IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.301
Volume 3, Issue 3, March 2023

Re- Thinking Urban Green Spaces: Do Unique Urban Green Spaces Enhances the Urban Biodiversity?

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Abstract: *The diversity between different plants, animals and other species in a given habitat at a particular time is called Biodiversity. Biodiversity goes undetected by the vast majority of people in urban areas. Urban areas houses many native and non- native species, but unfortunately to a lot of eyes vegetation is an undifferentiated mass of green and all creepers with six legs are just unknown insects. Human needs for modernization and urbanization leads to the destruction of habitat of flora and fauna, deteriorating the quality of soil, water and air. So, the available green space in urban areas becomes a critical reserve of biodiversity in urban environments. To restore the lost habitat and integrate biodiversity, concerns into urban planning are urgently needed. In urbanized areas like Mumbai, green space not only holds aesthetic value and helps conservation of local biodiversity but also provides values and services. Therefore, a Biodiversity Garden was developed in Somaiya campus, Mumbai, with an earnest attempt to conserve urban biodiversity and enhance the nature engagement among the general public, serving as a site for learning and earning. Success rate of the project have been analysed to detect the difference on how unique green spaces in urban areas can bring, by recording the species richness and examining how environment focused projects can set a sustainable ground in terms of social and economic aspects to protect the habitat in future and provide essential service to society. Further observations resulted that, in an area of 10,000 sq ft with more than 1350 plant saplings about 23 species of butterflies, 12 different species of birds, 8 different species of insects have been recorded in the garden within a period of one month. This study will give insight on how the biodiversity garden as a concept of sustainable business model can enhance the opportunity for people to connect with nature, witness ecological processes in action while making unique decisions regarding conservation initiative.*

Keywords: Biodiversity, Urban Green Spaces, Urban Biodiversity, Conservation, Eco-Entrepreneurship, Green Business Model.

I. INTRODUCTION

The diversity between different plants, animals and other species in a given habitat at a particular time is referred to as Biodiversity. Biodiversity goes undetected by the vast majority of people in urban areas. Urban areas house many native and non- native species, for instance 150 different species of butterflies are found alone in Mumbai urban landscape but unfortunately to a lot of eyes vegetation is an undifferentiated mass of green and all creepers with six legs are just unknown insects. However human needs for modernization and urbanization lead to the destruction of habitat of flora and fauna, deteriorating the quality of soil, water and air. So, the available green space in urban areas becomes a critical reserve of biodiversity in urban environments. To restore the lost habitat and integrate biodiversity concerns into urban planning are urgently needed.

In urbanized areas like Mumbai, green space not only holds aesthetic value and helps conservation of local biodiversity but also provides various values and services. Therefore, a unique strategy to maintain the green space is required to meet the goal of conservation of biodiversity and maintaining the social and economic value and hence "The Biodiversity Garden" – A Sustainable Business Model was introduced in Somaiya campus, Mumbai, with an approach to support the conservation of the Urban Biodiversity in a concrete environment, engage people with nature and enhance public health which was awarded by US Consulate and Ekonnect Knowledge Foundation, Mumbai. So, the existing concept of butterfly garden was worked upon and made it into a biodiversity garden where education will be facilitated while developing a business model. By understanding the concept of a garden one realizes that nature works

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in a complex network and food chain is one of the most significant parts of it. Using this as an advantage, we planned to make a provincial ecosystem which is a representation of the location by providing the right tools that nature needs to heal itself.

The goals and objectives can be accomplished by introduction of regional flora and fauna ensuring their survival and protecting them from eradication, conducting nature trials, workshop and publishing nature trail guide books to facilitate education to the public. Establishing a proper agenda and implementing the strategy, Biodiversity Garden as a business model was successfully established and other goals were fulfilled in the year 2020. Biodiversity Garden houses to more than 1350 plants and attracts other species including birds, butterflies and insects and compiled the objectives of installing animal homes, signages and exhibits. For any conservation activity it is important to make people aware, and hence we took a step to conduct nature trails at the biodiversity garden for students and visitors guided by volunteers who will help to know about their surroundings and importance of biodiversity. The volunteers are trained in "Naturalist Training Program" and workshops organized and coordinated by the team. It is sustainable in terms of social, environmental and economic aspects. The present report has documented the events and the benefits of having a unique green space like Biodiversity Garden as a sustainable business model for society.

Why Build a Biodiversity Garden?

Biodiversity is essential to maintain a healthy ecosystem; for instance, pollinators maintain a healthy plant community. Healthy plant communities are crucial for a healthy ecosystem to exist. Many animal species such as birds and mammals depend on the plants as their food source and habitat. Insects helps in decomposition of dead plant and animal to add nutrients in soil, some worms and bugs helps to aerate the soil and allows the water to move in, which in turn is necessary for the growth and this cycle continues maintaining other services such as air filtration, climate regulation, water purification and maintains food chain. Social aspects such as health benefits, provides peaceful environment, education, recreation, experiential learning to the general public. Such unique spaces on campuses benefit both the campus as well as the students. Building a biodiversity garden provides endless opportunities to engage students in hands- on activities that enhance leanings. Students can become engaged in developing the garden, observe the change that occurs throughout the year with plants and animals and also look into management aspects.

Scientific studies suggest that plant related activities improve human wellbeing, both mental and physical. From an environmentalist perspective, these areas serve as habitats for various plants and animals that provide various ecosystem services to the city. Transpiration of plants can have a cooling effect on city climates during the hotter seasons. "Plant surfaces can filter air pollutants (NO2, SO2, O3 and particles with a size less than 10µm), thus helping to clean city air. Additionally, green areas increase the retention of water through high soil infiltration rates at times of intense rainfall events". (Winkler, 2019). Urban heat island effect is a growing concern in cities and its effects can be reduced by increasing green space around the city. Gardening can be a business, as mentioned earlier Biodiversity Garden is a replicable Business model which is to enhance the Eco-entrepreneurship skills among the youth leaders for Environmental conservation, so the measures of the profitability has been calculated while developing the Biodiversity Garden.

Efforts have been made to document what species are present in the garden. Based on the results, an innovative, sustainable urban garden concept is introduced that can serve as a useful tool to further encourage citizens to protect the urban biodiversity, engage people with nature and development towards bio economy. We believe that the project will heal the lost diversity, ensure its survival and enable it to last for decades.

II. LITERATURE REVIEW

Biodiversity loss is a global crisis. The research says that "biological extinction has been a natural phenomenon in geological history, but the rate of extinction was perhaps one species every 1000 years. But man's intervention has speeded up extinction rates all the more. Between 1600 and 1500, the rate of extinction went up to one species every 10 years." (Chandrakar, 2012)

The major driver for the extinction of biodiversity is rapid urbanization leading to habitat loss, fragmentation, and increased level of pollution in water, air and soil, disturbance in the natural ecosystem process. As a result, the density of urban biodiversity substantially decreases. One study shows that decline in biodiversity decreases the capacity of

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ecosystems to maintain ecological processes such as nutrient cycling. Some researchers say that reduction in urban biodiversity affects human well-being and the probability of obtaining benefits from nature at individual and community levels decreases. Research on urban biodiversity has been carried out at various geographic areas and results that urban gardens provide a crucial habitat for urban biodiversity. Another research in the city and urban landscape scale reveals that urban areas can relatively contain high levels of biodiversity (Alvey, 2006). Various experimental studies were conducted to enhance biodiversity by significantly increasing the diversity of plants in urban gardens. The concept of butterfly garden was introduced to conserve and protect these pollinators.

