

自然主导、人工引导工业废弃地改造

—— 以唐山市野生动物园为例

Reconstruction of Industrial Wasteland Led by Nature and Guided by Man

— Taking Tangshan Wildlife Park as an Example

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摘要：当前中国工业城市正处于产业转型升级阶段，面临生态系统恶化、土地荒置等城市重大问题。本文基于唐山市产业转型背景，以唐山市野生动物园为例，提出自然主导、人工引导的改造策略，构建土壤、植物、水系、生物关键因子修复路径，旨在恢复自然的生态循环体系，为城市工业废弃地景观改造提供新思路。

关键词：工业废弃地；自然修复；人工修复；唐山市野生动物园

Abstract: At present, China's industrial cities are in the stage of industrial transformation and upgrading, and they are faced with major urban problems of deteriorating ecosystem and abandoned land. Based on the background of industrial transformation in Tangshan City, this paper takes Tangshan Wildlife Park as an example, proposes a transformation strategy led by nature and guided by man to build a restoration path for soil, plants, water systems and biological key factors and restore the natural ecological cycle system, and provides a new idea for landscape reconstruction of urban industrial wasteland.

Key words: industrial wasteland; natural restoration; manual restoration; Tangshan Wildlife Park

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1. 自然主导、人工引导工业废弃地改造内涵

1.1 工业废弃地的概念

工业废弃地指原土地属性为工业用地, 目前处于闲置状态的土地。工业废弃地最初为自然景观, 人们在其中从事工业生产活动, 不顾生态发展规律进行改造, 具体表现为伐林建厂、乱排乱放等行为。

1.2 自然主导、人工引导的概念

自然主导、人工引导修复为前期通过人工探寻区域存在问题的关键因子, 改善关键因子的制约性^[1], 后期生态系统通过自身关键因子的组织、调节能力进行修复的方法^[2]。它突出生态系统的自我修复能力, 同时不拒绝人的主观能动性。

1.3 国内工业废弃地改造研究现状

人们在工业废弃地改造中进行了长时间的修复, 表现为大面积、单一的绿化景观。这些景观多病、多虫、生长能力弱, 依赖营养剂、杀虫剂等人工手段, 难以依靠自然规律进行演替^[3]。专家发现在降低人的活动后, 通过自然的自身循环系统对其修复, 会产生一定的积极效果。例如, 德国鲁尔工业区废弃地经过自然的修复, 其生态系统产生了丰富的物种种类^[4], 并探索出工业森林^[5]、荒野自然^[6]等多个工业废弃地修复理念, 应用于矿山、河流、森林等空间中, 但仅凭自然修复难以快速修复场地生态, 且耗费时间^[7]。唐山市工业废弃地改造为野生动物园后增加了生物多样性, 加快了生态系统正向演替。因此, 笔者尝试从自然主导、人工引导的视角, 探究自然与人在工业废弃地改造中的耦合关系, 并从此案例中探究城市工业废弃地改造的其他方向。

2. 唐山市野生动物园工业废弃地现状评价

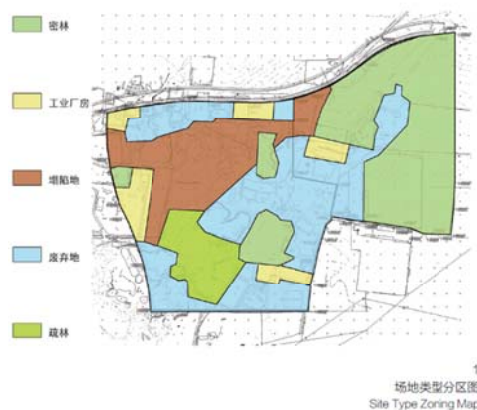
2.1 场地概况

唐山市野生动物园位于唐山市开平区，东湖生态郊野公园中北部，是修复城市生态系统的重要点位。原场地内为洗煤厂、熟料厂、铁粉厂等，场地内按面积由大到小排列依次为废弃地、密林、塌陷地、疏林、工业厂房（图 1），区域内多为建筑废料、煤矸石、粉煤灰、垃圾堆等废弃物。

