

Research on legal regulation of invasive alien species in China

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Abstract: With the vigorous development of international trade and the in-depth advancement of economic globalization, China is facing the increasingly serious problem of invasive alien species, which poses a major threat to China's ecological environment, economic development and human health. At present, although China has a comprehensive institutional norms in the prevention and control of invasion of alien species, but in the face of the challenge of invasion of alien species, China is still facing problems such as insufficient legal basis and imperfect specific legal system. Based on this understanding, this paper discusses the prevention and control of invasive alien species legal regulation, that although in recent years China has made certain achievements in the field of prevention and control of invasive alien species, but still faces a number of problems to be solved, should promote the relevant legislative amendments, and combined with the experience of developed countries to summarize the perfect.

Keywords: alien species; prevention and control; legal regulation

1. Introduction

Biodiversity, as the basis for the survival and development of human society, provides us with abundant resources. However, the increasing pace of globalization and the growing frequency of international trade and economic activities have undoubtedly posed serious challenges and obstacles to the conservation of biodiversity, and one of the most prominent environmental problems is the invasion of alien species.

As a country with a large population, vast territory and diverse ecosystems, China is also facing the serious threat of invasive alien species. Since the reform and opening up, the rapid development of China's foreign trade has led to more and more alien species being brought into new ecosystems, either intentionally or unintentionally, and as these species lack the constraints of natural enemies and natural conditions, they tend to multiply and spread rapidly, posing a serious threat to local biodiversity and ecological balance. About half of the world's 100 most threatening invasive alien species published by the World Conservation Union (IUCN) have already invaded China. Ministry of Ecology and Environment (2020) proposed that nationwide, more than 660 invasive alien species have been identified, of which 71 invasive alien species have posed or potentially posed a threat to natural ecosystems and have been included in China's List of Invasive Alien Species, and 219 invasive alien species have invaded 69 national nature reserves, of which 48 invasive alien species have been included in the List of Invasive Alien Species in China. China has just become one of the countries most seriously jeopardized by invasive alien species. Therefore, effective management, prevention and control of invasive species has become an important issue to maintain ecological balance and protect biodiversity.

2. Overview of invasive alien species

2.1. Definition of the concept of invasive alien species

In nature, those species that are naturally distributed in a certain geographical area are called native species. Alien species are the opposite of native species. The concepts of alien species and invasive alien species first originated from the concept of “biological invasion” in the book “The Ecology of Plant and Animal Invasions” by the British animal ecologist Charles Elton. In recent decades, with the acceleration of economic globalization, the invasion of alien species has become more and more serious, and biodiversity and ecological environment are facing serious challenges. Nowadays, people have deeply recognized the seriousness of the problem of invasive alien species and are actively seeking effective preventive and control measures. As a result, words such as alien species and invasive alien species have become hot topics of public discussion and frequently appear in people’s discussions.

According to the definition given by the World Conservation Union (IUCN), invasive alien species, also known as exotic biological invasions, are species that have been introduced from their natural range through intentional or unintentional human activities, have developed a capacity for self-regeneration in local natural or semi-natural ecosystems and have caused obvious damage or impacts on local ecosystems or landscapes. From the above definition, it is clear that the following conditions must be met for an invasive alien species: First, the alien species has been introduced or entered into a new ecosystem; second, the species, which can be a species, subspecies, or lower taxon, including all of its components, gametes, or propagules, possesses the ability to survive and reproduce in that new environment; and, third, the species has established a population in a natural or semi-natural ecosystem or environment (Tong, 2008.). Whether or not a species constitutes an invasive alien species is not limited by the geographical boundaries of a country or region. When a species enters an ecosystem outside its natural range and reproduces there, causing significant ecological or economic damage, it can be characterized as an invasive alien species.