Further many papers have investigated the impact of urbanization on butterflies, which shows that urbanization has a strong negative impact on species richness and abundance. Research has also been done to find the significance of butterfly garden and urban gardens; it has proven to attract many species of butterflies as well as other species and also shows that butterfly -friendly gardening practices are efficient to conserve the butterfly species irrespective with the level of surrounding urbanization. It is recommended to enhance the number of green areas in cities with native species as discovered in a study that "Native bird species diversity has been shown to decline with an increase in exotic plant species in Delhi, and the same has been found in other cities in the world". (Khera, 2009) Some studies also reveal that soil fauna increases with increase in plant diversity and reduction in soil activity such as tilling, which will strongly influence the ecosystem function and services.

There have been many studies that disclose the services provided by the urban garden. Most of the recent studies state that people in urban areas have lost a connection with nature and have highlighted the importance of ecosystem services provided by the urban garden, for human well-being. Nature exposure is important for human mental and physical well-being. A research study reveals that green spaces contribute considerably to improve the e urban climate and mitigate the urban heat island effect. Urban plants can affect the local air pollution via removal of air pollution and effects on local microclimate. Urban gardens help to maintain good air quality and decrease the heat island effect which is a major issue in urban environments. Integration of this holistic perspective of green spaces and human nature interrelation, many infrastructure policies have been proposed and implemented after research studies.

For any conservation activity people engagement is necessary and it is important to spread awareness among the general public and hence a method to educate people about the importance of biodiversity needs to be fostered. Some studies are made on people- biodiversity interaction and states that more interdisciplinary studies are required to further explore the people–biodiversity interactions, if urban gardens are properly managed, we can partly counterbalance the deleterious effect of urbanization. Research also states that over half of the world's population lives in urban areas documented in the UN report 2018, and this number may increase in future as more and more humans keep shifting in urban areas, which can result in decline in biodiversity and people may lose connection with nature. But with some wisdom and enthusiastic group of people, nature can be bought back in urban spaces where biodiversity can thrive and people live healthier and harmoniously with nature.

III. MATERIAL AND METHODOLOGY

Project Site

Somaiya Vidyavihar Campus is situated at Central east of Mumbai, Maharashtra, India at 19° 04'23.26", 72° 53'51.33" E and elevation of 15ft. Somaiya Campus is surrounded by gardens, grounds with different trees, shrubs and herbs. The site chosen for the setting up the garden is north of the campus hostel premises selected as per the requirements mentioned below. The Google earth image of the garden developed area is depicted in Fig 1.

Landscaping of Garden

The plot of land about 10,000sqft was approved to develop the garden. It was an open space before and then developed into a different species habitat of birds, insects and butterflies. We started with the ground development and plantation considering these three requirements:

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Fig 1: Biodiversity Garden at Somaiya Vidyavihar Campus

Sun Exposure: The garden should receive at least 5-6 hours of sunlight a day preferably southern sun. Butterflies use morning sunlight for basking as butterflies are cold blooded, they need sunlight to maintain their body temperature. As animal diversity depends on plant diversity, it is important to locate the plants in an area that receives the most sun throughout the day so that the plants will thrive.

Protection from High Winds: Butterflies need to be protected from intense winds, gardens should be protected by fences or trees, this shelter on the edges of your garden. Shelter can be created by planting shrubs or trees such as Ashoka (Polyalthia longifolia). The tree is also a host plant of Tailed Jay and Common Jay butterflies and houses many insects' diversity.

Access to Water: A water source was sprinkler system or hose hookup that is near your garden. Having a garden with all the above suitable requirement has increased the chances of attracting biodiversity to the garden, and maintaining the garden as a healthy ecosystem.

Landscape of Garden

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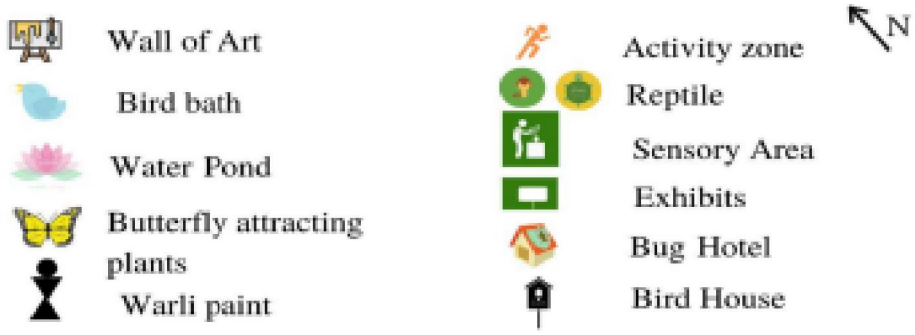

Fig 2: Landscape of Biodiversity Garden

Survey and Identification of Faunal Diversity

After the development of the garden, a study was conducted on a daily basis for 3 months. The findings presented are based on the field survey on a daily basis. The method used for the survey was random count. A preliminary survey was carried out before the development of the garden. Checklists of flora and fauna were prepared. Photographs were taken for positive identification; the species found was identified using reference books, taxonomy keys and expert's opinion.

Tracking the Use of Biodiversity Habitat and Resource

Though the diversity count has been studied in the garden, the use of habitat and resources within the garden is relatively less understood. Plant diversity is important for the faunal diversity. "Behaviour and resource use are necessary in assessing landscape ecological value of species which will help in understanding the conservation value of the park". (Tam, 2016)

Understanding the Nature Food Chain

There is a special vegetation area planted specifically for butterflies which consists of host and nectar plants to attract butterflies, a survey has been made to understand the prey predator relationship in the garden.

Study of Butterfly Life Cycle

Lifecycle of 2 butterflies were recorded which includes species of tiger and lime butterfly. The butterflies were not reared but rather observed in its natural environment. The findings presented are based on the field survey on a daily basis.

Requirements as a Business Model

Designing of Nature Trial

Biodiversity garden becomes a hands-on science experience for the students to learn about plants, insects and environment. The study of metamorphosis of butterflies, interesting facts about birds, student's enthusiasm is exciting. This knowledge is shared and students take their individual effort to protect the diversity by starting to plant nectar and host plants at their home. So, we design nature trails accordingly based on the visitor's age, syllabus, course and subject. We also add fun learning and activities to make sure they learn and take on nature's wonder with them and remember it for long.

Biodiversity Garden as a Business Model

The biodiversity garden is an Eco- entrepreneurship model, where the environment and the business must be balanced. We worked on some elements of business during the workshop, which helped us at the later stages. Some essential elements like cost benefit analysis, USP, competitive profiling, identification of target audience and risks were studied. Some measures include profitability index, internal rate of return, Present value.

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IV. EXECUTION

After the project initiation and the planning processes, the execution of the project began. Project execution's key purpose was to complete the work defined in the project plan and to meet key project objectives.

Approval for the project site of an area of approximately 10,000 sq. ft which is opposite to the Somaiya Institute of Management Studies at Somaiya Vidyavihar Campus was sanctioned. As per the pre-planned schedule the ground development process should have been started by the month of august, but due to prolonged precipitation in the year 2019 till the month of mid-November the project couldn't initiate the process. By the end of November, the project started with a full swing.

