

Study on Ecological Landscape Regeneration Strategy of Chongqing Special Steel Factory Site under the Concept of Rewilding

Qiusha Wang^{1*}

¹ Art College, Chongqing Technology and Business University, Chongqing, China

Email Address

250700906@qq.com (Qiusha Wang)

*Correspondence: 250700906@qq.com

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Abstract:

Against the compound background of the intensifying global ecological crisis, the urgent need for biodiversity conservation, and the growing demand for the transformation of urban industrial heritage sites, the protection and construction of butterfly habitats are confronted with multiple challenges. As an important component of urban spatial resources, the ecological landscape regeneration of urban industrial heritage sites creates new possibilities for the construction of butterfly habitats, and the transformation strategy based on the rewilding theory has become a crucial breakthrough to achieve this goal. Taking the Special Steel Factory in Shapingba District, Chongqing as the research object, this study argues that the transformation of urban industrial heritage sites based on the concept of rewilding can not only significantly increase the scale of urban butterfly populations and promote the process of regional biodiversity conservation, but also endow urban industrial heritage sites with ecological service functions and cultural inheritance value, so as to promote the coordinated development of urban ecological benefits, social benefits, and economic benefits.

Keywords:

Rewilding Concept, Urban Industrial Relics, Ecological Landscape, Butterfly Habitat

1. Introduction

1.1. Research Background

Against the background of the rapid advancement of global urbanization, the gradual withdrawal of traditional industrial enterprises has made industrial heritage sites important carriers for the reconstruction of urban space and the renewal of urban functions. These industrial heritages not only contain rich historical and cultural connotations, but also are residual resources that need to be integrated and redeveloped in the development of contemporary cities [1]. It is worth noting that current urban industrial heritage sites generally face multiple challenges, including

soil pollution, ecosystem degradation, the decline of landscape features, and the simplification of functional structure. These problems require us to adopt innovative ecological restoration technologies and spatial regeneration strategies to achieve the coordinated improvement of ecological landscape benefits and social and economic benefits.

Meanwhile, the sharp decline of biodiversity worldwide has become an environmental challenge that needs to be addressed urgently. As a sensitive indicator species of ecosystems, the population dynamics and diversity changes of butterflies can effectively reflect the quality of the environment and the health status of ecosystems. With the acceleration of urbanization and the expansion of human activities, natural habitats have been continuously occupied, resulting in a significant reduction in the area of habitats for pollinators including butterflies, which are thus facing severe survival threats. In this context, the protection and restoration of butterfly habitats are not only related to the maintenance of the stability of urban ecosystems, but also of great practical value for improving the public's ecological awareness and enhancing the effectiveness of environmental education.

In recent years, the concept of rewilding, which has emerged in the field of international ecological restoration, has provided an innovative theoretical framework for urban renewal and ecological landscape regeneration [2]. This concept emphasizes minimizing human intervention to promote the self-succession of ecosystems and the restoration of species diversity. Compared with the limitations of traditional urban ecological landscape regeneration that mainly focuses on vegetation restoration and landscape beautification, the rewilding concept pays more attention to the systematic restoration of the self-regulation mechanism of ecosystems and biodiversity. Therefore, exploring how to combine the rewilding concept with the renewal process of China's urbanization and studying its innovative application in the ecological transformation of urban industrial heritage sites have become important issues in the current development of ecological landscape regeneration and urban renewal.

As an important historical relic in the industrial development history of Shapingba District, the site of Chongqing Special Steel Factory is in urgent need of the reconstruction of ecological landscape functions and the reuse of space after the factory's relocation. This industrial site not only has complex topographic features and rich industrial heritage resources, but also contains significant potential for improving regional biodiversity through rewilding strategies. Taking this urban industrial heritage site as an example, this study explores the method of constructing butterfly habitats based on the rewilding theory, and its research results have both academic value and practical guiding significance.