2.2 场地问题识别

（1）土壤

工业生产活动遗留了建筑废料、煤矸石、粉煤灰、垃圾堆等各种有害污染物，污染物通过大气沉降、沉积、渗滤的方式侵蚀场地土壤，按网格布点法从污染区域采样，取三种土样（表层土、20 cm 深、40 cm 深）检测重金属含量，与当地合格土样进行对比发现，西北区域重金属含量较高。



（2）植被

东部地区为林地，以杨树和柳树为主，局部区域有火炬树、松树、枣树等。植被贫瘠，类型单一，植物之间缺乏科学组合，生态调节能力弱，难以促进场地生态良性发展。

（3）水系

工业废弃地中有小煤矿厂，煤矿开采破坏了土壤的基本构造，影响地下水位，水量的减少又导致植被生长困难。工业产生的煤矸石、粉煤灰等长期堆积又通过沉积、渗滤污染水系（图 2）。硬质驳岸较多，割裂了土地与水系之间的联系，植物无法生长，缺乏净化能力。

（4）生物场地内生境类型单一且恶劣，动物较少，以麻雀、乌鸦、喜鹊等鸟类为

主，难以进行生态系统内部物质资源的转换。

3. 工业废弃地转型野生动物园的改造策略

3.1 改造中“自然”与“人工”的思辨

“自然修复”适用性高，资金投入低，对丰富生物多样性等方面有较好成效，但短期效果不明显，改造时间较长。“人工修复”见效快，资金投入高，但对原场地生态系统影响较深，更易更改原生态系统发展方向。单一修复路径并不是最优解，将二者结合，前期通过充分发挥人工修复中人的主观能动性实现工业废弃地的快速恢复，后期利用自然恢复能力，可实现最符合原真性的土地重生。二者结合中，前期要明确人工引导的内容、方向，确定引导方式的合理性，后期要避免人类活动的干扰，使人作为生态系统自然修复的促进者，而非主宰者。

3.2 工业废弃地转型思考

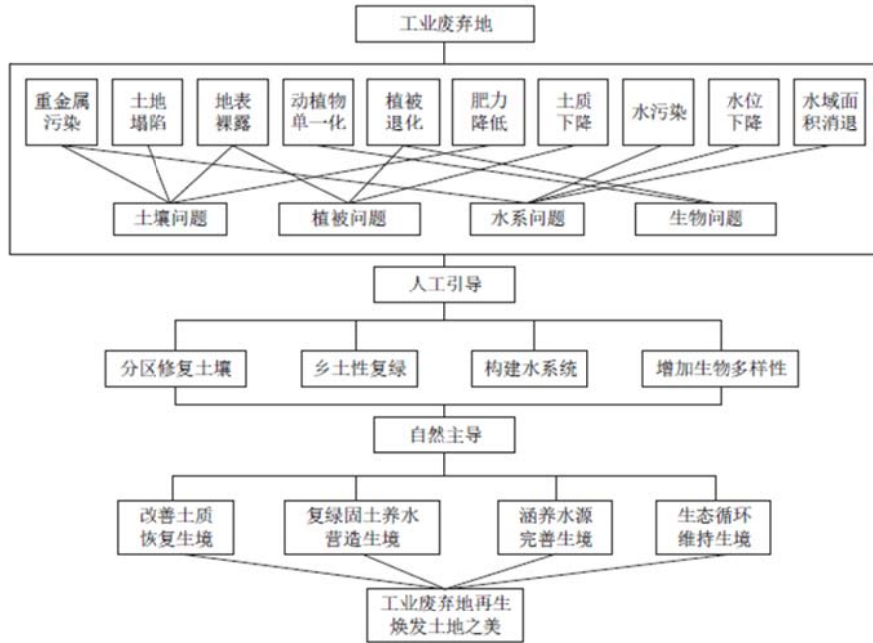
分析场地现状，获取 10 个表象问题，按生态系统逻辑分析得出土壤、植被、水系、生物四类生态系统强相关因子。建立自然主导、人工引导的生态系统修复框架，前期通过人对自然规律的认识及科学技术的掌握对四类强相关因子进行修复，实现分区修复土壤、乡土性植物快速复绿，构建河、谷、渠、湖四级水系统，增加生物多样性，以期尽快达到自然修复的条件（图 3）。后期依靠自然规律进行以土质为关键、以水系为主导、以植物为核心、以生物多样性为目标的生态系统恢复^[8]。

