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**BMB Technical Bulletin** **APR 11, 2018**
**2018- 02**

SUBJECT : **PROCEDURES IN THE CONDUCT OF ASSESSMENT OF URBAN BIODIVERSITY**

Pursuant to Republic Act 7160 also known as the *Local Government Code of 1991*, the DENR Administrative Order 2016-12 entitled *Adopting the Philippine Biodiversity Strategy and Action Plan 2015-2028,* the *Convention on Biological Diversity*, and other existing rules and regulations and support policies, and in order to provide sound basis for informed decisions on the management of the biological diversity within urban areas and for the development of an City Biodiversity Index that will be the basis of actions that would integrate city's biodiversity into local development plans, the attached Procedures in the Conduct of Assessment of Urban Biodiversity is hereby adopted.

SECTION 1. **Rationale.** Biodiversity in urban areas is important because in some cases, there are areas within the cities which harbor or affect critical ecosystems such as wetlands or may even provide links to centers of endemism[1]. City biodiversity exposes urban residents to an environment or landscape which facilitates their appreciation for nature. It also provides opportunities for recreation, health, relaxation and community cohesion. Green area accessibility has also been linked to reduced mortality and improved the perceived and actual general health. Psychological benefits of green spaces increase with biodiversity and green windows increase job satisfaction and reduce stress[2].

In May 2008, the Convention on Biological Diversity (CBD) member countries began discussion on promoting biodiversity in an urban setting. It was during this time that a Plan of Action was forged in Nagoya, Japan, which encourages Parties to actively engage subnational governments, cities and other local authorities in implementing the CBD and advocates the use of the City Biodiversity Index (CBI), also known as the Singapore Index on Cities' Biodiversity (Singapore Index) as a monitoring tool to assist local authorities to evaluate their progress in urban biodiversity conservation. It is important to note however, that the CBI is not a tool to compare the status of biodiversity across cities, but rather it is a tool to assess the

[1] ICLEI – Local Governments for Sustainability. 2010. Local Action for Biodiversity Guidebook: Biodiversity Management for Local Governments. Laros MT and Jones FE (Eds).
[2] DENR AO No. 2016-12 "Adopting the Philippine Biodiversity Strategy and Action Plan (PBSAP) 2015-2028" (13 June 2016)

performance of each city in creating a positive or negative impact in terms of biodiversity conservation[3].

The assessment of the existing biodiversity status within the urban areas, formulation and implementation of urban biodiversity management plan, and the development of CBI will be the bases for formulation of policies, possible integration in the Comprehensive Land Use Plan (CLUP), Zoning Ordinance (ZO) and other plans in the management of the city's biodiversity and updated actions for the succeeding plans.

SECTION 2. **Objectives.** This Technical Bulletin provides DENR Offices with the procedures in assisting local government units towards determining the condition of existing urban biodiversity that will update bio-physical profiles and develop relevant reports on the state of biodiversity. Results can in turn be used in the determination of the CBI, development and updating of urban management plan and other related conservation plans. Specifically, objectives of the Technical Bulletin are:

1. To provide better understanding and analysis of the biodiversity and the ecosystem services they provide in urban areas;
2. To provide standardized procedures in the conduct of urban biodiversity assessment;
3. To identify priority conservation areas/habitats in urban areas;
4. To provide inputs for a localized Urban Biodiversity Index and corresponding information management system aimed at sustaining the overall health of biodiversity; and
5. To develop a manual on tools for assessment of urban areas that conforms to the uniqueness and peculiarities of the urban setting based on the results of the pilot implementation of this technical bulletin.

SECTION 3. **Scope and Coverage**. This Technical Bulletin shall apply to all urban areas as defined in Section 4.

SECTION 4. **Definition of Terms.** For the purpose of this Technical Bulletin, the following definition of terms shall be used:

a. Biodiversity - variability among living organisms from all sources including terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part. This includes diversity within species and of ecosystems.[4]
b. Green space - land that is partly or completely covered with grass, trees, shrubs, or other vegetation. Green space includes parks, community gardens,

[3] Chan, L., Hillel, O., Elmqvist, T., Werner, P., Holman, N., Mader, A. and Calcaterra, E., 2014. User's Manual on the Singapore Index on Cities' Biodiversity (also known as the City Biodiversity Index). Singapore: National Parks Board, Singapore.
[4] Article 2 Convention on Biological Diversity (CBD)

and anthropogenic green spaces such as roof garden, roadside planting, private gardens, and urban parks.

c. Urban Biodiversity - is the variety and richness of living organisms including genetic variation and habitat diversity found in and on the edge of human settlements. This biodiversity ranges from the rural fringe to the urban core. At the landscape and habitat level it includes - remnants of natural landscapes like leftovers of primeval forests, traditional agricultural landscapes like meadows, areas of arable land, urban–industrial landscapes like city centers, residential areas, industrial parks, railway areas, formal parks and gardens, brown fields. [5]

d. Urban area as defined by National Statistical Coordination Board (NSCB) shall be as follows:

    i. If a barangay has a population size of 5,000 or more, then a barangay is considered urban, or
    ii. If a barangay has at least one establishment with a minimum of 100 employees, a barangay is considered urban, or
    iii. If a barangay has 5 or more establishments with a minimum of 10 employees, and 5 or more facilities within the two-kilometer radius from the barangay hall, then a barangay is considered urban.

    Further, all barangays in the National Capital Region are automatically classified as urban and all highly urbanized cities would be subjected to the urban-rural criteria in order to determine its urban-rural classification. All other barangays are therefore classified as rural. [6]

e. Highly Urbanized Cities - Cities with a minimum population of (200,000 inhabitants, as certified by the National Statistics Office, and with the latest annual income of at least P50,000,000.00 based on 1991 constant prices, as certified by the city treasurer.[7] All cities within Metro Manila are considered highly urbanized.[8]

f. Independent Component Cities - Cities whose charters prohibit their voters from voting for provincial elective officials. Independent component cities shall be independent of the province.[9] Cities include Dagupan City, Ormoc City, Santiago City, Naga City, and Cotabato City.[10]

[5] Thomas Elmqvist, 2012.
[6] NSCB Board Resolution No. 9, s 2003. http://nap.psa.gov.ph/pressreleases/2004/30Jan04_urban.asp
[7] Section 452, RA 7160
[8] List of HUCs, ICCs, and CCs by Income Classification. www.dilg.gov.ph/PDF_File/.../DILG-Facts_Figures-2011627-88553695cc.pdf
[9] City Classification, Philippine Standard Geographic Code. http://nap.psa.gov.ph/activestats/psgc/articles/con_cityclass.asp
[10] List of HUCs, ICCs, and CCs by Income Classification. www.dilg.gov.ph/PDF_File/.../DILG-Facts_Figures-2011627-88553695cc.pdf

g. Component Cities - Cities which do not meet the above requirements shall be considered component cities of the province in which they are geographically located. If a component city is located within the boundaries of 2 or more provinces, such city shall be considered a component of the province of which it used to be a municipality[11]. Examples of component cities are Laoag City, Tuguegarao City, Tarlac City, Batangas City, Legazpi City, and Roxas City.[12]

SECTION 5. **Urban Biodiversity Assessment**. Biodiversity Assessment is critical in the development of a local ecological profile and plans which would guide in the conservation of biodiversity in urban areas. Figure 1 shows the steps that should be followed for the assessment of biodiversity in the urban setting. Details of each of the phases shown in this diagram is in the attached Annex A.

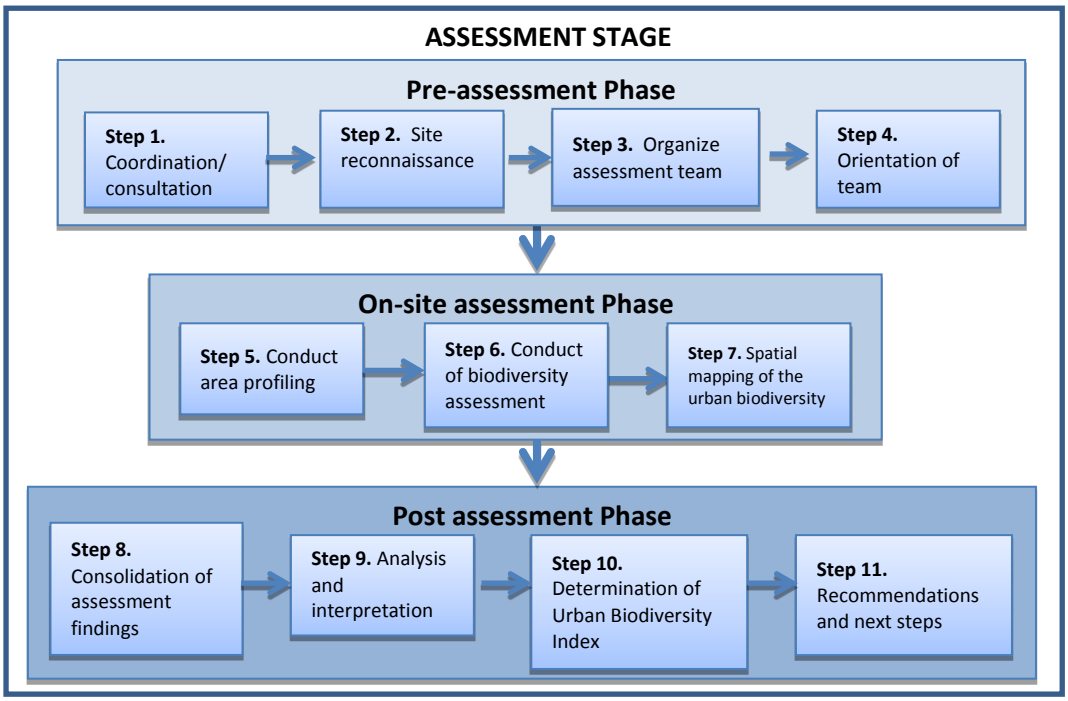



*Figure 1. Process of the Urban Biodiversity Assessment*

In the conduct of an urban biodiversity assessment, local government units are encouraged to forge partnerships with academic and research institutions, and civil society organizations as well as private and industrial sectors, who are involved in biodiversity conservation, to be able to tap their resources and expertise in assessment and monitoring. Assessment has three (3) phases as follows:

a. *Pre-assessment Phase*. In this phase, the local ownership and acceptance of the role of stakeholders, not only in the conservation but also in the development and implementation of local actions, is established. Activities include reinforcement of local understanding on urban biodiversity, preparation for the urban biodiversity assessment, and development of Urban Biodiversity Index.

[11] Ibid.
[12] List of HUCs, ICCs, and CCs by Income Classification. www.dilg.gov.ph/PDF_File/.../DILG-Facts_Figures-2011627-88553695cc.pdf

As this is the planning phase, there should already be an initial determination of the ecosystem services provided by the existing biodiversity to focus the assessment on identified services that need to be highlighted/improved. Creation of composite team should also be done during this phase to plan and determine preparatory activities prior to the biodiversity assessment.

b. *On-site Assessment Phase*. This is the actual assessment of the urban biodiversity. It is important to conduct area profiling, flora and fauna assessments, and charting/spatial mapping using existing tools to determine the overall situation of biodiversity in the area. It is the phase where the biodiversity management and determination of the Urban Biodiversity Index will be based.

c. *Post Assessment Phase*. This is where all the findings including technical reports, outputs of consultations, list/inventory of flora and fauna, maps with zoning, and proposed management options (strategic action plan) and monitoring plan are integrated and analyzed. Further, to monitor the health of the urban biodiversity, the assessment should be done at least every three (3) years or in time of the midterm review of the local development plans and the UBI as indicator of the state of the urban biodiversity.

SECTION 6. **Methodologies for Biodiversity Assessment.** For the assessment of urban biodiversity, existing tools for scientific, biological, and socio-economic assessment such as the Biodiversity Assessment and Monitoring System (BAMS) per BMB Technical Bulletin No. 2016-05, Socio-economic Assessment and Monitoring Systems (SEAMS) per BMB Technical Bulletin No. 2016-06, and other existing tools for flora and fauna assessments for cities with natural forests including wetlands may be used. Community-based approach or citizen science may also be used to provide opportunities for stakeholders to support biodiversity assessment. This approach can provide the assessment team with valuable information as it significantly expands the spatial and temporal scale in assessing the status and trends of biodiversity because the additional people allows considerably more data to be collected, both in terms of range and quantity.

SECTION 7. **Implementation Arrangement.** The concerned DENR Offices shall coordinate with and provide technical assistance to the LGUs thru the City Environment Office and City Planning and Development Office to support the implementation of this Technical Bulletin. Forging of partnerships between and among academic and research institutions, and civil society organizations as well as private and industrial sectors, who are involved in biodiversity conservation are encouraged to tap their resources and expertise in assessment and monitoring.

SECTION 8. **Monitoring.** To monitor the health of the urban biodiversity, the assessment should be done at least every three (3) years in time with the midterm review of the local development plans to determine the state of the urban biodiversity.

SECTION 9. **Reporting.** Concerned DENR Field Offices, through their Conservation and Development Division, or equivalent units, in coordination with the concerned LGUs,

through their City Environmental Office and City Planning and Development Office, should submit the results of the Urban Biodiversity Assessment to their respective Regional Directors to serve as basis for appropriate biodiversity management interventions. DENR Regional Offices should then submit the results and recommendations to the BMB Director for incorporation to and updating of the Philippines Biodiversity Strategy and Action Plan (PBSAP) implementation report. Further, the results of the assessment may also be included in the biodiversity section of the Ecological Profile (EP) or Comprehensive Land Use Plan (CLUP), website or other relevant platforms of the concerned LGUs.

This Technical Bulletin is hereby issued for the guidance of all concerned.

**THERESA MUNDITA S. LIM**
Director

## ANNEX A. PROCEDURES IN THE CONDUCT OF ASSESSMENT OF URBAN BIODIVERSITY

### I. Introduction

Biodiversity is a comprehensive concept, encompassing every form of life on Earth and all of the ecological processes associated with life. Several of the services provided by ecosystems, which contribute significantly to human wellbeing, are the direct products of biodiversity. Biodiversity is thus important to urban areas as it is where the majority of the human population is housed and because most urban areas are built on sites of high ecological diversity and productivity. However, the impact to the overall quality of the ecosystem activities in urban areas still contributes to the overall degradation of the environment. Hence, taking a step further into conservation, urban areas must embark on the assessment of its overall biodiversity in order to identify measures on how they can protect and enhance these areas for conservation and protection, as well as for the provision of ecosystem services, particularly those in relation to adaptation and mitigation of the impacts of climate change and disasters.

The scope of biodiversity in the cities in the Philippines is not as clearly defined as biodiversity in non-urban areas, and the status, trends, and threats to urban biodiversity are currently not well understood, thus the Philippine Biodiversity Strategy and Action Plan (PBSAP) has recently identified urban biodiversity as a thematic area. The PBSAP targeted that by 2028, there will be a 5% increase in the proportion of terrestrial natural areas in the 5 largest cities. In addition, by 2028, as result of improved conservation, ecosystem services provided by key biodiversity areas will be enhanced.

It is important for local governments and stakeholders to have a basic understanding of biodiversity. Though the term “biodiversity” may be new to most of them, some still regard biodiversity a major concern that needs to be addressed. And it would be best if the priority issues, policies and strategies and development programs on biodiversity conservation become part of the local governance system.

Recognizing the impact of cities in the areas of production, consumption, waste generation, pollution and habitat loss, A Plan of Action in Nagoya, Japan on CBD advocates the use of the City Biodiversity Index (CBI), also known as the Singapore Index on Cities’ Biodiversity (Singapore Index) as a monitoring tool to assist local authorities to evaluate their progress in Urban Biodiversity conservation. In this context, elements of the Singapore City Biodiversity Index (CBI) will be adapted to the environment of the cities in the Philippines.

## II. Stages in Urban Biodiversity Assessment

The management and development of urban biodiversity have three (3) stages: assessment, management planning, and implementation and monitoring as shown in Figure 1.

Biodiversity planning, management, and development will provide for a more strategic framework/perspective for assessing the current portfolio of an area and serve as a guide for the formulation of the urban biodiversity conservation plan. This will ensure that the management strategies and programs will address the issues, concerns, threats, and concerns in the area for the overall improvement and achievement in relation to biodiversity conservation.

