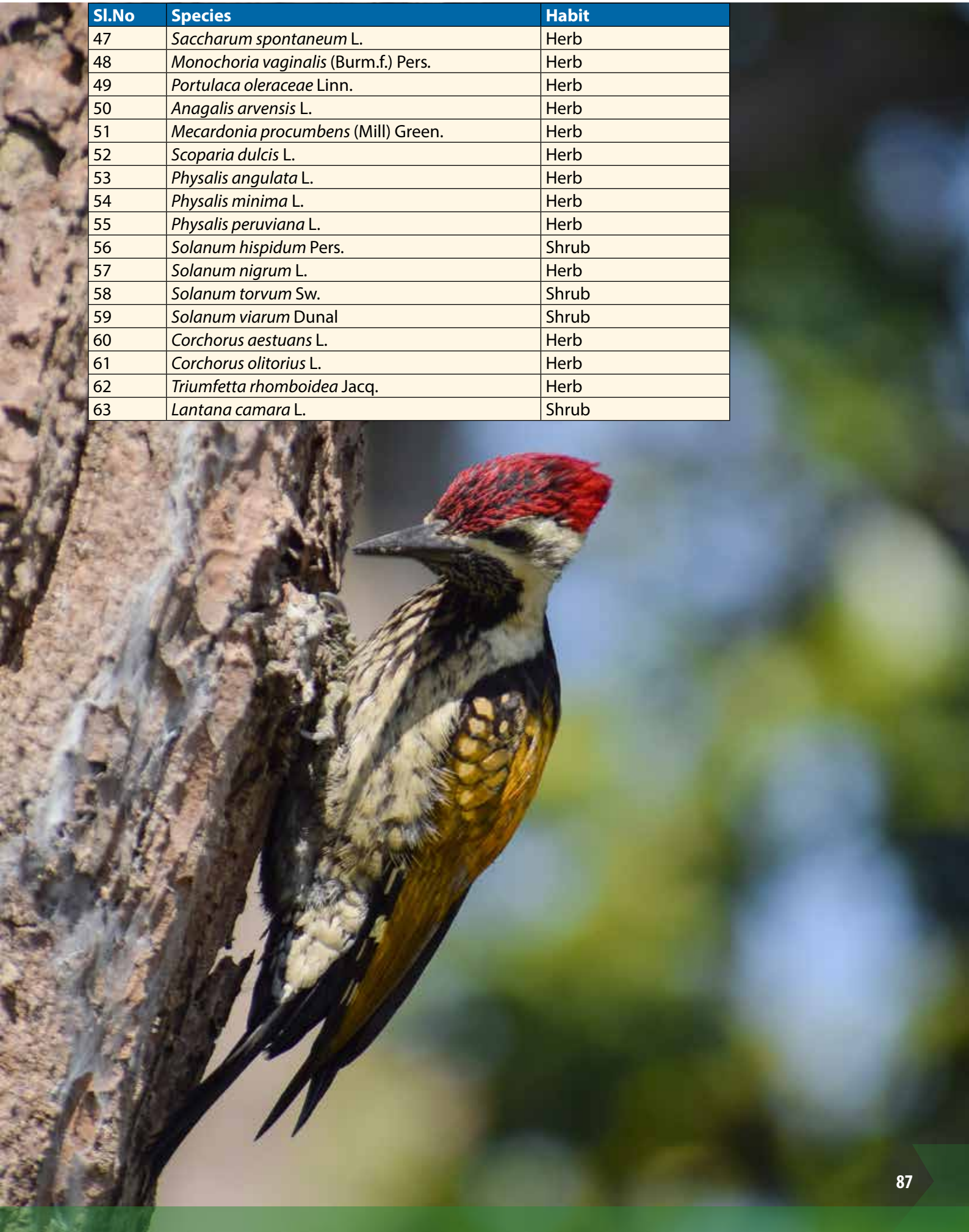
Sl. No.	Scientific Name
230	*Oreta sp.*
231	*Ornithospila avicularia*
232	*Orthonama obstipata*
233	*Orudiza protheclaria*
234	*Orygia postica*
235	*Ourapteryx sciticaudaria*
236	*Pachynoa sabelialis*
237	*Palpita asiaticalis*
238	*Palpita sp*
239	*Pangora distorta*
240	*Paracymoriza vagalis*
241	*Parapholodes fuliginea*
242	*Parapoynx fluctuosalis*
243	*Parasa hilaris*
244	*Parasa lepida*
245	*Pelagodes veraria*
246	*Penicilifera apicalis*
247	*Peratophyga hyalinata*
248	*Percnia belluaria*
249	*Pergesa acteus*
250	*Pericyma cruegeri*
251	*Perina nuda*
252	*Petelia distracta*
253	*Phalera grotei*
254	*Phazaca theclata*
255	*Phocoderma velutina*
256	*Pingasa ruginaria*
257	*Pleuroptya ruralis*
258	*Plutodes sp.*
259	*Polyphagozerra cf coffeae*
260	*Polyptychus trilineatus*
261	*Polytela gloriosae*
262	*Problepsis vulgaris*
263	*Protuliocnemis biplagiata*
264	*Pseudoadites frigida*
265	*Pseudomicronia sp.*
266	*Psillogramma sp.*
267	*Psilogramma discistriga*
268	*Psimada quadripennis*
269	*Ptochophyle near deviaria*
270	*Pycnarmon alboflavalis*
271	*Pycnarmon virgatalis*
272	*Pygospila tyres*
273	*Rhagastis acuta*
274	*Rhagastis velata*
275	*Rhodometra sacraria*
276	*Sameodes cancellalis*