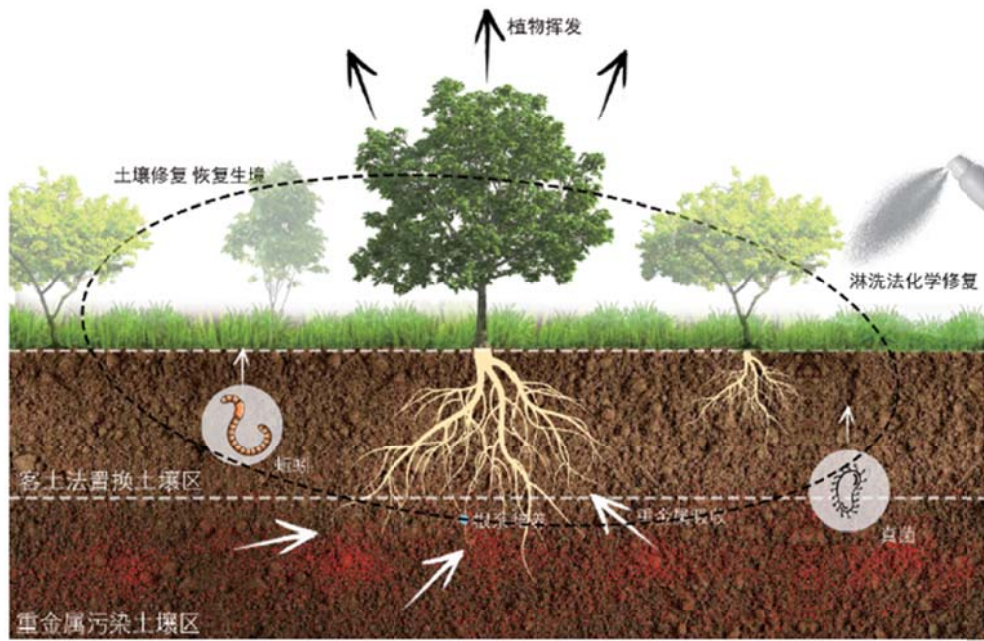
4. 自然主导、人工引导的改造实践

4.1 以安全为基础、土质为关键的土壤修复

土壤是自然中物质能量变化的基底，包括水资源传输、动物死亡后物质能量转移等生态过程^[9]。前期人工引导修复消除土壤污染与影响土壤肥力的障碍性因子，保证土壤安全。小面积污染土壤区域，采取客土法进行物理修复。污染土壤面积较大区域采取化学修复，以淋洗法为主，将含有冲洗助剂的水溶液、酸碱试剂和络合剂的溶液淋洗在污染土壤上，降低土壤污染程度，削弱土壤金属活性（图 4）。后期寻求植物、生物对土壤的持续修复作用。在重金属污染区域种植藎草、野艾蒿、珍珠梅、柳树、刺槐等对重金属耐性较强的植物，它们在生长中吸收一定量的重金属，从而降低污染程度。藎草、野艾蒿等草本植物可以通过每年的生长过程提高土壤中的有机质含量，年均可提高 $15\text{ t/hm}^2\sim 25\text{ t/hm}^2$ 。有机质含量的提高可以增强土壤螯合、吸附作用，进一步降低重金属污染程度，降低土壤酸性值^[10]。利用微生物活性对 Cu、Fe 等重金属进行还原或是刺激原生微生物生长促进生态良性循环。通过藻

类、苔藓等生物在土壤表面形成生物土壤结皮从而提升土壤的稳定性和保水性。野生动物园土壤修复后孔隙度加大，容重下降，增强了通气性、透水性和保水性，有利于土壤有机质含量的储存，促进植物的生长与涵养水源的能力，从而恢复生境。





4
土壤修复示意图
Schematic Diagram of Soil Restoration

4.2 以绿量为基础、自然演替为目标的植物修复

前期人工引导修复，根据场地及动物分区完成植物类别的选取、植物组团的配置、种植区域的界定，促进多层次绿量提升。植物种类多选择本地树种，乡土树种占据 70% 以上，因唐山缺水，固选择抗旱耐寒植物。植物组团按植被演替过程配置（裸地 — 草丛 — 灌丛 — 针叶林 — 针阔叶混交林），前期以藁草、野艾蒿等草本植物修复为主，将绣线菊、刺槐等重金属耐性好、耐干旱贫瘠植物作为植物修复的先锋树种。这些修复性植物的引入既可以实现绿量的短期增加，辅助场地进行生态系统的修复，又呈现充满野趣的植物景观^[11]。