2.2. Hazards of invasive alien species

2.2.1 Destruction of biodiversity

After entering local ecosystems, invasive alien species, through their own advantages of fast reproduction, constantly suppress and crowd out the living space of local species, forming dominant species, causing irreversible changes in the structure and function of local ecosystems, leading to a sharp decrease in the number of local species or even their extinction, and destroying the diversity of species and the diversity of ecosystems. In addition, the invasion of alien species not only threatens the genetic diversity of local species, but also triggers inbreeding and hybridization or leads to genetic mutation. The reduction or even extinction of native species and the decline of ecosystem functions caused by invasive alien species will ultimately change or destroy local natural features and landscape diversity. For example, in the early 20th century, water hyacinth was introduced as an ornamental plant for cultivation, because it has the effect of purifying water, Yunnan Dianchi in order to control water pollution has been a large number of planted water hyacinth, however, due to the amazing

reproductive capacity of water hyacinth, making the water seriously lack of oxygen, which threatens the other plants and animals in the watershed, leading to its decline in number or even extinction, and destroying the local biodiversity. It is understood that before the 1960s, Dianchi main aquatic animals have 68 species, the emergence of water hyacinth has led to the successive demise of aquatic plants in Dianchi, to the 80s, only 30 species of aquatic animals remain (Fu, 2019)! The water hyacinth has led to the demise of aquatic plants in Dianchi Pond.

2.2.2. Significant economic losses

The global economic costs of invasive alien species are extremely high, and in addition to the huge economic losses that countries suffer as a direct result, invasive species trigger a series of cascading reactions, and these indirect losses, which are difficult to quantify in monetary terms, cannot be ignored. For example, the invasion of the exotic noxious weed *Canada montana* into farmland will inhibit the growth of other plants, resulting in reduced crop yields and a decrease in agricultural income. To completely eliminate them in addition to relying on manual cleanup and eradication, it is also necessary to spray a large number of chemical herbicides, however, this practice of using pesticides in large doses will inevitably cause damage to the soil structure and ecological balance, which in turn increases the cost of restoration of the farmland system. Indirect economic loss mainly refers to the loss of indirect use value of ecosystem service functions caused by alien invasive species, such as regulating climate, maintaining soil, purifying the environment, and maintaining the stability of ecosystems, thus bringing about large-scale economic loss that is difficult to accurately estimate. The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) launched a major Invasive Alien Species Report on 4 September 2023, which states that invasive alien species caused more than US\$423 billion in annual losses globally in 2019, with the cost more than quadrupling every decade since 1970. And China, as one of the countries more seriously affected by the invasion of exotic organisms, according to incomplete statistics from the former Ministry of Environmental Protection, the annual losses caused by exotic species to the country's economy and environment have reached 200 billion dollars (Zhou et al., 2023).

2.2.3. Damage to human health

The invasion of alien species will not only damage biodiversity, but also directly or indirectly jeopardize human health and even life, and must be given high priority. In the history of mankind, there have been many invasions of alien species, which have brought serious harm to human health and life. As early as the 6th century A.D., the plague germs invaded the Middle East from Africa and then reached Europe, causing the death of about 100 million people, which undoubtedly brought a heavy disaster to human society (Zhu et al., 2023). This undoubtedly brought a heavy disaster to the human society. In China, in the 1930s, the triticale ragweed, which is native to North America, first appeared in the Tieling area of Liaoning Province in China, and it is estimated that it was introduced with the importation of seeds of wheat and soybeans, etc. Because of its strong resistance to cold and regeneration, it exudes a large amount of pollen in the blossoming season, and the water-soluble proteins in the pollen of the pollen are rapidly released after contact with human beings, and they can

cause allergic metamorphic reactions in human beings, for example, sneezing, asthma and so on (Yang, 2010). It has been formally introduced as a breeding species. Fukushima snail, which was officially introduced as a farmed species, contains many parasites and bacteria, which are not easy to clean, and even after cooking, it is not guaranteed that the parasites and eggs will be completely killed, and the parasites will invade the brain after consumption, damaging the central nervous system and causing symptoms such as severe headache, fever, vomiting, etc., which can lead to dementia in serious cases and even death, thus seriously jeopardizing human health. The red fire ant, which was introduced to Taiwan in 2003, is a very toxic exotic species. When a person is bitten by it, a series of toxic reactions will occur in the affected skin and it is easy to cause bacterial infections, which ultimately threaten the life of the person, and a number of fatal cases of red fire ants biting people at home and abroad have occurred! There have been many fatal cases of red fire ant bites at home and abroad (Zhao and Xu, 2015). There have been many cases of deaths from red fire ant bites at home and abroad.

