

Sustainable Ecology of the Metropolis and a Local Green Frame Involving Beneficial Insects on the Example of St. Petersburg

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Abstract. The article describes the results of design studies aimed at increasing the sustainability of the environment by attracting beneficial insects in the structure of the formation of a green frame. The work was carried out in 2021-2023, the vector of design research was formed on the basis of the St. Petersburg State University of Architecture and Civil Engineering (SPbGASU) undergraduate program and continues in the format of networking, including with the participation of Sevastopol State University (SevSU) undergraduate program " directions "Landscape architecture". The article describes both landscape and ideological practices that help attract beneficial insects to the territory of landscape objects, and also describes specific solutions on the example of the territory of the Petrogradsky and Kirovsky districts of the city of St. Petersburg, made with the participation of residents and the Improvement Committee. The importance of insects in the urban green network is described, the possibility of integrating special landscape zones into green infrastructure for this, the problem of creating a single ecological frame of the metropolis and a local green frame at the district level is considered. The author's design methodology is presented in terms of the transition from the urban and town-planning level to specific design solutions at the masterplan level and, further, to the development of specific landscape niches with the landscaping species composition.

1 Introduction

Landscape objects become more stable if their territory has high biodiversity [1]. At the same time, the issues of their design methodology, taking into account the provided ecosystem services, environmental conditions, further maintenance and operation according to the plan of the landscape architect, are relevant from the point of view of design research within the framework of the educational direction "Landscape Architecture". Creating conditions for biodiversity in the formation of a green frame is a modern aspect that has been in the focus of attention of our design and scientific group for several years.

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Biodiversity describes the diversity of life on Earth, including the 8 million plant and animal species on the planet, the ecosystems they inhabit, and the genetic diversity among them [2].

Based on a study of the international experience of gardeners and the processes associated with the landscape organization of green infrastructure, a trend was identified to attract beneficial insects, which greatly facilitates the care of plants. On the one hand, such trends are observed in private gardens, where gardeners attract beneficial insects to their plots for pollination and protection from pests [3], and on the other hand, in densely populated megacities such as Moscow [4], where beneficial insects are attracted mainly for pest control. Beneficial insects, namely entomophages, are also used as a biological method of combating crop pests [5]. At the same time, it is more difficult to attract beneficial insects in large cities, since the anthropogenic and noise loads are greater, but it is possible to create conditions for their comfortable habitat. It is important to note that the problem of creating conditions lies not only in the technical part of the issue, but also in the cultural and educational part, because many do not understand that some insects bring great benefits to green spaces. Many people are afraid of insects, although they understand their importance in the city's ecosystem. Therefore, it is important to engage in educational direction in order to popularize scientific achievements among the population related to the research topic. In this regard, several events with the public of St. Petersburg have been held over the past three years by the landscape association "Center for the Development of a Comfortable Urban Environment" (head - Danilova S., students of SPbGASU - Alekseev K., Kurik A., Konovalova E., Ostapchuk P.), which started as a structural subdivision of SPbGASU, and in 2022 continued its work as an independent project.

St. Petersburg is a northern city with a difficult climate; it is precisely because of the climate that experience in similar cities has been little studied. The topic of research and creation of conditions for beneficial insects is relevant in countries such as Finland, whose climate is similar to that of St. Petersburg. Thus, the Finnish Museum of Natural History conducted research on how to improve the condition of insects on the territory and came to the following conclusions [6]:

- 1) It is necessary to provide insects with a variety of replacement habitats, such as meadows, green roofs and artificial nests.
- 2) It is important to protect nature: avoid chemical pesticides, leave space for wild plants and rotting wood, and address pest control by learning about biological interactions.
- 3) Make decisions towards choices that have a positive impact on biodiversity in food production and decision making – choose organic whenever possible.

