AicQoL2022Penang

A Review on Urban Biodiversity Management:
Basic approaches for Local Authority level in Malaysia

Norziana Ahli [1], Robiah Suratman [1], Nadzirah Hosen [2], Zainab Toyin Jagun [3]

[1] Department of Real Estate, [2] Department of Urban and Regional Planning, Faculty of Built Environment and Surveying,
Universiti Teknologi Malaysia, Skudai, Johor, Malaysia
[3] Department of Estate Management, College of Environmental Studies, Federal Polytechnic Offa, P.M.B 420, Offa, Kwara State, Nigeria

zianaahli22@gmail.com, robiah@utm.my, nadzirah.hosen@utm.my, zainy4real@yahoo.com
Tel: 01110505968

Abstract
Urban biodiversity is significant and might influence urban dwellers' life quality. Therefore, the Local Authority in Malaysia must begin a step to conserve the urban biodiversity in every city and town. Proper management of urban biodiversity help to improve the life quality of the urban dwellers and benefit a million dwellers in urban areas. This study uses secondary data to gather all relevant information on the basic approaches of urban biodiversity management. The data shows that basic approaches should start with developing a system for inventory purposes and collaboration from private agencies and urban communities.

Keywords: Urban biodiversity; management; local authority; fauna species

1.0 Introduction

The change in environmental and rapid Urbanization are the main threats to biodiversity on a global scale (McDonald et al.,2020; Grimm et al.,2008; Seto et al.,2012; Guneralp and Seto,2013; Shwartz et al.,2014; Chen, Zhang, Liu and Zhang,2014). Due to the massive urbanization process, the population of urban dwellers is about to rise (European Union,2011; Eigenbrod et al.,2011) from 50% in 2010, and the amount about to increase to 70% in the next 40 years, in 2050 (United Nation,2013; UN, 2018). The increasing of urban dwellers population because society has migrated from rural to urban areas (NLM,2014; Abdul Rahman,2011). In addition, the areas of city and town might also expand and widen in 10 more years ahead (Seto et al.,2012; Haaland and Van Dan Bosch,2015; IPBES,2019).

Consequently, the city will become dense and packed with the human population, leading to biodiversity extinction (Botzat, Fischer and Kowarik,2016; Louv R.,2008). More space in the city contributed to the human population. For example, in the Midwest United States, the habitat of shrubland and grassland is declining due to the massive development in that area (Burhan and Thompson, 2006). Meanwhile, biodiversity habitat is getting jeopardized. This situation seems unfair to those living lives who live together in the same area. Humans get more tokens than biodiversity, which also need shelter for a long-term period. Urban biodiversity can stay in a crowded place. However, some local species cannot survive (Hahs et al.,2009), and the population cannot flourish (Kowarik & von der Lippe, 2018; Piana et al.,2019) due to the pressure from the city. Reducing the pressure from the city will decrease biodiversity loss in urban areas. Therefore, the Local Authority needs to start a plan to implement urban biodiversity conservation in the urban areas. This study aims to investigate

the basic approaches in urban biodiversity management at the local level in Malaysia, which help to increase the urban dwellers' quality of life. The formulation of two objectives in this study as shown below:

Table 1. The Aim and Objectives of This Study

Aim: To investigate the basic approaches in urban biodiversity management at the local level in Malaysia		
Objectives	(i)	To identify the importance of urban biodiversity (fauna conservation) to urban dwellers
	(ii)	To recommend two basic approaches in urban biodiversity management to local government in Malaysia

Source: Author (2022)

2.0 Literature Review

2.1 Definition of Urban Biodiversity
Lovejoy (1980) in Swingland I.R (2001) report mentioned that biodiversity originated as "Biological Diversity," which abbreviated to "biodiversity" and has remained in use ever since. Urban biodiversity does not have a fixed definition, and it can predict in many terms. Different terms depend on the research scope of the researchers. Urban biodiversity can be defined as a variety of flora and fauna species that live in urban areas (Werner and Zahner,2009; Puppim de Oliveira et al.,2014). Many different species of birds, insects, small mammals, invasive species can be found in the city surrounding. For example, in the city, we might find a lot of birds with the same look; however, some of them are categorized as different genes. This characteristic can be identified through the color of their body, the behavior pattern, and some other characteristics listed. Most urbanized species are found in the park areas due to green patches (Cao and Natuhara,2020). Some spaces are labeled with different colors in the urban areas, such as blue and green spaces. Turini and Knop (2015) stated that urban biodiversity also refers to all life in the city, including the fauna (birds, insects, and butterflies) and the homes, gardens, ponds, green roofs, and street trees. Urban biodiversity can be concluded as a variety of flora and fauna that live in any natural or settlement area in the city.