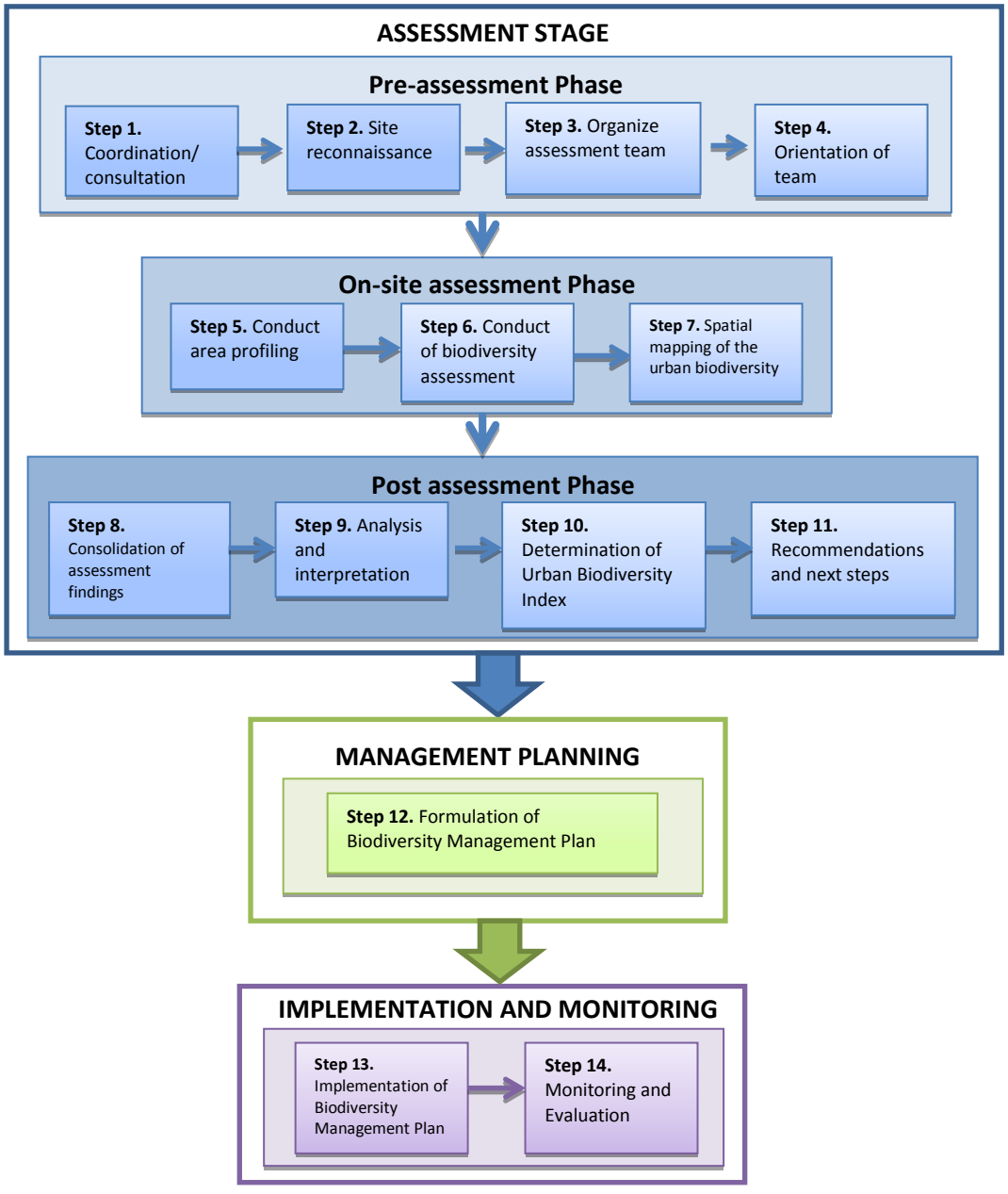



*Figure 1. Process Flow for the Management and Development of the Urban Biodiversity*

Biodiversity Assessment is a critical step in the development of a local environmental/ecological profile and plans, which would guide the conservation of the urban biodiversity. In the conduct of an urban biodiversity assessment, the local government unit is encouraged to forge partnerships with academic and research institutions, and civil society organizations as well as private and industrial sectors, who are involved in biodiversity conservation, to be able to tap their resources and expertise in assessment and monitoring. Assessment has three (3) phases: pre-assessment, on-site assessment, and post assessment.

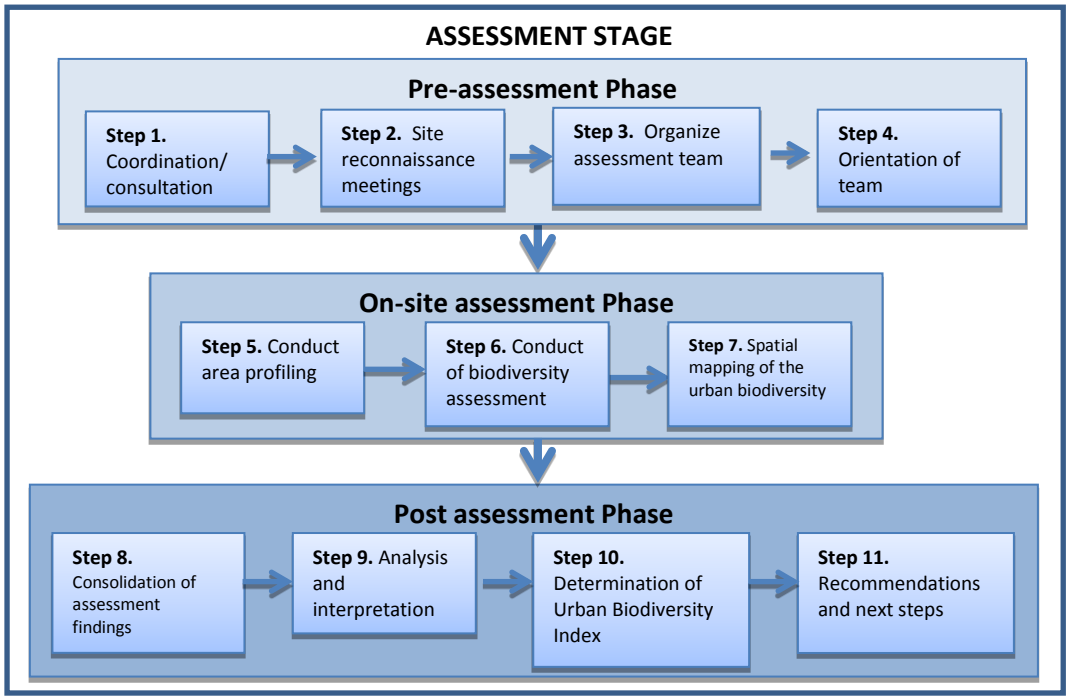
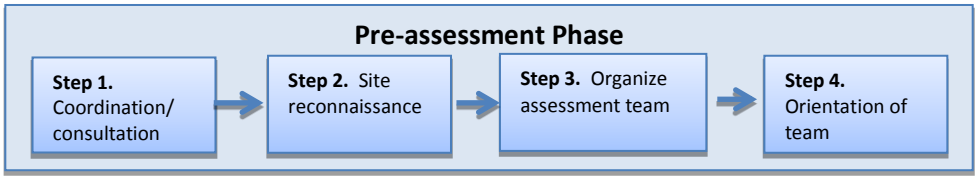



*Figure 1. Process of the Urban Biodiversity Assessment*

## *A. Pre-assessment Phase*

This is also the planning phase. In this phase, the role of local ownership and acceptance of the role of stakeholders not only in the conservation of urban biodiversity but also in the development and implementation of local actions is established. Activities include reinforcement of local understanding on urban biodiversity, preparation for the urban biodiversity assessment, and determination of Urban Biodiversity Index. As this is the planning phase, there should already be an initial determination of the ecosystem services provided by the existing biodiversity to focus the assessment to the services that need to be highlighted/improved.



***Step 1.*** *Coordination/consultation meetings with the concerned local government units, partners, and prospective team members.*

It is important to have meetings with the concerned stakeholders to discuss the objectives of the activities, working arrangements, logistics, and roles and responsibilities of each party.

It is necessary to have consultations to provide more comprehensive understanding of the baseline environment, identify interrelationships between biodiversity and other environmental and socio-economic aspects, identify data gaps and promote transparency in planning and decision-making process.

***Step 2.*** *Site reconnaissance*

This is an important step because it helps in setting up the spatial and temporal boundaries/parameters for the assessment. The information gathered from site reconnaissance will be used to evaluate the current status of the area and identify and select detailed sampling sites.

***Step 3.*** *Organize assessment team who will conduct area profiling*

A composite team of experts from various disciplines has to be identified in the conduct of the area profiling to be led by the LGU thru the City Environment Office and City Planning and Development Office. Foresters, biologists and urban/environmental planners are preferred to be part of the team. Knowledge of urban forestry is advantageous in conducting the inventory. The identification of flora and fauna is critical especially with regard to establishing the vegetative cover, indicating to the extent possible, and presence of rare, endemic, indigenous and exotic species in the area. Experience in conducting inventories is preferred in selecting members of the team. The LGU may pass a local resolution to institutionalize the creation of the assessment team and conduct of the biodiversity assessment.

***Step 4.*** *Orientation on biodiversity, Urban Biodiversity Index, area profiling, and biodiversity assessment.*

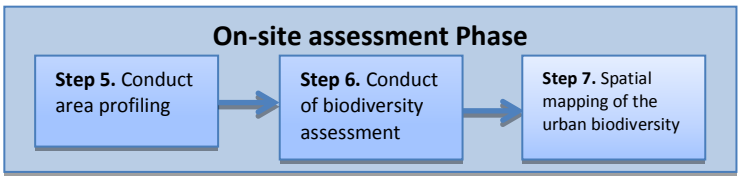
It is critical to conduct orientation on biodiversity assessment to the local government for them to be more informed and have a better understanding of the relevance and importance of biodiversity in their area. This step is crucial because the goal here is to get the support and commitment of the local chief

executive for conducting urban biodiversity assessment. The LGU can tap experts from DENR, academe, private sectors, etc. to conduct the orientation.

### *B. On-site Assessment Phase*

This is now the phase where actual urban biodiversity assessment will start. It is in this phase where the biodiversity management and determination of the Urban Biodiversity Index will be based. Given the complexities of the nature of the assessment, overwhelming could unnecessarily complicate the assessment. It is therefore important to remain focused on the purpose and information needed and maintain the analysis at a level that could be understood by local officials, planners, and stakeholders.

Primary and secondary data obtained from various sources will be used for the assessment. Primary data will be collected from surveys, interviews, and actual biodiversity assessment. Secondary data of the biophysical and socio-economic aspects can be gathered from existing plans, profiles, reports and publications.




***Step 5.*** *Conduct area profiling*

This gives an overview of the current condition of the environment. It involves a detailed and extensive review of secondary literature, including a compilation of thematic maps of the area, to characterize existing social, economic, physical, ecological, socio-cultural and institutional environment. The process should also ensure adequate stakeholder participation through Focus Group Discussions (FGD), Key Informant Interviews (KII) and other such tools for participatory approach. For areas with ecological profile (EP) already, information can be lifted from their existing EP or Comprehensive Land-Use Plan (CLUP) to provide a snapshot or profile of the locality. When conducting a baseline study, the following environmental conditions should be considered:

| **General Information** |
|---|
| • Area |
| • Location |
| • Accessibility |
| **Physical Features** |
| • Land resources (general land use, land classification, urban land use pattern) |
| • Topography (slope, elevation) |

| |
|---|
| • Geology (rock formations, landforms, soils, land capability classes) |
| • Coastal resources |
| • Freshwater resources |
| • Climatic condition |
| • Hydrological features |
| • Conservation areas and other special interest areas |
| **Biological Features** |
| • Flora |
| • Fauna |
| • Vegetative cover |
| • Feeding, nesting, rest areas, and breeding sites |
| **Socio-economic Features** |
| • Demographics (Population [sex-disaggregated], Migration, Resettlement, Age distribution, Roles of men and women, ethnography) |
| • Economics (Income and livelihood sources, Work/Employment profile, Rest and recreation patterns [impact on land use], industries, natural-resource use) |
| • Health and Sanitation |
| • Social services (e.g. hospital/health centers, schools, local government centers, police stations, fire stations, military detachments, etc.) |
| **Environmental Issues and Concerns** |
| • Air Quality and Air Pollution Control |
| • Water Quality and Wastewater Management |
| • Solid Waste Management |
| • Natural and Environmental Hazards and Disaster Risk Area |
| • Disturbance of habitat |
| • Soil Erosion |

***Step 6.*** *Conduct of Biodiversity Assessment*

Assessing the status and trends of biodiversity is essential for sustainable development strategies at all levels, from city to national. Biodiversity is crucial for the wellbeing of people and the environment. Ecological communities maintain the ecological and evolutionary processes that sustain life. Assessment is necessary to ensure that strategies, program and policies in terms of biodiversity conservation are properly implemented and achieved.

For the assessment of urban biodiversity, existing tools for scientific, biological, and socio-economic assessment such as the Biodiversity Assessment and

Monitoring System (BAMS) per *BMB Technical Bulletin No. 2016-05*, Socio-economic Assessment and Monitoring Systems per *BMB Technical Bulletin No. 2016-06*, and existing tools for flora and fauna assessments **(*see Attachment 1*)** for urban areas with natural forests including wetlands may be used. Community-based approach or citizen science may also be used to provide opportunities for stakeholders to support biodiversity assessment. This approach can provide the assessment team with valuable information as it significantly expands the spatial and temporal scale in assessing the status and trends of biodiversity since additional people allows considerably more data to be collected, both in terms of range and quantity.

The biodiversity assessment involves a number of key steps as provided below:

i. Defining the scope

A biodiversity assessment could potentially cover an enormous range of questions and require a huge investment in data gathering and analysis. It is therefore necessary to define the scope of the assessment. It should be focused on producing the information needed for specific decision-making and planning purposes. Stages in scoping:

- Determine the purpose of the assessment
- Define the limits or boundaries of the area to be assessed
- Determine who the stakeholders are in the assessment and what their information needs are
- Determine who may hold the information required to complete the assessment
- Select and agree on the methods, responsibilities and work schedule for the assessment

ii. Data Gathering

The principal aim of data gathering is to prepare general description of the area, including an inventory of the known biodiversity components that are present. This should be carried out in partnership with stakeholders, by collating and reviewing all relevant and available information on the area's status, biophysical characteristics, human use and biodiversity. Additional information may also need to be gathered from new field surveys and analysis of remote sensing data.

The composite team should gather and organize the information needed from various local government departments or offices. However, some information may not be available from the LGU. Thus, linking and networking with other stakeholders operating locally (or even nationally) is crucial. Moreover, some vital information will have to be sourced from the communities, thus, it is important for the assessment team to conduct community consultations through Focus Group Discussions and household surveys.

In conducting the biodiversity assessment, the context of biodiversity in the urban setting should be taken into consideration. It is important to compile and integrate all relevant information for analysis. It is advisable to conduct the assessment during dry and wet seasons. As such, the tables below are the recommended coverage of inventory as adopted from the *Procedural Guidelines for the Conduct of an Urban Biodiversity Inventory* by Dr. Leonora Gonzales with the Biodiversity Management Bureau (BMB):

| **SITE LOCATION** *(contains data on the site and local administration that cover the urban green space)* | |
|---|---|
| a. Region | |
| b. Province | |
| c. City/Municipality | |
| d. Barangay | |
| e. Street | |

| **AREA COVERAGE** *(contains data on the land occupied by the green space expressed in square meters. This category identifies the actual uses and activities in the area. It also enumerates the ancillary services provided to the visitors) (in hectares)* | |
|---|---|
| a. Total area | |
| b. Area planted | |
| c. Other functional uses, please specify | |
| d. Urban Green Space Facility | |
| e. Ancillary Services | |
| f. Pavements/ Walk Trail Facility | |
| g. Urban Green Space Uses and Activities | |

| **LAND USE CLASSIFICATION** *(This describes the land uses presents in the green space areas such as residential, commercial, industrial and institutional)* | |
|---|---|
| a. Residential<br>– R1 (Low Density)<br>– R2 (Medium Density)<br>– R3 (High Density) | |
| b. Commercial | |
| c. Industrial | |
| d. Institutional<br>– Hospital<br>– School<br>– Office<br>– Government Installation (police precinct, military camp, fire department) | |

| **VEGETATION/FLORA STRUCTURE** (this contains data and information on the kinds of flora species found and the levels of species richness and diversity) | |
|---|---|
| Total vegetative cover (in hectares) | |
| Total number of trees<br>Endemic<br>Native/Indigenous<br>Exotic | |
| Other vegetation<br>Endemic<br>Native/Indigenous<br>Exotic | |

| **FAUNA STRUCTURE** *(this contains data and information on the kinds of fauna species found and the levels of species richness and diversity)* | |
|---|---|
| a. Type of fauna species (list down)<br>- Endemic<br>- Native/Indigenous<br>- Exotic | |
| b. Total number of fauna species<br>- Endemic<br>- Native/Indigenous<br>- Exotic | |

***Step 7.*** *Charting and Spatial mapping of the urban biodiversity*

Maps are important tools that form part of any planning exercise. With the aid of photo-interpretation/analysis of the available satellite imagery this inventory and

assessment will use the Geographic Information System (GIS) technology to classify and identify the extent of existing vegetative cover as well as other objective and purpose of the green space. Data gathered from this process will be used as a guide maps for ground validation, actual inventory and assessment of the urban area.