1. Designing

Architect was appointed for designing the garden layout. The plan had 2 mounds and 5 flat beds, the mounds were for plantations and 2 flat beds for the activity zone. The area of each mound and the flat Bed are mentioned in Table 1

Sr. No	Plot	Area
1	Existing lily plot	110sq m
2	Mound 1	45sq m
3	Mound 2	103sq m
4	Flatbed 1 (sensory zone)	24sq m
5	Flatbed 2	10sq m
6	Central Mound	20sq m
7	Flatbed 3(activity area)	100sq m
8	Flat Bed 4	20sq m
9	Flat Bed 5 (host area)	28sq.m
10	Footpath	150.91 sq m

Table 1: Area and different zones in the Biodiversity Garden

2. Ground Development

The pathways were dug and filled by grit powder and the mounds were made with the addition of red soil and fertilizer. It took about 1 month to complete the process. The garden was fenced by a pigeon net and the mounds were demarcated with bricks and rocks.

3. Components of Garden

- Sensory zone (Flatbed 1)

  A sensory zone consists of plants with different colors, textures, smell and taste has been planted. Plants for this zone were selected peculiarly. The main purpose of the Sensory Garden was to stimulate senses and engage one's senses of sight, smell, touch and taste. One can enjoy a wide variety of sensory Experiences. Plants with scent such as Lemon grass, Merwa, Tulsi, Vekhand, Blooming flowers with different color like Flaming katy, Roses and leaf with different textures and colors like Persian metallic shield, Eranthemum, Tapioca and many more.

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- Bird bath
  Birdbath and bird homes have been added to attract birds.2 bird baths with different heights have been placed.

- Artificial Pond
  An artificial pond consisting of beautiful lotus, Fishes (guppies) has been added to control the breeding of mosquitoes they feed on the larvae of mosquitoes and many aquatic vertebrates and invertebrates have been spotted.

4. Plantation

Plant Types

- Host, nectar and alkaloid plants for butterflies and moths
- Nectar plants for bees
- Fruit and flower plants for birds and bats

Plant Varieties

- Native species
- Ornamental species
  The Plant categories cover the maximum area of the garden, with approximately 10 inches spacing between the saplings. The approximate quantity of plants was calculated with the help of the project office team with respect to the area. Plants were procured from Pathare The list of plants and their function has been mentioned in table 2.

Common name	***Scientific name***	***Function***	***Purpose/Attracts***
Ajwain	*Trachyspermum ammi*	Sensory	
Allamanda	*Allamanda cathartica*	Nectar plant	Great Eggfly,Grey Pansy,Orange Tip,Three spotgrass yellow
Ambemohor	*Pandanus amaryllifolius*	Sensory	
Aralia Golden	*Polysciasfruticosa*	Ornamental	
Arrowhead plant	*Syngonium podophyllum*	Ornamental,Sensory	Vision
Bamboo Grass	*Pogonatherum paniceum*	Nectar plant,Sensory	Dark Palm-Dart
Beetel	*Piper betle*	Sensory	Taste
Big Hemigraphis	*Hemigraphis alternata*	Ornamental	
Begonia	*Begonia semperflorens*	Sensory	Vision
Blue Hydrangea	*hydrangea*	Ornamental	

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	macrophylla		
Bryophyllum	*Bryophyllum pinnatum*	Host plant	
Buddha Belly Bamboo	*Bambusaventricosa*	Nectar plant,Sensory	Dark Palm-Dart
Cypress	*Cupressus spp*	Ornamental	
chlorophytum / Spider plant	*Chlorophytum comosum*	Ornamental	
Cuphea	*Cuphea hyssopifolia*	Nectar	Oriental Common Grass Yellow,Oriental Dark Palm-Dart,Oriental Psyche
Curry leaves	*Murrayakoenigii*	Host plant	Common mormon
Dalchini / Cinnamon	*Cinnamomum verum*	Sensory,Host plant	Smell,Oriental Common Mime
Dasmuli	*Eranthemumroseum*	Host plant	Common Spotted Flat
Firebush	*Hamelia patens*	Nectar plant	Lemon Emigrant
Flaming katy	*Kalanchoe blossfeldiana*	Host plant	Red Pierrot
Flax lilies	*Daniela*	Ornamental	
Fountain grass	*Pennisetum setaceum*	Ornamental	
Gokarna	*Clitoriaternatea*	Ornamental,Nectar plant	Common Emigrant
Gunj	*Arbus precatorious*	Sensory	Taste
Holy Basil	*Ocimumbasilicum*	Sensory	smell, Taste
HaldiKunkun	*Asclepias curassavica*	Host plant	Plain Tiger,Striped Tiger,Blue Tiger
Jamican spike	*Stachytarpheta jamaicensis*	Nectar plant	Common jay,Tailed jay,Common Emigrant
Jatropa	*Jatropha curcus*	Nectar plant	Plain Tiger,Striped Tiger
Juniper	*Juniperus spp.*	Ornamental	

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Kardal	*Canna indica*	Ornamental	
Lantana	*Lantana montevidensis*	Nectar plant	Great Eggfly,Grey Pansy,Tailed jay,Common Emigrant,Common crow
Lollipop	*Pachystachys lutea*	Ornamental	
Lemon	*Citrus limon*	Host plant	Lime Butterfly
Lemon Grass	*Cymbopogon flexuosus*	Sensory	Smell
Maranta ornata	*Calathea ornata*	Ornamental	
Marwa	*Origanum majorana*	Sensory	Taste
Melastoma	*Melastoma malabathricum*	Ornamental, Nectar plant	Peninsular Grey Count
Merantabicolor	*Calathea bicolor*	Ornamental	
Mini Tagar	*Tabernaemontana*	Nectar plant	Indian Wanderer,Demon grass
Mulberry	*Morindacitrifolia*	Attracts birds	
Nirgudi	*Vitex negundo*	Nectar plant	Indian Palm Bob,Tawny Coster,Blue Tiger,Common Jay,BrownAwl,Common Crow,SahyadriDartlet
Passion Flower	*Passiflora*	Ornamental, Host plant	
Pendanus / screw pine	*Pandanus amaryllifolius*	Ornamental	
Periwinkle	*Catharanthus roseus*	Ornamental	Grass demon,Lime Swallowtail,Indian Jezebel
Pink Ixora	*Ixora coccinea*	Nectar plant, Host plant	Indian Blue Mormon,Lime Swallowtail,Common Mormon,(Monkey Puzzle)
Plectranthus / Spurflower	*Plectranthus*	Ornamental	

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Plumbago	*Plumbago zeylanica*	Nectar plant, Host plant	Sahyadri Great Orange tip,Asian Zebra Blue
Pudina	*Mentha piperita*	Sensory	Taste
Purple persian shield plant	*Strobilanthes dyeriana*	Sensory	vision, touch
Purple Waffle plant	*Hemigraphis alternata*	Sensory	Vision
Red Fountain Grass	*Pennisetum setaceum*	Ornamental	sound
Red Ixora	*Ixora coccinea*	Nectar plant, Host plant	Indian Blue Mormon,Lime Swallowtail,Common Mormon
Ribbon grass	*Phalaris arundinacea*	Ornamental	
Rose	*Rosa spp.*	Ornamental,sensory	Vision
Ruellia	*Ruellia simplex*	Host plant	Chocolate Pansy, Lemon Pansy,Tiny Grass Blue
Rui	*Calotropis procera*	host plant	Tiger spp.
Shatavari	*Asparagus racemosus*	Ornamental	
Tapioca	*Manihot esculenta*	Ornamental	Vision
Vekhanda	*Acorus calamus*	Sensory	smell
Vetiver	*Chrysopogon zizanioides*	ornamental	
Wishbone flower	*Torenia spp.*	Ornamental	

Table 2: List of plant in the garden with functions

Finance of Biodiversity Garden.