2.2 The Importance of Fauna Conservation in Urban Areas
Urban areas are the best place to conserve biodiversity (Aronson et al.,2014) because the city is potentially helping to maintain its landscape for biodiversity habitat (The Nature Conservancy,2018) and able to save and conserve the variety of biodiversity, especially endangered species (Ives et al.,2016; Schwartz et al.,2014). Moreover, urban conservation is one part of the global agenda strategies. The declaration of the United Nations Habitat conference known as the New Urban Agenda strictly mentioned the accessibility of universal green patches and conservation of urban biodiversity in urban areas (UN Habitat,2016). Those responsible for managing the city should also consider others species instead of humans by sustaining them within the same area (Maller C.,2018; Rupprecht C.D.,2017). Urban areas provide shelter for human species and share the same 'house' with other living things (flora and fauna).

2.2.1 Increase the Interaction and Quality of Urban Dwellers' Life
Humans depend on biodiversity and its services (Alshaye and Oudah,2020), especially in urban areas. The existence of flora and fauna habitat in the urban areas help to increase the urban dwellers' quality of life (Keeler et al.,2019; Dearborn and Kark,2010) human health (Bulkeley H.,2021; San Gil Leon et al.,2020), and able to attract visitor from different regions (World Bank,2019). This situation is different from the wildlife located far from the urban area; the connection between biodiversity and urban dwellers is very close. Both of the elements are needed by each other. Some researchers proved this statement (Hosaka and Numata,2016; Cox and Gaston,2016; Zhang, Goodale, and Chen,2014), who stated that the interaction between urban dwellers and urban biodiversity is essential to urbanism nature and will help to instill the pro-environment attitude. Humans' interest in nature and love the other living nature species are some of the sustainability goals in urban areas. This phenomenon can be known as 'biophilia' (Wilson,1984 in K. Szlavecz et al.,2010). Therefore, it is vital that a well strategic plan managed and created by the Local Authority will help increase the demand for biodiversity in urban areas (Karvonen and Yocom,2011; Parker,2015). The sustainable biodiversity in urban areas helps make the city look livable (Kowarik et al.,2020). The previous studies prove that sustainable biodiversity in the metropolitan regions brings more benefits to the town and its occupants in an extended period.

2.2.2 Influence the Values, Behaviors, Knowledge, and Attitudes of Urban Dwellers
Humans are species that live nearby urban wildlife or urban biodiversity. To link the wildlife with human attraction in urban areas, a proper green space was built to increase the dwellers' quality of life. Meanwhile, the green spaces become very limited in urban areas due to massive development and high maintenance fee (Chiesura,2004; Balram & Dragicevic, 2005). If the green spaces become limited, the conservation efforts toward the urban biodiversity will also be affected. This s because urban dwellers demand greenery surrounding and love to check on the urban biodiversity. Urban biodiversity, which provides a lot of peaceful scenery in urban areas, especially in the park's area, helps reduce stress among the urban dwellers. If the Local Authority urges the urban communities to become more biodiversity-friendly, this will help to increase the interest of urban communities toward fauna conservation.

2.2.3 Sustaining the Food Web Process Among Urban Biodiversity
The primary source in the food web was probably from plants. Therefore, it is crucial to have a good pollinator system. However, since Urbanization takes place in the urban areas, most of the species are jeopardized in the massive development environment (Start et al.,2018; Raupp, Shrewsbury and Herms, 2010). The urbanization process changes toward food web or animal interaction in the urban

areas. If the Number of primary food sources such as the plants decreases, it will change the predator pattern of the food web. The impact will also influence the existence of animal predators (Gravel et al.,2011). Consequently, the predators who need the foods will become extinct and gone from the urban environment. Species interaction in the food web is essential to avoid any unpredicted action by these predators toward human life. While conserving the biodiversity in urban areas will help sustain the food web interaction, contributing to better biological management. For example, in urban areas, the conflict regarding monkey problems is never unsolved.