Sl. No.	Scientific Name
277	*Samia cynthia ricini*
278	*Sarbanissa albifascia*
279	*Sarbanissa catacoloides*
280	*Scardamia seminigra*
281	*Scopelodes testacea*
282	*Scopula pulchellata*
283	*Scopula sp.*
284	*Semiothisa elenora*
285	*Somena cf scintillans*
286	*Spaniocentra cf. lyra*
287	*Spaniocentra sp.*
288	*Spilosoma obliqua*
289	*Spirama sp.*
290	*Spodoptera litura*
291	*Spoladea recurvalis*
292	*Striglina scitaria*
293	*Striglina sp*
294	*Syllepte concatenalis*
295	*Syngamia falsidicalis*
296	*Syntomoides imaon*
297	*Teldenia vestigia*
298	*Terastia egialealis*
299	*Theretra alecto*
300	*Theretra clotho*
301	*Theretra griseomarginata*
302	*Theretra nessus*
303	*Theretra oldenlandiae*
304	*Theretra suffusa*
305	*Thinopteryx crocoptera*
306	*Thyas coronata*
307	*Thyas juno*
308	*Thyatira batis*
309	*Thysanoplusia orichalcea*
310	*Tiracola plagiata*
311	*Trabala vishnou*
312	*Traminda mundissima*
313	*Tridrepanna albonotata*
314	*Tridrepanna flava*
315	*Trigonodes hyppasia*
316	*Tyspanodes linealis*
317	*Vamuna remelana*
318	*Westermannia superba*
319	*Xanthodes intersepta*
320	*Xyleutes persona*
321	*Zamarada spp*
322	*Zamarada symmetra*
323	*Zeheba aureata*
324	*Zeheba lucidata*
325	*Zitha torridalis*
326	*Zurobata vacillans*

Table 16: List of invasive plant species found in the city of Dehradun, used in the calculation of Indicator 10