1.2. Research Purposes and Significance

1.2.1. Ecological Significance

The practical application based on the theoretical framework of rewilding shows that the ecological transformation of abandoned industrial heritage sites can be effectively converted into butterfly habitats, thereby significantly enhancing the site's biodiversity and ecological service functions [3]. By systematically restoring native vegetation communities and constructing a microhabitat system that meets the ecological needs of butterflies, this study provides stable nectar plants, breeding substrates, and migration corridor networks for butterflies, thereby optimizing the structure and function of urban ecosystems. This strategy not only successfully

realizes the population restoration of target species, but also creates a suitable habitat environment for other invertebrates and small mammals through the trophic cascade effect, which significantly promotes the restoration of ecosystem integrity at the regional scale.

1.2.2. Cultural and Social Significance

Urban industrial heritage sites are key witnesses of urban history. Their transformation is not only the renewal of physical space, but also the protection and inheritance of industrial culture. Integrating ecological landscape regeneration with industrial culture, retaining the core elements of industrial facilities and transforming them into part of butterfly habitats can create an ecological landscape space with profound cultural connotations, which can serve as a leisure green space for urban residents. In addition, environmental education activities can be carried out to enhance the public's awareness of biodiversity conservation and promote the sustainable development of the city.

1.2.3. Significance for Urban Renewal and Sustainable Development

Against the background of the simultaneous occurrence of global urbanization and ecological crisis, how to achieve the goal of promoting both urban renewal and ecological conservation has become a key issue in the current process of urban development. Taking Chongqing Special Steel Factory as an example, this study combines the restoration of ecological landscape with industrial culture, opening up new ideas for the sustainable utilization of abandoned industrial sites [4]. The research strategies are not only applicable to the central urban area of Chongqing, but also provide a reference for the renewal of industrial heritage sites in other cities.

2. Overview of Related Theoretical Research

2.1. The Concept of Rewilding

In recent years, against the background of the increasing global climate change and biodiversity crisis, the concept of rewilding has attracted widespread attention. On the one hand, researchers have focused on the introduction of large mammals; on the other hand, they have paid more attention to the conservation of microhabitat diversity and the restoration of ecological processes. The connotation of rewilding has gradually expanded from the initial "reintroduction of wild animals" to "reconstruction of a complete ecological network", covering multiple aspects such as soil microorganisms, pollinators, and environmental stress mitigation.

2.2. The Theory of Ecological Restoration for Urban Industrial Heritage Sites

The technologies for ecological landscape restoration of urban industrial heritage sites have been continuously innovated, and a systematic "three-in-one" method of "pollution control + ecological landscape + cultural regeneration" has gradually been formed.

2.2.1. Pollution Control

Technologies such as phytoremediation, microbial remediation, and engineered soil capping are widely used to address sites contaminated by heavy metals, organic matter, and other pollutants.

2.2.2. Ecological Restoration

This focuses on restoring soil health, reconstructing diverse plant communities, creating wetlands and water bodies, and introducing wild animals.

2.2.3. Cultural and Social Function Reconstruction

While restoring ecosystems, this approach emphasizes protecting and utilizing industrial heritage. Through spatial redesign, heritage sites are endowed with new functions, such as ecological parks, environmental education bases, and community farms.

2.3. Basic Principles for the Construction of Butterfly Habitat Landscapes

As an “indicator species”, butterflies are quite sensitive to environmental changes. The changes in their community structure can reflect the quality of urban green spaces, the diversity of vegetation, and the health status of ecological processes [5]. The construction of butterfly habitats not only improves the aesthetic value of the city, but also attracts other pollinators and small wild animals to inhabit, thereby enhancing the complementarity and stability of the ecosystem.

Butterflies and their habitats provide key ecosystem services, including:

- a. Pollination services: Promoting plant reproduction and fruit production in cities and surrounding farmlands;
- b. Biodiversity enhancement: As an intermediate link in the food chain, butterflies support the survival of natural predators such as birds and spiders [6];
- c. Ecological education and outreach: Butterflies’ intuitive, easy-to-understand life cycles make them ideal for ecological education and children’s nature experiences;
- d. Landscape aesthetics and mental health: Butterfly activities enrich the color and vitality of sites, helping to improve citizens’ psychological well-being.