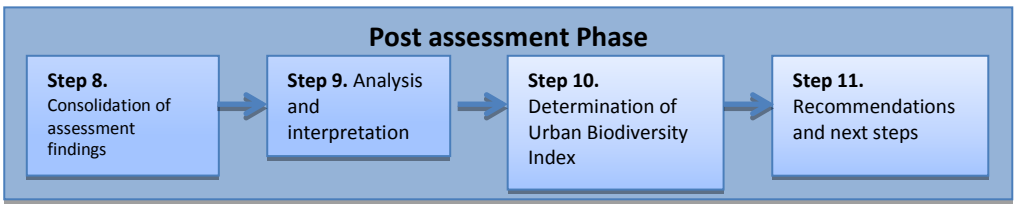
A Global Positioning System (GPS) device should be used on the ground to validate and acquire the coordinates of each site and its boundaries. In order to construct GIS generated maps, data gathered from the site will be processed, analyzed and laid out using the available GIS software.

To further enhance the assessment of the green space area, the geo-tagging technology shall be applied. Each of the inventoried and assessed sites should be photo-tagged using the handheld GPS unit with camera, android tablets, smart cellular phone and/or camera with GPS-feature.

Geo-tagging will be used for gathering spatial photographs consisting of latitude and longitude coordinates and other location specific information such as altitude, distance and data accuracy where the picture was taken. This tool will further aid in the transparency, accountability, evaluation as well as monitoring of the urban green space area.

To establish baseline information as well as monitoring stations for the LGUs, it is suggested to produce land use maps, thematic maps, and analytical maps of the city, including, the marine and coastal areas, freshwater wetlands such as rivers and lakes, and other conservation areas to visualize existing conditions and resources for appropriate biodiversity planning and management strategies.

### *C. Post Assessment Phase*




***Step 8.*** Consolidation of assessment findings

The findings derived from the process should be consolidated and presented in a biodiversity conservation plan. The plan should include all the outputs of the activities conducted and therefore must include both the quantitative and qualitative findings.

**Step 9.** Analysis and Database Management

Data gathered from the assessments shall be encoded into a database and analyzed for proper management strategies and interventions needed for the area. The results of the assessment will be presented in a Biodiversity Report which is part of the conservation plan to be formulated and implemented by LGU. The Biodiversity Report will sum up the present finding from the assessment. This can also serve as profile on biodiversity initiatives of the LGUs. Further, the results of the assessment may also be included in the biodiversity section of the Ecological Profile (EP) or Comprehensive Land Use Plan (CLUP), website or other relevant platforms of the concerned LGUs.

**Step 10.** Determination of Urban Biodiversity Index

The CBD recommends the use of biodiversity indices applicable to the urban setting and which can be monitored to determine the current biological health of the urban ecosystem. These indices can be localized to be able to better respond to the needs of the community and objectives of management.

The Urban Biodiversity Index has three components: a) Biodiversity in the area; b) Ecosystems services; and c) Governance and management which will provide a clear and accurate understanding of the current biodiversity in a given area. The information/data that will be gathered using the indicators is vital in assessing the area's potential as a part of the hierarchy and network of biodiversity stations to be established to promote connectivity and address issues of fragmentation of ecosystem and habitat loss, in addition to responding to the challenges of resiliency in the urban settlement. ***(See Attachment 2).***

**Step 11.** Recommendations and next steps

The findings and recommendations of the assessment shall provide guidance on the management strategies and interventions needed for the area. Recommendations should be considered by the concerned agencies and LGUs for them to integrate in their decision making process. Results of the biodiversity assessment should be integrated in the CLUP and Zoning Ordinance (ZO) of the city/municipality.

Formulation of conservation plan should be done after the assessment for this will provide a basis for monitoring plan implementation and progress towards the desired future and adjustment of planning strategies and actions as required. The plan should place the management of the area into a relevant

environmental, social and economic planning context. Where possible, planning decisions should be integrated into this broader planning framework.

Further, to monitor the health of the urban biodiversity, the assessment should be done at least every three (3) years or timed with the midterm review of the local development plans and the UBI as indicator of the state of the urban biodiversity.

## ATTACHMENT 1. TOOLS FOR BIODIVERSITY ASSESSMENT

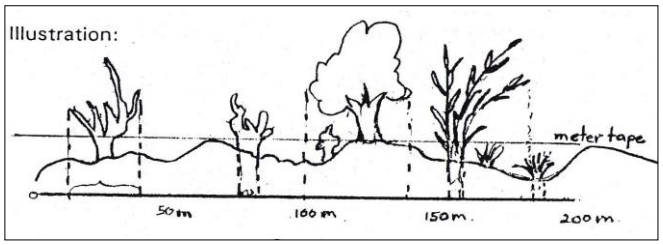
### A. FLORA ASSESSMENT

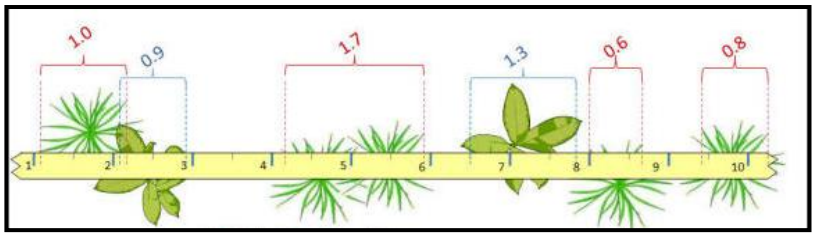
#### 1. LINE INTERCEPT TECHNIQUE

This technique measures cover, abundance and frequency of trees for areas dominated by grasses and other ground cover species.

How to conduct?

- Lay out transect line and Measurement of intercepts. A minimum of four (4) transect lines of desired length should be laid out on the ground and subdivided into 10-15 stations/intervals. Intervals per sampling station shall be established at every 100m of the transect length.




- Assess the cover using the the following formula should be followed:

$$\%\ \text{Species cover} = \frac{\text{Total intercept length of species}}{\text{Length of transect lines}} \times 100$$

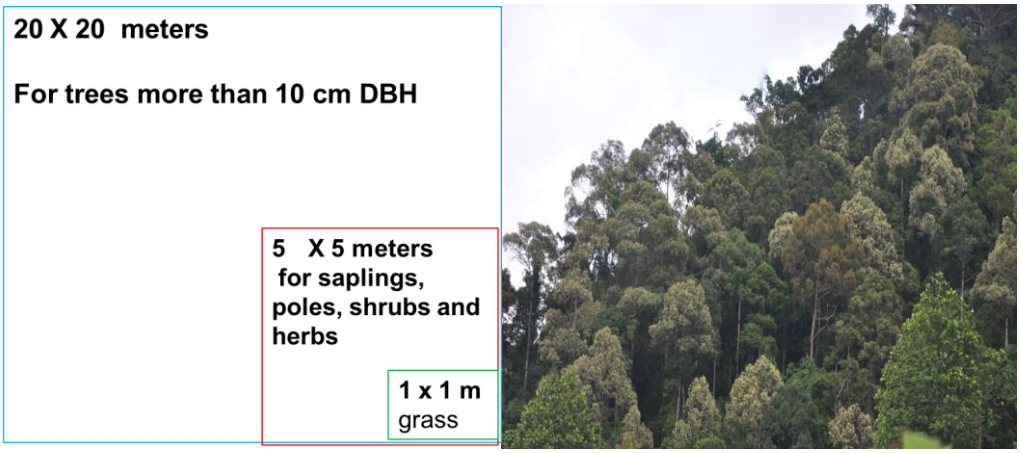
$$\%\ \text{Site cover} = \frac{\text{Total intercept length of all species}}{\text{Length of transect lines}} \times 100$$

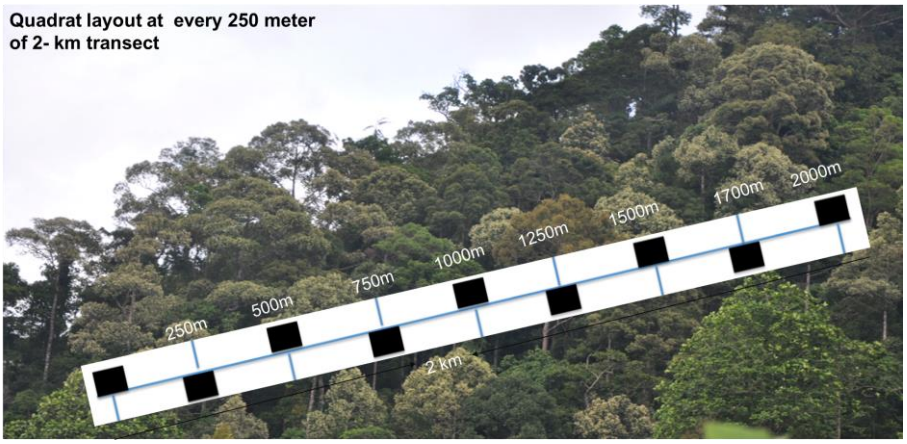
#### 2. QUADRAT METHOD

This is used to define sample area within the study site. The locations of the quadrat chosen should be representative to various vegetation types present within the study area and usually several quadrats are sampled to obtain more representative results. Plant species inside the quadrats are identified, density, frequency and

relative cover estimated. This allows for the computation of the Importance Value Index of species present in the area.

How to conduct?




Flora assessment would require the following for data analysis:

a. Importance values:

Density = Number of individuals / Area sampled

Relative Density = Density for a species x 100 / Total density for all species

Frequency = Number of plots where species occur / Total number of plots sampled

Relative Frequency = species frequency value x 100 / Total frequency for all species

$$\text{Dominance} = \frac{\text{Basal area or volume for a species}}{\text{Area sampled}}$$

$$\text{Dominance} = \frac{\text{Basal area or volume for a species}}{\text{Area sampled}}$$

$$\text{Relative Dominance} = \frac{\text{Species dominance}}{\text{Total dominance for all species}} \times 100$$

Importance Value = Relative Density + Relative Frequency + Relative Dominance

b. Diversity indices:

Species Richness (S) – total number of species in the site

Shannon Index of Diversity (aka Shannon-Weaver or Shannon-Wiener)

$$H' = - \Sigma\, pi * \ln pi$$

Species Evenness Index (J)

$$J = H' / Hmax$$

where $$Hmax = \frac{-\Sigma\, 1}{S} * \frac{\ln 1}{S}$$

Generate diversity indices (Shannon, Simpson's and Evenness index) using biodiversity software (such as MVSP, BioPro, Diversity, etc.)

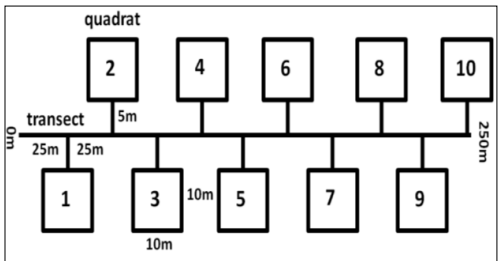
## B. FAUNA ASSESSMENT

For HERPETOFAUNA the following methods are suggested:

### 1. MODIFIED STRIP TRANSECT

How to conduct

- Traverse the transect and search for cryptic species, in potential microhabitats;
- Survey the transect from 7 to 11 in the morning and from 6 to 11 in the evening; and
- Photograph and note the descriptions of their microhabitats and ecological or behavioral observations.



Transect laid across habitat types


Cryptic search for herps

## 2. LIVE-TRAPPING WITH PIT-FALL AND GLUE TRAPS

This technique is used to capture terrestrial amphibians, small lizards and sometimes snakes inhabiting the forest floor. Box traps with appropriate bait is an effective means for trapping small terrestrial mammals unharmed. Pitfall traps (i.e., a container placed below the ground with the opening flush or just below the ground surface) could also be used to trap small mammals (e.g. shrews) when the animals fall through the opening into the container.

How to conduct

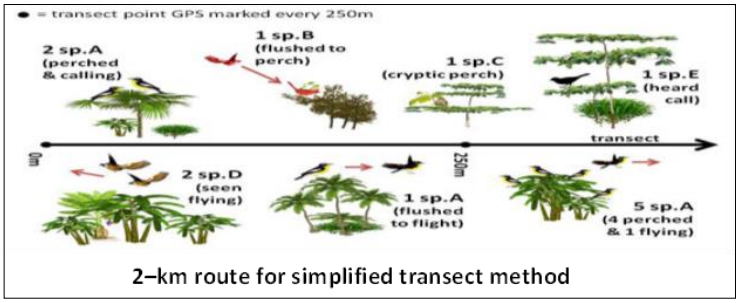
- Lay out pit-fall traps across the length of the designated central strip transect in each sampling site;
- Check the traps in the morning at around 0700 h and every other hour thereafter whenever possible until 1900 h; and
- Check these regularly to limit predation by other wildlife or ensure retrieval of live captures


Pitfall trap (buried) with a drift fence

Field equipment for safe handling of herpetofauna, particularly snakes, burrowing lizards and tadpoles during opportunistic sampling.

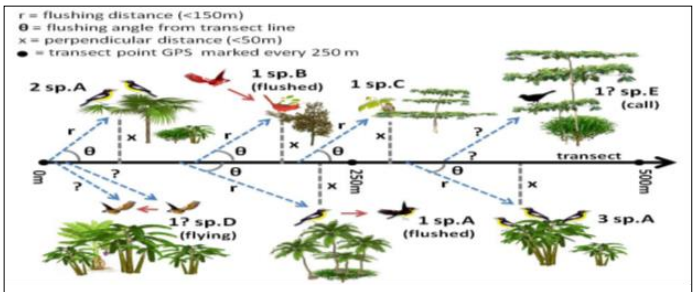
For <u>BIRDS</u> the following methods are suggested:

1. **LINE TRANSECT COUNT**
   a. <u>Simple transect line</u>
      For measuring indices of diversity and relative abundance



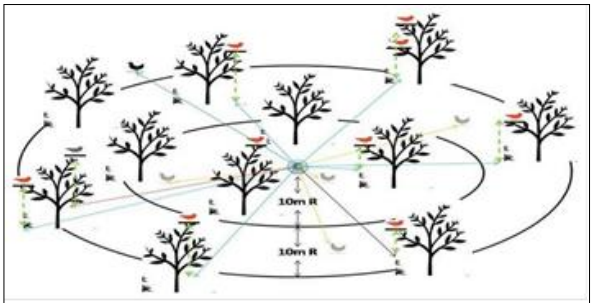
2–km route for simplified transect method

   b. <u>Perpendicular distance methods</u>
      For measuring indices of diversity and species density



2–km route for Perpendicular Distance method

   c. <u>Point counts circular plot (Time area count)</u>
      For measuring indices of diversity and species density



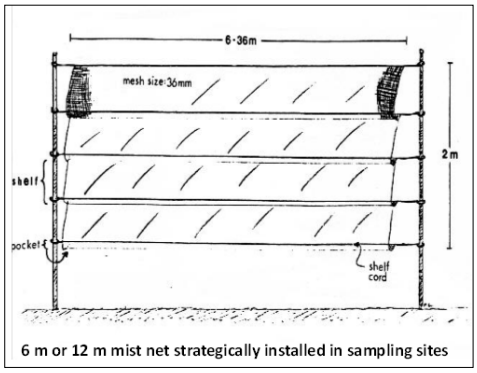
Point count/circular plot at every 250 m of a 2-km route

## 2. MIST NETTING

This is used to capture bats and birds. Nets were placed in travel lanes of bats at dusk and tended constantly. Any captured bats must be removed individually upon entangled and placed in temporary holding devices (e.g. cloth bags). The same is done with birds but only at dawn.

How to conduct

- Check the mist nets periodically for possible netted individuals, ideally every hour from 0530 to 2200 h to avoid mortalities



6 m or 12 m mist net strategically installed in sampling sites

For MAMMALS the following methods are suggested:

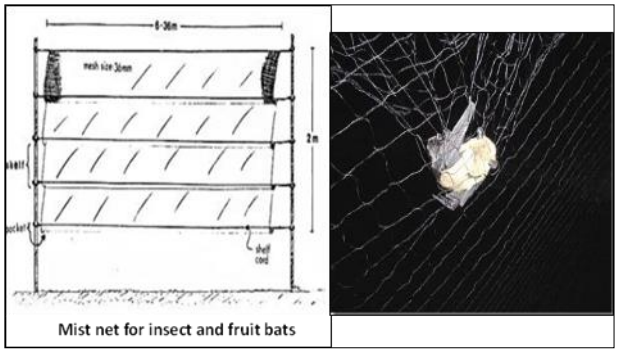
## 1. MIST NETS AND HARP TRAPS (for bats)

This is to capture and record diversity of fruit bats and insectivorous bats.

How to conduct

- Conduct net-watching during the activity peak of insectivorous bats (about 5:30-7:30 pm) and fruit bats up to 10 pm.


Harp trap for insect bats usually in mouth


Mist net for insect and fruit bats

2. **BAIT TRAPS and LIVE/CAGE TRAPS** (for rodents)

This is to record diversity of rodents and other mammals.