These conclusions formed the basis of our project study and will be supplemented by the results of the next stage. Residents of St. Petersburg notice the problem of the extinction of beneficial insects within the city. The study is a direct continuation of already existing concepts - the project on the street. Ufimskaya, Petrogradsky district, which is at the stage of implementation and the project of landscaping the highways of St. Petersburg. In the 2020-2021 academic year, residents of Ufimskaya Street turned to SPbGASU and the Center for the Development of a Comfortable Urban Environment for help, as they noticed the mass extinction of bumblebees in their area in the city center. Several students and specialists of the university have developed concepts for the improvement of this territory, touching on the topic of attracting beneficial insects to the territory of squares and st. Ufimskaya in September 2020. On April 17, 2021, the Center for the Development of a Comfortable Urban Environment held the event "Dialogue with the City" with an exhibition of projects, where SPbGASU students and their leader (Danilova S.B.) met with representatives of the Aptekarsky Ostrov municipality on the basis of the Youth Center "Chamber of Crafts" [7, 8], where it was decided to create working documentation based on conceptual projects and bring students' ideas to life. Further, the Committee for the

Improvement of St. Petersburg became interested in the project, the project was presented together with the project of flower decoration of the highways of St. Petersburg, performed as part of a summer practice (headed by Danilova S.) to residents and the media at a series of events and an official round table in the summer of 2021 “ On the maintenance of urban lawns” and further was recommended by the Committee for implementation, but so far the work is not progressing due to administrative barriers, since such a pilot experience needs special support from the Government and support from information resources. A territory such as the Green Corridor can be an important link between the unified Green Frame of St. Petersburg and the local green frame of the Petrogradsky District.



Fig 1.1. Round table in the St. Petersburg Improvement Committee



Fig. 1.2. Public events - meetings with residents of Ufimskaya st., Triologue with the city, media interviews

The green frame is a set of undeveloped and not covered with artificial materials (for example, asphalt) urban areas with vegetation cover. The Green Framework is sometimes referred to as the Ecological Framework, the conceptual series will be discussed in separate publications. The green (ecological) frame in the city is necessary to maintain a favorable ecological state of the urban environment, which in turn is important for the physical and mental health of citizens [9]. The creation of a green ecological frame of the city can improve the overall condition of insects in the city, as green corridors and interconnected cores will appear in the structure of the city. The continuous green network will become a habitat for many insects, birds and small animals (Figure 2).

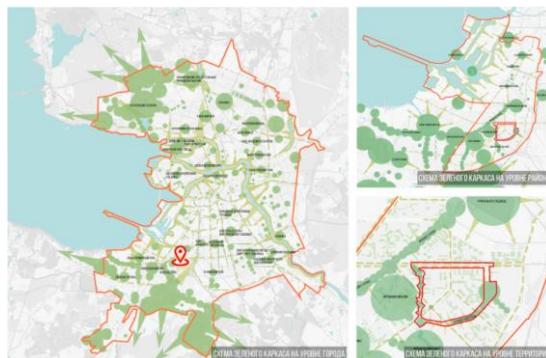


Fig. 2. Green frame diagram on three levels

2 Research Methodology

Design studies, taking into account the identified relevance and specificity, were continued by the authors. A whole fan of graduation qualification works of the “bachelor’s” level under the guidance of Danilova S.B. in 2021-2022, it was united by the theme of the formation and restoration of the Unified Green Frame of St. Petersburg. The sites were selected taking into account the plans for the repair of these areas by the Improvement Committee in 2023-2024, which reflects an attempt to synchronize scientific and practical efforts, taking into account funding opportunities. As part of the topic of biodiversity, the design site was chosen as part of the thesis (student Kurik Agata, supervisor Danilova S.) identified by the authors in the process of the Green Ring of the Kirovsky district of St. Petersburg. The design site is located in the southern part of the Kirovsky district, the design area includes the metro stations “Leninsky Prospekt” and “Prospect Veterans”, the area around the Dachnaya River, the square with the monument to Viktor Tsoi, a fragment of Leninsky Prospekt with the adjacent territory and Novatorov Boulevard (Fig. 3).