Sl.No	Species	Habit
1	*Alternanthera philoxeroides* (Mast.)Griseb.	Herb
2	*Alternanthera sessilis* (L.) R.Br. ex DC.	Herb
3	*Amaranthus spinosus* L.	Herb
4	*Celosia argentea* L.	Herb
5	*Gomphrena celosioides* Mart.	Herb
6	*Asclepias curassavica* L.	Herb
7	*Calotropis procera* (Willd) Dry & Ait.	Herb
8	*Ageratum conyzoides* L.	Herb
9	*Ageratum houstonianum* Mill.	Herb
10	*Bidens pilosa* L.	Herb
11	*Blumea lacera* DC.	Herb
12	*Emilia sonchifolia* (L.) DC.	Herb
13	*Galinsoga parviflora* Cav.	Herb
14	*Gnaphalium pensylvanicum* Willd.	Herb
15	*Parthenium hysterophorus* L.	Herb
16	*Sonchus asper (L.) Hill.*	Herb
17	*Tridax procumbens* L.	Herb
18	*Youngia japonica* (L.) DC.	Herb
19	*Cardamine hirsuta* Lin.	Herb
20	*Rorippa dubia* (Pers) Hara.	Herb
21	*Canabis sativa* L.	Herb
22	*Chenopodium album* L.	Herb
23	*Chenopodium murale* L.	Herb
24	*Cleome viscosa* L.	Herb
25	*Convolvulus arvensis* L.	Herb
26	*Evolvulus nummularius* L.	Herb
27	*Ipomoea nil* (L) Roth.	Herb
28	*Cuscuta chinensis* Lam.	Herb
29	*Cuscuta reflexa* Roxb.	Herb
30	*Cyperus difformis L.*	Herb
31	*Cyperus iria* L.	Herb
32	*Euphorbia hirta* L.	Herb
33	*Cassia absus* L.	Shrub
34	*Indigofera linifolia* (L.f.) Retz.	Shrub
35	*Melilotus alba* Medik.	Herb
36	*Mimosa pudica* L.	Herb
37	*Sesbania bispinosa* L.	Herb
38	*Sida acuta* Burm.	Shrub
39	*Urena lobata* L.	Shrub
40	*Martynia annua L.*	Herb
41	*Ludwigia octovalvis* (Jacq.)Raven	Herb
42	*Oxalis corniculata* L.	Herb
43	*Argemone mexicana* L.	Herb
44	*Passiflora foetida* L.	Herb
45	*Echinochloa colonum* L.	Herb
46	*Imperata cylindrica* (L.) Beauv	Herb

Sl.No	Species	Habit
47	*Saccharum spontaneum* L.	Herb
48	*Monochoria vaginalis* (Burm.f.) Pers.	Herb
49	*Portulaca oleraceae* Linn.	Herb
50	*Anagalis arvensis* L.	Herb
51	*Mecardonia procumbens* (Mill) Green.	Herb
52	*Scoparia dulcis* L.	Herb
53	*Physalis angulata* L.	Herb
54	*Physalis minima* L.	Herb
55	*Physalis peruviana* L.	Herb
56	*Solanum hispidum* Pers.	Shrub
57	*Solanum nigrum* L.	Herb
58	*Solanum torvum* Sw.	Shrub
59	*Solanum viarum* Dunal	Shrub
60	*Corchorus aestuans* L.	Herb
61	*Corchorus olitorius* L.	Herb
62	*Triumfetta rhomboidea* Jacq.	Herb
63	*Lantana camara* L.	Shrub



