

# Research on Landscape Design of Wetland Parks from an Ecological Perspective

-- Taking wuhan east lake national wetland park as an example

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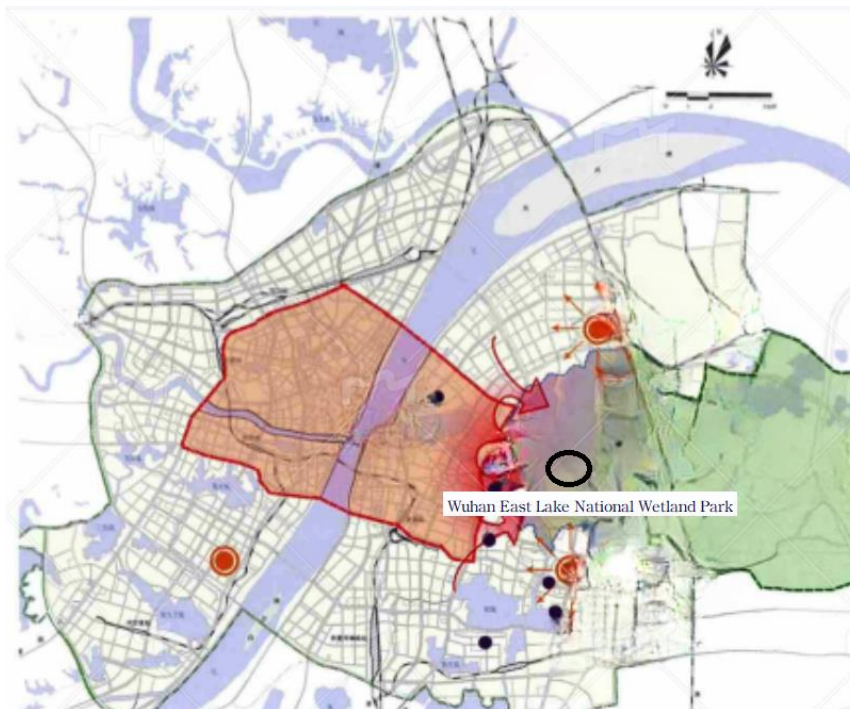
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**Abstract.** Urban wetland parks represent a unique ecosystem within cities, possessing significant environmental regulation and social service functions. This paper takes Wuhan East Lake National Wetland Park as its research subject. Through an investigation of the current status of East Lake National Wetland Park, and in conjunction with relevant theories on wetland park landscape construction, it analyzes the landscape construction strategies of Wuhan East Lake National Wetland Park from an ecological perspective.

**Keywords:** Wuhan East Lake National Wetland Park, Landscape Design, Wetland Parks.

## 1. Introduction

Wuhan East Lake National Wetland Park is located in the eastern part of central Wuhan City, and is divided into eight scenic areas: Baima, Yuguang, Luoyan, Tingtao, Moshan, Houhu, Yujiashan, and Chuidi [1]. It borders on Wuhan's Third Ring Road to the east and extends south near Meishan and Houshan, adjacent to Luxiang Urban Sub-center. To the west, it connects with Yujiahu and Moshan scenic areas, closely adjacent to Wuhan's central activity area where human activities are abundant. It borders on Donghu Qinghe Bridge in the north and relies on Wuhan's High-speed Railway Station to form the Yanghu Urban Sub-center (Figure 1). East Lake Wetland Park has become a transitional zone between the urban center and the ecological green area.



**Figure 1.** The location map of Wuhan East Lake National Wetland Park

During the 1950s and 1960s, East Lake had good water quality with a transparency of over 2 meters. A healthy aquatic ecosystem was formed by planktonic plants, aquatic plants, benthic animals, and fish [2]. However, after the 1960s, with artificial construction and aquaculture development, agricultural wastewater, urban domestic wastewater, and wastewater from factories and medical

facilities flowed into East Lake, leading to reduced biodiversity, continuous deterioration of water quality, and shrinking distribution of aquatic plants. Although water quality restoration efforts were made in the 21st century, some areas within the Yujiahu Recreational Zone and Binhu Recreational Zone still have odorous water bodies, water pollution, eutrophication of algae, deteriorating living environments for aquatic animals, and decreasing coverage of aquatic vegetation. The construction of lakefront spaces such as docks, as well as shoreline development, has resulted in hardened lake banks, further water quality deterioration, and degraded wetland vegetation in East Lake. This paper focuses on landscape design for Wuhan East Lake National Wetland Park, with ecological restoration and the development of recreational functions as the starting points.