3. Project Overview of Chongqing Special Steel Factory

3.1. Basic Site Overview

3.1.1. Geographic Location and Historical Background

Chongqing Special Steel Factory is situated in the Shijingpo Area of Shapingba District, Chongqing. Founded in the 1950s, it is one of the representative heavy industry enterprises in southwest China. As a witness to Chongqing’s industrial development, the factory retains abundant memories of industrial history and traces of urban evolution. In recent years, driven by industrial restructuring and urban spatial expansion, the factory ceased operations in 2006 following the environmental protection-related relocation of Chongqing Iron and Steel Co., Ltd. Its former site was included in Chongqing’s industrial heritage protection program in 2017, with industrial relics within the factory area awaiting spatial restructuring and landscape renewal.

3.1.2. Existing Ecological Environment and Spatial Pattern

The site of Chongqing Special Steel Factory covers a large area with a undulating terrain, which is a typical mountainous terrain in Chongqing. There are a large

number of industrial heritage sites in the park, such as factory buildings, chimneys, and conveyor belts. The original vegetation in the site has been largely cleared, and only some weeds and self-grown shrubs remain at present. There is a lack of systematic greening measures and landscape regeneration plans. Due to the long-term accumulation of raw materials and waste in some areas, the soil is at risk of pollution and degradation. The water resources are relatively scarce, and the microclimate environment is affected by hard pavements and the volume of buildings. The heat island effect is relatively obvious in some areas in summer. The overall ecosystem function is relatively weak, the level of biodiversity is low, and the frequency of indicator species such as butterflies is also low.

3.1.3. Industrial Heritage and Surrounding Environment

The factory retains a wealth of industrial buildings and equipment, including blast furnaces, steel production lines, warehouses, and transportation rails—featuring a complex yet hierarchical spatial structure. Although some old buildings are damaged, they hold high cultural value as industrial heritage and possess potential for spatial restructuring and landscape renewal. The site maintains close connections to surrounding residential areas, schools, and transportation hubs—providing practical conditions for its transformation into a public ecological space and environmental education base.

3.2. Current Site Problems

- a. Ecosystem Degradation: Soil contamination, simplified ecological structure, and low biodiversity;
- b. Spatial Function Fragmentation: The large site lacks effective zoning and circulation organization, failing to meet diverse ecological and human needs;
- e. Urgent Industrial Heritage Protection: Industrial relics face the risk of damage and neglect, requiring integration with ecological landscape regeneration to preserve the site's cultural heritage [7];
- f. Limited Public Participation: The site remains closed with weak management, and there is a lack of spaces for public engagement and science popularization activities.

3.3. Renewal Goals and Challenges

Based on the idle status of Chongqing Special Steel Factory, this study takes local butterfly species as the core to systematically build a diverse habitat with a complete life cycle, deeply integrates the concept of rewilding, selects local plants and natural succession methods to restore the ecological landscape system, realizes the reuse of Chongqing's urban industrial heritage space and its organic integration with the ecological landscape, innovatively introduces an APP-based interactive popular science platform and a community-participated co-construction mechanism, and creates a unique image of the industrial heritage site to enhance the vitality of the site.

4. Research on Site Ecological Landscape Regeneration Strategies Under the Rewilding Concept

4.1. Overall Spatial Layout

The overall layout fully considers the natural ecology, the historical culture of industrial heritage sites, and the leisure needs of citizens. Through rewilding design and the introduction of butterfly habitats, it has achieved a wonderful transformation of the abandoned urban industrial heritage site [8]. The original industrial heritage buildings are retained and renovated, following the principle of “restoring the old as the old”, and some industrial buildings are partially renovated to inject new vitality into them and enhance the profound heritage of historical culture. The three core landscape areas include butterfly habitats, rewilding areas, and industrial farms. Through diverse plant configuration and ecological design techniques, a vibrant and diverse ecological environment has been successfully created.

4.2. Optimization of Tourist Routes

A red-colored route runs through the entire site: it not only guides foot traffic but also the red route runs through the entire area. On the one hand, it plays a role in guiding the flow of people; on the other hand, it serves as a prominent visual highlight [9]. The route design facilitates citizens' leisure and sightseeing and skillfully connects various functional areas. Different functional areas are divided, and the setting of corridors not only connects each core landscape area, but also skillfully separates different functional areas. The route design is flexible and diverse, including understory paths and aerial corridors, which enriches the travel experience and increases the fun of sightseeing. It coordinates the relationship between human beings and the natural environment, meets the needs of residents and tourists, and improves the overall environment of the park.