Cage trap

Fauna assessment would require the following for data analysis:

**Species Richness (S)** – total number of species in a sampling site

**Relative Abundance (*pi*)**– number of individuals per species against the total number of individuals of all species or number of individuals per km transect

**Density** = $\frac{\text{Number of individuals samples}}{\text{Area sampled}}$

**Trapping success -** the proportion (or percentage) of captures per specie or for all species, can be calculated from the total trap-days or nigh (net or baited traps) accumulated sampling site.

**Shannon Index of Diversity** (aka Shannon-Weaver or Shannon-Wiener)

$H' = -\Sigma [ni/N \ln ni/N]$

**Species Evenness Index (J)**

$J = H' / Hmax$

where $Hmax = - \frac{\Sigma 1}{S} * \frac{\ln 1}{S}$

**Simpson's Dominance Index (c)**

$c = \Sigma(ni/N)2$

## ATTACHMENT 2. SINGAPORE INDEX ON CITIES' BIODIVERSITY

### USER'S MANUAL ON THE SINGAPORE INDEX ON CITIES' BIODIVERSITY
### (also known as the City Biodiversity Index)

## INTRODUCTION

### Cities and Biodiversity

1. A new urbanisation threshold was crossed in 2008 when the World Urbanisation Prospects: The 2007 Revision reported that more than half of the world's population lived in cities. By 2050, the global population is expected to increase to 9.2 billion, of which 6.4 billion will be living in urban areas. As urban populations burgeon, the role that cities play in biodiversity conservation becomes increasingly relevant. Effective land use and management of natural ecosystems in urban areas can be beneficial to both residents and biodiversity that exist within and around the city. Hence, cities must be part of the solution to stem global biodiversity loss.

2. It is commonly assumed that cities, being urban areas, are devoid of flora and fauna – the reality is that many cities have rich biodiversity, regardless of geographical location and climate. Some are even located within or near biodiversity hotspots, while others are important stopover sites for migratory species. The ecosystem services that urban biodiversity provides to the local area are innumerable and often undervalued. Beyond aesthetics, ecosystems regulate the supply and quality of water, air and soil as well as moderating ambient temperatures. Water supply to urban areas frequently comes from catchment areas within or beyond the city boundaries; these catchment areas are sustained by natural ecosystems that store and purify the water. Urban greenery replenishes oxygen, sequesters carbon, absorbs solar radiation, reduces air pollution, maintains water balance and regulates surface temperature in urban landscapes through shading and evapotranspiration. Parks and natural areas provide recreational and educational opportunities to residents and contribute towards the liveability of a city.

### Local Action, Global Reach

3. Cities are coming together to form partnerships, share experiences and seek solutions. In 2006 at the ICLEI - Local Governments for Sustainability (ICLEI) General Assembly in Cape Town, South Africa, more than 300 representatives of ICLEI member cities and local authorities gathered to establish a pilot project on Local Action for Biodiversity (ICLEI-LAB). This was followed by a meeting on "Cities and Biodiversity: Achieving the 2010 Biodiversity Target" hosted by Curitiba, Brazil in March 2007. Here, the Global Partnership on Cities and Biodiversity was initiated to support cities in the sustainable management of their urban biodiversity resources, provide assistance in the implementation of national and international strategies, and serve as a platform for cities to share best practices. It expanded in 2010 and was renamed the Global Partnership on Local and Subnational Action for Biodiversity to include other levels of local and subnational authorities such as the Network of Regional Governments for Sustainable Development (nrg4sd), an international organisation representing some 50 subnational governments from 30 countries. The partnership is facilitated by the Secretariat of the Convention on Biological Diversity (SCBD) and engages other city networks such as the World Mayor's Council on Climate Change, the Biophilic Cities Project, as well as scientific networks on urban biodiversity such as the Urban Biosphere Network (URBIS), and the Urban Biodiversity and Design Network (URBIO).

4. The partnership of cities, local authorities and subnational governments continues to grow from strength to strength, and the global community is acknowledging its contributions to biodiversity conservation. The Conference of Parties (COP) is the governing body of the Convention on Biological Diversity (CBD) and advances the implementation of the Convention through the decisions made at its periodic meetings. At the Ninth Meeting of the COP to the CBD (COP-9) in May 2008 in Bonn, Germany, mayors of the Steering Committee (Bonn, Curitiba, Montreal and Nagoya) then addressed ministers and high ranking officials from Parties at the high-level segment of COP-9 on 29 May 2008; this was the first time cities spoke at the highest level forum of a United Nations (UN) environmental convention. Following the mayors' address at the high-level segment of COP-9, Mr Mah Bow Tan, former Minister for National Development of Singapore, proposed the establishment of an index to measure biodiversity in cities.

5. The adoption of Decision IX/28[1], at COP-9 marked a watershed in efforts to recognise the role of cities and local authorities in stemming global biodiversity loss; the decision encourages national governments to engage cities in the implementation of the CBD. Decision IX/28 provided leverage for cities, subnational governments and local authorities to be more involved in CBD's programme of work on local authorities.

6. 2010 marked the year when the global community assessed progress in achieving the 2010 Biodiversity Target[2]. At the Tenth Meeting of the COP to the CBD (COP-10), Parties adopted Decision X/22 on the Plan of Action on Subnational Governments, Cities and Other Local Authorities for Biodiversity. The Plan of Action supports the implementation of the Strategic Plan for Biodiversity 2011-2020 at the national and local levels by providing recommendations to national governments on how they can engage local authorities and translate national strategies to the local context. It also encourages the use of the City Biodiversity Index (CBI) as a monitoring tool to assist local authorities to evaluate their progress in urban biodiversity conservation, which can be further included in national reports. In recognition of Singapore's leadership and contributions in the development of the Index, the CBI was renamed the Singapore Index on Cities' Biodiversity, or Singapore Index. **Annex A** provides brief information on the Strategic Plan for Biodiversity 2011-2020 and how it will guide global conservation efforts in the next decade.

7. Approximately 6,000 delegates representing national governments, UN agencies, intergovernmental organisations, non-governmental organisations (NGOs), academia, private sector and local authorities gathered again in 2012 in Hyderabad, India to attend the Eleventh Meeting of the COP to the CBD (COP-11). Through Decision XI/8 adopted at COP-11, Parties to the CBD welcomed the report on the implementation of the Plan of

[1] Paragraph 6 of Decision IX/28 reads, "*Invites* Parties to engage their cities and local authorities, where appropriate, in: (a) The application of relevant tools and guidelines developed under the Convention with a view to contributing to the achievement of the three objectives of the Convention and its goals and targets; and (b) The compilation of information on biodiversity status and trends, including communicating to National Governments any commitments and activities that will contribute to the targets of the Convention on Biological Diversity."

[2] In April 2002, the Parties to the Convention committed themselves to achieve by 2010 a significant reduction of the current rate of biodiversity loss at the global, regional and national levels as a contribution to poverty alleviation and to the benefit of all life on Earth. This target was subsequently endorsed by the World Summit on Sustainable Development and the United Nations General Assembly and was incorporated as a new target under the Millennium Development Goals.

Action and further encouraged the Biodiversity Indicators Partnership to use the Singapore Index to monitor the progress of urban settlements in achieving the Aichi Biodiversity Targets. The potential links between individual Aichi Biodiversity Targets and the relevant Singapore Index indicators are highlighted in **Annex B**.

**An Index to Measure Urban Biodiversity**

8. Actions to conserve biodiversity should start with stock-taking and identifying baselines, followed by regular monitoring of conservation initiatives. Prior to the development of the Singapore Index, existing environmental and sustainability indices for cities and local authorities covered broader environmental issues and where biodiversity was considered, it typically formed only a minor component of the composite scores. In addition, indices that focussed specifically on biodiversity were targeted at the national level, which made local application challenging.

9. Following the proposal at the high-level segment of COP-9, the SCBD, in partnership with Singapore and the Global Partnership on Local and Subnational Action for Biodiversity, organised a series of expert workshops in 2009, 2010 and 2011 to develop and refine a biodiversity index for cities. The workshops, attended by technical experts on urban biodiversity and ecology, international organisations and city officials, discussed and identified indicators that would enable cities to monitor and evaluate their urban biodiversity conservation efforts. The discussions and outcomes of the workshops are summarised in **Annex C**.

10. The Singapore Index serves as a self-assessment tool for cities to benchmark and monitor the progress of their biodiversity conservation efforts against their own individual baselines. It comprises two parts: first, the "Profile of the City" provides background information on the city; and second, 23 indicators that measure native biodiversity in the city, ecosystem services provided by biodiversity, and governance and management of biodiversity. Each indicator is assigned a scoring range between zero and four points, with a total possible maximum score of 92 points (see Table 1). Cities will have to conduct a baseline scoring in the first application of Singapore Index. It is recommended that subsequent applications of the Singapore Index take place every three years to allow sufficient time for changes to have taken effect or the results of biodiversity conservation efforts to materialise.

## Table 1: Framework of the Singapore Index on Cities' Biodiversity

**SINGAPORE INDEX ON CITIES' BIODIVERSITY**

**PART I – Profile of the City**

Location and size (geographical coordinates (latitudes and longitudes); climate (temperate or tropical); rainfall/precipitation (range and average); including maps or satellite images where city boundaries are clearly defined)

Physical features of the city (geography, altitude, area of impermeable surfaces, information on brownfield sites, etc.)

Demographics (including total population and population density; the population of the region could also be included if appropriate, and for the purpose of placing it in the regional context)

Economic parameters (Gross Domestic Product (GDP), Gross National Product (GNP), per capita income, key economic activities, drivers and pressures on biodiversity)

Biodiversity features (ecosystems within the city, species within the city, quantitative data on populations of key species of local importance, relevant qualitative biodiversity data)

Administration of biodiversity (relevant information includes agencies and departments responsible for biodiversity; how natural areas are protected (through national parks, nature reserves, forest reserves, secured areas, parks, etc.)

Links to relevant websites including the city's website, environmental or biodiversity themed websites, websites of agencies responsible for managing biodiversity

**PART II - Indicators**

| Core Components | Indicators | Maximum Score |
|---|---|---|
| **Native Biodiversity in the City** | 1. Proportion of Natural Areas in the City | 4 points |
| | 2. Connectivity Measures | 4 points |
| | 3. Native Biodiversity in Built Up Areas (Bird Species) | 4 points |
| | 4. Change in Number of Vascular Plant Species | 4 points |
| | 5. Change in Number of Bird Species | 4 points |
| | 6. Change in Number of Butterfly Species | 4 points |
| | 7. Change in Number of Species (any other taxonomic group selected by the city) | 4 points |
| | 8. Change in Number of Species (any other taxonomic group selected by the city) | 4 points |
| | 9. Proportion of Protected Natural Areas | 4 points |
| | 10. Proportion of Invasive Alien Species | 4 points |
| **Ecosystem Services provided by Biodiversity** | 11. Regulation of Quantity of Water | 4 points |
| | 12. Climate Regulation: Carbon Storage and Cooling Effect of Vegetation | 4 points |
| | 13. Recreation and Education: Area of Parks with Natural Areas | 4 points |
| | 14. Recreation and Education: Number of Formal Education Visits per Child Below 16 Years to Parks with Natural Areas per Year | 4 points |
| **Governance and Management of Biodiversity** | 15. Budget Allocated to Biodiversity | 4 points |
| | 16. Number of Biodiversity Projects Implemented by the City Annually | 4 points |
| | 17. Existence of Local Biodiversity Strategy and Action Plan | 4 points |
| | 18. Institutional Capacity: Number of Biodiversity Related Functions | 4 points |
| | 19. Institutional Capacity: Number of City or Local Government Agencies Involved in Inter-agency Co-operation Pertaining to Biodiversity Matters | 4 points |
| | 20. Participation and Partnership: Existence of Formal or Informal Public Consultation Process | 4 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 |
| | 22. Education and Awareness: Is Biodiversity or Nature Awareness Included in the School Curriculum | 4 points |
| | 23. Education and Awareness: Number of Outreach or Public Awareness Events Held in the City per Year | 4 points |
| | **Native Biodiversity in the City (Sub-total for indicators 1-10)** | **40 points** |
| | **Ecosystem Services provided by Biodiversity (Sub-total for indicators 11-14)** | **16 points** |
| | **Governance and Management of Biodiversity (Sub-total for indicators 15-23)** | **36 points** |
| | **Maximum Total:** | **92 points** |

**What the Singapore Index can do for Biodiversity Planning in your City**

11. The Singapore Index is a pioneering self-assessment tool designed to help cities better understand how they can improve their biodiversity conservation efforts over time. It is not a tool for comparing and contrasting the performance of different cities, as context is core to performance, nor is it a tool to be used only once. Cities should make an initial baseline measurement; identify policy priorities based on their measurements and then monitor again at periodic intervals.

12. The Singapore Index helps cities to accomplish their biodiversity goals via three interrelated mechanisms, which are vital to positive policy outcomes. First, the Index is a tool that allows cities to create baseline measurements of their current biodiversity profiles and then monitor and assess these over time. Secondly, it serves as a public platform upon which biodiversity awareness raising exercises can be launched. Finally, the Index acts as portal among various departments within city governance, academics, NGOs and the public, encouraging better communication, stronger networks and more co-operation, through data collection and sharing of mutual goals, which ultimately results in better policy outcomes. Indicators can serve as important policy tools in the measurement of economic, social and environmental variables.

13. The Singapore Index encourages cities to complete a baseline assessment of their biodiversity and then monitor this over time. As a tool this provides cities with valuable information that they might not otherwise have and can aid in the decision-making process as it helps to identify strengths, weaknesses and trends over time. Brussels has found the Singapore Index to be useful in identifying gaps in the local biodiversity management strategies, and it has led to an improvement in the data collection system.

> *"For the last 20 years, we (Brussels) have been looking at biodiversity, so we had a lot of data on that. But it showed we lacked precise data on how many programmes and visits to nature areas that we have, which is part of the ecosystem services component."* —Ms. Machteld Gryseels, Director of Brussels Environment Division.

14. The Singapore Index also serves as a valuable method of awareness raising allowing cities to mobilise their citizenry in efforts to protect and enhance locally important populations of species and ecosystems. Scientific evidence (for example, Danielsen et al. 2010, Environmental monitoring: the scale and speed of implementation varies according to the degree of people's involvement) indicates that where local people are involved in monitoring and data collection, better policy outcomes are often the case. The Index provides opportunities for citizen and city collaboration and potential media exposure which can help cities create momentum behind biodiversity conservation efforts. In a study conducted by *Corporate Knights*[3] on good sustainable development practices in Canadian cities, Edmonton and Montreal scored a perfect score for their biodiversity monitoring efforts, attributing their performance to the use of the Singapore Index.

[3] *Corporate Knights* is a quarterly Canadian magazine dedicated towards advocating responsible business practices within Canada and promoting sustainable development globally.

15. The Singapore Index has also been instrumental in helping local, national and regional government departments to exchange information and ideas on measuring biodiversity. This creates a new network of policy actors around the issue of biodiversity and further embeds the idea into policy discourse. There has been growing participation of NGOs, universities and consultancy firms and this has benefited biodiversity policy in the cities that applied the Index by presenting new policy opportunities that might not have readily existed without the synergies created by the networks involved in data collection. For example, in Lisbon, Portugal, the application of the Singapore Index led to the development of a Local Biodiversity Strategy and Action Plan. It has also been creatively used in Singapore by city planners in the master planning of new districts and the Building and Construction Authority in their Green Mark for Districts scheme. Here the Index helped to create new networks of actors who came together to formulate policies that would not have been possible otherwise.

16. We would therefore encourage you apply the Singapore Index to your city – capture your baseline data; promote biodiversity actions and create new policy networks that will further your conservation and enhancement efforts. If you need further information or clarifications regarding the application of the Singapore Index, please contact Singapore_Index@nparks.gov.sg.

## THE SINGAPORE INDEX ON CITIES' BIODIVERSITY
## PART I: PROFILE OF THE CITY

17. As the Singapore Index focuses on only a few parameters, it is important that other information not captured in the Index be provided so as to give a more holistic picture of the native biodiversity that can be found in the city[4]. The profile of the city will include important general information on the city, and in particular, details of the biodiversity found within, in order to set the background of the city and to place the city's evaluation for the Index in the proper perspective. The data and information including images of native flora, fauna and ecosystems in cities should be included in this section which will be used for the computation of the indicators. The information could include (but need not be limited to) the following:

(i) Location (geographical coordinates (latitudes and longitudes); climate (temperate or tropical); temperature (range and average); rainfall/ precipitation (range and average); other relevant information)

(ii) Size (land area, illustrated with Google maps or satellite images with clearly defined city boundaries; number of administrative units within the city or local authorities)

(iii) Population (including total population and population density of the city; the population of the region could also be included if appropriate, for the purpose of placing it in the regional context)

(iv) Economic parameters (Gross Domestic Product (GDP), Gross National Product (GNP), per capita income, key economic activities, economic drivers and pressures on biodiversity)

(v) Physical features of the city (geography, altitude of the city, area of impermeable surface, information on brownfield sites, etc.)