2.3 How Can Local Authority Manage Fauna Conservation in Urban Areas?

Some cities and towns in other regions are taking a first step in the planning program to focus on urban biodiversity conservation (Nilon et al.,2017). For example, in Cape Town, Singapore, and Canada. These countries have better planning and regulation related to urban biodiversity. Meanwhile, other countries seem not concerned about urban biodiversity conservation. The local authority needs to identify the elements of fauna conservation in urban areas. Singapore has urban biodiversity tools, known as City Biodiversity Index (CBI). CBI was used to monitor and assess the country's urban biodiversity status. It is advantageous, and this is one of the high-quality tools that every country can use. In addition, CBI was qualified by a global organization, Convention Biological Diversity (CBD). Therefore, CBI is an effective tool to monitor the condition of urban biodiversity in the country. There are a few indicators that are linked to urban fauna conservation. Table 1 below displays the fauna elements in CBI's indicators. However, the role of the Local Authority is not necessarily focused on the fauna conservation itself, but the Local Authority should also concern the conservation of the habitat or ecosystem of the fauna species. This is because without a 'home,' the fauna species cannot survive in a crowded place. Wang et al. (2019) highlight several initiatives of urban biodiversity conservation. The initiatives are species and natural resources supervision, building a breed center and developing a reintroduction program, developing a charity foundation for wildlife conservation, producing a green industry with biodegradable products, and developing a biodiversity conservation technology. At the local level, the Local Authority can use these initiatives to conserve the urban biodiversity in the city.

2.3.1 Local Authority and Urban Biodiversity Data Management System

Urban biodiversity information is needed to complete and provide data to the authority level. Due to the lacking of urban biodiversity habitat information and data regarding species occurrence collection, biodiversity assessment could not work and function at the local level (Li et al.,2019). Europe United's (2020) report stated that three core components should be included in urban biodiversity management. The three core components are an urban biodiversity data system for policy development purposes, finance management in urban biodiversity management, and essential multi-stakeholders in one organization. Ryo et al. (2014) add extra elements regarding urban biodiversity management. For example, laws, policies, and acts suitable to be implemented in crowded areas.

2.3.1.1 Application Information System for Urban Biodiversity Assessments

Nowadays, many new technology has been developed to gain as much information and data regarding something. Local Authority needs to learn and develop their system to conserve urban biodiversity. By developing the system, the Local Authority can urge the urban community to use the application system and provide the data for Local Authority use. The occurrence data of urban biodiversity was helpful and valuable because it is supervised by a professional method (Ballard et al.,2017), although the actions were criticized as a low-standard method (Devictor et al.,2010). For example, iNaturalist and eBird application system (Li et al.,2019). These applications are beneficial for urban biodiversity assessments. Although the efforts in planning and conserving biodiversity in urban areas are challenging (Ferrier, 2002; Margules and Pressey,2000), the Local Authority can start a little effort by developing the information system for their data system. By using eBirds and iNaturalist application, the numbers change in urban biodiversity can be identified (Spear et al.,2017; Silvertown, 2009), such as the numbers of fauna species and their mobility in the metropolitan area. Introducing the application system to the urban community helps detect the mobility of the species, the population trends of the urban biodiversity, the habitat where the urban biodiversity used to live and plan further actions for conservation management.

2.4 Collaboration with other Private Agencies and Urban Communities

Multi-stakeholders play a vital role in making one urban biodiversity program organized successfully. Their role as a solution toward some issues regarding biodiversity is an essential factor, especially in conservation efforts (Sutherland et al.,2010) in urban areas. The multi-stakeholders comprised all levels of the organization to work together and synergically to create a plan on urban biodiversity conservation to produce an effective result. The plan's effectiveness depends on the efforts of the multi-stakeholders (Hostleteler,2021). Collaboration or synergy is a critical step to implement conservation in the city. The only key to gathering all stakeholders is to gain different perceptions, new ideas, and agendas in conserving biodiversity. Stakeholders play an essential role in deciding on one project, and **Figure 1** below shows how the stakeholders get involved in any project. The elaboration will be included on how the stakeholders are able to get involved in biodiversity conservation in urban areas.
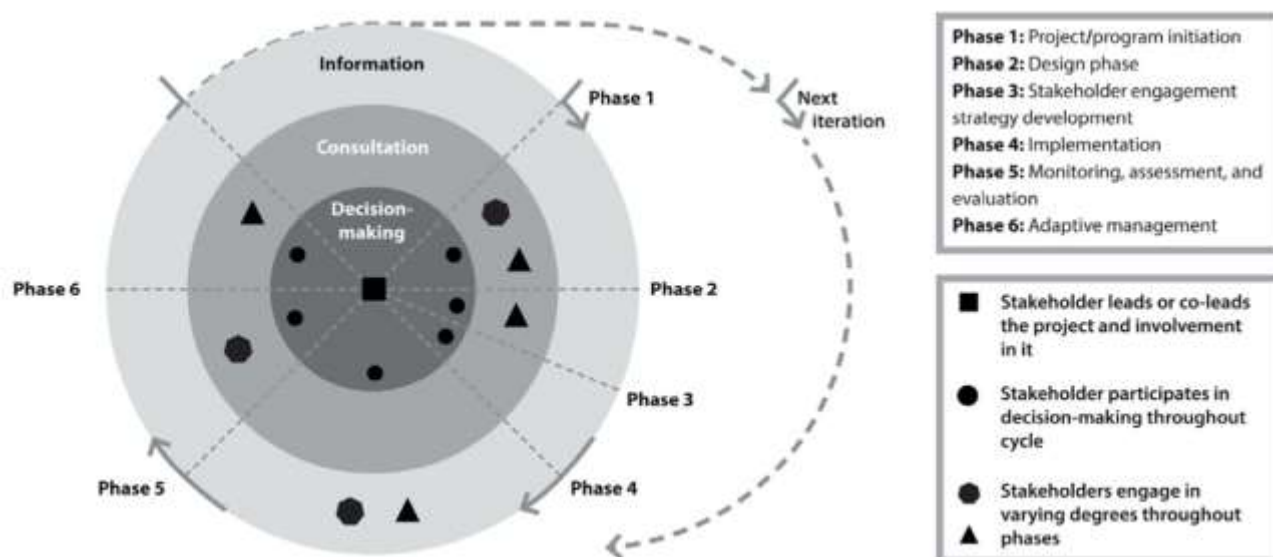
Fig. 1. The Phases of Different Stakeholder Engagement
Source: Sterling E.J. et al.,(2017)