This territory has never been considered as a single object, the “ring” is currently fragmented according to the status of the territories and funding programs. The interconnection of the territories included in the design site was not purposefully identified, however, according to the urban planning assessments of the structure of spaces, all parts form something integral in terms of pedestrian and transport and green links. The plots, according to the urban planning, landscape and compositional analysis, gravitate toward the formation of a unified system of landscaped public spaces. It can be argued that a local green frame has been identified and some foundations of the methodological approach to identify areas with the potential of an important link in the unified green frame of St. Petersburg.

Assessment of a set of environmental conditions at the design facility, such as wind regime, illumination regime, hydrological regime, soil compaction level, air and soil pollution level, noise pollution level is presented in the ecological zoning scheme (Fig. 4).



Fig. 3. Location plan



Fig. 4. Ecological zoning scheme

According to data from the website of the Administration of St. Petersburg [10] dated 01/01/2020, 336,157 people live in the Kirovsky district. The workload of the metro station “Leninsky Prospekt” is on average 1,077,935 people per month, and 35,931 per day [11]. The workload of the metro station “Prospect Veteranov” is on average 938,424 people per month, and 31,261 per day [11]. These data give an idea of how many people are the users of the territory and of the anthropogenic load in the area of metro stations.

Since the topic of the WRC is a sustainable green frame landscape with the attraction of beneficial insects, a survey was created on the topic of human interaction with them. During the survey, it turned out that many imagine that insects can benefit plants, and also believe that only those insects that pose a direct danger to humans should be exterminated within the city. At the same time, the problem of the extinction of beneficial insects in cities worries more than 72% of respondents. Therefore, many are in favor of attracting beneficial insects to public spaces.

3 Results and Discussions

The project is aimed at developing a sustainable and comfortable environment, as well as the formation of a local green frame as part of the unified Green Frame of St. Petersburg. The territory should draw attention to the problem of the extinction of beneficial insects in cities.

It is planned to introduce a single identity on this topic with thematic playgrounds, small architectural forms, a paving line, equipment in order to develop the identity of the territory (Fig. 5 and 6).



Fig. 5. Playgrounds with identity



Fig. 6. Quiet rest places with identity

It is proposed to develop a unified bicycle-pedestrian infrastructure and solve the problems of transport infrastructure (Fig. 7).



Fig. 7. Unified bicycle-pedestrian network

A special assortment of plants is being developed for the territory, which takes into account the existing plantings and the need to maintain the structure and tiering of the green structure to perform its functions, and also depends on environmental and anthropogenic environmental factors and the proposed functional zoning. The relationship between functional and landscape zoning and the methodology for presenting these results is an important stage in ongoing research.

The alternation of open and closed spaces is directly related to the functional zoning of the territory. For example, public transport stops are supposed to have open spaces where a large crowd of people can fit. In quiet recreation areas, spaces are closed, and in playgrounds they are semi-closed, shade must be provided there, both by organizing

canopies and with the help of green spaces. this aspect should also be taken into account at all stages from general zoning to the development of a landscaping plan and an assortment of plantings for specific landscape niches.

The pedestrian route is a linear system, so the green spaces along it are planted linearly. Group and landscape plantings are applicable to squares. On the banks of the river, plants are planted not only strengthening them, but also emphasizing the natural relief of the slopes. This information was included in the volumetric-spatial schemes of biotopes (landscape niches), synthesizing the features, relationships and volumetric-spatial characteristics of landscaping elements, taking into account their compatibility with each other and the functions produced within the framework of the ecosystem approach.

