Ecological Restoration Technologies of Urban Artificial Landscape Lakes

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Abstract Aiming at the problems of water pollution and ecological environment degradation in urban artificial landscape lakes, the ecological restoration technologies of artificial landscape lakes at home and abroad were studied to provide some reference for the ecological restoration of urban artificial landscape lakes in China.

Key words Artificial landscape lake; Ecological restoration technology; City

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Natural landscape resources in a city are limited. Under the guidance of the comprehensive water conservancy demand of a city and the water-loving demand of residents, artificial lakes, as a kind of water landscape, came into being. Artificial landscape lakes in a city can not only optimize urban ecological environment, and ensure regional ecological security, but also profoundly affect the future development of the city. However, there are problems such as water pollution and ecological environment degradation in urban artificial landscape lakes, so it is urgent to adopt appropriate ecological restoration technology according to its characteristics and structure. A site-scale urban artificial landscape lake is mainly composed of water in the artificial lake, lakeside zones and land near the lake, so its ecological restoration should be conducted mainly in these three restoration units. At the same time, the restoration is not simply structural restoration, but to consider the overall habitat and organisms of artificial lakes and the structure and function of ecological system, comprehensively use a variety of ecological restoration technologies, and fully consider the combination with landscape design, so as to ultimately achieve the overall ecological system restoration goal of urban artificial landscape lakes.

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1 Ecological restoration technologies of water in artificial landscape lakes

1.1 Eco-friendly physical restoration technology

1.1.1 Environmental sediment dredging. Sediment dredging refers to the manual cleaning of pollutants and sediment at the bottom of a lake. Sediment dredging can increase the transparency of water in an artificial lake, but has the risk of damaging the aquatic ecosystem. Therefore, it should be conducted in a season with low community activity, and the thickness of dredged sediment should be strictly controlled to minimize the impact on benthic organisms. Environmental sediment dredging combined with ecological restoration can reduce the content of pollutants in artificial lakes and lay a foundation for the construction of water ecosystems[1].

1.1.2 Composite biofilm purification technology. Composite biofilm purification technology is to generate a thin film on the surface of natural materials such as pebbles or synthetic materials such as fibers as a place for microorganisms to thrive, and microorganisms play a role in degrading pollutants to optimize water quality.

1.2 Aquatic plant remediation technology Aquatic plant remediation technology means using aquatic plants to remove pollutants from water by using their absorption, transformation and co-degradation with microorganisms[2]. Aquatic plants are the key to the healthy operation of ecosystem of artificial landscape lakes. Aquatic plant community can reduce water disturbance and water velocity, and reserve a good habitat for benthic animals. Large aquatic plants are an important factor to maintain the stability of water environment, and can absorb a certain amount of pollutants while changing the chemical properties of sediment[1]. Aquatic plant restoration technology has the advantages of low cost and energy consumption, and it is a kind of ecological restoration technology suitable for artificial landscape lakes.

1.3 Aquatic animal restoration technology Aquatic animal restoration technology mainly uses the predation relationship of food webs and the complex facilitation or inhibition relationship

between organisms to change the allocation of animal communities in artificial landscape lakes, so as to improve water quality and form natural ecological landscape[3]. Algae, benthic animals, zooplankton and phytoplankton in the water body jointly serve the integrity of aquatic ecosystem of artificial landscape lakes[4].

1.4 Microbial remediation technology Microbial remediation technology means artificially assisting microbial culture, and using their characteristics to decompose pollutants and nutrient-rich substances in the water body and control algae, and increase the self-purification ability of the water body. At present, centra biologcal system (CBS) is a commonly used method by adding biological strains to repair water body[5].

1.5 Collaborative remediation technology of aquatic organisms There is a complex feeding relationship between aquatic plants, aquatic animals and microorganisms, and they can promote or inhibit each other, so the comprehensive collaborative remediation technology of aquatic organisms is often used in practical operation. Filter-feeding fish feed on plankton, and the debris and waste are broken down by microorganisms. Submerged plant communities can become habitats for aquatic organisms, and improve underwater light conditions. Meanwhile, algae and snails can further promote the formation of the food chain through the form of attachment. The synergistic effect of aquatic organisms plays an important role in water purification.

1.6 Construction of artificial ecological floating islands The strong absorption capacity and adsorption of plant roots and the decomposition of microorganisms are the main mechanisms of purification by artificial ecological floating islands. Artificial ecological floating islands mean aquatic or terrestrial plants are planted on a floating island to construct a habitat suitable for the growth of microorganisms and aquatic plants and form a small ecosystem to purify water quality. Nutrient-rich substances can be removed from the water in the process of regular harvesting of aquatic plants on floating islands.