## 2. Design Principles

The Overall Planning Guidance of National Wetland Park points out that the planning of urban wetland park should take into account the integrity of the ecosystem, the relative independence of regional units and the continuity of the surrounding environment [3]. Therefore, ecology and environmental protection are the first principles of landscape design of Wuhan East Lake Wetland Park. In the process of landscape design, the objective law of ecological succession should be followed to minimize the artificial traces, protect the continuity of wetland ecosystem, and build a wetland system that integrates scientific, ecological, biodiversity and landscape appreciation. Specifically, through the construction of vegetation ecosystem and waterfront ecosystem, improve water quality and promote the interconnection and sharing among various populations.

Secondly, there are aesthetic principles. Wetland parks are ecological theme parks that aim to conserve and utilize diverse wetland landscape resources and favorable ecological environments, while also equipping them with a series of tourism and leisure facilities, thus providing people with venues for sightseeing, leisure, and entertainment [4]. Therefore, during the landscape design process, consideration must be given to their sightseeing and leisure functions, highlighting the ecological beauty and cultural artistic conception of Wuhan East Lake National Wetland Park. By combining different plants, vegetation communities for various seasons can be created, forming a colorful, undulating, and well-arranged vertical vegetation landscape that enhances the ornamental value of plant landscapes. East Lake is a cultural treasure rich in Chu and Han styles, boasting numerous historic sites such as the Xingyin Pavilion, the statue of Qu Yuan, Chu Tian Platform, Lisao Monument, Li Bai's Eagle-Releasing Platform, Hongshan Pagoda, and Wuying Pagoda. Therefore, when designing the landscape, visual effects among historic sites, water bodies, and plants should be taken into account, and gardening techniques such as "blank-leaving" and "borrowing scenery" can be employed to emphasize the cultural connotations of East Lake.

Finally, the principles of landscape design are functional and practical. In 2024, Wuhan East Lake National Wetland Park received more than 550,000 tourists in a single day [5], tourists come here to enjoy leisure, recuperate and relax. Therefore, it is necessary to take into account the behavior and needs of tourists in landscape design, and increase the practicality and education of landscape design.

## 3. Landscape design practice of Wuhan East Lake National Wetland Park

### 3.1. Ecological status of Wuhan East Lake National Wetland Park

The wetland area of Wuhan East Lake National Wetland Park is dominated by plants such as *taxodium ascendens*, *metasequoia glyptostroboides*, *Taxodium pdistichum*, *salix babylonica*, *lotus*, and *phragmites australis*. The forest area is primarily composed of evergreen and deciduous broad-leaved mixed forests, including *pinus massoniana* lamb, cedarwood, and seedlings of broad-leaved trees. The production area focuses on nurseries and fruit trees. Through diversity analysis at the landscape level, it was found that the vegetation landscape within Wuhan East Lake Scenic Area exhibits a relatively high degree of fragmentation [6]. Although this landscape pattern can form a diversified ecological environment, there is no naturally formed dominant patch type, which is not

conducive to the construction of thematic patch types and the survival of many species that depend on large patches.

More than 40% of the boundary of Wuhan East Lake National Wetland Park is lake shore, but there is no buffer transition area, which is not conducive to the ecological protection of lake and wetland resources. Moreover, its riverside is dominated by hard rock riprap embankment [7]. Hard rock riprap embankment is a kind of embankment made of unprocessed irregular stones. Although this embankment has strong stability and flood resistance, its permeability and water permeability are poor [8], which cuts off the exchange and circulation of water and gas between the soil mass on the embankment and its upper space, and reduces the ability to adjust air temperature and humidity. Cutting off the ecological communication between land and water. Hard rock riprap embankment destroys the plant roots in the waterfront area to create a suitable growth environment for fish, frogs, mussels, and other organisms, reducing species, destroying ecological service

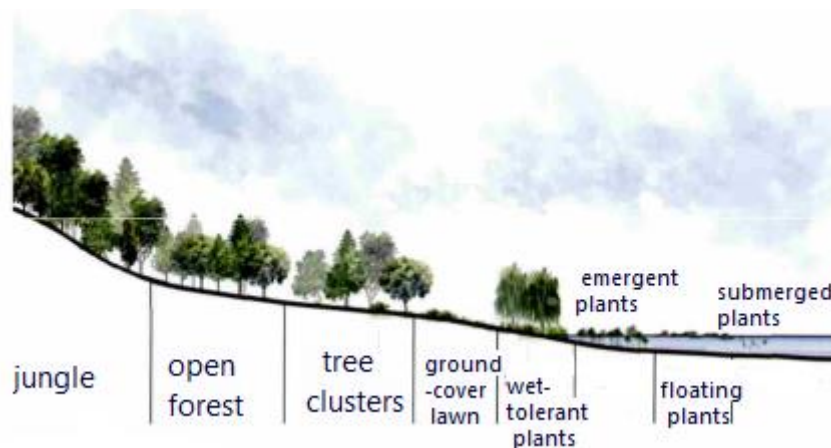
### **3.2. Objectives and contents of landscape design of Wuhan East Lake National Wetland Park**

