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USING INDICATOR FAUNA ELEMENTS IN BIOTOPE MAPS FOR URBAN LANDSCAPE PLANNING

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Abstract

With the developing technology and increasing population, cities are rapidly and unplanned growing around the world and therefore the natural environment and species are under threat. To eliminate the negative effects of this treatment, qualified tools and data are needed to make appropriate planning decisions. To benefit from the biotope maps, which are important data sources, they should be prepared rapidly in parallel with the speed of urbanization. Detection of

sensitive ecosystems in urban landscapes can be achieved by mapping biotopes. These maps are also important for the development, management, and continuity of ecological infrastructures. From this point of view, to obtain a biotope map that will be prepared for urban landscape planning, it is thought that the determination of the required biotope classes with indicator fauna elements may be more practical. In this study, the literature based on indicator fauna elements was examined and evaluated concerning urban landscape planning. As a result, it was determined that biotope maps, prepared based on indicator fauna elements, could be obtained rapid and qualified data.

Keywords

Urban Landscape Planning, Biotope Map, Indicator Fauna Elements, Urban Wildlife

1. Indicator Species

Indicators are the determining tools and elements that represent the variables according to the purpose of the study and used to provide time and practicality to study when it is impossible to inventory and monitor all plant and animal taxa.

The species with low tolerance and most easily affected by changes in ambient conditions are called indicator species (Chambers, 2008). Changes in the environment and the current state of the environment, biodiversity of ecosystems or habitats can be monitored with indicator species and they used to take precautions against ecological changes. This can provide data to management and protection plans (Pakkala et al., 2014; Siddig et al., 2016).

Indicator species may vary according to the subject of the study. For example, studies on single species, such as habitat use or land-use models, should be on a closer scale such as the species presence, number, distribution, the aspect of the location, the relationship with humans and other living things, the slope of the land, soil structure, geology, etc. all biotic and abiotic factors studies are required. However, the studies carried out by regional development agencies such as EEA (European Environment Agency) on a higher scale, where a large number of species are handled together, are sufficient to consider only the abundance and distribution of indicator animal groups (European Environment Agency, 2019).

Biotope indicators are the most sensitive species to changes in the habitat. It may be an animal species that require a specific plant species or there may be species groups that require different habitat types. For example, where the cabbage butterfly (*Pieris brassicae*) exists, we can understand that there are plants around the group of cabbage (Brassicaceae spp.), which are

the hosts of this butterfly, and the cabbage butterfly can be considered as an indicator of these plants. In the same way, since pine trees are the habitat of the bird called pine tit (*Parus ater*), pine tit is an indicator of pine groves and water birds are indicators of wetlands (Sözgen, 2019).

Kutzenberger (2001), has approached animal ecology with a perspective of data constitute to landscape planning. In this context, the species belonging to the 6 indicator animal groups were listed and the relationship between the habitats of these species and their landscape use was revealed. Thus, he was able to identify characteristic cultural landscapes. These determinations allow to be classified according to important living environments and planned according to biodiversity criteria for a landscape. Compared to the detailed study of a single group of animals, handling more than one indicator group allows for a holistic assessment of animal communities. This assessment method also provides the emergence of the most representative indicator species.

In this study, we hypothesize that it will be faster and easier to obtain data on plants and animal species for a biotope map for urban landscape plans in areas where indicator animal species are detected.

2. Biotope Maps for Urban Landscape Planning

The most important task of landscape planning to nature protection; to conserve ecosystems that are worth conservation and landscape elements together with the plant and animal species they contain. The concept of biotope in landscape planning gains importance at this point. For successful landscape planning, it is necessary to determine the basic components of the landscape, namely biotopes, and to ensure that the relations between biotopes are in an optimum state. Three main approaches are adopted in preparing nature conservation plans that are closely related to biotopes. These are; the conservation of endangered plant and animal populations, the conservation of biotopes including communities and ecological processes, and in this way, the conservation of biologically and/or ecologically rich areas (Sarı Nayim, 2010).