The main planning core of the Leninsky Prospekt fragment is the area around the Leninsky Prospekt metro station, as this is the main point of attraction not only for the site, but also for the district. It is the approaches to the station that are the main directions that determine spatial solutions. Since the territory is subjected to too much anthropogenic pressure, it cannot become a place for the placement of habitats for beneficial insects. However, the territory has a great educational potential; here, with the help of identity and information stands, you can popularize information about beneficial insects. The black-and-yellow color of the design and the shape of the honeycombs in the MAF will inform residents about the most famous beneficial insects - bees. (Fig. 8 and Fig. 9).



Fig. 8. Axonometry Art. Metro station “Leninsky Prospekt”



Fig. 9. Bus stop at metro station “Leninsky Prospekt”

The main planning axis of the Dachnaya River fragment is the river itself, it and its banks determine the spatial structure of this section, including geoplastics. The project takes into account the existing features of the relief with a pronounced drop in the direction of the river. The all-season use of this space and the coastal landscape are taken into account; therefore, it is planned to plant groups and individual plants that do not lose their decorative qualities throughout the year. Coniferous plants are envisaged among such plants. Plants with the function of strengthening the banks will be planted along the

coastline of the Dachnaya River, which will emphasize the existing relief. The project provides for the maximum preservation of existing trees. An identity with color solutions is provided for this territory, canopies resembling flowers are added, in the design of the IAF you can often find the shape of honeycombs. (Fig. 10).



Fig. 10. Axonometry of a fragment of the river. Dachnaya

The territory is divided into several functional zones with subzones, one of the main differences of which is the functionality of landscaping: plants with high wind, dust and gas resistance are planted along the streets with heavy traffic, and in the zone of thematic gardens aimed at attracting beneficial insects, it is proposed plant those plants that will serve as food and shelter for insects. The landscaping matrix in tabular form shows the division of the assortment by characteristics and functions, including the suitability for use as a food base for insects (Fig. 11).

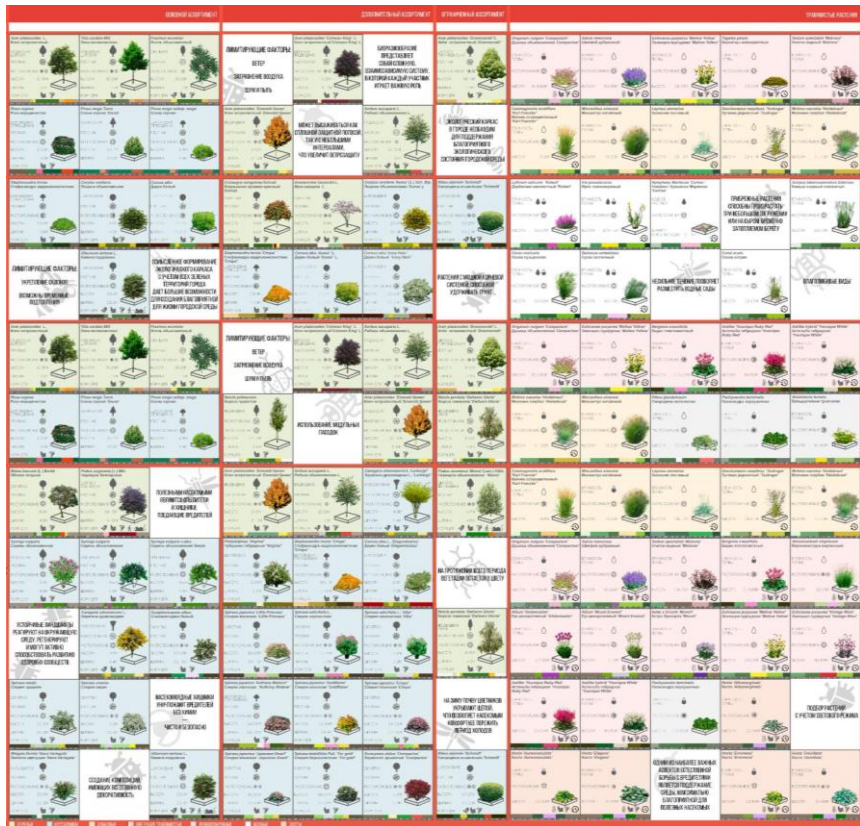


Fig. 11. Gardening matrix - an assortment of plants with characteristics and an indication of their suitability for food by beneficial insects