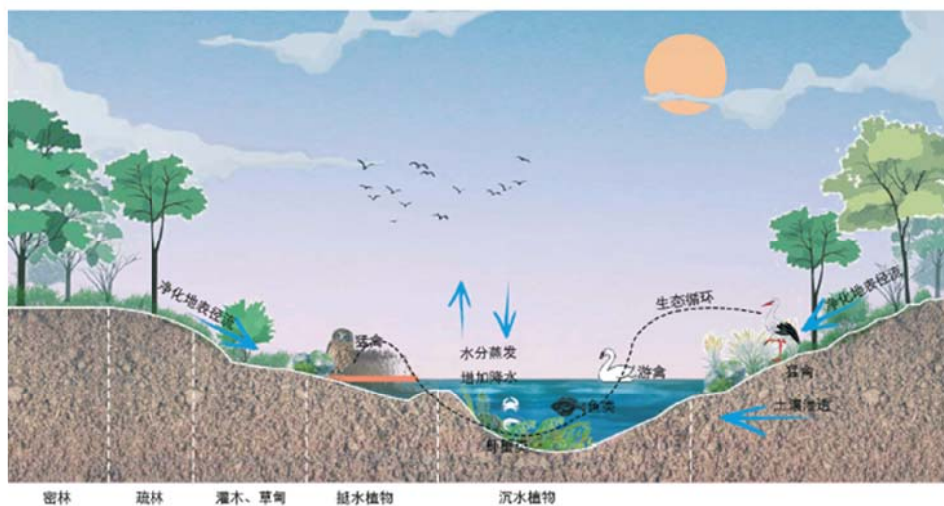
后期通过标识、道路的边界形成植物封育区，减少人为活动的影响，依靠自然生长规律进行自然主导下的植被演替，多种植物在生长的过程中受到自然的筛选，包括水分、阳光的争夺、种子被动物吞食等，这些过程检验了植物的生存能力，逐渐构建该区域的种子库，形成最优植物群落（图 5）。相比于城市中种类单一的植物，其生存能力强，较少使用杀虫剂等化学试剂，避免了有绿无虫。昆虫的增量促使以昆虫为食的鸟类增多，在植物生长的过程中，逐渐形成包括喜鹊、乌鸦、刺猬等小型动物的生境。植物修复后绿量增加且稳定演替，促进工业废弃地持久复绿，营造生境。



5

植物修复前后对比图

Comparison Before and After Plant Restoration



6

水系修复示意图

Schematic Diagram of Water System Restoration

4.3 以水量为基础、水质为关键的水系修复

前期人工引导完成水系统建立，利用现有地貌构建具有收集、净化、补水、调控径流、

泄洪的水系格局，形成具备河、谷、渠、湖的四级水系统，为多种鸟类、鱼虾类、水禽类、水生植物提供生存空间。近水驳岸设计 10 m 生态缓冲带，从水到岸依次为沉水植物 — 挺水植物 — 草甸 — 灌丛 — 疏林 — 密林，梯度植物种植净化地表径流、保持水质(图 6)。软化水系堤岸、坝体，堤岸采用护坡砖或石材，水面上部空隙供植物生长，下部空隙为水生昆虫的栖息场所，为水生生物的生存提供必要条件。河床铺设块石、卵石或沙质底质，重建会呼吸的水系。

后期利用水生动物及植物的配置构建自然主导的水系生态循环系统，完成水源收集、水质提升、水循环利用、食物链的闭环。通过地形高差、引流管道，多点位分散式收集场地内雨水。使雨水经过植物梯度净化带过滤后进入水系，补充地表水量及地下水含水层。水系不同的空间形态，如浅滩、深水、驳岸等为植物、鱼虾、昆虫提供生存空间，水生植物净化水质，植物又为鸟类提供栖息、庇护场所及食物源，鸟类则为河岸植物传播繁殖体。水 — 植物 — 鱼 — 鸟共存的生态系统，既增加了植物多样性又增加了鸟类多样性，有效促进了生态系统的有序发展^[12]。修复后，野生动物园水系生境类型多样性增加，河流环境异质性提高，河道及河岸生境质量优化，河流景观品质变优，生境逐渐得到完善(图 7)。

