Urban Rewilding: State of the Art of Berlin's Urban Ecological Space Protection

Xue Fei, associate professor and master's tutor in the Department of Urban and Rural Planning, School of Urban Construction, Beijing University of Technology, xuefei@bjut.edu.cn
Lang Yuexi , a master's student in the Department of Urban Construction, Beijing University of Technology
Cao Yue, Assistant Professor, Department of Landscape, School of Architecture, Tsinghua University, corresponding author, caoyue@mail.tsinghua.edu.cn
Hu Shuying , a master's student at the Department of Urban Construction, Beijing University of Technology
Zhang Bowen, a master's student in the Department of Urban Construction, Beijing University of Technology
Xia Chuyu, Lecturer, Department of Urban and Rural Planning, School of Urban Construction, Beijing University of Technology

Abstract: Rewilding has emerged as a pioneering approach to creating high-quality urban ecological spaces and protecting urban biodiversity. This paper reviews the evo-lution of Berlin's urban ecological space planning, underscoring its distinct character- istics in rewilding. Building on this foundation, the paper analyzes three typical re- wilding cases, namely, Nature Park Südgelände, Green Belt Berlin, and Tempelhofer field, leading to a summary of practical methods and implementation mechanisms of Berlin's urban rewilding practice. Fristly, after World War II, Berlin initiated biotype surveys, identifying the ecological benefits of rewilding through biotype mapping. Secondly, the withdrawal of human activities, zoning, and the designation of rewild- ing areas are used as three fundamental methods of rewilding. Thirdly, the leader- ship role played by the academia constitutes the key to Berlin's rewilding success, supplemented by rigorous ecological survey, stakeholder consensus, and effective policy mechanisms. The goal of this paper is to provide fresh ideas for enhancing the quality of urban green spaces in China by demonstrating the value and success of urban rewilding practice.

Keywords: rewilding; urban ecological space; urban ecosystem service; urban biodiversity conservation; nature education

Rewilding is a conservation method aimed at restoring ecosystem functions and structures to achieve self-operation and self-sustainment of the natural environment. Initially, this approach was used to introduce large vertebrate conservation to recreate wilderness. The Wildlands Project (TWP, 1991), jointly proposed by American biologist Michael Soulé and environmental activist David Foreman, was the first practice of rewilding. Reintroduction of previously existing wolves [1]. Since then, some scholars have proposed an early definition of rewilding based on this method. Donlan et al. [2] believe that the purpose of rewilding is to restore local species conditions to those before the emergence of humans ; Stanley proposed restoring large-scale landscapes by introducing key populations, and using the presence of large fauna as a basis to judge whether rewilding is successful. standards.

Rewilding at this stage emphasizes the restoration and reappearance of the past, with the key point being the reintroduction of key local species that have disappeared.

With the reuse of agricultural wastelands in Europe, many scholars have shifted the focus of rewilding to reducing human interference and restoring natural habitats. Duffener et al. [3] believe that rewilding is a process in which humans interrupt their activities and regain control of natural processes; Höchtl et al. [4] believe that rewilding is the self-development of cultivated landscapes without human control; George emphasized that rewilding should "Resist the urge to control nature." Some scholars [5-6] have proposed that rewilding has a futuristic nature and believe that rewilding should not forcibly restore past landscapes or forcibly preset future effects, but should be based on the potential of the habitat and allow it to develop freely. Subsequently, Carver et al. [7] defined rewilding as an emerging method aimed at restoring ecosystem functions and achieving self-sustainment of the natural environment, and emphasized that scale, connectivity, and human influence are the basic elements of rewilding. From the perspective of biodiversity, Perino et al. [8] proposed that rewilding can achieve dynamic ecological restoration from three aspects: restoring trophic level complexity, reducing external random interference, and helping population spread. Rewilding at this stage puts the focus of habitat restoration more on re-establishing plant communities and emphasizes the exclusion of human activities. The main reasons include the high requirements for scale and connectivity of rewilding, as well as the possible two-way interference between people and the environment after rewilding. This two-way interference includes, on the one hand, the threat to humans from wild animals in the rewilding edge areas, and on the other hand, the damage and disturbance to the rewilding environment caused by the entry of humans.