3. Status quo and dilemma of legal regulation of invasive alien species in China

3.1. Lack of specialized legislation

In Han Fei Zi, there is a famous saying, “There is no such thing as the law that governs a people (Chen, 2007)”. The meaning conveyed by this saying is that there is nothing more effective than the law in regulating people’s behavior. It emphasizes the central role played by law in maintaining social stability, an idea that is equally applicable to facing challenges in nature and ecosystems, such as the problem of invasive alien species. Invasive alien species not only threaten biodiversity and jeopardize the ecological balance, but may also have a significant impact on agriculture, fisheries and even the economic security of the country as a whole. It was therefore particularly urgent to establish a sound legal system to deal with invasive alien species.

The Biosafety Law stipulates that the State shall strengthen the prevention of and response to the invasion of alien species and protect biodiversity. This is the highest-ranking law on invasive alien species, and it is also the first time that invasive alien species are explicitly included in the scope of legal regulation. However, the provisions of the law for invasive alien organisms are more inclined to the principle of guidance, and did not formulate specific implementation rules, in practice, it is difficult to get the real application, and has the operability of the provisions of the Environmental Protection Law, the Wildlife Protection Law, the Entry and Exit Animal and Plant Quarantine Law, State Border Sanitary and Quarantine Law, the Measures for the Management of Invasive Species of Alien Organisms, etc., which have a lot of content and are not systematic, and in the case of the invasion of alien species, it is not possible to make a clear statement. The content of these laws and regulations are numerous and fragmented, in the specific prevention and control of invasive alien species in the actual work, there will inevitably be some gaps and loopholes, China at this stage has not formulated the prevention and control of invasive

alien species of specialized laws, the lack of high-level laws, resulting in the prevention and control of invasive alien species work inefficiently, and unable to achieve synergistic and efficient prevention and control purposes. In recent years, the situation of invasive alien species is not optimistic, as the global scope of invasive alien species by one of the most serious loss of the country, the invasion of alien species always affects our country's biodiversity, ecological security, public health and other aspects of the prevention and control of invasive alien species is a long way to go, we must rule of law on the invasion of alien species, the development of a prevention and control of invasive alien species of specialized laws, in order to We must legalize the invasion of alien species, formulate a special law to prevent and control the invasion of alien species, so as to build a perfect legal system, and provide a solid legal guarantee for the future response to invasive alien species.

3.2. Inadequate alien species listing system

The alien species listing system is the basis for the prevention and management of invasive alien species, and a sound listing system is essential for preventing invasive alien species. The List of invasive alien species in China is a list issued by the Government of China of invasive alien species that have caused greater harm in China. The list was released in four batches in 2003, 2010, 2014, and 2016, and includes a total of 71 species. Article 18 of the Biosafety Law requires the State to establish a biosafety list and inventory system. 2022 On 20 December 2022, the Ministry of Agriculture and Rural Development (MARD), together with the Ministry of Natural Resources (MNR), the Ministry of Ecology and Environment (MOE), and five other ministries, organized and released the List of Key Management Invasive Species in accordance with the Biosafety Law. To a certain extent, the above list has made some progress in preventing and controlling the invasion of alien species in China, but the list system still has some deficiencies in the process of implementation.