(vi) Biodiversity features and characteristics such as:

- Ecosystems found in the city
  - Mandatory: Cities should list ecosystems present within the city when they first apply the Index. The IUCN Habitat Authority File (http://intranet.iucn.org/webfiles/doc/SSC/RedList/AuthorityF/habitats.rtf) can be used as the reference list for cities to select the ecosystems that occur within their city boundaries.
  - Optional: Maps which show the location of ecosystems, if available.

- Species found in the city (data will be used for the calculation of indicators 3, 4, 5, 6, 7, 8 and 10)

[4] Annex E provides a proposed format for submission of city profiles and subsequent calculations/references used in the application of the Index.

- Mandatory species: Number of species of vascular plants, birds, butterflies and two other taxonomic groups of the city's choice. The data from the first year of participating in the Index will form the baseline for future monitoring.
- Optional species: Cities can also list the total number of species for other taxonomic groups if they have the data. This would give a more complete picture of the species diversity in the cities.

- Quantitative data on populations of key species of local importance. These include quantitative data on major taxonomic groups which are used to determine the conservation status of the species.

- Relevant qualitative biodiversity data. These include write-ups on the natural history of the cities, ecological rehabilitation and restoration initiatives, special biodiversity features, re-introduction of native species, etc.

(vii) Administration of biodiversity (relevant information may include a list of agencies and departments responsible for biodiversity; how natural areas are protected (through national parks, nature reserves, forest reserves, secured areas, parks, etc.) with information such as what categories of natural areas there are in your city, where the protected areas are located, what is the size of the protected areas, what are the aims of conserving these areas and functions of these areas etc.)

(viii) Links to relevant websites including the city's website, environmental or biodiversity specific websites and websites of agencies responsible for biodiversity.

## PART II: INDICATORS OF THE SINGAPORE INDEX ON CITIES' BIODIVERSITY

| CBI | INDICATORS | VARIABLES | SCORE |
|---|---|---|---|
| Native Biodiversity | **INDICATOR 1: PROPORTION OF NATURAL AREAS IN THE CITY** | | |
| | RATIONALE FOR SELECTION OF INDICATOR<br><br>Natural ecosystems harbour more species than disturbed or man-made landscapes, hence, the higher the percentage of natural areas compared to that of the total city area gives an indication of the amount of biodiversity there. However, a city by definition has a high proportion of modified land area and this is factored into the scoring.<br><br>Taking into account the inherent differences in the richness in biodiversity of tropical versus temperate regions, new versus mature cities, large versus small cities, developing versus developed countries, it was agreed at the Third Expert Workshop on the Development of the City Biodiversity Index that the working definition of "natural areas" is as follows:<br><br>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.<br><br>Natural ecosystems are defined as all areas that are natural and not highly disturbed or completely man-made landscapes. Some examples of natural ecosystems are forests, mangroves, freshwater swamps, natural grasslands, streams, lakes, etc. Parks, golf courses, roadside plantings are not considered as natural. However, natural ecosystems within parks where native species are dominant can be included in the computation.<br><br>The definition also takes into consideration "restored ecosystems" and "naturalised areas" in order to recognise efforts made by cities to increase the natural areas of their city. Restoration helps increase natural areas in the city and cities are encouraged to restore their impacted ecosystems. | HOW TO CALCULATE INDICATOR<br><br>(Total area of natural, restored and naturalised areas) ÷ (Total area of city) × 100%<br><br>WHERE TO GET DATA FOR CALCULATIONS<br><br>Possible sources of data on natural areas include government agencies in charge of biodiversity, city municipalities, urban planning agencies, biodiversity centres, nature groups, universities, publications, etc. Google maps and satellite images can also provide relevant information for calculating this indicator. | BASIS OF SCORING<br><br>Based on the assumption that, by definition, a city comprises mainly man-made landscapes, the maximum score will be accorded to cities with natural areas occupying more than 20% of the total city area.<br><br>0 points: < 1.0%<br>1 point: 1.0% – 6.9%<br>2 points: 7.0% – 13.9%<br>3 points: 14.0% – 20.0%<br>4 points: > 20.0% |

| CBI | INDICATORS | VARIABLES | SCORE |
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| Native Biodiversity | **INDICATOR 2: CONNECTIVITY MEASURES OR ECOLOGICAL NETWORKS TO COUNTER FRAGMENTATION** | | |
| | RATIONALE FOR SELECTION OF INDICATOR<br><br>Fragmentation of natural areas is one of the main threats to the sustainability of biodiversity in a city. Hence, it has been selected as an indicator to chart possible future trends. However, it is not easy to measure fragmentation. Some of the ways to measure fragmentation include mean patch size or distance between patches or effective mesh size, etc.<br><br>It is recognised that the fragmentation of natural areas affects different species differently. For example, a road may not be a barrier for birds but it can seriously fragment a population of arboreal primates. A strip of urbanisation may not affect the dispersal of wind-pollinated plants but a plant that depends on small mammals for dispersal will be adversely affected. While these differences have been considered, a pragmatic approach towards the calculation of this indicator is adopted, as reflected in the formula used here. Furthermore, to encourage positive actions to increase connectivity or reduce barriers to connectivity, it would be more meaningful to measure connectivity rather than fragmented plots.<br><br>This indicator score can be improved when more of the fragments are connected. | HOW TO CALCULATE INDICATOR<br><br>$Indicator\ 2 = \frac{1}{A_{total}}\left(A_1^2 + A_2^2 + A_3^2 + ... + A_n^2\right)$<br><br>Where:<br>• $A_{total}$ is the total area of all natural areas<br>• $A_1$ to $A_n$ are areas that are distinct from each other (i.e. more than or equal to 100m apart)<br>• $n$ is the total number of connected natural areas<br><br>This measures effective mesh size of the natural areas in the city. $A_1$ to $A_n$ 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.<br><br>However, exceptions to the above rule includes anthropogenic barriers such as:<br>• Roads (15m or more in width; or are smaller but have a high traffic volume of more than 5000 cars per day)<br>• Rivers that are highly modified and other artificial barriers such as heavily concretised canals and heavily built up areas<br>• Any other artificial structures that the city would consider as a barrier<br><br>Details and illustrations of how this indicator may be calculated are included in **Annex D**.<br><br>WHERE TO GET DATA FOR CALCULATIONS<br><br>Satellite images can be used in the computation of this indicator. | BASIS OF SCORING<br><br>The effective mesh size is an expression of the probability that two points randomly chosen within the natural areas of a city are in the same patch or are considered connected (< 100m between the patches with no major barrier between). It can also be interpreted as the ability of two animals of the same species placed randomly in the natural areas to find each other. The more barriers in the landscape, the lower the probability that the two locations will be connected, and the lower the effective mesh size. Therefore, larger values of the effective mesh sizes indicate higher connectivity.<br><br>0 points: < 200 ha<br>1 point: 201 - 500 ha<br>2 points: 501 - 1000 ha<br>3 points: 1001 - 1500 ha<br>4 points: > 1500 ha |

| CBI | INDICATORS | VARIABLES | SCORE |
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| Native Biodiversity | **INDICATOR 3: NATIVE BIODIVERSITY IN BUILT UP AREAS (BIRD SPECIES)** | | |
| | RATIONALE FOR SELECTION OF INDICATOR<br>It is acknowledged that cities comprise largely of built up areas and brownfield sites with anthropogenic green spaces and minimal natural features. However, it should be recognised that built up areas and brownfield sites do harbour biodiversity, e.g., birds, like swallows and swiftlets, nest under roofs of buildings; plants grow on buildings; butterflies rely on shrubs and grassy patches for food, dragonflies breed in water features, etc. Some built up areas and brownfield sites have more biodiversity than others. By enhancing certain features in such areas, the biodiversity could be improved. Hence, native biodiversity in built up areas and brownfield sites should be an indicator.<br><br>Most cities have data on bird species, hence, this taxonomic group will be used as an indicator. The number of native bird species in built up areas and anthropogenic green spaces is inevitably lower than that found in sites with natural ecosystems; however implementing appropriate measures such as planting fruit trees, shrubs with berries, etc. may attract birds into built up areas of the city. | HOW TO CALCULATE INDICATOR<br>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.<br><br>WHERE TO GET DATA FOR CALCULATIONS<br>City councils, universities, NGOs, etc. | BASIS OF SCORING<br>The number of bird species in built up areas and anthropogenic greenery and green spaces is inevitably lower than that found in sites with natural ecosystems.<br><br>0 points: < 19 bird species<br>1 point: 19 - 27 bird species<br>2 points: 28 - 46 bird species<br>3 points: 47 - 68 bird species<br>4 points: > 68 bird species |

| CBI | INDICATORS | VARIABLES | SCORE |
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| Native Biodiversity | **INDICATORS 4 - 8: CHANGE IN NUMBER OF NATIVE SPECIES** | | |
| | RATIONALE FOR SELECTION OF INDICATOR<br>As this is an Index focussing on biodiversity in cities, it is essential that the native flora and fauna diversity be incorporated as indicators.<br><br>Three key taxonomic groups that are most surveyed worldwide, i.e., plants, birds and butterflies, have been selected as "core indicators". To ensure fairness and objectivity in the Index, cities can select two other taxonomic groups that would reflect their best biodiversity.<br><br>To ensure that these five indicators on species are unbiased against any city based on its geographical location, ecological history, size, land use, etc., it was decided that<br>• All cities and local authorities are requested to list the number of native species of a) vascular plants, b) birds, c) butterflies, d) at least two other taxonomic groups, and e) any other taxonomic groups that they have data, in Part I: Profile of the City<br>• The indicators will measure the change in number of species over time rather than the absolute number of species<br>• The first year of application will be taken as the baseline year for the species count. The net change in species numbers (increase in number of species due to re-introduction or restoration efforts minus the number of species that went extinct) will be incorporated in the subsequent calculations of the Singapore Index.<br><br>Conducting more surveys on the target groups (to document new species or rediscoveries) and reintroducing locally extinct native species would help to increase the number of extant native species. | HOW TO CALCULATE INDICATORS<br>The change in number of native species is used for indicators 4 to 8. The three core groups are:<br>• Indicator 4 : vascular plants<br>• Indicator 5 : birds<br>• Indicator 6 : butterflies<br>These groups have been selected as data are most easily available and to enable some common comparison.<br><br>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.)<br><br>The above data from the first application of the Singapore Index would be recorded in Part I: Profile of the City as the baseline.<br><br>Net change in species from the previous survey to the most recent survey is calculated as:<br>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.<br><br>WHERE TO GET DATA FOR CALCULATIONS<br>Possible sources of data include government agencies in charge of biodiversity, city municipalities, urban planning agencies, biodiversity centres, nature groups, universities, publications, etc. | BASIS OF SCORING<br>Data listed in Part I: Profile of the City will be used to measure change in species diversity. Cities' first application will be considered as the baseline information for all subsequent monitoring. In their subsequent applications of the Index, cities will calculate the net change in species for the respective taxonomic groups.<br><br>The scoring range below is based on the acceptance that it is not easy to recover or re-introduce species successfully over a short period of time. However, species recovery, re-introduction and restoration efforts must be given due recognition.<br><br>0 points: maintaining or a decrease in the number of species<br>1 point: 1 species increase<br>2 points: 2 species increase<br>3 points: 3 species increase<br>4 points: 4 species or more increase |

| CBI | INDICATORS | VARIABLES | SCORE |
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| Native Biodiversity | **INDICATOR 9: PROPORTION OF PROTECTED NATURAL AREAS** | | |
| | RATIONALE FOR SELECTION OF INDICATOR<br><br>Protected or secured natural areas indicate the city's commitment to biodiversity conservation. Hence, the proportion of protected or secured natural areas is an important indicator.<br><br>The definition of protected natural areas should be broadened to include legally protected, formally secured areas, and other administratively protected areas, as different cities have different terminologies and means for protecting their natural areas. | HOW TO CALCULATE INDICATOR<br><br>(Area of protected or secured natural areas) ÷ (Total area of the city) × 100%<br><br>WHERE TO GET DATA FOR CALCULATIONS<br><br>Possible sources of data include government agencies in charge of biodiversity, city municipalities, urban planning agencies, biodiversity centres, nature groups, universities, publications, etc. | BASIS OF SCORING<br><br>The following points are awarded for the respective proportions of protected natural areas in the city:<br><br>0 points: < 1.4%<br>1 point: 1.4% - 7.3%<br>2 points: 7.4% - 11.1%<br>3 points: 11.2% - 19.4%<br>4 points: > 19.4% |

| CBI | INDICATORS | VARIABLES | SCORE |
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| Native Biodiversity | **INDICATOR 10: PROPORTION OF INVASIVE ALIEN SPECIES** | | |
| | RATIONALE FOR SELECTION OF INDICATOR<br><br>Invasive alien species out-compete native species and, thus, threaten the survival of native species and the integrity of ecosystems. As cities are very open to influx of alien species, this indicator measures the status of this threat.<br><br>The definition of alien invasive species adopted follows that accepted by the SCBD, i.e.:<br>An alien species whose introduction and/or spread threatens biological diversity (For the purposes of the present guiding principles, the term "invasive alien species" shall be deemed the same as "alien invasive species" in Decision V/8 of the Conference of the Parties to the Convention on Biological Diversity).<br><br>It is inevitable for cities, which are open to external influences, to have alien species. Alien species which are not invasive or detrimental to native species are not considered in this indicator. In fact exotic or alien species enhance the diversity in many cities.<br><br>Cities can decide on the taxonomic groups which are most problematic for their city or where most data are available. | HOW TO CALCULATE INDICATOR<br><br>To ensure that the comparison of invasive alien species with that of native species is meaningful, it would have to be a comparison of identical taxonomic groups.<br><br>(Number of invasive alien species) ÷ (Total number of species) × 100%<br><br>WHERE TO GET DATA FOR CALCULATIONS<br><br>Possible sources of data include government agencies in charge of biodiversity, city municipalities, urban planning agencies, biodiversity centres, nature groups, universities, publications, etc. | BASIS OF SCORING<br><br>The scoring range is based on the premise that the more invasive alien species that are in the city; the more destructive impact will be to the native species.<br><br>0 points: > 30.0%<br>1 point: 20.1% - 30.0%<br>2 points: 11.1% - 20.0%<br>3 points: 1.0% - 11.0%<br>4 points: < 1.0% |

| CBI | INDICATORS | VARIABLES | SCORE |
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| Ecosystem Services | **INDICATOR 11: REGULATION OF QUANTITY OF WATER** | | |
| | RATIONALE FOR SELECTION OF INDICATOR<br>Climate change is in many places predicted to result in increased variability in precipitation which in urban landscapes may translate into high peaks in water flow and damage to construction, business and transport. Vegetation has a significant effect in reducing the rate of flow of water through the urban landscape, e.g. through presence of forest, parks, lawns, roadside greenery, streams, rivers, waterbodies, etc. | HOW TO CALCULATE INDICATOR<br>Proportion of all permeable areas (including areas identified in indicator 1 plus other parks, roadside, etc. but excluding artificial permeable surfaces*, if applicable) to total terrestrial area of city (excluding marine areas under the city's jurisdiction).<br><br>(Total permeable area) ÷ (Total terrestrial area of the city) x 100%<br><br>WHERE TO GET DATA FOR CALCULATIONS<br>Possible sources of data include government environmental agencies, city municipalities, urban planning, water and land agencies, satellite images, etc.<br><br>*See http://en.wikipedia.org/wiki/Permeable_paving | BASIS OF SCORING<br>The following points are awarded for the respective proportions of permeable areas in the city:<br><br>0 points: < 33.1%<br>1 point: 33.1% - 39.7%<br>2 points: 39.8% - 64.2%<br>3 points: 64.3% - 75.0%<br>4 points: > 75.0% |

| CBI | INDICATORS | VARIABLES | SCORE |
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| Ecosystem Services | **INDICATOR 12: CLIMATE REGULATION: CARBON STORAGE AND COOLING EFFECT OF VEGETATION** | | |
| | RATIONALE FOR SELECTION OF INDICATOR<br>Two important aspects of climate regulation services are carbon storage and cooling effects provided by vegetation, in particular tree canopy cover. Climate regulation services are affected by many factors, including the size of trees, the different characteristics of tree species, and other variables.<br><br>With regards to carbon storage, plants capture carbon dioxide during photosynthesis, hence, capturing carbon that is emitted by anthropogenic activities. Canopy cover of trees, which includes those that are naturally occurring and planted in a city, is accepted here as an indirect measure of the carbon sequestration and storage services.<br><br>Plants, through shading, evapotranspiration, and decreasing the proportion of reflective surfaces, reduce the ambient heat in the air and the surface temperature in the urban landscape. As a general rule, a 10% increase in vegetation cover reduces the temperature by about three degrees.<br><br>The extent of tree canopy cover can also act as a proxy measure for filtering of air and numerous other biodiversity benefits. Planting of native trees to increase the canopy cover is encouraged.<br><br>This indicator is optional for cities in the desert or arid zones or other ecological zones where extensive canopy cover in the city may not be feasible. | HOW TO CALCULATE INDICATOR<br>Carbon storage and cooling effect of vegetation<br><br>(Tree canopy cover) ÷ (Total terrestrial area of the city) x 100%<br><br>WHERE TO GET DATA FOR CALCULATIONS<br>City councils and satellite images. | BASIS OF SCORING<br>The more trees there are in a city, the higher would be the carbon stock of ecosystem services value provided. Tree canopy cover is being used here as a proxy measurement of the number of trees in a city.<br><br>The following points are awarded for the respective proportions of canopy cover within the city:<br><br>0 points: < 10.5%<br>1 point: 10.5% - 19.1%<br>2 points: 19.2% - 29.0%<br>3 points: 29.1% - 59.7%<br>4 points: > 59.7% |