Figure 2 shows the phases of different stakeholder engagement in a specific project. The stages are displayed in the circle shape where the upper right position is the beginning of the project. Five phases included l. the figure above. The engagement of stakeholders increases as the movement moves toward the center. The square shape represents the multi-stakeholders who contribute to the projects. Meanwhile, the shape of the others, such as the diagonal, triangle, and circle, represent stakeholders from different backgrounds and times. In conclusion, the whole project can be decided by various stakeholders' backgrounds, which contribute to a successful result at the end of the project. This is due to collaboration from different stakeholders. For example, the square shape represents the leader. However, the other shapes might represent various stakeholders with diverse backgrounds and jobs. Every stakeholder plays a different role in every phase. Some are working on information parts. Meanwhile, the other stakeholders charged for the consultation part and the essential components were the decision-making, the final core components that lead to the results.

In the biodiversity scope, these phases of different stakeholder involvement can be implemented into biodiversity conservation projects to make sure the tasks can be successfully done at the end of it. In addition, interaction and cooperation from different background stakeholders are needed to participate in biodiversity conservation (Niraj et al.,2012). For example, in biodiversity conservation, the stakeholders involved comprised government departments (Federal, State, and Local Government), urban communities, researchers, and the private sector. By gathering the stakeholders, they might contribute by giving new ideas, funding, and a new plan or agenda.

3.0 Methodology

3.1 Secondary Data Sources
The literature review is obtained by using secondary data sources. Secondary data was used to analyze and interpret a related study's information. In addition, secondary data came from earlier study sources. Many types of secondary data can be found, especially from online materials, government reports, government websites and etc. For example, government publications, journals, articles, books, etc.

3.2 Selected Articles or Journals
The articles or journals were selected by using an online approach. Only selected journals and articles were chosen to construct the review section. The researcher is using an application named were "Publish or Perish." All journals and articles were selected according to 5 years past. The researcher also looks for the latest articles or journals which help to support this review study. The papers were selected from different sources or websites such as Scopus, Web of Science, Google Scholar, and CrossRef*.

3.3 Limitation Knowledge
Urban biodiversity is not a new issue. It has been one of the main global issues. However, some countries do not practice proper urban biodiversity management. Due to the lacking of urban biodiversity habitat information and data regarding species occurrence collection, biodiversity assessment could not work and function at the local level (Li et al.,2019). Therefore, this study will help to provide knowledge on the basic approaches that the country can carry out in managing urban biodiversity. Urban biodiversity management in this study highlights the basic strategies from the bottom level. The management should start at the bottom level, the local government to do any conservation action toward fauna species.

4.0 Findings

Figure 2 below shows the findings of the overall study. It shows the connection between the Local Authority, the private agencies, and urban communities to conserve fauna species in urban areas.
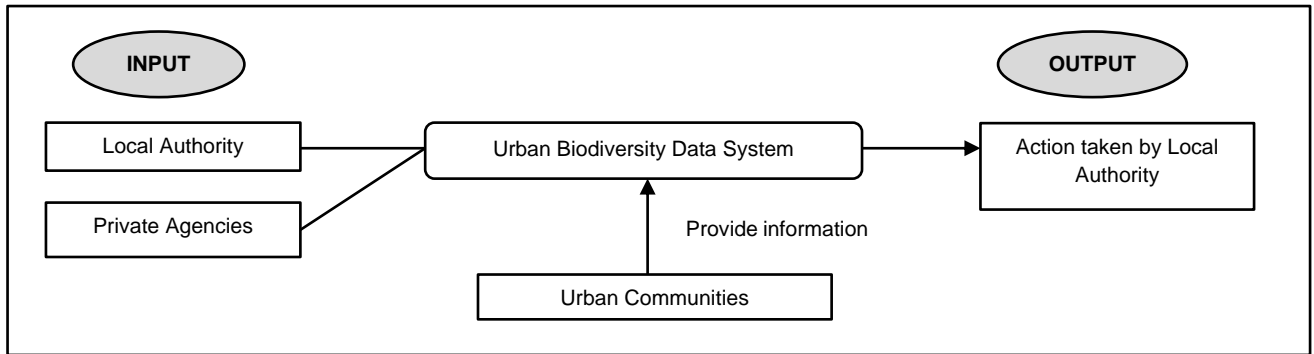