To achieve an ecologically functional landscape; biotopes should be protected with the species and genetic diversity they contain. By mapping, ecologically important biotopes required sensitive ecosystems are determined for nature conservation and the development, management, and continuity of ecological infrastructure can be provided by protected area methods (Forman, 1995).

The main concern of nature protection is the conservation of species and biotopes. According to this; Biotope mapping of habitats created by natural and cultural landscapes for species has an important place in conserving biological diversity by creating an ecological base that will shed light on many issues (Güngöroğlu et al., 2008).

Especially sensitive biotopes (dune, wetland biotopes, and pseudomaki formation biotopes) are adversely affected by landscape changes that tend to be urbanized (Aksu, 2012). Therefore, it is necessary to determine the important habitats on the biotope scale of the area to be planned at first.

Biotope mapping is the identification and characterization of habitats. The most important issue to be considered in urban landscape planning studies is to protect biodiversity by ensuring the sustainability of natural species in the planning region. Thus, the habitat requirement for the fauna and flora of the city is provided, as other living creatures will also have the opportunity to live (City nature project, 2019).

Biotope mapping studies, which are important for ensuring the sustainability of the urban ecosystem, are used extensively in planning studies (Gürkan, 2016; Löfvenhaft et al., 2002; Lu and Wang, 2018; Mansuroğlu et al., 2006; Sukopp and Weiler, 1988; Yılmaz et al., 2010).

3. Fauna Elements as Biotope Indicators

Fauna elements, which are the main elements of biodiversity and consist of animal species, need to move in the environment in which they live in. This need arises from the diversity of the factors that compose the living environment. Variation of variables in the environment constitutes the priority of the variables that should be obtained for the studies on the habitats of wild animals. Plants, which are the most affected variable among habitat factors, come to the forefront in determining habitat preferences of animal species. In particular, the distribution of plant species also plays an important role in the field choice of animals. (Süel et al., 2013).

Some fauna elements can be explained by giving examples from the literature about the indicated biotopes. González-Valdivia et al. (2011), identified ecological indicators of habitat and biodiversity in a Neotropic landscape (in Central and South America). For this purpose, they identified indicator types of different taxa characterizing different landscape units and revealed how management changed the composition of species. In the study, two groups of animals were

identified, one of them is a tropical rain forest with a natural landscape and the other an agricultural area with a cultural landscape. The presence of fauna elements among the areas, 218 bird species, 74 butterfly species and 50 gastropods (snails, etc.) were identified. Among these, 10 birds, 4 butterflies, and 8 gastropod species were found to be indicators of forest habitat and 28 birds, 10 butterflies, and 2 gastropod species were found to be characteristic for agricultural areas. They stated in the conclusion that the use of indicator species to characterize specific ecological areas has great importance in conservation/restoration biology.

It is a known fact that there is a positive relationship between the abundance of bird species and increasing the distance to the urban center. The great tit (*Parus major*) is considered as an indicator of urban forests (Sanesi et al., 2009). Tits are birds living in both forest and maquis type habitats (Riddington and Gosler, 1995; Redhead et al., 2013). Rock pigeon (*Columba livia*), small dove *(Streptopelia senegalensis*), sparrow (*Passer domesticus*), carrion crow (*Corvus corone*), swift (*Apus apus*) are urban exploiters seen in highly urbanized areas (Kark et al., 2007). Censuses of swifts (*Apus apus, Apus melba, and Apus pallidus*) are very difficult because they are very mobile. If they are examined in terms of abundance in the areas they are considered as urban exploiters (Herrando et al., 2012). Starlings (*Sturnus vulgaris*) were found in urban-suburban areas and open green recreation areas with cavities for nesting (Blair, 1996). Gulls (Larus spp.) and people often share common habitats, and increasing gulls occupy urban areas. The population growth of gulls is directly or indirectly related to the increase in the availability of food sourced from human activities. With the increase of artificial foods, the fertility of gulls increased and mortality rates decreased. Gulls seem to have excessive abundance as a result of their opportunistic and sociable nature, which makes them highly adaptable to living in human-changed habitats. Gulls are well adapted to nesting human-made structures such as roofs (Hatch, 1996; Smith, 1992; Vidal et al., 1998). Magpie (*Pica pica*) has adapted to the urban and they are seen more in urban areas than in rural areas even they are considered urban exploiters (Jokimäki et al., 2017; Tatner, 1982). Jay (*Garrulus glandarius*) may be an indicator of a forest ecosystem because the adaptability of this species is high in a forest ecosystem organized of oak species or predominantly in oak species (Belabed et al., 2017). In Figure 1, an example of the bird species seen in the urban landscape biotope types is given.