An artificial ecological floating island is mainly composed of floating island plants, floating island planting carrier, and floating island fixed device. The selected plants are often water-tolerant varieties, and are fixed on the floating island carrier through the floating island fixing device. At the same time, the depth adjustment of artificial floating islands has a certain flexibility, and the corresponding depth can be adjusted according to the change of the water environment to meet the growth needs of different types of plants.

Artificial ecological floating islands, as one of the most reasonable and economical ways to realize self-purification of ecosystem of artificial landscape lakes, can not only increase the proportion of water plants, but also save the use area of lakeside zones and improve the landscape quality of water in artificial landscape lakes. Artificial ecological floating islands provide various favorable conditions for the circulation and development of ecosystem of artificial landscape lakes[6].

2 Ecological restoration technologies of lakeside zones of artificial landscape lakes

2.1 Construction of artificial wetlands Based on ecological principles, an artificial wetland, as a complex ecosystem, uses plant absorption, microbial decomposition, filtration and adsorption to construct artificial substrates or fillers, imitate natural wetland ecosystem, or transform and strengthen natural wetlands, optimize the combination of microorganisms and aquatic plant communities in time and space, remove organic matter and nutrient elements in water and decompose heavy metals[7].

The structure of an artificial wetland in an artificial landscape lake is generally composed of aquatic plants and a filler bed. The bed is made of soil, gravel and professional fillers, and the surface of the bed is planted with aquatic plants to form a unique small ecosystem. The selected plants are tolerant to water and easy to survive, and have high economic and ornamental value, and pollutants in the ecosystem are finally removed by regularly replacing substrates or harvesting plants[2].

There are various types of artificial wetlands, and they can be generally divided into free surface flow, horizontal subsurface flow and vertical flow artificial wetlands according to the difference in layout or flow mode[8]. Artificial wetlands have the advantages of water conservation, low cost, easy maintenance and energy saving, *etc.* Its function has developed from single pollution control into comprehensive water purification, habitat construction, biological reproduction, biological protection and landscape effect. It is a very landscape ecological restoration technology, and has shown strong vitality in the ecological restoration practice of artificial landscape lakes.

2.2 Construction of ecological revetments The ecological revetment of an artificial landscape lake refers to the revetment with ecological function. There are various types of ecological revetments, and there are three kinds of ecological revetments with high ecological benefits, including natural ecological revetments, natural transformed ecological revetments and stepped ecological revetments. In addition to the practical functions of protecting dikes and protection against erosion, the "permeability" of ecological revetments can also closely link the water ecosystem and the terrestrial ecosystem to promote the exchange and circulation of matter and energy. The rich form and porous structure ensure strong permeability, and promote the normal operation of aquatic animal communities. Meanwhile, ecological revetments can inhibit the mutual infiltration of pollutants between water body and lakeside zones to achieve the effect of purifying water body. Beautiful revetments also have a good landscape effect, and can fully meet the hydrophilic needs of residents.

3 Ecological restoration technology of land near an artificial landscape lake

The land near an artificial landscape lake is the area closest to the urban interface, and also the area closest to the urban point

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source and non-point source pollution. The ecological restoration of the land near the lake is realized mainly by the restoration of plant communities.

Plants are the most critical and active component in the ecosystem of an artificial landscape lake. For the restoration of plant communities in artificial landscape lakes, the transition in the horizontal direction should be fully considered, and the basic pattern of aquatic plants – hygrophytes – terrestrial plants should be followed from the water body to the land near the lake. Meanwhile, the combination of trees, shrubs and ground cover in the vertical direction should be paid attention to, so as to form a reasonable composite structure. The trees, shrubs and grass as terrestrial plants have different ecological functions. The composite structure of trees – shrubs – grass can effectively trap and decompose pollutants, and form good animal and plant habitats and rich plant landscape.

The restoration of plant community must be based on the comprehensive analysis of water form, water matrix, climate, hydrology, topography and other factors of artificial landscape lakes, and combine with the seasonal variability of dominant species to ultimately determine the size of plant population and the complexity of population structure configuration. Under the artificial positive intervention, a stable and harmonious ecosystem of an artificial landscape lake can be finally formed after a gradual process from simple to complex.

4 Conclusions

An urban artificial landscape lake is mainly composed of water, lakeside zones and land near the lake, so nine kinds of ecological restoration technologies suitable for these three restoration units are introduced respectively, such as aquatic biological collaborative restoration technology, artificial wetland and plant community restoration technology. The above restoration technologies need to be comprehensively applied to restore the whole ecosystem of an artificial landscape lake.

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