German ecologists first began to pay attention to the study of rewilding within cities. Kowarik [9] first mentioned the German word Verwilderung , treating it as the German meaning of rewilding, and believed that urban rewilding is the potential improvement of urban wilderness. Sukopp et al. [10] have discovered the basis of urban rewilding in urban wastelands since the 1970s. Kunick [11] first proposed the protection of agricultural wastelands in inner cities in the 1970s as an ecologist to study urban biodiversity. venue. Herbst et al. [12] called wilderness areas within cities "urban wildlife areas", believing that these areas can bring opportunities for urban residents to come into contact with wild animals in their daily lives, and emphasized their Low artificiality unlike nature green spaces. Diemer et al. [13] first proposed urban rewilding in the European context and defined urban rewilding space, dividing it into urban and rural rewilding areas and micro-level rewilding. rewilding micro - cosms . It further pointed out that this kind of space is reserved for rewilding and is different from the urban wilderness that already exists in the city. Kowarik [9] pointed out that urban rewilding usually involves cultural ecosystem services that make it have both social and ecological value. Jørgensen [14] believes that rewilding should be viewed more inclusively and that trying to separate nature from culture may be unhelpful or even harmful. Rewilding has attracted the attention of many scholars. However, due to its requirements in terms of scale, remoteness, and naturalness, large-scale rewilding practices are currently dominated by small and medium-sized cities. Rewilding practices are hampered by small numbers, fragmentation, and lack of universal laws.

Berlin, the capital of Germany, has superior natural endowments and high-quality

ecological foundation. Its ecological space has the characteristics of rich biodiversity, allowing independent natural existence, and strong continuity of the landscape system. Due to its special historical background, there are large areas of industrial wasteland and post-war ruins in the city, which provides the possibility for its urban rewilding practice. This article summarizes the development process and characteristics of Berlin's urban ecological space, taking Natur Park Südgelände , Grüne Band Berlin and Tempelhofer Field as examples. Analysis of the practical characteristics of urban rewilding in Berlin's ecological space and its experience introduction , with a view to serving the high-quality development of urban green ecological space in China.

1 Review of the development history of Berlin's urban ecological space

Berlin has a total area of 891.70km2, of which the ecological space area is 322.97km2, accounting for about 36%. The history of ecological space planning in Berlin originated in the 19th century. Its content has expanded from early private garden planning based on decorative aesthetics to today's systematic landscape planning that includes biodiversity protection and is compatible with land use. This article analyzes three stages: before World War II (1840-1945), after World War II and before the unification of Berlin (1945-1990), and after the unification of Berlin (1990 to the present).

1.1 Before World War II : Ecological spatial planning from 1840 to 1945

In the early 19th century, Berlin's ecological space planning gradually shifted from emphasizing decoration to emphasizing leisure. "Die projektierten Schmuckund Grenzzüge von Berlin mit" (Die projektierten Schmuckund Grenzzüge von Berlin mit) proposed in 1840 by the palace planner Peter Joseph Lenné Nächster Umgebung) [15] is the first formal ecological spatial plan in Berlin; in 1870, the Office of the Director of Municipal Parks (Amt des Städtischen) was established by the Berlin City Council. Gartendirektors) marked the official beginning of the history of green space management in Berlin [16]. The green spaces at this time were called "Volksparks" , mostly imitating pastoral scenery. Many suburban forests were re-planned to be used as public leisure places, and man-made nature replaced the previous wilderness areas at this time [17].