| CBI | INDICATORS | VARIABLES | SCORE |
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| Ecosystem Services | **INDICATORS 13 –14: RECREATIONAL AND EDUCATIONAL SERVICES** | | |
| | RATIONALE FOR SELECTION OF INDICATOR<br><br>Biodiversity provides invaluable recreational, spiritual, cultural and educational services. It is essential for physical and psychological health. | HOW TO CALCULATE INDICATOR<br><br>**Indicator 13:**<br>(Area of parks with natural areas and protected or secured natural areas)*/1000 persons<br><br>*Some cities refer to this as accessible green spaces<br><br>**Indicator 14:**<br>Average number of formal educational visits per child below 16 years to parks with natural areas or protected or secured natural areas per year<br><br>WHERE TO GET DATA FOR CALCULATIONS<br><br>Indicator 13: City councils<br><br>Indicator 14: School records | BASIS OF SCORING<br><br>**Indicator 13:**<br>0 points: < 0.1 ha/1000 persons<br>1 point: 0.1 - 0.3 ha/1000 persons<br>2 points: 0.4 - 0.6 ha/1000 persons<br>3 points: 0.7 - 0.9 ha/1000 persons<br>4 points: > 0.9 ha/1000 persons<br><br>**Indicator 14:**<br>0 points: 0 formal educational visit/year<br>1 point: 1 formal educational visit/year<br>2 points: 2 formal educational visits/year<br>3 points: 3 formal educational visits/year<br>4 points: > 3 formal educational visits/year |

| CBI | INDICATORS | VARIABLES | SCORE |
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| Governance and Management | **INDICATOR 15: BUDGET ALLOCATED TO BIODIVERSITY** | | |
| | RATIONALE FOR SELECTION OF INDICATOR<br><br>This indicator evaluates the financial commitment of city governments towards the maintenance and enhancement of biodiversity.<br><br>The relative amount spent on biodiversity related administration by a city can be seen as a representation of the city's commitment towards environmental stewardship. It is recognised that there are numerous other factors affecting the amount allocated towards biodiversity, but in general the greater the proportion of the total city's budget allocated, the greater the level of commitment by the city.<br><br>In cities where the functions of maintaining greenery and biodiversity conservation are also assigned to the private sector or government linked corporations, the budget for these government linked companies or the amount of government funds paid to the private sector may also be included in the calculations. | HOW TO CALCULATE INDICATOR<br><br>(Amount spent on biodiversity related administration) ÷ (Total budget of city) × 100%<br><br>Computation should include the city's or municipality's manpower budget as well as its operational and biodiversity related project expenditures. The calculation may also include the figures of government linked corporations that have a component spent on biodiversity, and the amount of government funds paid to private companies for biodiversity related administration where such figures are available.<br><br>WHERE TO GET DATA FOR CALCULATIONS<br><br>Possible sources of data include government agencies responsible for biodiversity conservation and finance departments. For cities where the budgets of government linked companies are included, annual reports of those companies can provide relevant data. | BASIS OF SCORING<br><br>The following points are awarded for the respective proportions of the city budget allocated to biodiversity:<br><br>0 points: < 0.4%<br>1 point: 0.4% - 2.2%<br>2 points: 2.3% - 2.7%<br>3 points: 2.8% - 3.7%<br>4 points: > 3.7% |

| CBI | INDICATORS | VARIABLES | SCORE |
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| Governance and Management | **INDICATOR 16: NUMBER OF BIODIVERSITY PROJECTS IMPLEMENTED BY THE CITY ANNUALLY** | | |
| | RATIONALE FOR SELECTION OF INDICATOR<br>This indicator measures the number of biodiversity related projects and programmes that the city authorities are involved in, either as the main player or in partnerships with other entities where the city is a key collaborator.<br><br>Programmes and projects are not limited to the conservation of protected areas but could include those pertaining to species conservation (e.g. plants, birds and butterflies), species recovery, biodiversity surveys, biodiversity enhancement projects, restoration projects, procurement of green services, etc.<br><br>For a project or a programme to be included in this indicator, biodiversity must be an important consideration in the stated objectives.<br><br>A programme designed to conserve species that are non-native to the city, but threatened elsewhere (e.g. zoo species conservation projects) can be considered as well. | HOW TO CALCULATE INDICATOR<br>Number of programmes and projects that are being implemented by the city authorities, possibly in partnership with private sector, NGOs, etc. per year.<br><br>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:<br>1. Biodiversity related<br>2. Ecosystems services related<br><br>WHERE TO GET DATA FOR CALCULATIONS<br>Possible sources of data include city authorities, private corporations and NGOs that conduct such activities, etc. | BASIS OF SCORING<br>The following points are awarded for the respective numbers of biodiversity related programmes or projects in the city:<br><br>0 points: < 12 programmes/projects<br>1 point: 12 - 21 programmes/projects<br>2 points: 22 - 39 programmes/projects<br>3 points: 40 - 71 programmes/projects<br>4 points: > 71 programmes/projects |

| CBI | INDICATORS | VARIABLES | SCORE |
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| Governance and Management | **INDICATOR 17: POLICIES, RULES AND REGULATIONS – EXISTENCE OF LOCAL BIODIVERSITY STRATEGY AND ACTION PLAN** | | |
| | RATIONALE FOR SELECTION OF INDICATOR<br>To ensure that there is good governance, sound policies must be formulated. To facilitate the implementation of biodiversity management policies, rules and regulations must be put in place. This section evaluates the existence of policies, rules and regulations relevant to biodiversity, in particular if they are aligned with the national agenda and CBD's initiatives, like the National Biodiversity Strategy and Action Plan (NBSAP) and/or the correspondent subnational strategies.<br><br>Some of the CBD initiatives include plant conservation, forest biodiversity, global taxonomy initiative, invasive species programme, marine biodiversity conservation, protected areas, etc.<br><br>The initiatives might not be termed "Local Biodiversity Strategy and Action Plan" (LBSAP) as long as the city can justify that a similar plan exists. | HOW TO CALCULATE INDICATOR<br>Status of LBSAP (or any equivalent plan); number of associated CBD initiatives.<br><br>WHERE TO GET DATA FOR CALCULATIONS<br>Possible sources of data include city councils, CBD national focal points, ICLEI-Local Governments for Sustainability LAB Initiative, United Nations University and IUCN or CBD websites and publications. | BASIS OF SCORING<br>To ensure that biodiversity is conserved in a city, it is advisable to formulate and implement an LBSAP (or any equivalent plan). This needs to be aligned with the NBSAP so that biodiversity conservation efforts are synchronised and synergised.<br><br>0 points: No LBSAP*<br>1 point: LBSAP not aligned with NBSAP<br>2 points: LBSAP incorporates elements of NBSAP, but does not include any CBD initiatives**<br>3 points: LBSAP incorporates elements of NBSAP, and includes one to three CBD initiatives<br>4 points: LBSAP incorporates elements of NBSAP, and includes four or more CBD initiatives<br><br>* LBSAP or equivalent.<br>** 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). |

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| Governance and Management | **INDICATORS 18 – 19: INSTITUTIONAL CAPACITY** | | |
| | RATIONALE FOR SELECTION OF INDICATOR<br><br>Institutions are necessary for the effective implementation of projects and programmes. Hence, the existence of biodiversity focussed and biodiversity related institutions will greatly enhance biodiversity conservation in a city.<br><br>Some of the essential institutions include a well managed biodiversity centre, herbarium, zoological garden or museum, botanical garden, insectarium, etc. It is more important to measure whether the functions of these institutions exist rather than the physical existence of these institutions. Hence, if a herbarium is situated in a botanical garden, then two functions exist in the city under one institution.<br><br>Many biodiversity issues are cross-sectoral and, hence, involve inter-agency efforts. The evaluation of inter-agency coordination is an important indicator of the success of biodiversity conservation, more so in a city where it is so compact. This indicator promotes mainstreaming of biodiversity. | HOW TO CALCULATE INDICATOR<br><br>**Indicator 18:**<br>Number of essential biodiversity related functions* that the city uses.<br><br>* The functions could include the following: biodiversity centre, botanical garden, herbarium, zoological garden or museum, insectarium, etc.<br><br>**Indicator 19:**<br>Number of city or local government agencies involved in inter-agency co-operation pertaining to biodiversity matters.<br><br>WHERE TO GET DATA FOR CALCULATIONS<br><br>City councils | BASIS OF SCORING<br><br>**Indicator 18:**<br>0 points: No functions<br>1 point: 1 function<br>2 points: 2 functions<br>3 points: 3 functions<br>4 points: > 3 functions<br><br>**Indicator 19:**<br>0 points: one or two agencies* cooperate on biodiversity matters<br>1 point: three agencies cooperate on biodiversity matters<br>2 points: four agencies cooperate on biodiversity matters<br>3 points: five agencies cooperate on biodiversity matters<br>4 points: More than five agencies cooperate on biodiversity matters<br><br>* Agencies could include departments or authorities responsible for biodiversity, planning, water, transport, development, finance, infrastructure, etc. |

| CBI | INDICATORS | VARIABLES | SCORE |
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| Governance and Management | **INDICATORS 20 – 21: PARTICIPATION AND PARTNERSHIP** | | |
| | RATIONALE FOR SELECTION OF INDICATOR<br><br>Indicator 20 evaluates the existence and the state of formal or informal public consultation process pertaining to biodiversity related matters.<br><br>Indicator 21 measures the extent of informal and/or formal partnerships, or collaboration with other entities. As it is impossible for any single agency to carry out all the activities, responsibilities, projects and programmes that have biodiversity implications, hence, it is inevitable that engagement of all levels of the population must be facilitated. These include the city officials in various departments, other spheres of government, the public, private sector, NGOs, etc.<br><br>Such partnerships should have substantial and long term involvement on the part of the city officials, such as programmes like Payments for Ecosystem Services (PES). | HOW TO CALCULATE INDICATOR<br><br>**Indicator 20:**<br>Existence and state of formal or informal public consultation process pertaining to biodiversity related matters.<br><br>**Indicator 21:**<br>Number of agencies/private companies/NGOs/academic institutions/international organisations with which the city is partnering in biodiversity activities, projects and programmes.<br><br>Instances of inter-agency co-operation listed in IND19 should not be listed here again.<br><br>WHERE TO GET DATA FOR CALCULATIONS<br><br>City councils | BASIS OF SCORING<br><br>**Indicator 20:**<br>0 points: No routine formal or informal process<br>1 point: Formal or informal process being considered as part of the routine process<br>2 points: Formal or informal process being planned as part of the routine process<br>3 points: Formal or informal process in the process of being implemented as part of the routine process<br>4 points: Formal or informal process exists as part of the routine process<br><br>**Indicator 21:**<br>0 points: No formal or informal partnerships<br>1 point: City in partnership with 1-6 other national or subnational agencies/private companies/NGOs/academic institutions/international organisations<br>2 points: City in partnership with 7-12 other national or subnational agencies/private companies/NGOs/academic institutions/international organisations<br>3 points: City in partnership with 13-19 other national or subnational agencies/private companies/NGOs/academic institutions/international organisations<br>4 points: City in partnership with 20 or more other national or subnational agencies/private companies/NGOs/academic institutions/international organisations |

| CBI | INDICATORS | VARIABLES | SCORE |
|---|---|---|---|
| Governance and Management | **INDICATORS 22 - 23: EDUCATION AND AWARENESS** | | |
| | RATIONALE FOR SELECTION OF INDICATOR<br><br>Education can be divided into two categories, formal through the school curriculum or informal. Two aspects will be evaluated, i.e., formal education and public awareness. While indicator 14 gives an indication of school children's use of recreational services provided by ecosystems, indicators 22 and 23 highlight:<br>(i) if biodiversity is included in the school curriculum; and<br>(ii) the number of outreach or public awareness events are held per year<br><br>For indicator 22, most cities have no jurisdiction over school curricula. The incorporation of this indicator creates the opportunity for city officials to liaise with education officers so that biodiversity courses are taught at pre-school, primary, secondary and tertiary levels.<br><br>For indicator 23, the event should either be organised entirely by the city authorities, or there should be a heavy involvement of the authorities before the event can be considered for inclusion in the indicator. Events that just take place within the city are not considered, as they are not representative of the governance exerted by the city authorities. | HOW TO CALCULATE INDICATOR<br><br>**Indicator 22:**<br>Is biodiversity or nature awareness included in the school curriculum (e.g. biology, geography, etc.)?<br><br>**Indicator 23:**<br>Number of outreach or public awareness events held in the city per year.<br><br>WHERE TO GET DATA FOR CALCULATIONS<br><br>Education department, city councils, NGOs | BASIS OF SCORING<br><br>**Indicator 22:**<br>0 points: Biodiversity or elements of it are not covered in the school curriculum<br>1 point: Biodiversity or elements of it are being considered for inclusion in the school curriculum<br>2 points: Biodiversity or elements of it are being planned for inclusion in the school curriculum<br>3 points: Biodiversity or elements of it are in the process of being implemented in the school curriculum<br>4 points: Biodiversity or elements of it are included in the school curriculum<br><br>**Indicator 23:**<br>0 points: 0 outreach events/year<br>1 point: 1 - 59 outreach events/year<br>2 points: 60 -149 outreach events/year<br>3 points: 150-300 outreach events/year<br>4 points: > 300 outreach events/year<br><br>Cities are requested to include a full list of the events included in the calculation for indicator 23, as well as information on how many people attended the event or were targeted where available. |

## ANNEX A:

### The Convention on Biological Diversity Strategic Plan for Biodiversity 2011-2020 and the Aichi Biodiversity Targets

1. The Convention on Biological Diversity (CBD) is a global agreement addressing all aspects of biodiversity: genes, species and ecosystems. In 2010, Parties to the CBD adopted the Strategic Plan for Biodiversity 2011-2020 at the Tenth Meeting of the Conference of Parties to the CBD (COP-10). It serves as the overarching United Nations framework for countries and stakeholders to safeguard biodiversity and the benefits it provides. The Strategic Plan includes 20 ambitious but realistic targets, known as the Aichi Biodiversity Targets. These 20 targets are grouped under five strategic goals:

   **Strategic Goal A** Address the underlying causes of biodiversity loss by mainstreaming biodiversity across government and society

   **Strategic Goal B** Reduce the direct pressures on biodiversity and promote sustainable use

   **Strategic Goal C** Improve the status of biodiversity by safeguarding ecosystems, species and genetic diversity

   **Strategic Goal D** Enhance the benefits to all from biodiversity and ecosystem services

   **Strategic Goal E** Enhance implementation through participatory planning, knowledge management and capacity building

2. National governments have committed to update their National Biodiversity Strategies and Action Plans (NBSAPs) and develop national targets which are in line with the Aichi Biodiversity Targets. The NBSAP charts out how a country intends to fulfil CBD objectives and the action plans it intends to implement. In turn, cities, local authorities and subnational governments can contribute towards the implementation of national action plans by establishing Local Biodiversity Strategies and Action Plans (LBSAPs) that are in line with their respective NBSAPs.

3. To track global progress in achieving the Aichi Biodiversity Targets, countries are required to submit regular national reports (every four to five years). Decision X/22 and Decision XI/8 support the alignment of local actions with national strategies - national governments are encouraged to engage cities, local authorities and subnational governments in their NBSAP review and national reporting. The Singapore Index is tailored for application by urban settlements and can be used as a reporting framework at the local level which could subsequently feed into the national report to the CBD.