Fig. 2. The Implementation of Basic Approaches into A Strategy of Fauna Conservation
Source: *Author (2022)*

Figure 2 above shows the approaches that the local authority can implement in their territory areas. The approaches are by developing the data system, and it directly linked it with the collaboration from private agencies and the urban communities.

4.1 The Input: Developing Urban Biodiversity Data System

As for the input part, local authorities and private agencies are responsible for developing a data system of urban biodiversity. This is a basic approach for both parties to conserve fauna species in urban areas. Most of the urban areas seem lacking in the aspects of inventory matters. This is why developing a data system will help keep the inventory of some fauna species within urban areas. Therefore, every Local Authority has its

4.2 The Process: Urban Communities Role or Responsibility

As conserving the urban biodiversity (fauna species) is significant for urban dwellers' quality of life, developing an application or a system for urban community use will help to increase the joyfulness between the urban dwellers to take part in this conservation. This is easier to raise the concern among urban dwellers toward fauna conservation around them. With the development of the data system, the urban community can snap, upload and update the location where the fauna lives. For example, in any recreational park, we might have a lot of visitors. The visitors will snap any animals they saw and upload the pictures with location updated in the application. Instead of that, visitors also should snap the animals' niche area. This is very crucial because the niche area of the animal should be protected, and the Local Authority should plan a different strategy to relocate or sustain the niche area at its original place.

4.3 The Output: Action Taken by Local Authority Level in Malaysia

The output should comprise the actions taken by the Local Authority after developing the urban biodiversity data system. The information related to the fauna species will be kept in the inventory system. In addition, the Local Authority can identify the places where the fauna lives. By knowing the location of the fauna species, it is easier for the Local Authority to plan some strategies to increase the fauna's population and sustain its habitat in the target areas.

5.0 Discussions

Regarding the previous reviews which have been made, it is vital to develop a data system or application for urban biodiversity. This is because the primary users are among the urban community. The issues regarding the inventory of fauna species data are still lacking among the local authority management. To help the Local Authority restore the inventory of fauna species, the urban community is the one who can fulfill the requirement needed by the Local Authority. Instead of developing the data system for urban biodiversity, the Local Authority can develop a policy on urban biodiversity management, especially in the conservation of fauna species. Policy development aims to ensure that city dweller are always aware that other living things interconnect in the same space.

The review reveals that urban biodiversity is an essential component in urban areas. Urban biodiversity is needed by the urban dwellers; meanwhile, urban biodiversity needs urban dwellers to sustain themselves in the city or town. The quality of life of the urban community is also affected due to well-managed urban biodiversity in the city. The urban community can enjoy the view of fauna species around the city and will be able to recognize the species and their habitat in the urban areas. The awareness among the urban community can improve effectively.

6.0 Conclusion and Recommendations

The reviews show that local governments should take alternative approaches seriously. The action or any policies planned under the Local Government regarding urban biodiversity will influence the action taken by the urban community. The Local Authority should develop the system and inventory of the fauna species in urban areas for monitoring and assessment purposes. Increasing the efforts in urban biodiversity conservation, especially the fauna species, will increase the awareness of fauna conservation among the urban community. The urban community will have the chance to enjoy the fauna species conservation and be aware of the extinction of fauna species in the city.

Acknowledgements

References

Abdul Rahman Embong. (2011). Pembandaran dan kehidupan bandar di Semenanjung Malaysia. *Akademika* 81(2), 23-39

Alshaye. I & Oudah. T. (2020). Resilience in the Anthropocene, Mainstreaming Nature-Based Solutions to Build Resilient Cities: Nature- Based Solutions. U20 Riyadh 2020 Urban. Retrieved on 10 February 2022 at https://www.urban20.org/wp-content/uploads/2020/11/Resilience-in-the-Anthropocene.pdf

Aronson, M.F.J., La Sorte, F.A., Nilon, C.H. *et al.* (2014) A global analysis of the impacts of Urbanization on bird and plant diversity reveals key anthropogenic drivers. *Proceedings of the Royal Society B: Biological Sciences*, 281, 20133330.