Expenditure for the development Biodiversity Garden

Recipient of Grant	K J Somaiya College of Science and Commerce
Title of Project	The Biodiversity Garden
Reporting Period	'March 2020'

Sanctioned Grant: INR 3, 12,750 (4500 USD)

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PARTICULARS	QUANTITY	Total (Rs)
Materials and Ground Development		
Bhoomi services for supply and preparation of garden		1,60,554
Procurement of plants from Pathare nursery Kalyan	1250	26510
Additional plants from Pathare Nursery	107	2,290
Design development for garden by Architect		15,000
Total		**2,04,354**
Education Materials		
Signages for plants (Sensory zone)	13	2720
Signages for plants (Host/ Nectar plants)	7	
Signages for plants (trees)	20	
Fabrication of signages	40	3360
Development of exhibits [2x2(1)] [4x3(10)]	11	46,079
Development of animal homes		0
Bird baths		
Bird homes		
Printing of the Nature trail guide book	150	10,050
Total		**62,209**
Travel Expenses for procurement of plant		2500
Travel Expenses for team members		807
TOTAL		**3307**
Workshop		
Honorariums	Workshop 1	20,000
	Workshop 2& 3	20,000
Total		**40,000**
Creatives		
Pebbles	22 kg	1040
Paints	9 shades	1550

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Brush and Tyre	4	290
Total		**2880**
TOTAL		**3,12,750**

Table 3: Finance of the biodiversity garden

V. OBSERVATIONS

Project monitoring is focused on tracking project performance, progress, links the activities to the objectives and also potential risks and obstacles that if left unaddressed. Biodiversity refers to diversity between different plants, animals and other species in a given habitat. Insects are important components of biodiversity, which are closely related to plants. Insect variations help us to determine ecosystem health. Butterflies are the insects belonging to the order Lepidoptera, excellent in environmental and plant biodiversity indicators as they rapidly decline with severe environmental destruction and pollution.

Butterflies are important pollinators for flowering plants; they bring about sexual reproduction which is important in giving rise to the natural plant varieties and hybrids. Butterflies are important flagship species for insect conservation, because of their important service in environmental quality assessment. With all the important features mentioned above butterflies are easy to find, measure and also have high reproductive rate, hence butterflies have been studied in detail with respect to their behaviour, habitat and resource requirement have been quantitatively assessed to evaluate the ecosystem health. A preliminary and post survey before and after the development of biodiversity gardens was studied. Species richness was quantitatively accessed.

A). A preliminary and post survey before and after the development of biodiversity gardens was studied. Species richness was quantitatively accessed.

PRE-SURVEY

Survey Period: 3 August 2019- 3 September 2019

Fauna Pre-Survey	
Common Name	Scientific Name
BUTTERFLIES	
Palm fly	*Elymniashypermnestra*
Painted lady	*Vanessa cardui*
Common jay	*Graphiumdoson*
Grey Pansy	*Junoniaatlites*
Common crow	*Euploea core*
Common Emigrant	*Catopsilia Pomona*
BIRDS	
Purple Rumped sunbird	*Leptocomazeylonica*
House sparrow	*Passer domesticus*
Magpie robin	*Copsychussaularis*

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Common myna	*Acridotheres tristis*
INSECTS	
Long Horned bettle	
Bark praying mantis	*Gyromantiskraussii*
Blue bottom fly	*Calliphora vomitoria*
MAMMAL	
3 Striped Squirrel	*Funambulus palmarum*
REPTILE	
Oriental garden lizard	*Calotes spp.*

Table 5: Post-survey of the site

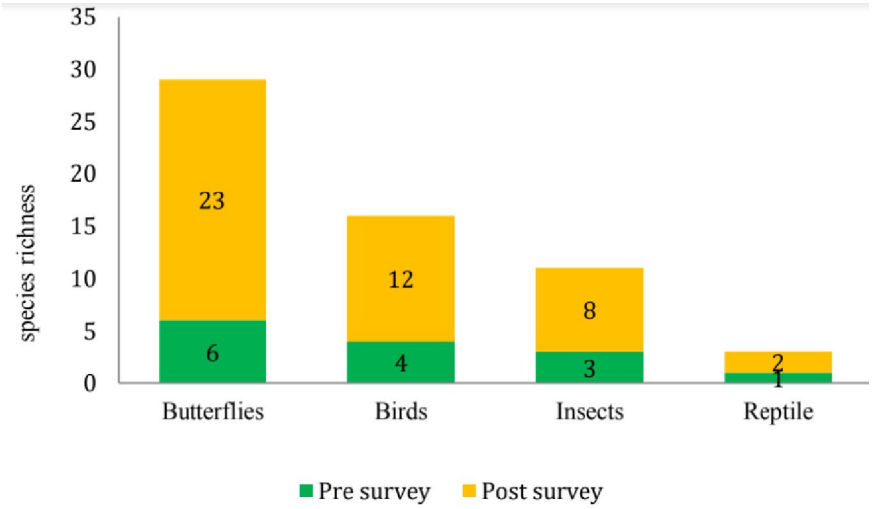

Fig 3: Species richness with recorded before and after the development of Biodiversity Garden

All the scientific names followed in the present study are in accordance with their common name. Photographs were taken for positive identification. The photographs are attached in the appendix. The species richness was calculated, and it results that introduction of Biodiversity Garden has added a net worthy addition of diversity to the Somaiya campus. The butterfly diversity has increased, which can be a result of the addition of butterfly attracting plants. The bird and the lizard population has also increased which is reducing the larvae of butterflies in a short time, so certain conservation methods can be adapted to preserve the larvae.

B) Survey of Butterflies: Butterflies are considered good environmental indicators, so an assessment of butterfly species diversity was carried out at Biodiversity Garden in Somaiya campus consisting of various host and nectar plants to evaluate the health of the ecosystem. A comparative analysis of butterflies was made before and after the development of the biodiversity garden. Percentage of occurrence was calculated to determine the status and studied their relative abundance. Different butterfly behaviour was observed during the study. Therefore, it can be stated that development of such gardens can restore the habitat to some extent and can offset the effects of anthropogenic interference.