4.3. Optimization of Site Space

4.3.1. Industrial Farm

The industrial farm incorporates the characteristics of the original industrial heritage site: its planting areas are divided into separate bed plots, where various crops (including multiple leafy vegetables and other plant types) are grown—demonstrating a diversified planting strategy. Landscape trails crisscross between the planting beds, facilitating movement and viewing. Clear paths between beds support farm operation and management while creating visitor routes. Several wooden or metal structures are covered with greenery, enhancing the landscape's ecological attributes. Bridges and corridors are also integrated to connect different areas, allowing visitors to view planting zones from multiple perspectives—adding layering to the landscape and offering varied viewing angles.

4.3.2. Butterfly Habitats

Butterfly habitats form the ecological core of the overall design strategy. By planting butterfly-preferred plants, the site attracts butterflies to inhabit and reproduce here. As indicator species reflecting ecological conditions, butterflies enhance the region's ecological value and make the area a popular spot for citizens to observe and photograph butterflies. Decorations and landscape features shaped like butterflies are installed in these habitats to boost visual interest and reinforce the butterfly habitat theme. Dynamic elements are abundant: low-lying plant areas are specially placed alongside trails to provide butterflies with habitats and foraging grounds, while also allowing children and pedestrians to observe and interact with butterflies up close—fostering a sense of connection between humans and nature.

4.3.3. Rewilding Areas

By introducing natural elements, rewilding areas exhibit ecological scenes of natural succession. Human intervention is minimized here, allowing natural vegetation and wild animals to reproduce freely and form a diversified ecosystem [10]. Various plant types create diverse habitats for different organisms: for example, flowers and herbs provide food and shelter for insects like bees and butterflies, while climbing plants offer nesting sites for birds. Landscapes are integrated with industrial buildings: plants grow naturally around structures, softening the rigid lines of factory buildings. Vertical climbing plants cover building structures and columns, enriching plant layers, providing shade and cooling effects, and improving the buildings' microclimate.

4.4. Plant Optimization

Priority is given to native plants from Chongqing and southwest China. These plants are adapted to local climate and soil conditions, which enhances ecosystem stability and reduces long-term maintenance costs—while also meeting the needs of both nectar sources and host plants.

To support butterfly reproduction and population stability, nectar plants and host plants are scientifically configured based on the butterfly life cycle. The resulting plant communities feature rich layers and diverse structures. Common butterfly species in Chongqing—such as swallowtail butterflies, monarch butterflies, white butterflies, and satyr butterflies—are considered in the development of “butterfly-friendly” plant communities. Plants with varied flowering periods, rich colors, and distinct seasonal changes are selected to enhance the site's landscape appeal and improve citizen experiences. Through multi-layered planting of arbors, shrubs, and herbs, a diversified microhabitat is established to provide food, shelter, and breeding spaces for butterflies and other wild animals.

In terms of natural succession and community self-organization, the rewilding concept is integrated to appropriately guide natural succession and reduce manual pruning and intervention. This allows plant communities to gradually achieve self-regulation and renewal, showcasing seasonal changes and landscape aesthetic value.

5. Conclusion and Reflection

Focusing on the two aspects of ecological restoration of urban industrial heritage sites and the construction of butterfly habitats under the concept of rewilding, this study conducts a comprehensive and systematic research and innovative practice with the Special Steel Factory in Shapingba District, Chongqing as the research object. It analyzes the history, current situation, and ecological characteristics of the site in detail and depth, puts forward a strategy for creating a diversified ecological landscape centered on local butterflies in Chongqing, and attempts to explore a specific path for integrating the protection of urban industrial heritage sites with ecological landscape regeneration. By adopting the rewilding method of low intervention and natural succession, the ecological function of the site is restored, the biodiversity is enhanced, and the abandoned industrial space is endowed with new ecological and social values. This project strengthens the inheritance of industrial memories, shapes the uniqueness of the site, and promotes community co-construction and the dissemination of the concept of ecological civilization through environmental education and public participation.

Conflicts of Interest

The author declare that there is no conflict of interest regarding the publication of this article.

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