4.4 以丰富性为基础、稳定性为目标的生物修复

生物丰富性与稳定性是生态系统自然修复的最终目标。前期需要人工调查环境及生物本底，针对性引进生物，实现生物丰富性。如在百鸟园旁的水系中，以食物链的关系引进生态修复的物种，形成氮、磷、有机物 — 浮游生物、水生植物 — 蚊虫等昆虫 — 青蛙、鱼、鸭、鹅 — 大型猛禽的生物网，增加了水系生物的丰富性。通过各类生物的捕食、排便、死亡等促进水系生态系统中的物质转化，维持了生态系统的稳定性。唐山市野生动物园根据生境的不同引入不同种类生物，修复后，哺乳纲、鸟纲、两栖纲、鱼纲等动物种类增加到 200 余种、数量增加到 3000 余只；植物上百种，绿化面积 604 500 m²；构建山地、密林、草原、溪流、疏林、荒漠、湿地等多种生境(图 8)。

唐山市野生动物园中生物按照自然规律进入演替过程，多种生物既依存自然，又促进着自然的发展，维持生态系统的稳定。动物吞食野果可以有效传播植物种子，进行植物更新。随着时间的延伸，雨水滋润大地，植物萌发演替，动物栖息繁衍，生态逐渐良性发展，渐渐摆脱工业废弃地的影子(图 9)。

5. 结语

本文以唐山市野生动物园改造为研究对象，对工业废弃地现状进行分析，辨析“自然修

复”与“人工修复”的优劣，挖掘表象问题找到影响生态的关键因子，通过自然主导、人工引导消除生态胁迫性因子、重构自然生态序列，使工业废弃地短时间内脱离逆向生态演替，并得出以下结论与展望：场地改造前期应用“人工修复”，后期进行“自然修复”，延续场地原真性的同时缩短改造时间；自然主导、人工引导改造策略相辅相成，在分析工业废弃地的现状问题上调整自然与人工的占比与先后顺序，自然主导、人工引导只是一种方式，恢复生态才是目的；修复过程中，谨慎采取人工手段，防止对场地造成破坏，避免二次污染。



7

水系修复前后对比图

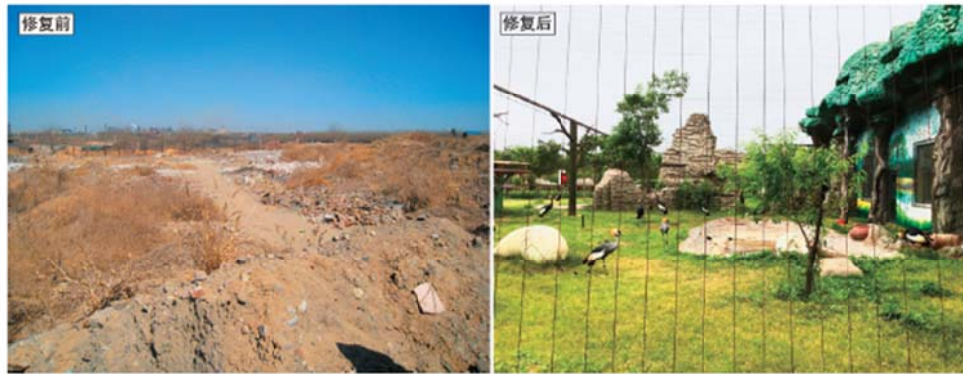
Comparison Before and After Water System Restoration



8

生物类型图

Type Diagram of Biology



9

生物修复前后对比图

Comparison Before and After Biology Restoration

1. Connotation of Reconstruction of Industrial Wasteland Led by Nature and Guided by Man

1.1 The Concept of Industrial Wasteland

Industrial wasteland refers to land whose original land property is industrial land and is currently in an idle state. The industrial wasteland was initially a natural landscape, and people engaged in

industrial production activities in it, disregarding the law of ecological development and recklessly transforming it, specifically in the form of deforestation and factory construction, indiscriminate discharge and other behaviors.