Ballard, H. L., Robinson, L. D., Young, A. N., Pauly, G. B., Higgins, L. M., Johnson, R. F., & Tweddle, J. C. (2017). Contributions to conservation outcomes by natural history museum-led citizen science: Examining evidence and next steps. *Biological Conservation*, *208*, 87-97.

Botzat, A., Fischer, L. K., & Kowarik, I. (2016). Unexploited opportunities in understanding liveable and biodiverse cities. A review on urban biodiversity perception and valuation. *Global environmental change*, *39*, 220-233.

Bulkeley, H. (2021). Climate changed urban futures: environmental politics in the anthropocene city. *Environmental politics*, *30*(1-2), 266-284.

Burhans, D. E., & Thompson III, F. R. (2006). Songbird abundance and parasitism differ between urban and rural shrublands. *Ecological Applications*, *16*(1), 394-405
Cao, Y., & Natuhara, Y. (2020). Effect of Urbanization on vegetation in riparian area: Plant communities in artificial and semi-natural habitats. *Sustainability*, *12*(1), 204.

Chan, L., & Anshari, M. (2010). A model for assessing biodiversity conservation in cities: The Singapore Index on Cities' Biodiversity.

CityGreen, Centre for Urban Greenery and Ecology. *National Parks Board, Singapore*, *4*, 78-87.

Chen, M., Zhang, H., Liu, W., & Zhang, W. (2014). The global pattern of Urbanization and economic growth: evidence from the last three decades. *PloS one*, *9*(8), e103799.

Cox, D. T., & Gaston, K. J. (2016). Urban bird feeding: Connecting people with nature. *PloS one*, *11*(7), e0158717

Dearborn, D. C., & Kark, S. (2010). Motivations for conserving urban biodiversity. *Conservation biology*, *24*(2), 432-440.

de Camargo, J. F., da Silva, F. L., & Smith, W. S. (2021). City Biodiversity Index and the Cities-Biodiversity Relationship: a Case Study for Sorocaba, SP, Brazil.

Devictor, V., Whittaker, R. J., & Beltrame, C. (2010). Beyond scarcity: citizen science programmes as useful tools for conservation biogeography. *Diversity and distributions*, *16*(3), 354-362.

Eigenbrod, F., Bell, V. A., Davies, H. N., Heinemeyer, A., Armsworth, P. R., & Gaston, K. J. (2011). The impact of projected increases in Urbanization on ecosystem services. *Proceedings of the Royal Society B: Biological Sciences*, *278*(1722), 3201-3208.

Elmqvist, T., Fragkias, M., Goodness, J., Güneralp, B., Marcotullio, P. J., McDonald, R. I., ... & Wilkinson, C. (2013). *Urbanization, biodiversity and ecosystem services: challenges and opportunities: a global assessment* (p. 755). Springer Nature.

Europe United. (2020). Good Governance for Biodiversity. A Policy Brief from the Policy Learning Platform on Environment and Resource Efficiency. Retrieved on 10 February 2022 at https://www.interregeurope.eu/fileadmin/user_upload/plp_uploads/policy_briefs/Policy_brief_biodiversity_governance.pdf

European Union (2011). Cities of tomorrow Challenges, visions, ways forward. Retrieved from http://ec.europa.eu/regional_policy/sources/docgener/studies/pdf/citiesoftomorrow/citi esoftomorrow_final.pdf

Ferrier, S. (2002). Mapping spatial pattern in biodiversity for regional conservation planning: where to from here?. *Systematic biology*, *51*(2), 331-363.

Gravel, S., Henn, B. M., Gutenkunst, R. N., Indap, A. R., Marth, G. T., Clark, A. G., ... & 1000 Genomes Project. (2011). Demographic history and rare allele sharing among human populations. *Proceedings of the National Academy of Sciences*, *108*(29), 11983-11988.

Grimm, N. B., Faeth, S. H., Golubiewski, N. E., Redman, C. L., Wu, J., Bai, X., & Briggs, J. M. (2008). Global change and the ecology of cities. *science*, *319*(5864), 756-760.

Güneralp, B., & Seto, K. C. (2013). Futures of global urban expansion: uncertainties and implications for biodiversity conservation. *Environmental Research Letters, 8*(1), 014025.