Since the 20th century, Berlin's ecological space planning has paid more attention to the functionality and continuity of ecological space. In the 1910 Greater Berlin competition, Rudolf Eberstadt first proposed the concept of a wedge-shaped green space (green wadge) in his design plan [18], using the radial urban road and railway network as a skeleton to arrange ecological spaces deep into the city [19]; Hermann From the perspective of strengthening the continuity of residential areas , Jansen arranged a large number of continuous green spaces on both sides of the residence as the center of the planning [20]. In 1915, Berlin architect and planner Wagner[21] proposed the open space theory (freiflächentheorie) in his book "Urban Public Health Greening" (Das Sanitäre Grün der Städte) , and in 1926 he proposed the "Open Space Master Plan" (open-space planning), emphasizing the continuity and practicality of ecological space.

This stage is the beginning of urban ecological space planning in Berlin and even Germany. The scattered and weakly connected ecological spaces in Berlin began to develop into systematic green space planning.

1.2 After World War II and before the reunification of Berlin: Ecological spatial planning from 1945 to 1990

The accumulation of post-war ruins has dealt a major blow to Berlin's ecological space and posed huge challenges to reconstruction efforts. West Berlin and East Berlin had different urban green space development policies and models at this stage. East Berlin focused on repairing parks and green space systems damaged during the war [22], while West Berlin focused more on the construction of an ecological space planning system and habitat surveys [23]. Before the reunification of the two Germanys, East Berlin had achieved great results in the construction of green residential areas , providing housing for a large number of post-war refugees and carrying out large-scale transformation of courtyard greening; West Berlin had formulated a series of landscape plans including species protection plans. The planning system was legally binding and was used later.

Post-war East Berlin mainly carried out the following work: ① Clearing ruins to highlight the mountain landscape on the edge of the city; ② Emphasizing the restoration of urban greening in areas covered by ruins; ③ Restoring or redesigning previous city squares, including Dunhofer Square, Koch Erwitz Square, etc.; ④ Carry out the construction of a large number of green residential areas . Its planning feature is to take residential area planning as the starting point and integrate residential greening, open spaces in kindergartens and schools, sports facilities and traffic greening into unified planning, forming an overall green space system planning. From the 1982 "Stadt Park - Park City / Exhibition Federal Republic of Germany" (Stadt Park - Park Stadt / Eine Ausstellung aus der Bundesrepublik Deutschland), it can be seen that East Berlin has built and beautified more than 10,000 courtyard green spaces.

At this stage, nature protection in East Berlin and even East Germany relied largely on non-professional citizen organizations, such as the Urban Ecology Interest Group (interessengruppen) . städtökologie) etc. These organizations played an important role in the establishment of the Green Belt Berlin.

West Berlin paid more attention to the construction of the planning system. In 1948, a new Green Space and Horticulture Office was established in West Berlin, with the focus of work being to restore urban green spaces destroyed by the war as quickly as possible. A series of decrees issued until the 1980s , such as the 1965 Land Use Planning, Monument Protection Law, etc., were not fully implemented during the West Berlin stage, but were improved and continued after the reunification of Germany. In 1988, landscape plans containing species conservation plans (landschafts programm eins chließlich artenschutz program (LaPro for short) was promulgated to incorporate city-wide ecological issues into planning. LaPro 's plans for the entire city are legally binding and include both an assessment of the current status of the city's natural landscape and the determination of its future development goals.

The ecological research in West Berlin at this stage laid the foundation for future ecological research in Berlin and even Germany. Ecologists began to regard cities as objects of ecological research and conducted quantitative studies on the species, distribution and scale of animals and plants in ecological spaces within them. In 1952, East Berlin restricted West Berliners from entering its territory, causing many biologists in West Berlin to narrow their research scope to the inner city [10]. In 1957, Herbert Sukopp conducted a habitat survey of the nature reserve in West Berlin and published a list of wild plant species, including 1,269 plant species, and added records of 1,685 animal species in subsequent