First of all, the current list of invasive alien species only lists species that have already posed a threat to the ecosystem, but does not address species that are potentially threatening, thus failing to play an effective preventive role. According to Article 5 of the Import and Export Commodity Inspection Law, imported and exported commodities listed in the catalog shall be inspected by commodity inspection agencies. It can be seen that the system is only limited to the inspection of commodities that have been explicitly included in the list, and does not clearly categorize and regulate these commodities that may carry the risk of invasive alien species. This also means that even if certain commodities are potentially hazardous, as long as they are not listed, they do not need to undergo special inspection and examination, and thus the system fails to meet the need to effectively respond to the risks and threats posed by different invasive alien species. Secondly, the existing lists do not provide a reasonable categorization of invasive alien species. Most of the lists are categorized according to external forms, such as the List of Key Management Invasive Species, which categorizes invasive species such as plants, insects and fish. The National List of Quarantine Pests of Agricultural Plants categorizes quarantine pests into insects, nematodes, bacteria, weeds and so on. The List of invasive alien species in China simply lists the invasive species and does not categorize them. This classification is

easy to ignore the degree of damage to the ecological environment caused by invasive alien species, which is not conducive to the role of the list in the early warning, prevention and control of invasive alien species, if the degree of damage to the ecological environment caused by invasive alien species to carry out the classification of risk levels can make the list system more scientific and targeted.

3.3. Inadequate inspection and quarantine system for alien species

At present, the quarantine scope of China's inspection and quarantine system is too limited, such as the "Entry and Exit Inspection and Quarantine of Animals and Plants Law" stipulates that the scope of application is animal infectious diseases, parasitic diseases and dangerous plant diseases, insects, weeds and other pests, and the quarantine target of the "Phytosanitary Regulations" is the disease, insect and weed that are dangerous and can be spread along with plants and their products.

In current practice, it can be found that China's current legal system of inbound and outbound animal and plant quarantine has not yet included ballast water carried by inbound and outbound ships in the scope of quarantine, an omission that undoubtedly poses a hidden danger to biosecurity. As ship ballast water contains a large number of disease-causing bacteria and pathogens, the discharge of ballast water can trigger infectious diseases, seriously threatening human life and health. The International Maritime Organization (IMO) estimates that up to 12 billion tons of ship ballast water are transshipped around the world each year, carrying about 3000 species of organisms every day to spread around the globe (Xie et al., 2022). So far, about 500 species of exotic organisms have been confirmed to be carried by ship ballast water globally. The damage to the marine environment caused by the invasion of marine organisms triggered by the discharge of ballast water from ships has been recognized by the Global Environment Facility as one of the four major threats to the oceans. Incidents of invasive alien species carried by ships' ballast water have brought negative impacts to several countries and regions, and a typical example is the invasion of zebra mussels into the Great Lakes of the United States in the 1980s. Zebra mussels carried in ships' ballast water clogged sewer pipes and turbines at hydroelectric power plants, causing \$5 billion in economic losses to the United States (Liu and Zhou, 2011). Currently, our law requires only that water from plants and animals be removed from the water. Currently, our laws only require animal and plant quarantine for shipments originating from infected areas, but even shipments from non-infected areas may carry pests and diseases that pose a threat to the health of our animals and plants. When these unquarantined means of transportation enter the country, they may bring epidemics into the country and have a serious impact on the local ecosystem.

3.4. Inadequate risk assessment systems for alien species

Assessing the risk of alien species is a key step in preventing the invasion of alien species, and a comprehensive assessment of alien species can help to effectively manage and control the potential threat posed by alien species to the ecosystem. However, there are serious deficiencies in the legal regulation of risk assessment of alien species in China, with relevant provisions appearing sporadically in laws or regulations, and the provisions are rather general. For example, the Measures for the

Management of Exotic Species stipulates that the approval department should organize and carry out timely examination and assessment, and that those assessed to be at risk of invasion will not be allowed to enter the country, while no further provisions have been made for the specific assessment work. The more specific provisions are the Technical Guidelines for Environmental Risk Assessment of Alien Species and the Administrative Provisions on Risk Analysis of Imported Plants and Plant Products. The Technical Guidelines for Environmental Risk Assessment of Alien Species provide specific provisions on the principles, contents, working procedures, methods and requirements for environmental risk assessment of alien species, but the scope of assessment is limited to the ecological hazards caused by alien species that may be caused by planning and construction projects, and the legal status of alien species is not defined. However, the scope of its assessment is limited to ecological hazards caused by planning and construction projects that may lead to invasive alien species, and its legal status is low, making it impossible to comprehensively deal with invasive alien species.