According to the ecological problems faced by Wuhan East Lake National Wetland Park summarized above, the contents of landscape design are put forward as follows: 1) Establish a complete vegetation ecosystem through vegetation restoration, create diverse lakeside ecosystems, and enhance the aesthetic experience of Wuhan East Lake National Wetland Park. 2) Use the concept of ecological revetment to transform the lake shoreline, restore the natural characteristics of the lake shore, and ensure the diversity of species and the stability of the ecosystem. 3) Improve the landscape design of Wuhan East Lake National Wetland Park, and increase the humanized design of landscape sketches based on the needs of tourists, so that the landscape sketches are not only beautiful, but also have strong practical functions, and can be integrated with the natural landscape of Wuhan East Lake National Wetland Park.

### **3.3. Implementation of landscape design of Wuhan East Lake National Wetland Park**

#### **3.3.1. Construct the integrity of vegetation ecosystem**

The terrain of Wuhan Donghu National Wetland Park is divided into a mountain area, a gentle land area, and a waterfront wet area. In Moshan and Maanshan, an evergreen coniferous forest was planted on the upper slope, and some deciduous broad-leaved forest species, such as camphor tree, celtis sinensis pers and osmanthus tree, were appropriately introduced on the lower slope, gradually forming a vertical gradient change of evergreen coniferous forest, theopencedrymion and broad-leaved mixed forest from the top to the foothills. For the gentle land area, the vegetation types of various broad-leaved forests are mainly used, and the vegetation types of coniferous forests with ornamental value are added in some parts, such as taxodium ascendens and metasequoia glyptostroboides. These trees are resistant to water and moisture, grow slowly, and have compact or graceful tree forms, which bring richness to the wetland layer and texture. In the riparian wetland area, efforts are made to gradually restore the wetland plant community dominated by natural aquatic plants, fostering a well-formed natural wetland vegetation zone. Through strategic plant arrangement, a comprehensive vegetation ecosystem is established, transitioning smoothly from aquatic plants to terrestrial plants, forming a coherent system of "jungle - open forest - tree clusters - groundcover lawn - wet-tolerant plants - emergent plants - floating plants - submerged plants." This enhances both the biodiversity and the layered landscape of East Lake Wetland Park (Figure 2).



**Figure 2.** Vegetation ecosystem of East Lake in Wuhan

The landscape planning of Wuhan East Lake National Wetland Park should also take into account the uniformity of seasonal scenic change [9]. The planning and application of plant species in various plant communities are considered from the perspective of the four seasons landscape effect of vegetation. Spring plant landscape includes peach, plum, cherry, magnolia and other ornamental flowering plants, a tea garden for picking experience activities and camphor trees, salix babylonica, alchornea davidii franch and other ornamental leaf plants. Summer plant landscape is based on chinese rose, lotus, magnolia grandiflora, albizia julibrissin, and other ornamental flowering plants. The plant communities that form the rural pastoral landscape, consisting of miscanthus, setaria viridis, and various ornamental herbaceous plants, as well as the various plant communities ranging from pale green to dark green hues. Autumn plant landscape mainly includes a large number of plant communities with bright autumn leaves, such as cotinus coggygia scop, liquidambar formosana, pistacia chinensis bunge, ginkgo biloba, osmanthus community based on aromatic experience, and pyracantha fortuneana, citrus, papaya and other plant communities based on fruit. The winter plant landscape is characterized by ornamental flowering plants dominated by wintersweet flower, camellia japonica, oil-tea camellia, daphne flowering plants, deciduous plant communities focused on the ornamental branches and trunks of species such as chinar, lagerstroemia indica, and papaya, and plant communities centered around evergreen species like cedar, pinus massoniana lamb , and cypress.