updates. During the investigation , Sukopp found that due to human intervention, plant and animal communities in many protected areas have been reduced and degraded. In the late 1970s , ecologists strengthened the structure of Berlin's habitat community survey results and used spatial classification, statistical index setting, and map rendering to visualize their survey results, forming the earliest biotope mapping. In 1974, Wolfram Kunick constructed the vegetation ecological structure of West Berlin using 17 sample areas as representatives. In 1986, Sukopp 's working group produced an ecological community map (ö kochoren) based on the habitat mapping of West Berlin. karte), this map divides the Berlin area into 69 spatial units based on main vegetation types, soils, climate and specific levels of human influence (hemerobia) [24]. The above research work led to the formulation of the Red Lists of Endangered Species. Habitat mapping based on the habitat inventory and the formulation of the red list of endangered species have enabled ecologists to discover the important protective role of urban wasteland in urban environment and biodiversity, and the ecological benefits of rewilding have initially emerged.

1.3 Period of accelerated development (1990 to present)

After the reunification of Berlin, an urban ecological space plan was formed that took into account landscape planning, land use and biodiversity protection [25]. In 1990, the Berlin Environmental Atlas began as an official ongoing documentation project (currently updated to 2020, seventh edition). 1991 Department of Landscape Development and Open Space Planning (Abteilung Landschaftsentwicklung und Freiraumplanung) decided to establish a city-wide landscape and species protection plan, which came into effect in 1994 and is still in use today. In 2016, after two updates , LaPro [26] added the concept of citywide compensation and considered it in parallel with land use planning (der flächennutzungsplan , FNP). The Berlin Urban Green Space Charter promulgated in 2018 emphasizes 9 guidelines and 62 specific projects for ecological space planning, and its specific projects are reflected in the Berlin City 2030 Action Plan [27]. Germany's nature reserve plan, including the Federal Species Protection Regulations, also puts forward higher-level planning requirements for ecological space [28]. At the same time, Germany's ecological space is linked to climate protection. It uses spatial planning as a means to protect urban ecological space while emphasizing green and low-carbon development in terms of spatial structure, traffic maps, energy, and land use to alleviate climate pressure [29].

In terms of biodiversity protection, the 2012 Berlin Biodiversity Strategy emphasized the feasibility of more wilderness in cities [30]. In 2020 Berlin joined the Alliance of Cities for Biodiversity (Bündnis Kommunen für Biologische Vielfalt) to address accelerating species extinction. On this basis, Berlin pays more attention to nature education, and the Berlin Senate adopted a green and sustainable Berlin education mission statement in 2021.

1.4 Summary

The planning and evolution of Berlin's urban ecological space are inseparable from the three-way intersection of research, management and urban nature [31]. The first is the interaction between management and research. The generation of urban ecological knowledge in Berlin was inseparable from the political opinions of the time, and relative ecological knowledge and related action proposals were quickly transformed into planning documents. There are three main mechanisms that ensure the mutual promotion of management and science: ① The sites and objects selected during the habitat survey period

(from 1957 onwards) were restricted by early regional naturalism, which hinted at its potential management concepts; ② Political groups transformed the public's ecological understanding The pursuit of knowledge serves as a means to convey their political opinions; ③ Ecological research is mostly conducted under the commission of public institutions, making ecological knowledge more consistent with the management concepts of managers and policymakers. Secondly, study the protection of urban nature. Urban nature conservation proceeds through the generation and application of scientific knowledge, for example early open space policies relied on specialized academic research. With the emergence of open space theory, urban landscape vegetation mapping, and various field surveys around nature, different types of experts are involved in urban ecological space planning. With the establishment of biome protection systems, ecological knowledge has begun to occupy a central position in urban nature policy formulation. Finally, urban nature imposes constraints on management concepts. In the process of urban renewal in Berlin after the war, the contradiction between the current status of urban nature, ecological protection goals and urban development became the main reason that restricted the implementation of some planning documents. Since the 1990s , the purpose of Berlin's urban ecological space planning has been more to reduce the harm caused by urban development to ecological space.