1.2 The Concept of Natural Domination and Manual Guidance

Restoration led by nature and guided by man is a method of artificially exploring the key factors of regional problems in the first stage, improving the constraints of the key factors^[1], and restoring the ecosystem at a later stage through the organization and regulation ability of its own key factors^[2]. It highlights the self-healing capacity of ecosystems without rejecting human initiative.

1.3 Current Status of Domestic Industrial Wasteland Reconstruction Research

People have carried out restoration for a long time in the reconstruction of industrial wasteland, which manifests itself in large, single green landscapes that are diseased, insect-ridden, weak in growth, dependent on artificial means such as nutrients and pesticides, and are difficult to rely on natural laws for succession^[3]. Experts have found that after decreasing human activity, there is more positive effect on its restoration through the natural own circulatory system. For example, after natural restoration, the abandoned site in industrial area of Ruhr, German, whose ecosystem has produced a rich variety of species^[4], has explored several industrial wasteland restoration concepts such as industrial forest^[5], wilderness nature^[6], applied to the mine, river, forest and other spaces; however, natural restoration is difficult to quickly restore the ecology of the site, and is time-consuming^[7]. After the industrial wasteland in Tangshan was transformed into a wildlife park, the biodiversity increased and the positive succession of the ecosystem was accelerated. Therefore, the author tries to explore the coupling relationship between nature and man in the reconstruction of industrial wasteland from the perspective of natural domination and manual guidance, and explore other directions of urban industrial wasteland reconstruction from this case.

2. Evaluation of the Status of Industrial Wasteland in Tangshan Wildlife Park

2.1 Site Overview

Tangshan Wildlife Park is located in Kaiping District, Tangshan City, in the north-central part of Donghu Ecological Country Park, which is an important point for restoring the urban ecosystem. The original site includes a coal washing plant, a clinker plant, an iron powder plant, and so on.

The site is wasteland, dense forest, collapsed land, sparse forest and industrial plant in order of site area (figure 1), and is mostly covered with construction waste, coal gangue, fly ash, garbage dump and other wastes.

2.2 Site Problem Identification

(1) Soil

Industrial production activities left over construction waste, coal gangue, fly ash, garbage and other harmful pollutants, and pollutants eroded the site soil by means of atmospheric deposition, sedimentation and infiltration. Soil samples (surface soil, 20 cm deep and 40 cm deep) were collected from the contaminated areas by the grid method, and the heavy metal content was detected. Compared with the local qualified soil samples, the heavy metal content in the northwest region was higher.

(2) Vegetation

The eastern area is woodland, dominated by poplar and willow, with torch trees, pine trees and date palms in the local area. The vegetation is barren, single type, lack of scientific combination among plants, weak ecological regulation ability, and difficult to promote the ecological benign development of the site.

(3) Water system

There are small coal plants in the industrial wasteland. Coal mining destroys the basic structure of the soil and affects the groundwater level, and the reduction of water volume leads to difficulties in vegetation growth. The long-term accumulation of industrial gangue and fly ash pollutes the water system through deposition and percolation (figure 2). There are many hard barges, which cut the connection between the land and the water system, and plants cannot grow and lack the purification ability.

(4) Biology

The site has a single and poor habitat type, with few animals, mainly birds such as sparrows, crows and magpies, making it difficult to convert material resources within the ecosystem.

3. Reconstruction Strategies for Transforming Industrial Wasteland into Wildlife Park

3.1 The Discernment of “Natural” and “Artificial” in Reconstruction

“Natural restoration” has high applicability, low capital investment, and good effect on enriching

biodiversity; however, the short-term effect is not obvious, and the transformation time is longer. “Artificial restoration” has fast results and high capital investment, but it has a deeper impact on the original site ecosystem and is easy to change the direction of the original ecosystem development. A single restoration path is not the optimal solution. By combining, we can achieve a rapid restoration of industrial wasteland by giving full play to human initiative in artificial restoration in the early stage, and use the natural restoration capacity in the later stage to achieve the most in line with the original land regeneration of the site. In the combination, the content and direction of manual guidance should be clarified and the rationality of the guidance method should be determined in the early stage, and the interfering nature of human activities should be avoided in the later stage, so that people can act as facilitators rather than masters of the natural restoration of the ecosystem.