In addition, China has not yet established a unified risk-assessment body, but rather risk-assessment bodies set up by various functional departments within their areas of competence, such as the Management Office for the Prevention of Invasive Alien Forestry Pests set up by the State Forestry Administration and the Invasive Alien Organisms Prevention and Control Center set up by the Ministry of Agriculture. Risk assessment of alien species requires cross-sectoral cooperation, but the lack of an effective coordination mechanism between the various departments, as well as discrepancies and shortcomings in policy implementation, have led to inefficiencies and loopholes that have prevented the risk assessment system from giving full play to its practical utility.

3.5. Lack of public participation mechanisms for alien species

Invasive alien species is one of the major challenges facing the global ecosystem at present. Due to the complexity and extensiveness of invasive alien species, it is far from enough to rely solely on the strength of governments and scientific research institutions, and the promotion of civic awareness and public participation also play a crucial role.

First of all, our laws do not make clear provisions for public participation. 2021 The State Council promulgated the Opinions on Further Strengthening Biodiversity Conservation, which put forward the requirement of “comprehensively promoting public participation in biodiversity conservation”, reflecting the importance and enhancement of the role of the public in biodiversity conservation. However, China’s laws lack clear provisions on public participation mechanisms, and public awareness of invasive alien species remains at a superficial level. In many cases, the public has fewer opportunities to receive education on ecological environmental protection, and information about invasive alien species is often not widely disseminated. The media, schools, communities, etc. have reported less on such issues, making it difficult for the public to acquire relevant knowledge from daily information channels. Secondly, China has not yet established a comprehensive interactive platform for information on invasive alien species, which prevents the public from obtaining relevant information

in a timely manner and from providing feedback and complaints to the government. This status quo greatly limits the public's participation and influence on the issue of invasive alien species. The lack of timely access to information on invasive alien species restricts the public's knowledge of invasive alien species, and many people are not aware of the existence of invasive alien species in their own localities, let alone taking appropriate measures to prevent and control them. The lack of avenues to provide feedback and complaints to the government reduces the real-time and effective management of invasive alien species, and also leads to a decline in the public's trust in the government's management efforts. Therefore, in solving the problem of invasive alien species, it is important to establish an effective platform for information interaction and to give full play to the role of public participation in order to ensure the public's right to know, to supervise and to report.

4. Status of legal regulation of invasive alien species abroad

4.1. Japan

As an island nation, Japan is surrounded by the sea and is geographically isolated. This makes it easy for alien species with low barriers to entry to enter Japan's waters and coastal areas through transportation, attachment of organisms in the water, and wind dispersal, with potential impacts on local ecosystems, for which the Government of Japan has taken a series of legal and policy measures.

In terms of legislative models, Japan has adopted a core specialized legislative model to address invasive alien species, as reflected in the enactment of the Invasive Alien Species Law in 2004. This law systematically consolidated and upgraded provisions related to invasive alien species that had previously existed in a fragmented manner in various laws, and unified them into a specialized law. The Act contains detailed provisions on the introduction, cultivation, storage, transportation and liability of alien species. The greatest advantage of this specialized legislative model is that it can effectively integrate and coordinate other relevant laws and regulations, contributing to a more complete and coherent legal system.