Annexure 3 - Calculation of Connectivity Areas

Table 17: Number and area of patches used in the calculation of Indicator 2

Patch id	Area (ha)	Area*Area (ha^2)	Patch id	Area (ha)	Area*Area (ha^2)
A1	3436.14	11807058.10	A39	2.72	7.40
A2	135.33	18314.21	A40	2.66	7.06
A3	65.29	4262.58	A41	2.50	6.26
A4	44.93	2018.96	A42	2.49	6.19
A5	31.74	1007.70	A43	2.36	5.59
A6	31.59	997.80	A44	2.36	5.58
A7	29.96	897.75	A45	2.29	5.23
A8	19.46	378.85	A46	2.26	5.11
A9	17.12	293.03	A47	2.21	4.89
A10	17.03	289.89	A48	2.18	4.76
A11	15.76	248.28	A49	2.09	4.37
A12	14.97	224.02	A50	2.04	4.17
A13	11.75	138.06	A51	1.95	3.80
A14	11.54	133.12	A52	1.95	3.80
A15	11.28	127.35	A53	1.84	3.38
A16	11.08	122.87	A54	1.81	3.29
A17	8.74	76.36	A55	1.75	3.06
A18	6.73	45.25	A56	1.66	2.77
A19	6.42	41.22	A57	1.58	2.48
A20	6.35	40.36	A58	1.57	2.45
A21	5.99	35.82	A59	1.42	2.02
A22	5.30	28.06	A60	1.31	1.70
A23	5.29	27.97	A61	1.30	1.69
A24	5.01	25.08	A62	1.30	1.68
A25	4.95	24.49	A63	1.15	1.33
A26	4.83	23.36	A64	1.15	1.33
A27	4.69	21.97	A65	1.15	1.31
A28	4.30	18.51	A66	1.14	1.29
A29	4.26	18.11	A67	1.14	1.29
A30	4.18	17.51	A68	1.13	1.27
A31	3.95	15.60	A69	1.13	1.27
A32	3.74	14.02	A70	1.11	1.24
A33	3.53	12.46	A71	0.99	0.974
A34	3.47	12.04	A72	0.96	0.921
A35	3.33	11.12	A73	0.96	0.914
A36	3.20	10.22	A74	0.93	0.859
A37	2.98	8.88	A75	0.91	0.826
A38	2.88	8.31	A76	0.89	0.790

Patch id	Area (ha)	Area*Area (ha^2)
A77	0.87	0.762
A78	0.85	0.730
A79	0.85	0.725
A80	0.84	0.709
A81	0.84	0.704
A82	0.84	0.701
A83	0.83	0.694
A84	0.82	0.667
A85	0.78	0.606
A86	0.78	0.602
A87	0.77	0.590
A88	0.77	0.585
A89	0.75	0.561
A90	0.71	0.500
A91	0.71	0.499
A92	0.65	0.429
A93	0.65	0.419
A94	0.64	0.416
A95	0.64	0.412
A96	0.56	0.310
A97	0.55	0.303
A98	0.55	0.298
A99	0.54	0.295
A100	0.53	0.282
A101	0.53	0.280
A102	0.52	0.274
A103	0.51	0.261
A104	0.50	0.254
A105	0.50	0.253
A106	0.50	0.252
A107	0.49	0.240
A108	0.49	0.236
A109	0.47	0.220
A110	0.47	0.220
A111	0.47	0.220
A112	0.46	0.215
A113	0.45	0.201
A114	0.44	0.190
A115	0.43	0.182
A116	0.41	0.171
A117	0.41	0.169
A118	0.40	0.162
A119	0.40	0.158
A120	0.37	0.138
A121	0.34	0.117
A122	0.33	0.111

Patch id	Area (ha)	Area*Area (ha^2)
A123	0.33	0.110
A124	0.32	0.102
A125	0.32	0.100
A126	0.32	0.099
A127	0.31	0.098
A128	0.31	0.097
A129	0.30	0.092
A130	0.30	0.090
A131	0.30	0.088
A132	0.29	0.085
A133	0.29	0.084
A134	0.29	0.083
A135	0.28	0.080
A136	0.27	0.075
A137	0.26	0.070
A138	0.26	0.066
A139	0.25	0.061
A140	0.23	0.054
A141	0.23	0.052
A142	0.23	0.051
A143	0.22	0.050
A144	0.22	0.049
A145	0.22	0.048
A146	0.22	0.048
A147	0.22	0.047
A148	0.21	0.046
A149	0.21	0.046
A150	0.21	0.043
A151	0.20	0.042
A152	0.20	0.039
A153	0.20	0.038
A154	0.19	0.035
A155	0.19	0.035
A156	0.18	0.034
A157	0.18	0.034
A158	0.18	0.033
A159	0.18	0.033
A160	0.18	0.032
A161	0.18	0.032
A162	0.18	0.031
A163	0.18	0.031
A164	0.17	0.030
A165	0.17	0.029
A166	0.17	0.029
A167	0.17	0.029
A168	0.17	0.029