3.2 Thinking about the Transformation of Industrial Wasteland

We analyzed the current situation of the site, obtained 10 apparent problems, and analyzed by ecosystem logic to arrive at four categories of strong ecosystem-related factors: soil, vegetation, water system, and biology. The framework of ecosystem restoration led by nature and guided by man was established. In the early stage, the four strong ecosystem-related factors were restored through human understanding of natural laws and mastery of science and technology to achieve to restore the zoning soil, rapidly regreen the native plants, build a four-level water system of rivers, valleys, canals and lakes, and increase biodiversity in order to reach the conditions of natural restoration as soon as possible (figure 3). In the later stage, the ecosystem restoration with soil quality as the key, water system as the leading, plants as the core and biodiversity as the target is carried out by relying on natural laws^[8].

4. The Reconstruction Practice of Natural Domination and Manual Guidance

4.1 Soil Restoration with Safety as the Basis and Soil Quality as the Key

Soil is the substrate for material-energy changes in nature, including ecological processes such as water transfer and material-energy transfer after the death of animals^[9]. In the early stage, restoration guided by man eliminates soil pollution and obstructive factors affecting soil fertility to ensure soil safety. For small areas of contaminated soil, physical remediation is carried out by the guest soil method. Large areas of contaminated soil are chemically remediated by the

drenching method, in which aqueous solutions containing rinsing aids, acid and alkaline reagents and complexing agents are drenched on the contaminated soil to weaken the degree of soil contamination and reduce soil metal activity (figure 4). Later on, the continuous remediation effect of plants and organisms on the soil is sought. Tolerant plants such as Carex, Artemisia, pearl plum, willow and acacia are planted in the heavy metal contaminated area, and they absorb a certain amount of heavy metals in their growth, thus reducing the pollution level. Herbaceous plants such as Carex and Artemisia can increase the organic matter content of the soil through the annual growth process, with an average annual increase of $15 \text{ t/hm}^2 \sim 25 \text{ t/hm}^2$. The increase in organic matter content can enhance soil chelation and adsorption, further reducing the degree of heavy metal contamination and lowering the soil acidity value^[10]. The use of microbial activity to reduce heavy metals such as Cu and Fe or to stimulate the growth of native microorganisms promotes a virtuous ecological cycle. Biological soil crusts are formed on the soil surface by algae, mosses, and other organisms to enhance soil stability and water retention. The restoration of wildlife park soil increases porosity, decreases bulk weight, enhances aeration, water circulation and water retention, facilitates storage of soil organic matter content, promotes plant growth and water holding capacity, and thus restores habitat.

4.2 Plant Restoration with Green Volume as the Basis and Natural Succession as the Goal

In the first stage of restoration guided by man, the selection of plant categories, the configuration of plant groups and the definition of planting areas are completed according to the site and animal zoning to promote multi-level green volume enhancement. Plant species are mostly local species, with native species occupying more than 70% of the site, and drought-resistant and cold-tolerant plants are selected due to water shortage in Tangshan. Plant groups are configured according to the vegetation succession process (bare ground, grass, scrub, coniferous forest, mixed coniferous forest), with herbaceous plants such as Carex, Artemisia and other herbaceous plants being the main restoration plants in the early stage, and heavy metal-tolerant and drought-resistant plants such as hydrangea and acacia as the pioneer species for plant restoration. The introduction of these restorative plants can be a pioneer species. The introduction of these restorative plants can not only increase the green volume in the short term, but also assist the site in ecosystem restoration, and present a wild and interesting plant landscape^[11].

In the later stage, plant sealing areas are formed through the boundaries of signs and roads to

reduce the influence of human activities and rely on natural growth laws for vegetation succession under natural domination. A variety of plants are subject to natural screening in the process of growth, including competition for water and sunlight, seeds being swallowed by animals, etc. These processes test the survival ability of plants and gradually build the seed bank of the area to form the optimal plant community (figure 5). Compared with the single species of plants in the city, their ability to survive is high, and less chemical agents such as pesticides are used to avoid having greenery without insects. The increase of insects prompts the increase of birds that feed on insects and gradually forms a habitat for small animals including magpies, crows, hedgehogs, etc. as the plants grow. The increased amount of green and stable succession after plant restoration promotes lasting greening of industrial waste sites and creates habitats.