Furthermore, this paper aims to highlight the aesthetic ambiance of East Lake Wetland through the arrangement of different plant species. The lotus, regarded by ancient Chinese as the "gentleman among flowers," symbolizes truth, goodness, and beauty, representing steadfastness, purity, and integrity. The water lily symbolizes ecology and harmony. Therefore, this paper selects the lotus and water lily as the main landscape plants, while also taking into account historical monuments, to emphasize the cultural heritage of the Wuhan region. For instance, the Tingtao Scenic Area in East Lake is a cluster of attractions dedicated to commemorating the patriotic poet Qu Yuan. The area includes sculptures of Qu Yuan, Xingyin Pavilion, Changtian Tower, Huguang Pavilion, Chufeng Garden and other structures such as pavilions, towers, and halls. In the vast water areas outside these structures, lotus communities of various varieties such as root lotus, seed lotus, and ornamental lotus can be planted in clusters, complemented by a variety of aquatic plants featuring water lilies and Victoria water lilies, forming a unique aquatic ecosystem. The collocation of lotus and water lily not only symbolizes Qu Yuan's noble and unyielding character, but also expresses the praise and admiration of later generations. While feeling the spirit of Qu Yuan, people can also sit in the pavilions and enjoy the breezy lotus pond landscape outside the window while sipping tea. The large area of the lake reflects the reflection of plants and buildings, and the light reflected from the lake can add color to the buildings and plants, expand the landscape of the space, and produce the artistic conception of the combination of virtual and real. The distant mountain and lake area is a kind of blank-leaving design, which extends people's visual space and gives people a sense of vast water. Close by, when the sun shines, are lotus flowers in full bloom. In the distance is the sparkling lake, full of beauty. In addition, hydrophilic spaces with different characteristics can be designed around

some hydrophilic trestle paths to facilitate tourists enjoying themselves at close range. On the basis of large-scale planting of summer lotus, small patches of autumn lotus are cultivated, creating a unique landscape where summer lotus withers while autumn lotus blooms. In late autumn, the autumn lotus and the chrysanthemum garden on the shore echo each other, and the chrysanthemum lotus is put together, adding bright and clever colors to the East Lake in autumn, forming a scene of point-and-point combination.

### 3.3.2. Lake shore ecological environment construction

There is a water pollution problem in East Lake, and aquatic plants are the key elements of water ecological restoration. Aquatic plants can remove pollutants from the water or reduce their toxicity through direct adsorption and absorption of pollutants and collaborative microbial decomposition of pollutants [10]. Therefore, this paper considers the use of plant populations to achieve the goal of absorbing pollution, improving water quality, protecting species diversity, and building a waterfront ecosystem suitable for living organisms.

Studies have shown that aquatic plants of different life types have plants with high removal rates of pollution factors such as total phosphorus and total nitrogen [11]. For example, *Alisma orientalis*, *Phragmites australis*, *Canna indica*, *Typhaorientalis*, *calamus*, *Scirpusvalidus*, *Sagittaria trifolia*, *Arundo donar*, *Cyperus involucratus* are among the emergent plant. Among submerged plants, *Ceratophyllum demersum*, *Myriophyllum aquaticum*, *Vallisneria natans*, *Myriophyllum rotophylla verticillatum*. *Eichhornia crassipes*, *Salvinianatans*, *Azolla imbricata*, *Pistiastratiotes* are among the floating plants. Water lily, *Trapa bispinosa* are among the floating leaf plants. Therefore, this paper combines the landscape effects of the water shoreline and selects a combination of wetlands and aquatic plants. Emergent plants chosen include *typhaorientalis*, lotus, *Phragmites australis*, *arundo donar*, *canna indica*, *sagittaria trifolia*. For floating plants, those less affected by water quality, such as *nymphoides peltatum*, water lilies, *eichhornia crassipes*, *trapa bispinosa* are selected. Pollution-tolerant submerged plants include *vallisneria natans*, *potamogeton malaianus*, black algae, which can form an "underwater forest" to purify wastewater and stabilize the structure and function of the aquatic ecosystem. *Phragmites australis*, and *arundo donar* can create a gentle beauty along the shoreline, providing a good long-distance view and forming a natural landscape where the water body and plants complement each other. Wetland plants such as *metasequoia glyptostroboides* and *salix babylonica* are tall and straight, not only depicting the shape of the lakeshore but also dividing the overall space. *Metasequoia glyptostroboides* and *salix babylonica* help establish large-scale lakeshore wetland plant communities and emergent plant communities, creating a rich landscape hierarchy and seasonal viewing effects.