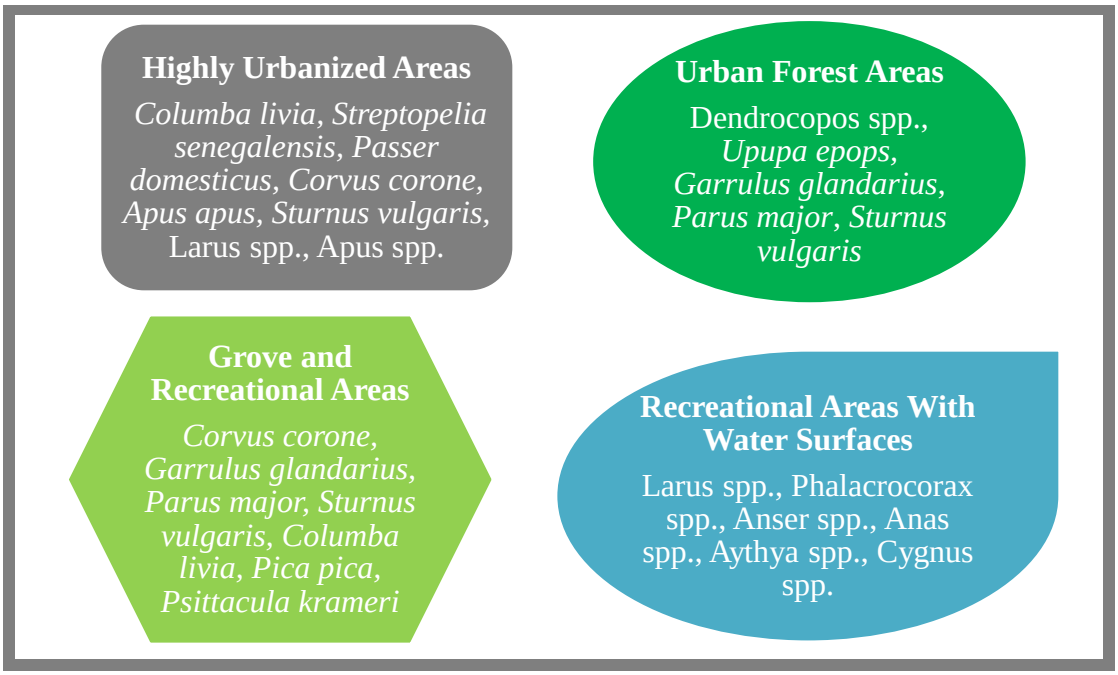

Figure 1: *A Schematic Example for Bird Species Seen in the Urban Landscape Biotope Types*

Biotopes are habitats of more than one species. Species can use different biotopes as long as they provide the habitat they need and can live in a common biotope with different species.

Additionally, Passeriformes species in an area are considered as a robust indicator of environmental change in habitat (Tabur, 2014).

The abundance of mammal species decreases in open areas around the settlement and the habitats near buildings, but increases in areas with a height of 21-50 cm vegetation from the ground. This is due to pollution, human influences and disturbance or hunting by domestic animals. Accordingly, it is possible to say that the areas directly or indirectly under human influence are weak in terms of mammal species abundance (Dickman, 1987). Plant types preferred by some of the wild mammal species are given in Table 1.