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.301
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Pre-Survey (Butterflies)

Common name	*Scientific name*	*Family*	*Relative Abundance*
Palm fly	*Elymniashypermnestra*	Nymphalidae	Common
Painted lady	*Vanessa cardui*	Nymphalidae	Less common
Common jay	*Graphiumdoson*	Papilionidae	Common
Grey Pansy	*Junoniaatlites*	Nymphalidae	Less common
Common crow	*Euploea core*	Nymphalidae	Common
Common Emigrant	*Catopsilia Pomona*	Pieridae	Common

Table 6: Pre-survey of butterflies

Post Survey (Butterflies)

Common name	Scientific name	Family	Relative Abundance
Forget me not	*Catochrysops Strabo*	Lycaenidae	Rare
Red Pierrot	*Talicadanyseus*	Lycaenidae	Common
Lineblue	*Prosotasnora*	Lycaenidae	Rare
Zebra blue	*Tarucusplinius*	Lycaenidae	Rare
Lime Butterfly	*Papiliodemoleus*	Papilionidae	Common
Common jay	*Graphiumdoson*	Papilionidae	Less Common
Tailed jay	*Graphiumagamemnon*	Papilionidae	Common
Common Mormon	*Papiliopolytes*	Papilionidae	Common
Tawny Rajah	*Charaxesbernardus*	Nymphalidae	Rare
Great Eggfly	*Hypolimnasbolina*	Nymphalidae	Less Common
Commander	*Moduzaprocris*	Nymphalidae	Rare
Striped tiger	*Danaus genutia*	Nymphalidae	Common
Plain tiger	*Danaus chrysippus*	Nymphalidae	Common
Blue tiger	*Tirumala limniace*	Nymphalidae	Common
Palm fly	*Elymniashypermnestra*	Nymphalidae	Common
Chocolate Pansy	*Junoniaiphita*	Nymphalidae	Rare

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Lemon Pansy	*Junonialemonias*	Nymphalidae	Rare
Peacock Pansy	*Junonia almanac*	Nymphalidae	Rare
Grey Pansy	*Junoniaatlites*	Nymphalidae	Rare
Common Baron	*Euthaliaaconthea*	Nymphalidae	Less Common
Common Crow	*Euploea core*	Nymphalidae	Common
Common Emigrant	*Catopsilia Pomona*	Pieridae	Common
Common grass yellow	*Euremahecabe*	Pieridae	Less Common

Table 7: Post Survey of butterflies

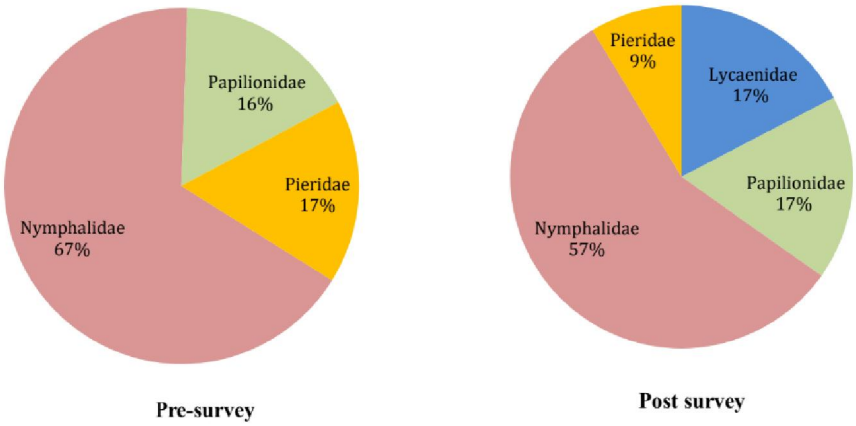

Fig 4: Family wise composition of Butterfly

In the study new species of butterflies have been sighted which was not recorded previously before the development of the biodiversity garden. No species of the Lycaenidae family was found earlier. During the study, some butterfly behaviour was observed in the garden which is defined in Table 8. Comparison of family wise composition is shown in fig 4; checklist in Table 4 and Table 5 which shows that species richness has increased. These results that butterfly diversity can be enhanced by setting up the garden, if suitable plants are planted. These observations on butterfly diversity will serve as the basis for the future studies on the ecology, biology and conservation of butterflies.

Behaviour	**Definition**
Feeding on nectar plant	Sucking nectar by proboscis from flower of plant
Feeding on fruits and concoction	Butterflies feeding on rotten fruits and concoction
Courtship	Male butterfly chasing after female butterfly in flight
Coupling	Male and female butterfly in mating position
Directed flight	Butterfly flying without stop
Oviposition	Female butterfly oviposition its egg on plant

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Puddling	Butterfly sucking water or liquids from the ground
Sun basking	Resting with its wing open facing towards the sun
Territory Guarding	Butterfly usually male, guarding a position by chasing after theinvading or nearby butterflies

Table 8: Butterfly behaviour observed in the garden

Vegetation

Grassland

Tree-cover

Open Zones

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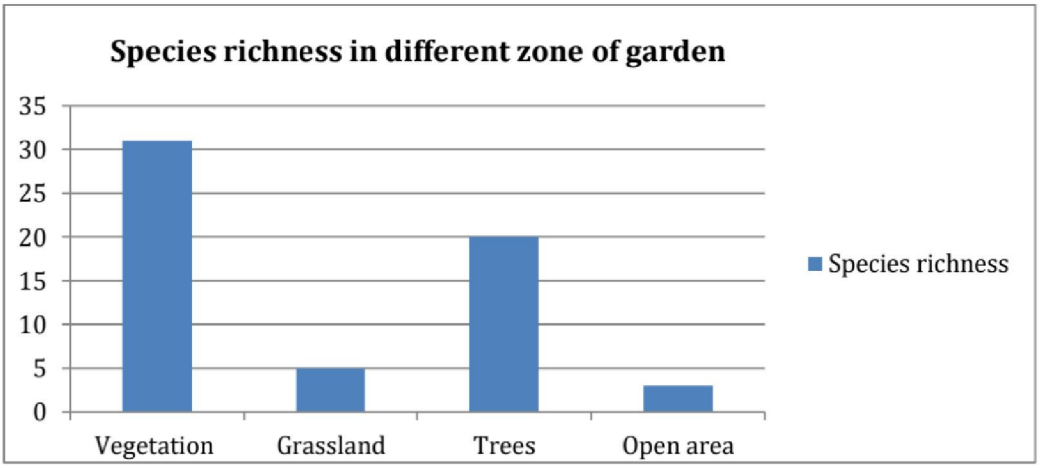

Fig 5: Types of zones in Garden

The majority of butterflies were observed feeding and resting in the vegetation zone and directed flight was observed in the majority in open areas. The birds were recorded from the tree zone and open area. Butterflies flew through open areas nonstop at a high frequency with different behaviour observed (courtship flight, tracking vegetation). It was observed that butterflies need all these four zones to complete their life cycle, so providing all the four
zones in the garden can enhance the efficiency of butterfly biodiversity. The birds were also found in the grassland feeding on caterpillars or macro invertebrates, similarly butterflies such as Red pierrot and line blue flew mostly in the grass patches. Many butterflies evidently make consistent use of non- native species; Lantana camara is an invasive (non- native) species 48% of butterflies in the garden feed on this non-native flowering plant results that urban butterflies are adapted to non-native species. The host plants have been used by butterflies to lay eggs, lime butterfly was found to have a close association with Lemon and Red pierrot with Bryophyllum; behaviour like breeding, oviposition, eggs, larvae and chrysalis was found which indicates that butterflies uses the resources and habitat.
The combination of all the 4 zones, with a major zone consisting of vegetation and trees (native species) will enhance the diversity of butterflies in a given area. Understanding Butterflies. The life span of a butterfly is comparatively short at around one to two months from its egg stage to the adult butterfly stage.