354

Haaland, C., & van Den Bosch, C. K. (2015). Challenges and strategies for urban green-space planning in cities undergoing densification: A review. *Urban forestry & urban greening*, *14*(4), 760-771

Hahs, A. K., McDonnell, M. J., McCarthy, M. A., Vesk, P. A., Corlett, R. T., Norton, B. A., ... & Williams, N. S. (2009). A global synthesis of plant extinction rates in urban areas. *Ecology letters*, *12*(11), 1165-1173.

Hosaka, T., & Numata, S. (2016). Spatiotemporal dynamics of urban green spaces and human–wildlife conflicts in Tokyo. *Scientific reports*, *6*(1), 1-6.

Hostetler, M. What actions are successful in activating cities to implement urban biodiversity conservation policies, campaigns, and projects?.

IPBES Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. 2019. Global Assessment Report on Biodiversity and Ecosystem Services of the Intergovernmental Science- Policy Platform on Biodiversity and Ecosystem Services. Brondizio ES, Settele J, Díaz S, Ngo HT, eds. IPBES

Ives, C. D., Lentini, P. E., Threlfall, C. G., Ikin, K., Shanahan, D. F., Garrard, G. E., ... & Kendal, D. (2016). Cities are hotspots for threatened species. *Global Ecology and Biogeography*, *25*(1), 117-126.

Karvonen, A., & Yocom, K. (2011). The civics of urban nature: enacting hybrid landscapes. *Environment and Planning A*, *43*(6), 1305-1322.

Keeler, B. L., Hamel, P., McPhearson, T., Hamann, M. H., Donahue, M. L., Prado, K. A. M., ... & Wood, S. A. (2019). Social-ecological and technological factors moderate the value of urban nature. *Nature Sustainability*, *2*(1), 29-38.

Kohsaka, R., Pereira, H. M., Elmqvist, T., Chan, L., Moreno-Peñaranda, R., Morimoto, Y., ... & Pearsell, G. (2013). Indicators for management of urban biodiversity and ecosystem services: City Biodiversity Index. In *Urbanization, biodiversity and ecosystem services: challenges and opportunities* (pp. 699- 718). Springer, Dordrecht.

Kowarik, I., & von der Lippe, M. (2018). Plant population success across urban ecosystems: A framework to inform biodiversity conservation in cities. *Journal of Applied Ecology*, *55*(5), 2354-2361.

Kowarik, I., Fischer, L. K., & Kendal, D. (2020). Biodiversity conservation and sustainable urban development. *Sustainability*, *12*(12), 4964.

Lepczyk, C. A., Aronson, M. F., Evans, K. L., Goddard, M. A., Lerman, S. B., & MacIvor, J. S. (2017). Biodiversity in the city: fundamental questions for understanding the ecology of urban green spaces for biodiversity conservation. *BioScience*, *67*(9), 799-807

Li, E., Parker, S. S., Pauly, G. B., Randall, J. M., Brown, B. V., & Cohen, B. S. (2019). An urban biodiversity assessment framework that combines an urban habitat classification scheme and citizen science data. *Frontiers in Ecology and Evolution*, *7*, 277.

Louv, R. (2008). *Last child in the woods: Saving our children from nature-deficit disorder*. Algonquin books.

Lovejoy, T. E. (1980). *The Global 2000 Report to the President (GO Barney, ed.), Vol. 2* (pp. 327-332). The technical report.

Maller, C. (2018). *Healthy urban environments: More-than-human theories*. Routledge.

Margules, C. R., & Pressey, R. L. (2000). Systematic conservation planning. *Nature*, *405*(6783), 243-253.

McDonald, R. I., Mansur, A. V., Ascensão, F., Crossman, K., Elmqvist, T., Gonzalez, A., ... & Ziter, C. (2020). Research gaps in knowledge of the impact of urban growth on biodiversity. *Nature Sustainability*, *3*(1), 16-24.

Nations, U. (2014). World urbanization prospects: The 2014 revision, highlights. department of economic and social affairs. *Population Division, United Nations*, *32*.

Nilon, C. H., Aronson, M. F., Cilliers, S. S., Dobbs, C., Frazee, L. J., Goddard, M. A., ... & Yocom, K. P. (2017). Planning for the future of urban biodiversity: a global review of city-scale initiatives. *BioScience*, *67*(4), 332-342.

Niraj, S. K., Krausman, P. R., & Dayal, V. (2012). A stakeholder perspective into wildlife policy in India. *The Journal of Wildlife Management*, *76*(1), 10-18.

Parker, S. S. (2015). Incorporating critical elements of city distinctiveness into urban biodiversity conservation. *Biodiversity and Conservation*, *24*(3), 683-700.

Piana, M. R., Aronson, M. F., Pickett, S. T., & Handel, S. N. (2019). Plants in the city: understanding recruitment dynamics in urban landscapes. *Frontiers in Ecology and the Environment*, *17*(8), 455-463.