4.3 Water System Restoration with Water Quantity as the Basis and Water Quality as the Key

In the first stage, the water system is artificially guided to build a water system pattern with collection, purification, water replenishment, runoff control and flood discharge, forming a four-level water system with river, valley, canal and lake, providing living space for many kinds of birds, fish and shrimp, waterfowl and aquatic plants. The 10 m ecological buffer zone is designed near the water barge, from water to shore in the order of submerged plants, water, holding plants, meadow, scrub, sparse forest and dense forest, with gradient planting to purify surface runoff and maintain water quality (figure 6). Soften the embankment and dam of water system with slope protection brick or stone, with the upper space of water surface for plant growth and the lower space for aquatic insect habitat, to provide the necessary conditions for the survival of aquatic organisms. The riverbed is paved with blocks and pebbles or sandy substrate to rebuild a water system that breathes.

In the later stage, the configuration of aquatic animals and plants is used to build an aquatic ecological circulation system led by nature to complete the closed loop of water collection, water quality enhancement, water recycling and food chain. Through terrain height difference and diversion pipeline, rainwater is collected in the site in a decentralized manner at multiple points. The rainwater is filtered through the plant gradient purification belt and then enters the water system to replenish the surface water volume and groundwater aquifer. The different spatial forms of the water system, such as shallow water, deep water and barge, provide living space for plants, fish and shrimp, and insects; aquatic plants purify water; plants provide habitat, shelter and

food source for birds and birds spread propagules for riparian plants. The ecosystem of water, plant, fish, bird coexistence increases both plant diversity and bird diversity, effectively promoting the orderly development of the ecosystem^[12]. After restoration, the diversity of habitat types in the water system of the wildlife park increased, the heterogeneity of the river environment improved, the quality of the river and riparian habitats was optimized, the landscape quality of the river became better, and the habitat was gradually improved (figure 7).

4.4 Biology Restoration with Abundance as the Basis and Stability as the Goal

Biological richness and stability is the ultimate goal of natural ecosystem restoration. In the first stage, we need to investigate the environment and biological background manually and introduce organisms in a targeted way to achieve biological richness. For example, in the water system next to the Hundred Bird Park, species for ecological restoration are introduced in the relationship of food chain, forming a biological network of nitrogen, phosphorus, organic matter-plankton, aquatic plants-mosquitoes and other insects-frogs, fish, ducks, geese-large raptors, increasing the richness. The predation, defecation and death of various organisms promote the transformation of materials in the aquatic ecosystem, maintaining the stability of the ecosystem. Tangshan Wildlife Park introduced different kinds of creatures according to different habitats. After restoration, the number of mammals, birds, amphibians, and fish increased to more than 200 species and 3,000 animals; hundreds of species of plants and 604,500 m² of greenery; and a variety of habitats such as mountains, dense forests, grasslands, streams, open forests, deserts, and wetlands (figure 8). Organisms in the Tangshan Wildlife Park enter the process of succession according to the laws of nature, and a variety of organisms both depend on nature and contribute to the development of nature and maintain the stability of the ecosystem. Animals swallowing wild fruits can effectively spread plant seeds and carry out plant renewal. With the extension of time, the rainwater nourishes the earth, plants sprout and evolve, animals live and reproduce, and the ecology gradually develops in a benign way, gradually getting rid of the shadow of industrial wasteland (figure 9).

5. Conclusion

In this paper, we take the reconstruction of Tangshan as the research object, analyze the current situation of industrial wasteland, identify the advantages and disadvantages of “natural restoration” and “artificial restoration”, find out the key factors affecting ecology, eliminate ecological stress

factors and reconstruct the natural ecological sequence through natural domination and manual guidance, so that industrial waste sites can be removed from reverse ecological succession in a short time, and draw the following conclusions and prospects. Application of “artificial restoration” in the early stage of site transformation, and “natural restoration” in the later stage, to continue the originality of the site while shortening the transformation time. Reconstruction strategies led by nature and guided by man complement each other, adjusting the proportion and sequence of natural and artificial in the analysis of the current situation of industrial waste sites. Natural domination and manual guidance is only a way, restoring the ecology is the purpose. In the restoration process, the artificial means adopted should be used carefully to prevent damage to the site and avoid secondary pollution.

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