2 Case study: Urban ecological space practice under the concept of rewilding

2.1 Berlin’s rewilding practice background

Berlin's heavy industrial background and the ruins left after World War II led it to attach great importance to the reuse of abandoned land. In response to the increasing shortage of urban nature and the protection of urban ecological space, many urban parks in Berlin have adopted rewilding development ideas. On the basis of respecting its history, the cultural characteristics of "damage and decay" given to it are gradually weakened. In the process of rewilding, its originality and naturalness are emphasized, with the aim of establishing an urban ecological space that is not completely controlled by humans. . Currently, rewilding and establishing wilderness landscapes within the city is becoming a prominent feature of Berlin’s urban ecological space.

2.2 Rewilding practice in Berlin

The Sagelander Nature Park, the Berlin Wall Green Belt and the Tempelhof Park are typical examples of Berlin’s urban rewilding ideas. By analyzing the site characteristics, historical background and design ideas of these three cases, we can better understand the prerequisites for urban rewilding intervention, design features and the positive impact that the rewilded urban ecological space will bring to the city.

2.2.1 Sakiland Nature Park

Natur Park Südgelände (2000) is Berlin's first successful case of converting an industrial wasteland into a natural park . The park is located south of the center of Berlin, with a length of about 1.5km and an area of 18hm2.

The park has undergone a transformation from a railway yard to nature regaining its dominance. The Sageland Nature Park was formerly the old Tempelhof railway marshalling yard (rangerbahnhofs). Part of the Tempelhof , after it ceased operations in 1952, its derelict state allowed nature to grow unchecked, with areas once dominated by sand and gravel being replaced by hay meadows, perennial meadow plants and native woods. Ecologists

Kowarik and Langer[36] conducted habitat surveys and drew habitat maps in the area in 1980 and 1991 respectively ; research by Kowarik et al.[37] showed that between 1981 and 1991 alone, the forest area increased from 37 % increased to 70%, while its herbaceous structure also provides habitat for native animal species such as birds, spiders, wild bees and wasps. In 1999, the Sageland Nature Park was designated a landscape protected area (landschaftsschutzgebiet), with parts of it a nature reserve (naturschutzgebiet ausgewiesen). Thereafter, formal planning was carried out by the Berlin Öko Con&Planland planning group and it was opened to the public in 2000 as part of the German Expo [38].

In order to retain the existing rewilding characteristics of the site to the greatest extent, the concept of zoned space was adopted in the planning. Both human activity areas and nature protection areas adopt the method of partial human control and partial natural development: ① In the landscape protection area, artificial intervention is used to maintain and control the natural evolution process to maintain the vegetation community at the most suitable environment for the survival of rare species. Stage; ② In nature reserves, allow uncontrolled development of nature to protect regional habitat communities.

Conservation of rewilded landscapes within the park maintains plant diversity and numerous microhabitats, and promotes the protection of native species richness. Currently, 30 species of birds, more than 350 species of plants and 49 species of fungi, including many endangered species of animals and plants, have been found in the park. The park also serves as a natural education function, cooperating with local biologists to provide tourists with wild nature interpretation services.

2.2.2 Berlin Wall Green Belt

The Berlin Wall Green Belt (Grüne Band Berlin, 2006) is located along the site before the fall of the Berlin Wall and is the largest linear ecological space in Berlin. The total length is about 15km and the area is about 67.3hm2[39]. The wild nature of this area, undisturbed by humans, was the starting point for the establishment of the Berlin Wall Green Belt. After the fall of the Berlin Wall in 1989, the German Federation for the Environment and Nature Conservation immediately organized environmentalists to discuss ecological issues in the area; in 1994, the Berlin Wall Green Belt was clearly included in the strategic goal of establishing a new park in the core area of Berlin. core areas, including protection of existing wild vegetation; the 2001-2002 “Green Belt List” (Bestandsaufnahme Grünes Band" project proved for the first time that green belts play an important role in protecting endangered species and their biotope types, laying the foundation for future protection [40].