Table 1: *Plant Species preferred by Some Wild Animals* (*Tabulated according to Oğurlu and Aksan (2013))*

Fauna Element	Preferred Plant Species
Wild Boar *Sus scrofa*	Storax *Sytrax officinalis*
Hare *Lepus capensis*	
Badger *Meles meles*	Terebinth *Pistacia terebinthus L.*
Hare *Lepus capensis*	
Beech Marten *Martes fonia L.*	Daphne *Daphne serisian Vahl*
Beech Marten *Martes fonia L.*	Phillyrea *Phillyrea latifolia L.*
Hare *Lepus capensis*	

Another group of indicator species is butterflies. Smaller butterflies with less mobility are excellent indicators of environmental changes and urbanization caused by human-regulated landscapes than large butterfly species which are migrating over long distances. Butterfly diversity can serve as a representative for plant diversity because butterflies are often directly dependent on plants. In a study conducted in Sapporo, Japan in 1977, it was concluded that urbanization caused a general decrease in butterfly fauna, and in 1986 and 1992 in Porto Alegre, Brazil, it was determined that butterflies decreased both in species and individuals. The study showed that while butterfly species richness peaked in moderately pristine regions, the relative abundance was reduced from natural areas to urban areas, and the butterfly species thought to represent the original natural environment (butterfly fauna which has already developed) most gradually disappeared as the environment became urban (Blair and Launer, 1997). The sizes of butterflies seen in urban areas vary according to their habitat dimensions. Since the habitat of small butterflies is narrower than large butterflies, the habitat they need is more pronounced. Therefore, small butterflies are better indicators than large butterflies (Kutzenberger, 2001; Kuussaari et al. 2014).

Gehrt and Chelsvig (2008) followed bat activity in natural areas, spread over 3,500 square kilometers, covering the Chicago metropolitan area in northeastern Illinois, USA. In conclusion, it has been reported that mowed areas in open habitats, has more bat activity than

agricultural areas, even though the relationship between urbanization and bats may vary according to environmental conditions, heterogeneous urban landscapes may represent the habitats of some bats in larger areas which are predominant or dominated by intensive farming.

There are other studies (Mert and Yalçınkaya, 2017; Sebastián-González and Green, 2013; Süel et al., 2017; Vielliard, 2000) intended for various landscapes related to indicator fauna elements.

4. A Biotope Map Based on Indicator Fauna Elements

Interdisciplinary handling the study of biotope mapping, enables more qualified results to be reached in a short time. Remote sensing technology makes important contributions in this sense (Güngöroğlu et al., 2008).

Within the scope of work no. 4 of the research project carried out within Besiktas district of Istanbul, habitats that will be used as reference for the first level biotope classification in approximately 1800 hectares of area (Besiktas district) have been identified by reference to indicator animal groups and these habitats have been classified in 1 / 10,000 scale map was obtained (Aksu et al., 2017).

This study was conducted for landscape planning at the district level. Animal species were identified in the research area from previous observations and literature. Then indicator species groups (birds, mammals, reptiles, and butterflies) were selected among these species. Afterward, layers were obtained by remote sensing from high-resolution satellite images and biotope classes were determined according to indicator fauna groups. 19 test points that could represent 14 different biotope classes (buildings, groves, cemeteries, parks, gardens, water surfaces, refuges, etc.) were identified and observations were made at these points to confirm the literature findings. The biotope map was obtained by classifying the habitats formed from the layers obtained from remote sensing and field observation findings (Figure 2).