4. For more information on the CBD Strategic Plan for Biodiversity 2011-2020, please see www.cbd.int/sp/

**ANNEX B:**

**Potential links between individual Aichi Biodiversity Targets and the relevant Singapore Index indicators**

| Aichi Targets | Potentially Relevant Singapore Index Indicators |
|---|---|
| **Target 1:** By 2020, at the latest, people are aware of the values of biodiversity and the steps they can take to conserve and use it sustainably. | **Indicator 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<br>**Indicator 22:** Education and Awareness: Is Biodiversity or Nature Awareness Included in the School Curriculum<br>**Indicator 23:** Education and Awareness: Number of Outreach or Public Awareness Events Held in the City per Year |
| **Target 2:** By 2020, at the latest, biodiversity values have been integrated into national and local development and poverty reduction strategies and planning processes and are being incorporated into national accounting, as appropriate, and reporting systems. | **Indicator 17:** Existence of Local Biodiversity Strategy and Action Plan<br>**Indicator 18:** Institutional Capacity: Number of Biodiversity related Functions<br>**Indicator 19:** Institutional Capacity: Number of City or Local Government Agencies Involved in Inter-agency Co-operation Pertaining to Biodiversity Matters<br>**Indicator 20:** Participation and Partnership: Existence of Formal or Informal Public Consultation Process<br>**Indicator 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<br>**Indicator 22:** Education and Awareness: Is Biodiversity or Nature Awareness Included in the School Curriculum |
| **Target 3:** By 2020, at the latest, incentives, including subsidies, harmful to biodiversity are eliminated, phased out or reformed in order to minimize or avoid negative impacts, and positive incentives for the conservation and sustainable use of biodiversity are developed and applied, consistent and in harmony with the Convention and other relevant international obligations, taking into account national socio-economic conditions. | **Indicator 15:** Budget Allocated to Biodiversity |

| Aichi Targets | Potentially Relevant Singapore Index Indicators |
|---|---|
| **Target 4:** By 2020, at the latest, Governments, business and stakeholders at all levels have taken steps to achieve or have implemented plans for sustainable production and consumption and have kept the impacts of use of natural resources well within safe ecological limits. | **Indicator 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 |
| **Target 5:** By 2020, the rate of loss of all natural habitats, including forests, is at least halved and where feasible brought close to zero, and degradation and fragmentation is significantly reduced. | **Indicator 1:** Proportion of Natural Areas in the City<br>**Indicator 2:** Connectivity Measures or Ecological Networks to Counter Fragmentation<br>**Indicator 17:** Existence of Local Biodiversity Strategy and Action Plan |
| **Target 6:** By 2020 all fish and invertebrate stocks and aquatic plants are managed and harvested sustainably, legally and applying ecosystem based approaches, so that overfishing is avoided, recovery plans and measures are in place for all depleted species, fisheries have no significant adverse impacts on threatened species and vulnerable ecosystems and the impacts of fisheries on stocks, species and ecosystems are within safe ecological limits. | **Indicator 17:** Existence of Local Biodiversity Strategy and Action Plan<br>**Indicator 19:** Institutional Capacity: Number of City or Local Government Agencies Involved in Inter-agency Co-operation Pertaining to Biodiversity Matters<br>**Indicator 20:** Participation and Partnership: Existence of Formal or Informal Public Consultation Process<br>**Indicator 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 |
| **Target 7:** By 2020 areas under agriculture, aquaculture and forestry are managed sustainably, ensuring conservation of biodiversity. | **Indicator 17:** Existence of Local Biodiversity Strategy and Action Plan<br>**Indicator 19:** Institutional Capacity: Number of City or Local Government Agencies Involved in Inter-agency Co-operation Pertaining to Biodiversity Matters<br>**Indicator 20:** Participation and Partnership: Existence of Formal or Informal Public Consultation Process<br>**Indicator 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 |

| Aichi Targets | Potentially Relevant Singapore Index Indicators |
|---|---|
| **Target 8:** By 2020, pollution, including from excess nutrients, has been brought to levels that are not detrimental to ecosystem function and biodiversity. | **Indicator 17:** Existence of Local Biodiversity Strategy and Action Plan<br>**Indicator 19:** Institutional Capacity: Number of City or Local Government Agencies Involved in Inter-agency Co-operation Pertaining to Biodiversity Matters<br>**Indicator 20:** Participation and Partnership: Existence of Formal or Informal Public Consultation Process<br>**Indicator 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 |
| **Target 9:** By 2020, invasive alien species and pathways are identified and prioritized, priority species are controlled or eradicated, and measures are in place to manage pathways to prevent their introduction and establishment. | **Indicator 10:** Proportion of Invasive Alien Species |
| **Target 10:** By 2015, the multiple anthropogenic pressures on coral reefs, and other vulnerable ecosystems impacted by climate change or ocean acidification are minimized, so as to maintain their integrity and functioning. | **Indicator 17:** Existence of Local Biodiversity Strategy and Action Plan<br>**Indicator 19:** Institutional Capacity: Number of City or Local Government Agencies Involved in Inter-agency Co-operation Pertaining to Biodiversity Matters<br>**Indicator 20:** Participation and Partnership: Existence of Formal or Informal Public Consultation Process<br>**Indicator 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 |

| Aichi Targets | Potentially Relevant Singapore Index Indicators |
|---|---|
| **Target 11:** By 2020, at least 17 per cent of terrestrial and inland water, and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscape and seascapes. | **Indicator 1:** Proportion of Natural Areas in the City<br>**Indicator 2:** Connectivity Measures or Ecological Networks to Counter Fragmentation<br>**Indicator 9:** Proportion of Protected Natural Areas<br>**Indicator 17:** Existence of Local Biodiversity Strategy and Action Plan<br>**Indicator 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 |
| **Target 12:** By 2020 the extinction of known threatened species has been prevented and their conservation status, particularly of those most in decline, has been improved and sustained. | **Indicator 1:** Proportion of Natural Areas in the City<br>**Indicator 2:** Connectivity Measures or Ecological Networks to Counter Fragmentation<br>**Indicator 3:** Native Biodiversity in Built Up Areas (Bird Species)<br>**Indicator 4:** Change in Number of Vascular Plant Species<br>**Indicator 5:** Change in Number of Bird Species<br>**Indicator 6:** Change in Number of Butterfly Species<br>**Indicator 7:** Change in Number of Species (any other taxonomic group selected by the city)<br>**Indicator 8:** Change in Number of Species (any other taxonomic group selected by the city) |
| **Target 13:** By 2020, the genetic diversity of cultivated plants and farmed and domesticated animals and of wild relatives, including other socio-economically as well as culturally valuable species, is maintained, and strategies have been developed and implemented for minimizing genetic erosion and safeguarding their genetic diversity. | **Indicator 1:** Proportion of Natural Areas in the City<br>**Indicator 2:** Connectivity Measures or Ecological Networks to Counter Fragmentation<br>**Indicator 3:** Native Biodiversity in Built Up Areas (Bird Species)<br>**Indicator 4:** Change in Number of Vascular Plant Species<br>**Indicator 5:** Change in Number of Bird Species<br>**Indicator 6:** Change in Number of Butterfly Species<br>**Indicator 7:** Change in Number of Species (any other taxonomic group selected by the city)<br>**Indicator 8:** Change in Number of Species (any other taxonomic group selected by the city)<br>**Indicator 9:** Proportion of Protected Natural Areas<br>**Indicator 17:** Existence of Local Biodiversity Strategy and Action Plan |

| Aichi Targets | Potentially Relevant Singapore Index Indicators |
|---|---|
| **Target 14:** By 2020, ecosystems that provide essential services, including services related to water, and contribute to health, livelihoods and well-being, are restored and safeguarded, taking into account the needs of women, indigenous and local communities, and the poor and vulnerable. | **Indicator 11:** Regulation of Quantity of Water<br>**Indicator 12:** Climate Regulation: Carbon Storage and Cooling Effect of Vegetation<br>**Indicator 13:** Recreation and Education: Area of Parks with Natural Areas<br>**Indicator 14:** Recreation and Education: Number of Formal Education Visits per Child Below 16 Years to Parks with Natural Areas per Year<br>**Indicator 17:** Existence of Local Biodiversity Strategy and Action Plan |
| **Target 15:** By 2020, ecosystem resilience and the contribution of biodiversity to carbon stocks has been enhanced, through conservation and restoration, including restoration of at least 15 per cent of degraded ecosystems, thereby contributing to climate change mitigation and adaptation and to combating desertification. | **Indicator 1:** Proportion of Natural Areas in the City<br>**Indicator 2:** Connectivity Measures<br>**Indicator 4:** Change in Number of Vascular Plant Species<br>**Indicator 5:** Change in Number of Bird Species<br>**Indicator 6:** Change in Number of Butterfly Species<br>**Indicator 7:** Change in Number of Species (any other taxonomic group selected by the city)<br>**Indicator 8:** Change in Number of Species (any other taxonomic group selected by the city)<br>**Indicator 9:** Proportion of Protected Natural Areas<br>**Indicator 12:** Climate Regulation: Carbon Storage and Cooling Effect of Vegetation |
| **Target 16:** By 2015, the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization is in force and operational, consistent with national legislation. | **Indicator 17:** Existence of Local Biodiversity Strategy and Action Plan |
| **Target 17:** By 2015 each Party has developed, adopted as a policy instrument, and has commenced implementing an effective, participatory and updated national biodiversity strategy and action plan. | **Indicator 17:** Existence of Local Biodiversity Strategy and Action Plan |

| Aichi Targets | Potentially Relevant Singapore Index Indicators |
|---|---|
| **Target 18:** By 2020, the traditional knowledge, innovations and practices of indigenous and local communities relevant for the conservation and sustainable use of biodiversity, and their customary use of biological resources, are respected, subject to national legislation and relevant international obligations, and fully integrated and reflected in the implementation of the Convention with the full and effective participation of indigenous and local communities, at all relevant levels. | Not Applicable |
| **Target 19:** By 2020, knowledge, the science base and technologies relating to biodiversity, its values, functioning, status and trends, and the consequences of its loss, are improved, widely shared and transferred, and applied. | **Indicator 18:** Institutional Capacity: Number of Biodiversity Related Functions<br>**Indicator 19:** Institutional Capacity: Number of City or Local Government Agencies Involved in Inter-agency Co-operation Pertaining to Biodiversity Matters<br>**Indicator 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 |
| **Target 20:** By 2020, at the latest, the mobilization of financial resources for effectively implementing the Strategic Plan 2011- 2020 from all sources and in accordance with the consolidated and agreed process in the Strategy for Resource Mobilization should increase substantially from the current levels. This target will be subject to changes contingent to resources needs assessments to be developed and reported by Parties. | **Indicator 15:** Budget Allocated to Biodiversity |

## ANNEX C:

### Discussions and Outcomes of the First, Second and Third Expert Workshops on the Development of the City Biodiversity Index

1. Singapore organised and hosted three expert workshops to develop and refine the indicators of the Singapore Index on Cities' Biodiversity. The reports of the workshops are available on the Convention on Biological Diversity (CBD) website. This annex highlights the key discussions and outcomes of the three workshops.

   - First Expert Workshop on the Development of the City Biodiversity Index, 10-12 February 2009 (UNEP/CBD/EW.DCBI/1/3; www.cbd.int/doc/?meeting=EWDCBI-01)

   - Second Expert Workshop on the Development of the City Biodiversity Index, 1-3 July 2010 (UNEP/CBD/EW.DCBI/2/3; www.cbd.int/doc/?meeting=EWDCBI-02)

   - Third Expert Workshop on the Development of the City Biodiversity Index, 11-13 October 2011 (UNEP/CBD/EW.DCBI/3/2; www.cbd.int/doc/?meeting=EWDCBI-03)

**First Expert Workshop on the Development of the City Biodiversity Index, 10-12 February 2009**

2. The key objectives of the workshop were to develop the City Biodiversity Index (CBI) as a self-assessment tool to:
   (i) assist national governments and local authorities in benchmarking biodiversity conservation efforts in the urban context; and
   (ii) help evaluate progress in reducing the rate of biodiversity loss in urban ecosystems.

3. A total of 17 technical experts on biodiversity indicators as well as city executives and representatives responsible for implementation and/or management of biodiversity and urban projects and programmes attended the workshop. These included four cities (Curitiba, Montreal, Nagoya, and Singapore), experts from the London School of Economics, Stockholm Resilience Centre, Institute of Housing and Environment (Germany), National University of Singapore, the International Union for Conservation of Nature (IUCN), ICLEI – Local Governments for Sustainability's Local Action for Biodiversity (LAB) Initiative and the East Asian Seas Partnership Council. From the Secretariat of the Convention on Biological Diversity (SCBD), Mr. Oliver Hillel, Programme Officer for Sustainable Use, Tourism and Island Biodiversity, attended the workshop.

4. Over the three day workshop, the experts deliberated on the format of the Index and agreed that it should comprise three components, that is:
   (i) native biodiversity in the city,
   (ii) ecosystem services provided by native biodiversity in the city, and
   (iii) governance and management of native biodiversity in the city.

5. The first component focuses on different aspects of native biodiversity, in particular what native biodiversity are found in the city, how they are conserved, what are the threats to native biodiversity, etc. The second component concentrates on the ecosystem services provided by native biodiversity in the city, including those pertaining to regulation of water, carbon storage, and recreational and educational services. The third component is concerned with the governance and management of biodiversity, encompassing budget allocation, institutional setups, number of biodiversity related projects, public awareness programmes, administrative procedures, etc.

6. The experts, divided into three groups, discussed in depth each of the components and decided on 26 indicators[5].

7. A technical task force, comprising Dr. Nancy Holman (London School of Economics), Mr. Peter Werner (Institute of Housing and Environment, Darmstadt, Germany), Professor Thomas Elmqvist (Stockholm Resilience Centre), Mr. Andre Mader (ICLEI-Local Governments for Sustainability LAB Initiative), Ms. Elisa Calcaterra (IUCN), Mr. Oliver Hillel (SCBD) and Dr. Lena Chan (NParks) was delegated to prepare the User's Manual.

**Second Expert Workshop on the Development of the City Biodiversity Index, 1-3 July 2010**

8. The objectives of the workshop were to:
   (i) review comments by cities which have test-bedded the Index;
   (ii) refine and improve the indicators of the CBI based on the essence of the components that was agreed at the First Expert Workshop (paragraph 4); and
   (iii) finalise the User's Manual for the CBI.

9. Thirty-two participants, including the SCBD, the technical task force, representatives from ASEAN Working Group on Environmentally Sustainable Cities, Brussels Capital Region, Curitiba, Edmonton, Montpelier, Montreal, Nagoya, Waitakere City and Singapore, resource experts, representatives from Aichi-Nagoya COP-10 CBD Promotion Committee and international organisations attended the workshop.

10. The participants examined the general approach to the selection of the indicators, crafting of the measurement of the indicators, and scoring of the indicators. Special attention was paid to ensure that the selection and scoring of the indicators were unbiased. Written feedback given was shared at the workshop and any concerns that were brought to the attention of the technical task force were addressed at the workshop. The decisions made during the workshop on the amendment of the indicators were incorporated into the revised indicators.

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[5] Twenty-six indicators were identified at the First Expert Workshop. As two of the indicators were very similar, one of them was removed during the preparation of the User's Manual for the CBI, resulting in a total of 25 indicators in the November 2009 version.

11. The following issues pertaining to the general approach to the formulation of the CBI were discussed extensively:

(i) Issue: It was recognised that cities in the temperate region have inherently a lower diversity than cities in the tropical region. The age of the cities, human intervention and other processes of succession could also be factors affecting the biodiversity of cities. The size of the cities too is an important factor in determining the biodiversity richness of the city.

Discussion and Conclusion: To ensure fairness and reduce bias, a number of amendments were made. First, it was agreed that the total number of ecosystems and total number of specific species be listed in the Profile of the City. The net change in species over time, where the first year of application is set as the baseline year, has been identified as an indicator to replace the total number of species. Secondly, statistical analysis based on the data from cities would be carried out. For the statistical analysis to be reliable, data input would be required from at least 20 cities. For scoring range with a maximum of 4 points, the mean from data given by the cities will be calculated and used as reference for the '2-point' score.

As the CBI is developed primarily as a self-assessment tool, the actual score of the indicators is secondary to the change in the score over time. Hence, the differences in the scores by cities in different ecological biomes should not be a cause for concern as cities are comparing how well they did in relation to their own past scores over a time period. The comparison among cities arose due to the availability of the data but comparison was never an intended result in the development of the CBI.

(ii) Issue: The validity of a single score based on the summation of the scores of a diverse range of indicators was questioned. Another system, segregating different characteristics of the indicators into five sectors, i.e., A, B, C, D and E, and summing up scores of the different elements separately was counter-proposed.

Discussion and Conclusion:
The participants deliberated on the merits and drawbacks of the single score and the counter-proposal. The consensus of the workshop was that a single score, which was a total of the scores for all the indicators, was preferred as long as the indicators were fair.

(iii) Issue: It was suggested that the ecological footprint of the cities should be included in the Index.

Discussion and Conclusion: The participants were informed that this issue had been raised at the previous workshop. Since many other indices like the World Economic Forum's 2005 Environmental Sustainability Index and 2008 Environmental Performance Index, WWF's Living Planet Report 2008 deal with ecological footprints and no other indices for cities, in particular, focus on biodiversity related parameters, it was agreed that this Index should concentrate on native biodiversity, ecosystem services provided by

biodiversity, and governance and management of biodiversity. By creating this niche, the Index could provide biodiversity related indicators for other indices that lack these specialised but important parameters.

(iv) Issue: For many of the cities, the extinction of species occurred more than a hundred years ago. It was beyond the control of the present generation.