The four life stages of a butterfly are
(1) Egg
(2) Larva [caterpillar]
(3) Pupa [chrysalis]
(4) Adult butterfly
Butterflies begin their life as an egg that is “laid on or near its host plant species.” Butterfly species has very specific plant food requirements for its caterpillars. There is a limited range of host plants that the mated adult female actively seeks out to lay her eggs. A host plant is that plant species where butterfly larva (caterpillar) feeds on during its time before it becomes a butterfly. Every species of butterfly has a specific host plant. For example, lemon is the only host plant for the Lime butterfly. Upon hatching from the egg, the caterpillar spends its entire time feeding on the leaves of its host plant to build its body mass before morphing into a dormant pupal stage.
Pupal stage is turning into chrysalis; during this time the caterpillar is ready to turn itself into a butterfly. When the butterfly emerges from the chrysalis it collects nectar from flowers of its nectar plant, seeking a mate, laying eggs, feeding other sources such decomposing fruits and animal carcasses to sustain. For a developed garden landscape, there are limited food sources, and it is essential to plant a wide variety of flowering plants that will serve to provide nectar to the butterflies. Understanding the life cycle and evolutionary adaptation of butterflies on being specific about the host plants the egg or the larvae can be spotted and the lifecycle of the butterflies can be observed, Similarly, 2 butterflies life cycles i.e., metamorphosis was recorded which includes lime butterfly and tiger butterfly on their host

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Impact Factor: 7.301
Volume 3, Issue 3, March 2023

plants Lemon (Citrus limon) and Bloodflower (Asclepias curassavica) respectively. Photographs were taken at different stages for identifying and record keeping.

Lifecycle of a Tiger butterfly

Lifecycle of a Lime butterfly

VI. RESULT AND DISCUSSION

The garden is well developed with all the events and components covered under the sanctioned amount of INR 3,12,750. Within an area of 10,000 sq.ft we tried to add different habitat features to attract the biodiversity which includes insects, birds and butterflies. The above results give us an insight on how biodiversity gardens in urban areas can support a diversity of species. There were 23 different species of butterflies, 12 species of birds, 11 species of insects recorded in the Biodiversity Garden. A Checklist made before and after the development of Biodiversity Garden, results in increase of the biodiversity, a new butterfly Family (Lycaenidae) which wasn't seen earlier was recorded and many new insects have been identified. The biodiversity garden was net worthy addition to the existing diversity of the Somaiya Campus, it has enhanced due to the plantation of suitable plants and creating suitable habitat, with butterflies belonging to the Nymphalidae were found to be maximum (57%) over 3 other families.10 species of common, 9 species of rare and 4 less common species of butterflies were found.

The study of the resource use by the butterfly species suggests that butterflies utilizes four different zones in garden (grasslands, artificial vegetation, trees and open areas), it results that it requires all kinds of vegetation for survival of larval, pupal and adult stage, their ideal habitat should be a mixture of grasslands, vegetation, trees and open areas. The vegetation consisting of host and nectar plants and native trees can be increased in a given space. This helped us to understand the resource use by species to enhance the conservation effort in future project plans. Caterpillars found on the host plant indicate that some butterflies choose their homes in the garden for completing their life cycle. There was a noticeable decline of caterpillars. When analysed, few things are evident. Due to fewer plantations of host plants the adult female butterfly didn't have enough plants to lay eggs. Natural enemies (Garden lizards, Birds and Insects) induced mortality of the caterpillars; overall survival of caterpillars was lower in the garden, which can be corrected by planting more host plants.

The study was conducted over a short period of time within 1 month after the development of the biodiversity garden. Nevertheless, diversity seen in the garden is good enough in that period of time in an urban environment. The

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Naturalist training program provided its volunteer's skills to be a successful Naturalist and some of them also led a batch of students for Nature trail in the Biodiversity Garden. The nature trail conducted at the biodiversity garden acknowledged the students with urban biodiversity and importance of urban gardens and its role in conserving biodiversity. The nature trails will promote a sense of belonging and a responsibility towards nature helping to make better future plans related to environment conservation.

In the morning and evening senior citizens visited the garden, we interacted with some of them on how they feel about the biodiversity garden, most of them did appreciate the sensory zone in the garden and their medicinal value, the exhibits and their content was also enjoyed by them. They even shared how they feel peaceful and fresh in the garden. They were interested to attend the nature trail and know more about the urban biodiversity.

Biodiversity Garden has accomplished all the goals and potentially plays an important role in mitigating the loss of biodiversity due to urbanization, shaping pro-environmental attitude in children,and has proven to be sustainable in terms of social, economic and environmental aspects.

VII. CONCLUSION

Biodiversity garden is an innovative nature-based solution supporting beautiful ecology and economy and a program enable people to experience nature and help addressing environmental and social justice concerns. The diversity has been attracted and education has been facilitated. This unique sustainable urban garden concept has further encouraged citizens to protect the urban biodiversity and development towards bio economy. The information observed above will allow us to understand the changes in distribution over time. The concept of Biodiversity Garden can be integrated with urban design, providing pleasant space for citizens, conserving biodiversity and also providing employment opportunities. This unique business model can be replicated across the globe, serving as a useful tool in decision making for conservation initiatives.

VIII. RECOMMENDATION

1. When developing a garden select a suitable location with availability of light, water supply.
2. While planting consider sunlight requirement shade loving plants to be planted at shady regions and sun loving plants to be planted at the region where sunlight is available throughout the daytime.
3. Take care when spacing plants, keep distance in-between plants.
4. Apart from flower nectar, butterflies also get minerals from rotten fruits and peels, which can be easily placed in the garden.
5. For attracting butterflies, presence of all such areas zones (grasslands, artificial vegetation, trees and open areas) in a garden will turn out to be favourable for dwelling of various species of butterflies as well as other species, and in turn, has contributed to the status of a healthy ecosystem of the biodiversity garden.
6. It is recommended to plant more host plants to increase the survival rate of caterpillars and also make sure to keep them isolated with less human interference. Care has to be taken to decrease effects of bird and reptile predator and human disturbance.
7. Native trees can be planted which appears to be habitat for more species like Mango, Peepal, Banyan instead of Gulmohor (Delonix regia) or Copper pod (Peltophorumpterocarpum) along the streets.
8. Go for organic gardening, avoid using pesticides which will affect the pollen as well as pollinators instead introduce natural enemies for the pest or parasite, like Guppy fishes in the pond will feed on mosquito's larvae and reduce their breeding.
9. Encourage people to plant curry leaves, bryophyllum and lemon in their balcony. We cannot reverse the negative effects of urbanization and development, but we can reduce them by utilizing available green space and planting trees and plants which support biodiversity. The Biodiversity Garden established in an urban environment to some extent has restored the habitat. Apart from accomplishing the goals the urban garden also improves mental health, promotes relaxation, positively impacts the urban microclimate and can improve economic opportunities by training volunteers and conducting nature trails. Therefore, a biodiversity garden is a unique approach for eco-restoration. Conservation is facilitated with suitable measures taken to mitigate urbanization and human

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Impact Factor: 7.301
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interference providing services of social benefits, education and spreading the awareness on the importance of having such unique green space in an urban environment.

REFERENCES

For the development of the biodiversity garden, we had a field visit to the existing butterfly garden in and around Mumbai, to get a few ideas and initiate the project. We interacted with the project manager and gardener about their experience and maintenance. We also noticed the success rate, the biodiversity count and the project expenditure as well; this gave us a rough estimation and idea on working on our plan.