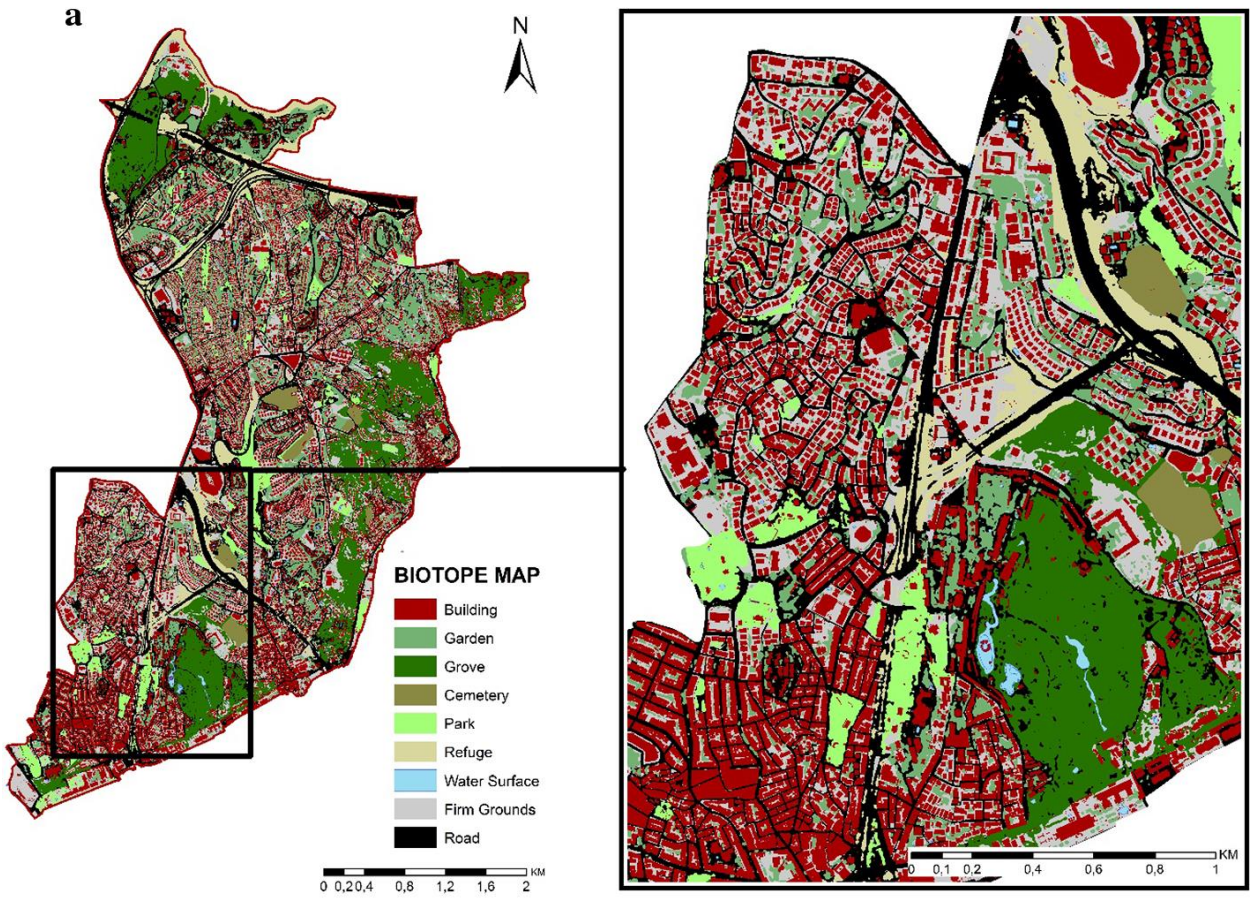

Figure 2: *Biotope Map of Besiktas District (Aksu and Küçük, 2018)*

5. Conclusion and Suggestions

Biotope mapping is an effective tool for evaluating different landscapes. Therefore, it is necessary to determine the important habitats on the biotope scale while preparing the landscape plans. However, studies on biotope mapping generally focus on vegetation types. Besides, identifying cultural landscapes based on animal groups and species is an important basis for local landscape planning and landscape maintenance as it provides information in less time. The relationships between biotopes determined by this method also constitute an important basis for evaluations at a regional scale (Kutzenberger, 1998). This approach, obtaining biotope maps more practical, efficient and applicable, makes biotope mapping based on indicator animal groups particularly attractive for planning studies.