Patch id	Area (ha)	Area*Area (ha^2)
A169	0.17	0.028
A170	0.16	0.025
A171	0.16	0.025
A172	0.16	0.024
A173	0.16	0.024
A174	0.15	0.024
A175	0.15	0.024
A176	0.15	0.022
A177	0.15	0.022
A178	0.15	0.022
A179	0.15	0.022
A180	0.15	0.021
A181	0.14	0.020
A182	0.14	0.020
A183	0.14	0.018
A184	0.13	0.017
A185	0.13	0.017
A186	0.13	0.017
A187	0.13	0.017
A188	0.13	0.016
A189	0.12	0.016
A190	0.12	0.015
A191	0.12	0.015
A192	0.12	0.015
A193	0.12	0.015
A194	0.12	0.015
A195	0.12	0.014
A196	0.12	0.014
A197	0.12	0.014
A198	0.12	0.013
A199	0.11	0.013
A200	0.11	0.013
A201	0.11	0.013
A202	0.11	0.013
A203	0.11	0.013
A204	0.11	0.013
A205	0.11	0.012
A206	0.11	0.012
A207	0.11	0.012
A208	0.11	0.012
A209	0.11	0.012
A210	0.11	0.011
A211	0.11	0.011
A212	0.11	0.011
A213	0.11	0.011
A214	0.10	0.011

Patch id	Area (ha)	Area*Area (ha^2)
A215	0.10	0.011
A216	0.10	0.010
A217	0.10	0.010
A218	0.10	0.009
A219	0.09	0.009
A220	0.09	0.008
A221	0.09	0.008
A222	0.09	0.008
A223	0.09	0.008
A224	0.09	0.007
A225	0.09	0.007
A226	0.09	0.007
A227	0.08	0.007
A228	0.08	0.007
A229	0.08	0.007
A230	0.08	0.007
A231	0.08	0.006
A232	0.08	0.006
A233	0.07	0.005
A234	0.07	0.005
A235	0.07	0.005
A236	0.07	0.005
A237	0.07	0.005
A238	0.07	0.005
A239	0.07	0.005
A240	0.07	0.005
A241	0.07	0.004
A242	0.06	0.004
A243	0.06	0.004
A244	0.06	0.004
A245	0.06	0.004
A246	0.06	0.004
A247	0.06	0.004
A248	0.06	0.003
A249	0.06	0.003
A250	0.06	0.003
A251	0.06	0.003
A252	0.06	0.003
A253	0.06	0.003
A254	0.05	0.003
A255	0.05	0.002
A256	0.05	0.002
A257	0.05	0.002
A258	0.05	0.002
A259	0.04	0.002
A260	0.04	0.002

Patch id	Area (ha)	Area*Area (ha^2)
A261	0.04	0.002
A262	0.04	0.002
A263	0.04	0.002
A264	0.04	0.002
A265	0.04	0.002
A266	0.04	0.001
A267	0.04	0.001
A268	0.04	0.001
A269	0.04	0.001

Patch id	Area (ha)	Area*Area (ha^2)
A270	0.03	0.001
A271	0.03	0.001
A272	0.03	0.001
A273	0.03	0.001
A274	0.03	0.001
A275	0.03	0.001
A276	0.03	0.001
A277	0.03	0.001

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