The field areas we visited are as follows –

1. Sacred Heart High School, Vashi
2. NASEOH, Chembur
3. Tata Serein, Thane
4. YMC Tara, Panvel
5. Urban Haat, CBD, Belapur
6. C.D. Deshmukh Udyan, Mulund.

Ladybird Environmental Consulting LLP (LEC) was appointed to execute the project.

URBAN HATT

- CBD Belapur, Navi Mumbai
- Managed by CIDCO
- The area with good number of local birds and butterflies
- 12 acres land

CD Deshmukh Udyan

- The duration of project work on site was 2 months.
- OASIS and Tata Motors Ltd. Are the stakeholders.
- Impact of project: Increased visit and awareness amongst public.
- Used for educational visits and craftsmen and artisans sell their products at fairs conducted. • Increased biodiversity of the area.

NASEOH Chembur, Mumbai

- Saplings were planted by the employees of Videojet Technologies India Pvt. Ltd. Mortality rate of 0%.
- Maintenance by the physically handicapped and disabled people.
- Sustainable for the local fauna and different types of birds and butterflies visit every now and then.

Sacred Heart High School, Vashi

- A project was implemented by United Way Mumbai.
- 100 saplings were planted.
- The aim of this project was to support local diversity of butterflies.
- The plants have grown well and have covered the whole garden.

Sr no	Name	Capital investment	Species count (Butterfly)	Species count (plants)	No. of employee
1	Urban Haat	Rs.2,05,260/-	28	100	25
2	YMCA	Rs. 3,75,890/-	23	1000	10+

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3	Sacred Heart High school	Rs. 1,68,480/-	13	200	7+
4	NASEOH	Rs. 2,80,600/-	32	500	12+
5	Chintamani Deshmukh	Rs. 3,55,000/-	14	600	6+

[1] 10 Ways Urban Farms Benefit the Community. (2016, March 1). Retrieved from the ecology centre, https://www.theecologycenter.org/10-ways-urban-farms-benefit-the-community/
[2] Bilodeau, S. (2019, February 6). The Importance of Urban Gardening. Retrieved from farm the world,gardening: https://farmtheworld.org/2019/02/06/urban-gardening/
[3] IssacKehimkar, 2008, The Book of Indian Butterflies, Bombay Natural History Society. KrushnameghKumte, 2000, Butterflies of Peninsular India, University press(Indian) Pvt. Ltd Almeida, M. (2009). Trees of Mumbai. Mumbai: Bombay Natural History Society.
[4] (n.d.).Alvey, A. A. (2006). Promoting and preserving biodiversity in the urban forest. Urban Forestry & Urban Greening, 5(4), 195-201.
[5] Anderson, A. (1998/04/01). Cultivating the garden of Eden: Environmental entrepreneuringJournal of Organisational Change Management, 135-144.
[6] Aronson, M. F. (n.d.). Lerman, S. B., MacIvor, J. S., ... & Vargo, T. (2017). Biodiversity in the city: key challenges for urban green space management. Frontiers in Ecology and the Environment, 15(4), 189-196.
[7] Banerjee, A. U. (2016). Urbanisation and greening of Indian cities: Problems, practices, and policies. Ambio, 442-457.
[8] Benoit Fontaine, B. B. (6 september 2016). Impact of urbanization and gardening practices on common butterfly communities in France. Ecology and Evolution, 8174- 8179.
[9] Bryant, B. M. (2006). Urban landscape conservation and the role of ecological greenways at local and metropolitan scales. Landscape and urban planning, vol. 76, no. 1-4, pp., 23–44.
[10] Burghardt, K. T. (2009). Impact of native plants on bird and butterfly biodiversity in suburban landscapes. Conservation biology, 23(1), 219-224.
[11] Cabral, M. (2017). Ecosystem services of allotment and community gardens: A Leipzig, Germany case study. Urban Forestry & Urban Greening, 44-53.
[12] Chamberlain et al. (2004)Chamberlain, C. a. (2004). Associations of garden birds with gradients in garden habitat and local habitat. Ecography, vol. 27, no. 5, pp., 589–600.
[13] Chandrakar, A. K. (2012). Biodiversity Conservation in India.
[14] Chowdhury, S. (2017). Butterfly diversity in a tropical urban habitat. Oriental Insects, 417- 430.
[15] Chua, G. (n.d.). Creating butterfly habitat and gardens to enhance urban biodiversity. CITYGREEN, 110-118.
[16] Culin, J. D. (1997). Relationship of butterfly visitation with nectar qualities and flower colorin butterfly bush. Buddleia davidii. News Lepid. Soc, 39, 35-38.
[17] Debapriya Chakraborty Thakur, P. C. (2017). An approch for butterfly conservation through setting up a gardern in an urban area,Kolkata, India. World scientific news, 69-85.
[18] Dennis, M. (2017). Ecosystem services of collectively managed urban gardens: Exploring factors affecting synergies and trade-offs at the site level. Ecosystem Services.
[19] Gairola and Noresah(2010)] S. Gairola and M. Noresah, "Emerging trend of urban green space research and the implications for safeguarding biodiversity: a viewpoint," Nature and science, vol. 8, no. 7, pp. 43–49, 2010.
[20] Garden et al. (2010)Garden, McAlpine, and Possingham] J. G. Garden, C. A. McAlpine, and H. P. Possingham, "Multi-scaled habitat considerations for conserving urban biodiversity: native reptiles and small mammals in brisbane, australia," Landscape Ecology, vol. 25, no. 7, pp. 1013–1028, 2010
[21] Goddard et al.(2010)Goddard, Dougill, and Benton] M. A. Goddard, A. J. Dougill, and T. G. Benton, "Scaling up from gardens: biodiversity conservation in urban environments," Trends in ecology& evolution, vol. 25, no. 2, pp. 90–98, 2010.

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.301
Volume 3, Issue 3, March 2023