Discussion and Conclusion: While it was accepted that the extinction of species had taken place, it was not productive to dwell on it by focusing on extinct species. Positive steps need to be taken and these should be incorporated into the Index to encourage proactive activities that would result in the restoration and rehabilitation of ecosystems and re-introduction of species. All the indicators, where necessary, have been revised to reflect this approach.

(v) Issue: There was feedback from several parties that insufficient attention was given to biodiversity in built up areas, considering most cities comprise built up areas and semi-natural cultural landscapes. The characteristics of built up areas and brownfield sites differ in different cities and there was a need to arrive at a common understanding of these land use features.

Discussion and Conclusion: The participants agreed with the above observation. The indicator on native biodiversity in built up areas, i.e., number of bird species, attempts to address this issue. One of the motivations of this Index was to promote the increase in native biodiversity in cities so as to reduce the rate of biodiversity loss. It has been increasingly shown that many cities could have higher biodiversity than the countryside which are heavily sprayed with herbicides and pesticides. The Index is seen as dynamic and evolving in nature. Positive indicators that aim to increase biodiversity like restoration, rehabilitation and re-introduction initiatives would most likely be added at a later date.

(vi) Issue: It was highlighted that for ecosystem services, it was difficult to isolate the services provided only by native biodiversity. Similarly, on governance and management, such actions are often directed at biodiversity in general. However, it is recognised that actions directed at the conservation and utilisation of native biodiversity should be encouraged.

Discussion and Conclusion: Therefore, components two and three were amended accordingly:

- ecosystem services provided by biodiversity in the city, and
- governance and management of biodiversity in the city

12. Specific changes in the CBI, resulting from the deliberations at the workshop, include:

(i) To standardise throughout the Index, proportions are used rather than percentages[6].

(ii) The scoring will be based on normalising the data provided by the cities. The statistical treatment of the cities' data would ensure a scientific basis for the scoring, fairness and objectivity. Statistical analysis will be applied to indicators 2 (Connectivity), 3 (Native biodiversity in built up areas), 9 (Proportion of protected areas), 11 (Regulation of water quantity), 12 (Climate regulation: carbon storage and cooling effect of vegetation), 15 (Budget allocated to biodiversity), and 16 (Number of biodiversity projects that are implemented by the city).

(iii) Indicator 2: Diversity of ecosystems in the 21 November 2009 version. This indicator has been deleted in the present version as it was not likely that the number of ecosystems would change significantly over a medium time period, which is the reporting time frame of the Index. However, information on the number of ecosystems in cities is still deemed important and hence, it will be recorded under the Profile of the City.

(iv) Indicator 3: Fragmentation in the 21 November 2009 version. To emphasise the positive solution approach of the Index, this indicator, re-numbered as indicator 2, will measure the connectivity measures or ecological networks efforts to counter fragmentation.

(v) Indicators 5, 6, 7, 8 and 9: Number of native species in the 21 November 2009 version. The numbers of these indicators have been changed to 4, 5, 6, 7 and 8, respectively, in this current version, due to the deletion of the indicator on ecosystems. It was agreed that to be fair to all the cities (see paragraph 11(i) above), the indicators should measure change in species number rather than the absolute number of species. 2010[7] has been identified as the baseline year and cities would record the number of species of the mandatory taxonomic groups of vascular plants, birds and butterflies and two other taxonomic groups of the city's choice in the Profile of the City.

(vi) Indicator 12: Freshwater services in the 21 November 2009 version. Many cities had problems with this indicator, hence the need to revise it. This indicator has been re-numbered as indicator 11: Regulation of Quantity of Water. As a result of climate change, there is increased variability of the quantity of precipitation and impermeable surfaces will further aggravate the problem. Hence, this is an indicator that highlights the importance of permeable surfaces, in particular wetlands and natural

[6] A decision was subsequently made by NParks to use percentages in the scoring ranges for the indicators, as it was felt that percentages provide a more intuitive figure than proportions.

[7] Due to cities having different years in which they first applied the Singapore Index, it was subsequently decided that the first year of application would be considered the baseline year, rather than 2010. This would also enable cities to apply the Singapore Index even if they do not have data from 2010 for their baseline year.

ecosystems, that would help regulate and moderate the flow of water due to extreme climatic conditions.

(vii) Indicator 13: Carbon storage in the 21 November 2009 version. While cities were agreeable with the number of trees in principle, there were issues that were difficult to resolve, like species of trees, girth size of trees, trees planted by the city council or should it include trees in private land, etc. The indicator has been re-numbered as indicator 12, and uses the proportionate area of tree canopy cover to the total area of the city as an indirect measure of both carbon storage and the cooling effect of vegetation.

(viii) Indicator 14: Recreation and educational services as in the 21 November 2009 version. This indicator measuring number of visits per person per year was deleted as there were differences in the desired number for different types of areas. For example, the carrying capacity of nature reserves and national parks are lower than that of parks. Achieving high and increasing numbers of visitors is not a desired outcome for nature reserves and national parks but would be for horticultural parks with less natural ecosystems.

13. While it is recognised that there are some other indicators that could be included in the CBI, due to the urgency of completing the CBI for submission to COP-10 in October 2010, minimum additions were made to the current version. Indicators that measure cities' efforts at restoring native biodiversity and habitats, ecosystem services, native biodiversity in landfill sites, green roofs and vertical greening initiatives, proximity to nature parks, and brownfield sites, etc., have been identified as important gaps that need to be addressed. Further revisions will include indicators that address these unrepresented areas.

14. The development of the CBI is a dynamic process, evolving for the better continuously so as to be more useful, to allow it to be applicable to more cities and to be more scientifically robust. The strengths of the CBI are that:
    (i) it is the only Index that focuses on biodiversity;
    (ii) its coverage is diverse and comprehensive, incorporating indicators on biodiversity, ecosystem services, and good governance and management;
    (iii) cities can do their own assessment, hence, building their capacity in biodiversity conservation and databases;
    (iv) the scores are quantitative, hence, it is objective and it is possible to monitor change over time; and
    (v) a diverse range of experts and stakeholders contributed to the design of the CBI.

15. The weaknesses of the CBI are that:
    (i) it is difficult to select indicators that all cities have data on;
    (ii) the scoring of some of the indicators is difficult due to the different ecological zones that cities are located in; and
    (iii) indicators for ecosystem services are difficult to design as this a new field of study.

**Third Expert Workshop on the Development of the City Biodiversity Index, 11-13 October 2011**

16. The objectives of the workshop were to:

    (i) finalise the scoring of the indicators of the Singapore Index on Cities' Biodiversity (Singapore Index)[8];

    (ii) discuss the roadmap on the contribution of the Singapore Index to the Eleventh Meeting of the Conference of Parties to the CBD (COP-11);

    (iii) define ways to further expand the use of the Singapore Index for cities (such as in planning and baseline setting) and for other levels of subnational government;

    (iv) discuss the documentation on cities' experiences on the application of the Singapore Index; and

    (v) provide inputs to the first edition of the Cities and Biodiversity Outlook.

17. A total of 26 technical experts on urban biodiversity conservation and planning as well as city representatives responsible for the implementation and/or management of biodiversity and urban projects and programmes attended the workshop. The participants noted that only 13 cities provided data for the establishment of scoring ranges for the seven indicators. To ensure a robust statistical normalisation exercise, the participants proposed that data from at least 50 cities was required. Participants also reviewed all 23 indicators of the Singapore Index and where necessary, suggested improvements to provide greater clarity in the data that were required.

18. The following issues were deliberated in greater detail:

    (i) For accountability and standardisation of reporting, it was agreed that the reporting of the implementation and scoring of the Singapore Index should be performed by the city officials. Universities, non-governmental organisations (NGOs), consultants, etc. can carry out the data collection and analyses but the reporting will have to be channelled through the city officials. Cities can report on their results and experiences to the SCBD, National Parks Board of Singapore (NParks) and ICLEI. The reports and case studies will be posted on the SCBD website.

    (ii) The meeting agreed that the indicators should not be changed as experts from diverse disciplines had worked on them during the last two workshops and further inputs had been provided by cities.

    (iii) In our efforts to maintain a high standard of scientific credibility, the methods for calculating the indicators should be reviewed stringently. Cities were requested to record in detail how the calculations were done and the assumptions made to ensure

[8] In recognition of Singapore's leadership in the technical development of the Index, the City Biodiversity Index was renamed the Singapore Index on Cities' Biodiversity, or Singapore Index.

standardisation of methodology. Extensive improvements were made in particular on indicator 2: Connectivity measures or ecological networks to counter fragmentation.

(iv) Based on feedback from several cities, clearer definitions were set for many of the indicators, including indicators, 1, 2, 4, 5, 6, 7, 8, 11, 15, 16, 17, 18, and 23, which are captured in the updated User's Manual of the Singapore Index.

(v) Seven of the indicators, i.e., indicators 2, 3, 9, 11, 12, 15 and 16, required statistical normalisation. Cities were requested to give their data to NParks so that the statistical normalisation exercise would be more stringent with a greater sample size.

(vi) In recognition that some cities might not have all the data and to facilitate participation by a diverse range of cities, the implementation of the Singapore Index could be done stepwise, i.e., cities can initially start with indicators that they have data on. They can plan to collect data on other indicators progressively. Cities are also encouraged to share any ideas on how they can improve on the application of the indicators to make them more relevant in their own geographical context. For example, using tree canopy cover in indicator 12 might not be suitable for cities in the desert or arid zones. Taking all these into consideration, cities are encouraged to apply all the 23 indicators.

(vii) It is emphasised that the Singapore Index is designed as a self-assessment tool. Hence, if it is used for comparative purposes, stratifications would have to be applied for more meaningful comparisons. Cities would have to be grouped according to geographical location, size, historical age, etc.

19. Mr. Andre Mader (ICLEI-Local Governments for Sustainability LAB Initiative) and Ms. Elisa Calcaterra (IUCN), both members of the Technical Task Force have left ICLEI and IUCN respectively. Ms. Shela Patrickson from ICLEI-Local Governments for Sustainability LAB Initiative attended the Third Expert Workshop and will replace Mr. Andre Mader in the Technical Task Force. The Technical Task Force now comprises six members: Dr. Nancy Holman (London School of Economics), Mr. Peter Werner (Institute of Housing and Environment, Darmstadt, Germany), Professor Thomas Elmqvist (Stockholm Resilience Centre), Ms. Shela Patrickson (ICLEI-Local Governments for Sustainability LAB Initiative), Mr. Oliver Hillel (SCBD) and Dr. Lena Chan (NParks).

**Third-Expert Workshop – After Note**

20. It is observed during the collation of cities' results for indicator 14 that the data and methodology does not fit the scoring range. The conventional approach is to take the total number of visits and divide it by the total number of students below 16 years old. This results in a number that may not fall within the scoring range. To get around this problem, Hamilton adopted a novel approach – Hamilton city authorities sampled schools with students of varying age groups (below 16) to obtain an estimated number that is representative of the student populous. We would also like to hear from other cities if they have alternative approaches in measuring indicator 14.

21. Data on the six indicators with no scoring ranges (i.e., indicators 3, 9, 11, 12, 15 and 16) were received from cities for normalization of the scoring ranges. These data were then compiled, and the cut off points for each indicator were determined using percentiles: the top 20% of cities scored 4 points, the next 20% scored 3 points and so on, with the lowest 20% of cities scoring 0 points based on the preferred method as indicated during the Third Expert Workshop and in ongoing consultation with the technical task force. The methodology for indicator 2 was changed during the Third Expert Workshop. Hence few cities were able to return their calculations based on the revised indicator since then. The scoring range for indicator 2 was established in consultation with Dr. Jochen Jaeger who proposed the method adopted for the calculations of this indicator. The final suite of indicators also utilises percentages rather than proportions, as the final result will be more intuitive.

## ANNEX D:

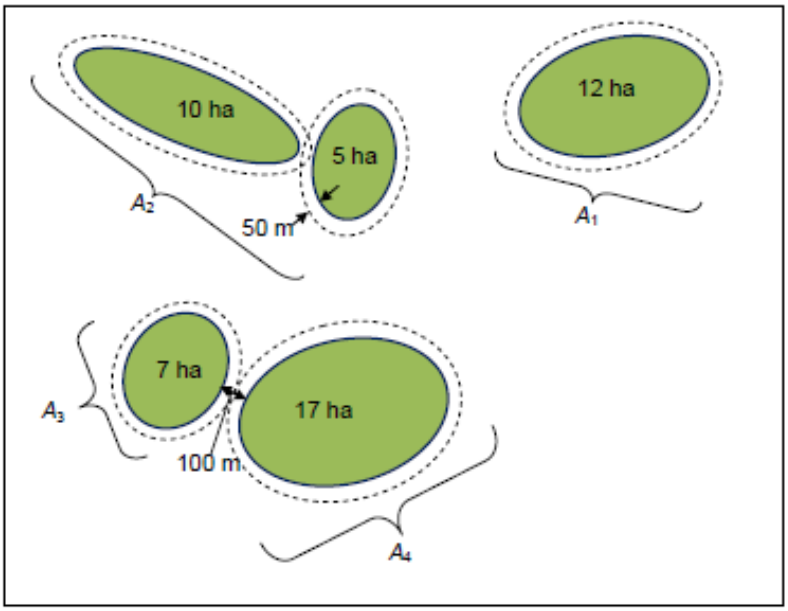
**Illustration of the calculation of effective mesh size of natural areas for indicator 2**

Formula:

$$Indicator\,2 = \frac{1}{A_{total}}\left(A_1^2 + A_2^2 + A_3^2 + ... + A_n^2\right)$$

where $A_1$ to $A_n$ represent the sizes of the natural areas, from natural area 1 ($A_1$) to natural area $n$ ($A_n$), $n$ is the total number of distinct natural areas and $A_{total}$ is the total area of all natural areas.

Example:




Calculation steps:

There are five patches in this landscape. We first add a buffer of 50 m around each patch to find out which patches are within 100m of each other: when the buffers overlap, the distance between the patches is less than 100m. The patch on the right (12 ha in size) is not connected to any other patches, and we name the patch $A_1$ (area = 12 ha). The two patches on the upper left are connected. Therefore, their areas have to be added, and we give this group of patches the name $A_2$ (area = 10 ha + 5 ha = 15 ha). The two patches at the bottom are exactly100m apart and therefore they are not considered connected and we give them the names $A_3$ (area = 7 ha) and $A_4$ (area = 17 ha). $A_{total}$ is the sum of $A_1$, $A_2$, $A_3$ and $A_4$, i.e. $A_{total}$ = 12 ha + 15 ha + 7 ha + 17 ha = 51 ha. We can now calculate the value of the effective mesh size for indicator 2 as

$$Indicator\,2 = \frac{1}{A_{total}}\left(A_1^2 + A_2^2 + A_3^2 + A_4^2\right) = \frac{1}{51\,\text{ha}}\left(12\times12\,\text{ha}^2 + 15\times15\,\text{ha}^2 + 7\times7\,\text{ha}^2 + 17\times17\,\text{ha}^2\right) = \frac{707}{51}\text{ha} = 13.86\,\text{ha}$$

**ANNEX E:**

**Proposed format for submission of application of the Singapore Index on Cities' Biodiversity**

## PART I: PROFILE OF THE CITY

1. Submission of the results should include a short write up with a basic description of the features of your city. Relevant maps, photos, charts or figures may also be included in this portion. As a guide, the following information can be put in, but the write up need not be limited to the following fields:

   (i) Basic information about your city
   - a. Location
   - b. Climate
   - c. Temperature
   - d. Rainfall/precipitation
   - e. Other relevant information

   (ii) Size (land area, defined by city boundaries)
   (iii) Population
   (iv) Economic parameters
   (v) Physical features of the city
   (vi) Biodiversity features and characteristics such as ecosystems and species found in the city, including quantitative data on populations as well as any other qualitative information
   (vii) Administration of biodiversity
   (viii) Links to relevant websites:
   - a. city's website
   - b. environmental or biodiversity specific websites
   - c. websites of agencies responsible for biodiversity

## PART II: INDICATORS OF THE SINGAPORE INDEX ON CITIES' BIODIVERSITY

2. For the calculations of the Index proper in Part II, submissions should detail the calculations that were made to arrive at the final figure, and cite the source of the figures wherever possible. The following table is a suggested format that may be used for the submission.

| INDICATOR | CALCULATION<br>Cities to indicate how the result was calculated | SOURCE<br>Please provide any references where the information was obtained | SCORE |
|---|---|---|---|
| **Native Biodiversity in the City** | | | |
| 1 | | | |
| 2 | | | |
| 3 | | | |
| 4 | | | |
| 5 | | | |
| 6 | | | |
| 7 | | | |
| 8 | | | |
| 9 | | | |
| 10 | | | |
| **Ecosystem Services Provided by Biodiversity in the City** | | | |
| 11 | | | |
| 12 | | | |
| 13 | | | |
| 14 | | | |
| **Governance and Management of Biodiversity in the City** | | | |
| 15 | | | |
| 16 | | | |
| 17 | | | |
| 18 | | | |
| 19 | | | |
| 20 | | | |
| 21 | | | |
| 22 | | | |
| 23 | | | |

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