Within the Berlin Wall Green Belt, the combination of native and exotic species forms a rewilding landscape, and the planning of most ecological spaces relies on the habitat base of past succession. For example, Nordbahnhofpark has enhanced the diversity of wild species in its central open space by reintroducing some dry grassland species. In terms of species diversity, since the biological communities in most arid areas are affected to varying degrees at different stages of development, a variety of habitat types have been formed in this area. The 2012 Protection and Development Plan (Pflege -und Entwicklungsplan , PEP) states that the woody and forest structures existing within the Berlin Wall Green Belt should be protected to further protect the rare plant and animal species existing within it [41].

2.2.3 Tempelhof Park

Tempelhofer Field is currently the largest green open space in Berlin, covering a total

area of approximately 386hm2 (approximately 1.3 Summer Palaces) . The park was formerly an airport and reopened to the public in 2010. In 2014, the Tempelhofer Feld Preservation Act (ThFG) officially designated the area as an urban open space and provided legal protection.

According to the 2016 Tempelhofer field Development and maintenance plan [32], the total protected area in the park is approximately 303hm2, which is divided into central grassland areas (zentralen wiesenbereich) and outer pasture ring (äußeren wiesenring).

The central grassland area is about 202hm2, which is used to protect the open grassland landscape and its unique flora and fauna. It is a key area for habitat protection in the park. Its center is dominated by damp meadows and ruderal meadows, with a total of 329 species of wild plants and 25 species of birds. The outer grassland ring is about 101hm2, providing various uses such as conferences, entertainment, leisure, and sports. The central pasture area is also spatially divided. Divided into high-intensity protected areas (intensive pflege), medium-intensity protected areas (mäßig intensive pflege), extensive protected areas (extensive pflege), wilderness reserves (ruderalaufwuchs), fallow areas (Brachen) and other areas (ergänzende maßnahmen). Among them, the wilderness reserve part has a large number of pioneer species (ruderal pioneer) and perennial meadows (perennial meadows). Except for weeding every 2-3 years, no other human intervention and care are added. The park also carries out regular grazing activities in the Skylark Reserve of about 23hm2 in the southern part of the central grassland area to achieve lower-intensity landscape maintenance.

2.3 Case summary

The rewilding practices of the Sageland Nature Park, the Berlin Wall Green Belt and the Tempelhof Park can be divided into active rewilding and passive rewilding. Active rewilding, for example: Sageland Nature Park has carried out certain interventions in the "remaining wild area" to maintain the vegetation level in the area at a scale most suitable for the survival of endangered species; the Berlin Wall Green Belt has adopted certain species measures in some areas. Reintroduction to re-create the native habitat. Passive rewilding relies more on nature's self-repair: Tempelhof Park adopts more passive rewilding methods, setting up protected areas to restrict human access, encouraging free wild succession, and controlling the remaining wild areas. Preserve as much as possible without giving the area any function, allowing it to develop naturally. Compared with artificial landscapes, rewilding areas not only contribute to local biodiversity and unique natural scenery , but also provide citizens with a real and free natural experience.

The idea of rewilding urban ecological space represented by these three parks has brought many benefits to Berlin. In terms of ecological benefits, the habitat status in the rewilded urban park has been protected and promoted, and the number of endangered species has also increased. According to statistics, nearly half of the bees in Berlin mostly appear in rewilded urban areas [42]. In terms of social benefits, the rewilded ecological space provides unique urban nature and provides people with a unique social space and natural experience.

Some scholars have also raised the risks and challenges inherent in rewilding. One is to reduce the challenges of human control to traditional urban planning and urban ecological restoration work [43]. Due to the particularity of the rewilding method, its project goals and

final results lack certainty, which conflicts with the current mainstream planning and design process [44]. The second is that rewilding may lead to some ecosystem disservices. Including allergic and other disease reactions caused by wild plants to residents, potential safety hazards brought by wild animals [45], and the loneliness and desolation that rewilding landscapes in cities may bring to people [46].