Puppim de Oliveira, J. A., Doll, C. N., Moreno-Peñaranda, R., & Balaban, O. (2014). Urban biodiversity and climate change. *Global Environmental Change*, *1*, 461-468

Raupp, M. J., Shrewsbury, P. M., & Herms, D. A. (2010). Ecology of herbivorous arthropods in urban landscapes. *Annual review of entomology*, *55*, 19-38.

Rupprecht, C. D. (2017). Ready for more-than-human? Measuring urban residents' willingness to coexist with animals. *Fennia-International Journal of Geography*, *195*(2), 142-160

San Gil Leon A. (2020). Resilience in the Anthropocene, Mainstreaming Natured-Based Solutions to Build Resilient Cities: Nature- Based Solutions. U20 Riyadh 2020 Urban. Retrieved on 10 February 2022 at https://www.urban20.org/wp-content/uploads/2020/11/Resilience-in-the-Anthropocene.pdf

Szlavecz, K., Warren, P., & Pickett, S. (2011). Biodiversity on the urban landscape. In *Human Population* (pp. 75-101). Springer, Berlin, Heidelberg.
Seto, K. C., Güneralp, B., & Hutyra, L. R. (2012). Global forecasts of urban expansion to 2030 and direct impacts on biodiversity and carbon pools. *Proceedings of the National Academy of Sciences*, *109*(40), 16083-16088.

Shwartz, A., Turbé, A., Julliard, R., Simon, L., & Prévot, A. C. (2014). Outstanding challenges for urban conservation research and action. *Global environmental change*, *28*, 39-49.

Silvertown, J. (2009). A new dawn for citizen science. *Trends in ecology & evolution*, *24*(9), 467-471.

Spear, D. M., Pauly, G. B., & Kaiser, K. (2017). Citizen science as a tool for augmenting museum collection data from urban areas. *Frontiers in Ecology and Evolution*, *5*, 86.

Start, D., Bonner, C., Weis, A. E., & Gilbert, B. (2018). Consumer-resource interactions along urbanization gradients drive natural selection. *Evolution*, *72*(9), 1863-1873.

Sterling, E. J., Betley, E., Sigouin, A., Gomez, A., Toomey, A., Cullman, G., ... & Porzecanski, A. L. (2017). Assessing the evidence for stakeholder engagement in biodiversity conservation. *Biological conservation*, *209*, 159-171.

Sutherland, W. J., Albon, S. D., Allison, H., Armstrong-Brown, S., Bailey, M. J., Brereton, T., ... & Clements, A. (2010). REVIEW: The identification of priority policy options for UK nature conservation. *Journal of Applied Ecology*, *47*(5), 955-65.

Swingland, I. R. (2001). Biodiversity, definition of. *Encyclopedia of biodiversity*, *1*, 377-391.

The Nature Conservancy. 2018. Nature in the Urban Century. Arlington, VA: The Nature Conservancy. https:222.nature.org/content/dam/tnc/nature/en/documents/TNC_NatureintheUrbanCentury_FullReport.pdf

Tok and Cherylyn Xiu Hui (2011). City Biodiversity Index. Retrieved on 19 June 2021. https://eresources.nlb.gov.sg/infopedia/articles/SIP_1765_2011-02-11.html

Turrini, T., & Knop, E. (2015). A landscape ecology approach identifies important drivers of urban biodiversity. *Global change biology*, *21*(4), 1652-1667.

UN Habitat. 2016. *Habitat III: New Urban Agenda*; United Nations: Quito, Ecuador.

United Nations (UN), 2013. Sustainable Development Changes. World Economic and Social Survey 2013. Department of Economic and Social Affairs, United Nations Publication, http://www.un.org/en/development/desa/policy/wess/wess current/wess2013/WESS2013.pdf

United Nations Human Settlements Programme. (2018). *The State of African Cities, 2018: The Geography of African Investment*. United Nations Human Settlements Programme.

Wang, Q., Qu, J., Wang, B., Wang, P., & Yang, T. (2019). Green technology innovation development in China in 1990–2015. *Science of the Total Environment*, *696*, 134008.

Werner, P., & Zahner, R. (2009). Biological diversity and cities: a review and bibliography (BfN-Skripten 245). *Bundesamt fur Naturschutz, Leipzig*

Wilson, E. O. (1984). *Biophilia*. Harvard University Press.

World Bank. (2019). Chongqing 2035: Spatial and Economic Transformation for a Global City-Overview. Washington, DC: World Bank.

Zhang, W., Goodale, E., & Chen, J. (2014). How contact with nature affects children's biophilia, biophobia and conservation attitude in China. *Biological Conservation*, *177*, 109-116.