Small architectural forms in this project create the identity of the area and thematically refer to the problem of beneficial insects, as many have a yellow color or a hexagonal figure. (Fig. 12 and 13) Bees are the most famous beneficial insects in the world, they cause the most positive associations in most people, so it was decided to refer to them in the design of small architectural forms. In the canopies, the shape of flowers is guessed, which also refers to the most famous pollinators.



Fig. 12. Thematic architectural landscape elements included in the environment



Fig. 13. Themed awnings, identity

One of the most unusual objects on the territory are insect hotels (Fig. 14). They consist of several different sections, providing insects with a place to nest (especially in winter), as well as for shelter or shelter. Hotels are mainly used to attract pollinators.



Fig. 14. Insect Hotel

4 Conclusions

The project presents solutions that are aimed at forming a local green frame as part of a single green frame with the creation of conditions for biodiversity.

The presented project offers a set of modern landscape solutions aimed at maintaining a sustainable environment, and also draws attention to the global problem of insect extinction in the city and possible measures to regulate this process. The project is a logical continuation of the already existing and accepted for implementation project st. Ufimskaya on the Petrograd side of St. Petersburg using participatory design tools. The methodology of the design stages, identified during the development of the study, is of particular value, as it allows the mutual integration of competences in landscaping, ecology, botany and soil science into the process of generating a landscape solution at an early stage of formation and offers specific methods and forms of presentation of materials. Important is the appearance of such materials as the Ecological Zoning Scheme, the Landscape Zoning Scheme and the Landscaping Plan (dendroplan), the landscaping matrix, which for the first time are used comprehensively in research and course design within the framework of the new educational direction "Landscape Architecture". This is an important part of the methodology being created in line with ongoing research on the formation of a green frame with the creation of conditions for biodiversity.

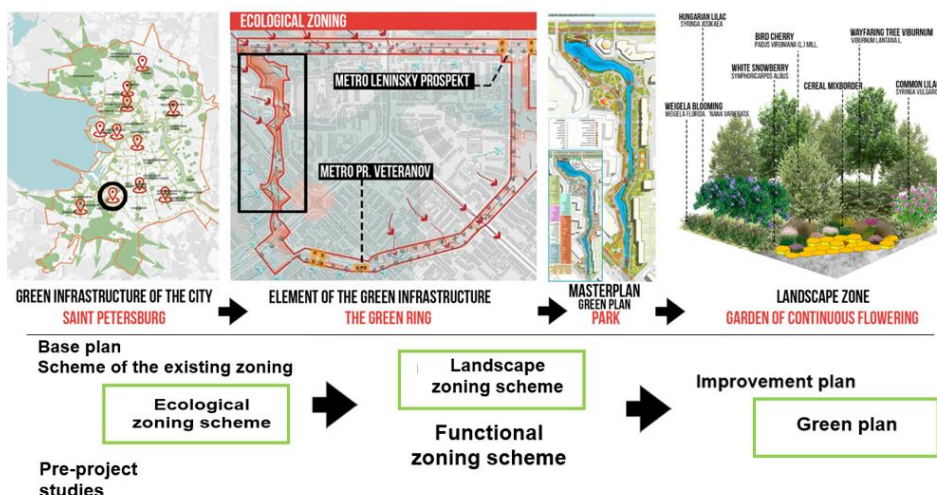


Fig. 15. Stages of landscape design and methods of developing a green framework

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- Minutes of the round table of the Committee for the Improvement of St. Petersburg on the issue of “Maintenance of urban lawns” 07/22/2021. (Minutes No. 19/21)

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