The existence of animals that can adapt to the ecological conditions in the urban areas constitutes the urban fauna. Each fauna element provides information about vegetation because

the plant species that urban fauna elements needed are predetermined. In addition, biotope classes in anthropogenic structures such as buildings, building gardens, refuges, water surfaces, etc. also constitute habitats for different animal groups. For example, tiles and unused chimneys on the roofs of buildings create suitable habitats for some birds, building gardens again for some birds, reptiles and mammals, water areas for amphibians, reptiles and birds, even refuges for birds and mammals, especially butterflies.

Green areas that have survived to the present day in urban areas and pristine natural landscape areas in the vicinity of the urban are the shelter of indicator species. However, other stress factors such as human interventions in the habitats of the species, the dominance of the invasive species in the habitats of the natural species, competition and noise causes the loss of indicator species and biodiversity. The effects of environmental pressures on humans and animals are similar. Even if the primary effects are the same, the secondary effects are vital to the animals (Erbesler Ayaşlıgil and Sözgen, 2019). Conservation of urban green spaces, revitalization of natural plant species in degraded areas and the creation of environments suitable for biodiversity in the urban landscape will enable more bird and plant species to live.

If biological ponds are integrated into green areas, there will be a great improvement in biodiversity as there will be new species (such as microorganisms, aquatic fungi, macroinvertebrates, fishes) thanks to the new aquatic ecosystem (Benzina and Bachir, 2018; Sharma, 2016).

Since biotope maps in landscape planning studies aim to identify and characterize the habitats of living things, the indicators should be selected from living species or species groups. Some groups of animals are important and effective indicators of their habitats. Based on these indicator groups, it is possible to make determinations and interpretations about living environments in many scales expeditiously. This form of assessment also provides important information about the indicator species of the nutrient source, reproduction, and the plants, namely the floristic structure, that have shelter according to the situation. It is possible to identify these indicator species and interpret biotopes with the observation technique.

Indicator fauna groups are used for a biotope map based on indicator animal species (butterflies, reptiles, mammals, songbirds, birds of prey, waterfowl, etc.). In line with the ecological needs of these groups, the biotope classes of the biotope map to determine and characterize the habitats can be determined. The creation of biotope maps is based on the habitats

of these groups rather than focusing on individual species. The prepared maps are such as to be data in the management and design processes of landscape planning.

Although biotope maps are important ecological data that can be used in many studies, which significantly increases the success of landscape plans, long-term studies are required to prepare them based on vegetation. However, as there are regions that are rapidly urbanizing today, it is necessary to obtain the plan data in the fastest way and create current plans. To achieve this, biotope maps should be prepared faster. Since indicator animals provide sufficient information about vegetation, biotope maps can meet the need for ecological data in accordance with the speed of urbanization.

Kutzenberger's (2001) research also shows that besides the vegetation types as indicator species, the efficient use of indicator animal species and their communities yields more practical and healthy results in the identification of cultural landscapes and revealing the relationship of these landscapes with each other. Therefore, when landscape planning is considered in a holistic approach, the habitats and relationships in a fragmented area need to be revealed in a detailed but practical manner with each other. Rather than focusing on all plant and animal species with their habitats, the basic characteristics of the landscape should be put forward and planned considering these indicative species.

In practical applications aimed at catching up with the speed of urbanization, it is almost impossible to inventory and monitors all taxa of plants. Indicator animal species or species groups may provide data for ecological landscape planning in conjunction with plant species.

It is both easier and faster to use indicator animal species to determine the existing biotope classes when making urban landscape plans. Since the selection of indicator animals from different groups will be indicative of different nutrients and shelter, it represents both the biodiversity and habitats of the research area.

In the future, biotope maps created in a short time can be used in various studies, especially in planning and design studies for rapidly urbanizing cities, depending on the scale of the study to be performed. By examining the perception of the indicator fauna group based on the indicator species, more detailed studies can be carried out for specific and sensitive uses.

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