2.4 Urban ecological space rewilding practices in other countries

As a world-famous garden city, Singapore also fully considered the interaction between humans and wild nature during its construction process. In the rail corridor part of its park connector network (PCN), it makes full use of the abandoned railway lines to create ecological spaces. This corridor is also used by wild animals for migration. During the development process of Bishan Ang Mo Kio Park, the abandoned cement canals were demolished. The demolished site formed a self-operating habitat community in less than two years. The restored natural river channel increased the biodiversity of the area by 30%, and eventually even achieved the active return of otters, forming a wildlife habitat [47].

Rewilding in the Netherlands focuses on adding wilderness elements to highly artificial environments. For large-scale spaces such as national parks, on the basis of strictly distinguishing artificial landscapes from natural landscapes, human intervention is reduced and natural development is allowed; inner city parks maintain "wilderness characteristics" through meticulous manual operation and maintenance. The educational significance of rewilding landscapes and the importance of public participation are emphasized throughout the overall rewilding process [48].

Chicago, USA, has achieved the rewilding of the "Big Marsh" area in its southeastern part through the joint cooperation of businesses, government agencies and local civil organizations. The swampy area is located on the eastern shore of Lake Calumet , Chicago's largest body of water . The area was used as a steel mill and landfill from the 1880s to 2002 . Since 2014, the growth of native vegetation has been restored by reshaping natural water flows and re-covering local soil, providing habitat for numerous wildlife. Currently, the area has seen the return of numerous marshland birds, as well as the reappearance of mammals such as white-tailed deer and beavers. In addition, the area has resurfaced roads in non-wild areas and is now the largest mountain bike park in southeast Chicago.[49]

3Comments and Enlightenments

Urban rewilding has become a major feature of Berlin’s ecological spatial planning. Based on sorting out the development history of Berlin's modern ecological space , Lachmund believed that Berlin's urban ecology is a combination of science, politics and urban nature, among which the development of urban wild space is the basis of urban natural planning. Characteristics[31]. This article summarizes the practical path of ecological space rewilding in Berlin by reviewing recent research, sorting out the development process, analyzing typical cases, and based on previous research (Figure 3). The following will discuss its successful experience and explore the possibility of urban rewilding practice based on the actual situation in my country.

3.1 Berlin’s experience in rewilding urban ecological space

It can be seen from the development of Berlin's urban ecological space and three typical rewilding cases that the realization of its urban rewilding results mainly relies on four points: academic leadership, solid research, multi-party consensus and mechanism promotion.

First, the academic community leads. Advanced perspectives from leading ecologists provide academic support for urban rewilding in Berlin. Herbert Sukopp , as the founder of the "Berlin Urban Ecology School", the impact of cities on their surrounding ecology has become the main clue of his research; Ingo Kowarik proposed the concept of "Fourth Nature", that is, the nature of specific urban industrial wastelands (specific urban industrial wasteland nature). nature) [37], and believes that wasteland is the prototype of urban ecosystem and should be regarded as a "new wilderness", that is, urban wilderness.

Second, conduct solid research. Habitat surveys are the basis for urban ecological spatial planning and biodiversity protection in Berlin. At present, Berlin landscape planning is still based on habitat mapping. The biotope mapping of the Berlin Environmental Atlas starts from biotope types, green volume, forest, vegetation heights and the number of migratory birds. Five aspects including the breeding bird population spatialized Berlin's habitat. In the latest version (released in 2013), more than 80,000 habitat community information was recorded and divided into 12 biome types [50]. At the same time, the Biotype Area Factor (BAF) is used as a specific way to implement landscape planning at the urban design level to ensure the quality of ecological space in the city [51].