[22] HamitAybrek, S. B. (2015). Butterfly gardening. ResearchGate, (p. 31). Turkey. Hildebrandt, S. (2016). Urban Gardening in Pune and Mumbai, India. Mumbai and Pune.
[23] Hostetler et al.(2011)Hostetler, Allen, and Meurk] M. Hostetler, W. Allen, and C. Meurk, "Conserving urban biodiversity? creating green infrastructure is only the first step," Landscape and Urban Planning, vol. 100, no. 4, pp. 369–371, 2011.
[24] Hogg and Nilon(2015)] J. R. Hogg and C. H. Nilon, "Habitat associations of birds of prey in urban business parks," Urban ecosystems, vol. 18, no. 1, pp. 267–284, 2015.
[25] Idohou, R. (2014). Biodiversity conservation in home gardens: Traditional knowledge, use patterns and implications for management. International Journal of Biodiversity Science and Management.
[26] Jaganmohan, M. (2012/12/01). Plant diversity and distribution in urban domestic gardens and apartments in Bangalore, India. Urban Ecosystems.
[27] Julliard, B. F. (2016). Impact of urbanization and gardening practices on common butterfly communities in France.
[28] Kark, D. a. (2010). Motivations for conserving urban biodiversity. Conservation biology, vol. 24, no. 2, pp, 432–440.
[29] Kasambe, R. Butterfly fauna of the Sanjay Gandhi National Park and Mumbai, Maharashtra.
[30] Khera, N., Mehta, V., &Sabata, B. C. (2009). Interrelationships of birds and habitat features in urban greenspaces in Delhi, India. Urban Forestry & Urban Greening, 8, 187–196.
[31] Khot et al. (2013)Khot, Quadros, and Somani] K. Khot, G. Quadros, and V. Somani, "Ant diversity in an urban garden at mumbai, maharashtra," in National Conference on Biodiversity: Status and Challenges in Conservation-FAVEO, vol. 2013, 2013, pp. 121–125.
[32] Koh, L. P., & Sodhi, N. S. (2004). Importance of reserves, fragments, and parks for butterfly conservation in a tropical urban landscape. Ecological Applications, 14(6), 1695-1708.
[33] Kong et al. (2010)Kong, Yin, Nakagoshi, and Zong] F. Kong, H. Yin, N. Nakagoshi, and Y. Zong, "Urban green space network development for biodiversity conservation: Identification based on graph theory and gravity modeling," Landscape and urban planning, vol. 95, no. 1-2, pp. 16–27, 2010.
[34] Konvicka, M., & Kadlec, T. (2011). How to increase the value of urban areas for butterfly conservation? A lesson from Prague nature reserves and parks. European Journal of Entomology, 108(2).
[35] Kowarik(2011)] I. Kowarik, "Novel urban ecosystems, biodiversity, and conservation," Environmental pollution, vol. 159, no. 8-9, pp. 1974–1983, 2011.
[36] Langemeyer, J. (2014). The generation of ecosystem services in urban gardens from a socio ecological systems perspective. Stockholm.
[37] Langemeyer, J. M. (2016). Ecosystem Services from urban gardens. 116-141.
[38] Larose, L. (2019). Businesstown. Retrieved from Businesstownmembership: https://businesstown.com/start-gardening-business/
[39] Levy, J.M., Connor, E.F. Are gardens effective in butterfly conservation? A case study with the pipevine swallowtail, Battusphilenor . Journal of Insect Conservation 8, 323–330 (2004). https://doi.org/10.1007/s10841-004-0796-7
[40] McDonald et al. (2008)McDonald, Kareiva, and Forman] R. I. McDonald, P. Kareiva, and R. T. Forman, "The implications of current and future urbanization for global protected areas and biodiversity conservation," Biological conservation, vol. 141, no. 6, pp. 1695–1703, 2008.
[41] Muvengwiet al. (2019)Muvengwi, Kwenda, Mbiba, and Mpindu] J. Muvengwi, A. Kwenda, M. Mbiba, and T. Mpindu, "The role of urban schools in biodiversity conservation across an urban landscape," Urban Forestry & Urban Greening, vol. 43, p. 126370, 2019.
[42] Mu¨lleret al. (2013) Mu¨ller, Ignatieva, Nilon, Werner, and Zipperer] N. Mu¨ller, M. Ignatieva, C. H. Nilon, P. Werner, and W. C. Zipperer, "Patterns and trends in urban biodiversity and landscape design," in Urbanization, biodiversity and ecosystem services: Challenges and opportunities. Springer, Dordrecht, 2013, pp. 123–174.
[43] Nagendra et al. (2013) Nagendra, Sudhira, Katti, and Schewenius] H. Nagendra, H. Sudhira, M. Katti, and M. Schewenius, "Sub-regional assessment of india: effects of urbanization on land use, biodiversity and ecosystem

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.301
Volume 3, Issue 3, March 2023

services," in Urbanization, biodiversity and ecosystem services: Challenges and opportunities. Springer, Dordrecht, 2013, pp. 65–74.

[44] Niemel¨aet al. (2010) Niemel¨a, Saarela, S¨oderman, Kopperoinen, Yli-Pelkonen, V¨are, and Kotze] J. Niemel¨a, S.-R. Saarela, T. S¨oderman, L. Kopperoinen, V. Yli-Pelkonen, S. V¨are, and D. J. Kotze, "Using the ecosystem services approach for better planning and conservation of urban green spaces: a finland case study," Biodiversity and Conservation, vol. 19, no. 11, pp. 3225–3243, 2010.

[45] Önder, S., &Akay, A. (2014). The roles of plants on mitigating the urban heat islands' negative Effects. International Journal of Agriculture and Economic Development, 2(2), 18.

[46] Pedersen Zari, M. (2018). The importance of urban biodiversity – an ecosystem services approach. Biodiversity International Journal.

[47] Ramesh et al. (2010)Ramesh, Hussain, Selvanayagam, Satpathy, Prasad, et al.] T. Ramesh, K. J. Hussain, M. Selvanayagam, K. Satpathy, M. Prasadet al., "Patterns of diversity, abundance and habitat associations of butterfly communities in heterogeneous landscapes of the department of

[48] Atomic energy (dae) campus at kalpakkam, south india," International Journal of Biodiversity and Conservation, vol. 2, no. 4, pp. 75–85, 2010.

[49] Sadler et al. (2010)Sadler, Bates, Hale, and James] J. Sadler, A. Bates, J. Hale, and P. James, "Bringing cities alive: the importance of urban green spaces for people and biodiversity," Urban Ecology. Cambridge University Press, Cambridge, pp. 230–260, 2010.

[50] Schaefer, w. (2010). creating a butterfly garden for NJ Schools and Afterschol Programs. Schoolyard Ecology, 1-23.

[51] Sharma, M., & Sharma, N. (2017). Suitability of butterflies as indicators of ecosystem condition: a comparison of butterfly diversity across four habitats in gir wildlife sanctuary. International Journal of Advanced Research in Biological Sciences, 4(3), 1-12.

[52] Susca, T. (2011). Positive effects of vegetation: Urban Heat Island and green roofs. Environmental pollution (Barking, Essex: 1987).

[53] Tam, K. C., &Bonebrake, T. C. (2016). Butterfly diversity, habitat and vegetation usage in Hong Kong urban parks. Urban ecosystems, 19(2), 721-733.

[54] Tiwary and Urfi(2016)] N. Tiwary and A. Urfi, "Spatial variations of bird occupancy in delhi: The significance of woodland habitat patches in urban centres," Urban Forestry & Urban Greening, vol. 20, pp. 338–347, 2016.

[55] Thakur, D. C., Chakrabarti, P., & Chaudhuri, A. C. (2017). An approach for butterfly conservation through setting up a garden in an urban area, Kolkata, India. World Scientific News, 61(2), 69-85.

[56] Tresch, S. F. (2019). Direct and indirect effects of urban gardening on aboveground and belowground diversity influencing soil multifunctionality. Sci Rep 9, 9769.

[57] Van Dyck, H., Van Strien, A. J., Maes, D., & Van Swaay, C. A. (2009). Declines in common,widespread butterflies in a landscape under intense human use. Conservation Biology, 23(4), 957- 965.

[58] Wikström, J. (n.d.). Motivations behind gardening in a rapidly urbanizing landscape. Stockholm Resilience centre.

[59] Winkler, B., Maier, A., & Lewandowski, I. (2019). Urban Gardening in Germany: Cultivating a Sustainable Lifestyle for the Societal Transition to a Bioeconomy. Sustainability, 11(3), 801.

[60] Zouliaet al. (2009)Zoulia, Santamouris, and Dimoudi] I. Zoulia, M. Santamouris, and A. Dimoudi, "Monitoring the effect of urban green areas on the heat island in athens," Environmental monitoring and assessment, vol. 156, no. 1-4, p. 275, 2009.