In summary, this paper integrates ecological revetments, wetland plants, and the inherent characteristics of the site to construct an ecological lakeshore landscape. By reconstructing and configuring wetland plant communities, the wetland ecosystem along the lakeshore is restored, biodiversity is increased, and a purification zone for the lakeshore wetlands is formed, ensuring continuity between aquatic and terrestrial areas. Along the coastal areas of the East Lake National Wetland Park, greenbelts are arranged to increase public space. These greenbelts surrounding the lake filter sewage, preventing or mitigating direct discharge of sewage into the lake.

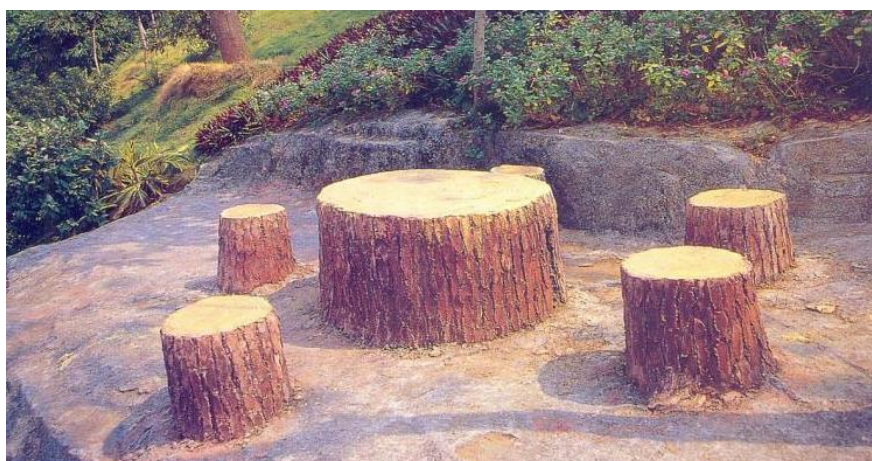
### 3.3.3. Humanized and multi-functional landscape sketch design

Landscape sketches in urban wetland park are small facilities and structures for rest, decoration, lighting and display, as well as for garden management and visitors' viewing, with ecological protection, leisure tours, and popular science education as the main contents in the park under the specific background of wetland [12]. It includes service pieces: toilet, trash can, etc. Leisure pieces: pavilion, stool, swing, pavilion, hydrophilic platform, hydrophilic boardwalk, etc. Display pieces: sculptures, guide plates, road signs, etc. Educational skits: picture galleries, background walls, etc. [13]. The design of the urban wetland park landscape sketch should be able to enrich the viewing angle of tourists, enrich the viewing content, highlight the function of the wetland main body, and meet the use of visitors. Therefore, its color, material, and shape design should not only show the

ecological characteristics of the wetland itself, but also highlight the local cultural heritage, but also coordinate with the surrounding environment to achieve overall harmony and unity.

Parks should establish structures such as pavilions and corridors at scenic spots with broad vistas, excellent landscape effects, or pleasant and comfortable environments to fulfill visitors' needs for rest, observation, entertainment, and other activities [14]. Natural raw materials like stone, wood, and bamboo should be selected, preserving their original colors and designing them in an antique style. The pyramidal roofs, rustic designs, gravel paths, and wooden walkways all exude a strong historical atmosphere and profound cultural heritage, making the buildings and their surrounding environment complement each other beautifully.

Tables, chairs, and trash cans are essential facilities in the East Lake National Wetland Park. It is advisable to use wood-imitation materials or other sustainable and recyclable materials, applying a coating on them while preserving their natural colors to extend their service life. Practical functions should be added to amenities to meet visitors' unexpected needs. The tables and chairs can be designed in a cylindrical shape, with the hollow part in the middle used to store emergency items such as raincoats and umbrellas, or designed as storage space for visitors to place items during their tour. Warm reminders such as “Open the latch on the table to find raincoats” should be posted. As shown in Figure 3. The trash cans design in Figure 4 employs a bionic design, with colors and shapes resembling tree roots, adding a wild charm and harmonizing with the natural wetland environment.



**Figure 3.** Table and chair design



**Figure 4.** Trash cans design

## 4. Summary

With the deepening of the national emphasis on resource protection, the construction of urban wetland parks will become an important way to protect wetland resources. Based on the in-depth investigation of Wuhan East Lake National Wetland Park, this paper summarized the ecological problems faced by Wuhan East Lake National Wetland Park, combined with the theories of landscape ecology, botany, and ecological planning, and put forward the landscape construction strategy of wetland park from the perspectives of plant planning, ecological revetment design and landscape sketch design.

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