Third, there is consensus among multiple parties. The rewilding of Berlin's urban ecological spaces is made possible by the involvement of governments, developers, researchers and the public. Since the 1970s , on the one hand, some planners have begun to call for respecting wilderness vegetation and protecting it in the form of parks; on the other hand, citizens' opposition to the government's large-scale urban development has led to subsequent wilderness ecological research and Park construction was realized. These activities led to the government first proposing wasteland protection for inner-city rural areas in 1974 [11]. Since then, Berlin has gradually strengthened its advocacy for the protection of wilderness within the city and the construction of ecological spaces based on it. Supporters of wilderness protection also work with universities to provide wilderness experience and nature education as an outlet, improving the nature education value of wilderness protection.

Fourth, mechanism promotion. Currently, many ecologists, represented by Ingo Kowarik , are serving in Berlin government departments, providing expert advice on urban ecological planning. At the same time, the German Green Party's political advocacy of ecological sustainability has opened up a political path and provided financial support for the construction of high-quality ecological space in Berlin. The Berlin Program stated that it is necessary to "protect the natural basis of life that is threatened by over-exploitation by industrialization and over-exploitation of resources" [52]. Since 1995, the Berlin Council for Urban Development and Environment has regularly published Berlin state-wide environmental map data on the Internet for the public to download and supervise at any time. At the same time, according to Articles 11 and 12 of Chapter 2 of the Berlin Nature Conservation and Landscape Management Act, landscape planning within the state of Berlin must undergo environmental impact assessment, draft solicitation of opinions from interested parties (for a period of one month), and plan publicity There are five steps including soliciting public opinions (for a period of one month), submitting the revised draft based on the opinions to the Berlin City Council for approval, and publicizing the final approved plan [53].

3.2 Discussion on the rewilding of urban ecological space in my country

In the current context of ecological civilization construction, the previous extensive and high-consumption planning and construction ideas no longer occupy the mainstream. Sustainable, low-energy consumption, and high-vitality ecological spaces have become a new window for future urban ecological planning. On the one hand, my country's urban ecological space is mainly characterized by strong decoration, high homogeneity, and weak regionality. High-density construction in built-up areas also puts higher demands on the quality of ecological space within it [54]. On the other hand, people's demand for native nature has increased significantly and is trending across all ages . Rewilding provides a new form of ecological space for cities and provides an opportunity to solve the above problems. Rewilding landscapes evokes people's memories and spiritual comfort of authentic nature and tradition to a certain extent. As a low-intervention, self-maintaining landscape, rewilding is also a lower-cost and low-maintenance land use method. As in parts of Europe , natural grazing can yield higher returns than low-intensity agriculture. Research [55] shows that using rewilding methods for flood control and carbon sequestration can also achieve better results.

In the context of the current focus on ecological restoration and biodiversity protection, combined with the current situation in my country, the evolution of Berlin's urban ecological space and the practice of urban rewilding in the past 40 years provide the following enlightenment.

First, strengthen the guidance and promotion of scientific research results in the academic community in the formulation of planning documents.

Second, planning practitioners should maintain close contact with civil society organizations and ordinary people. Rewilding areas in cities are generally small, fragmented and heterogeneous, with weak distribution patterns. Full and in-depth communication with local residents can promote rewilding ideas and habitat protection while meeting the needs of surrounding residents.

Third, government departments pay attention to and encourage new ideas and methods. Promote a systematic urban rewilding design approach from top to bottom and from small to large areas.

3.3 Summary and Outlook

Rewilding, as an ecological restoration method aimed at restoring autonomous nature, will receive more and more attention in China. It not only restores the nature that once existed in the local area, but also protects existing habitats as part of the urban environment base based on the present. . Although there are huge differences between Berlin's history, culture, economic and social systems and those of our country, its ecological space evolution and urban rewilding process can bring important enlightenment in terms of paths, that is, through academia to promote the planning department, and from the government to the top Through a combination of bottom-up and bottom-up methods, on the premise of strengthening public participation, we can achieve high-quality rewilding development of ecological space in the city and implement the construction of ecological civilization.