In terms of the legal system, the Government of Japan has established a scientifically standardized alien species listing system through the enactment of the Invasive Alien Species Act. The system categorizes alien species invading Japan into three main categories: Invasive alien species, alien species that have not yet been categorized, and organisms that do not need to be assigned a category name. The first category is invasive alien species that pose a known or potential threat to the ecosystem, human health, agriculture, forestry, fisheries, etc., and is equivalent to the "blacklist" proposed by the Global Invasive Species Program (hereinafter referred to as GISP). This is the most stringent category in the listing system, which absolutely prohibits its introduction outside the scope of permitted areas and requires key monitoring and urgent measures to control and remove it. The second category of unclassified alien species, equivalent to the "gray list" proposed by GISP, covers invasive species that have not been identified as posing a threat to the ecosystem. These species may have been introduced to some areas but have not yet demonstrated significant ecological impacts, and require further research and monitoring to determine their risk level; if they prove to be hazardous, they will be categorized as

Category 1, and if they are not hazardous, they will be categorized as Category 3. The third category is for organisms that do not need to be labeled with a category name, and is equivalent to the GISP's "white list" of invasive species that are known to pose no threat to ecosystems (Wang et al., 2007). These species may already exist naturally in some areas. These species may already be naturally occurring in certain areas or have been introduced in artificial environments and are widely accepted as exotic species that can be released. The ability of the Government of Japan to dynamically adjust the species on the list based on new scientific evidence is a good example of the timeliness and flexibility of its listing system.

4.2. New Zealand

New Zealand was uniquely situated in the south-western part of the South Pacific Ocean, and its beautiful natural landscape and relatively isolated geographical location gave it a unique ecological environment and tourism value, so that its economy depended mainly on agriculture, animal husbandry and tourism. In order to protect indigenous biodiversity and ensure the sustainable development of agriculture and tourism, New Zealand attached great importance to the issue of biosecurity and had adopted a series of stringent measures to address the threat of invasive alien species.

In terms of the legal system, New Zealand's Biosecurity Act establishes a stringent quarantine system covering four areas, namely, applications for first entry, requirements for plants and plant products, the establishment of a restricted list of pests, and the development of standards and guidelines for the implementation of quarantine management. Firstly, for applications for the first export of plants or plant products to New Zealand, they must meet the established health criteria for entry or be submitted to the New Zealand Ministry of Primary Industries for risk assessment. If the product is a newborn species, the applicant is required to submit an application to the Environmental Risk Management Bureau and undergo a risk assessment by the New Zealand Ministry of Primary Industries. Secondly, imported plants and plant products must comply with the health criteria, or they will be prohibited from entering the country. In response to the interception of prohibited items, the importer has to bear the cost of return or destruction; third, in terms of the development of pest lists, the Ministry of Primary Industries must ensure that imported goods do not carry exotic species, and its published pest lists will explain in detail the quarantine status of each organism, and the necessary treatment measures will be taken for restricted pests; fourth, the Ministry of Primary Industries has formulated specific standards for the implementation of quarantine management and Fourth, the Ministry of Primary Industries has developed specific quarantine management implementation standards and guidelines to ensure that risky goods are subject to import health standards before entering the country (Feng, 2021). Fourthly, the Ministry of Primary Industries has developed specific standards and guidelines for the implementation of quarantine management to ensure that risky goods need to meet import health standards before entering the country. The quarantine system of New Zealand provides a good template for us.

4.3. Australia

Located in the southern hemisphere, Australia is one of the most species-rich countries with many endemic plants and animals and a diverse natural environment. As immigration has increased, large numbers of exotic crops and domesticated animals have been introduced to meet the needs of Australia's growing population. However, this process not only brings beneficial species, but also increases the risk of invasive alien species, for which Australia has well-established laws and policies.

In terms of the legal system, Australia's National Weed Strategy, enacted in 1997, establishes a systematic risk assessment system for exotic species, with the innovative construction of a weed risk evaluation system comprising 49 questions (Huang et al., 2020). The system is in the form of a questionnaire, which takes into account various factors such as the biological characteristics of the alien plant, the degree of risk, the potential danger, and the mode of propagation and spread, and adopts a cumulative score to make the assessment, and strictly restricts the entry of those that do not meet the criteria. In addition, in order to improve the efficiency of the review, the National Weed Strategy has also established a weed list of exotics, which identifies the plant species that need to be prioritized for treatment, and by working with the assessment system, it can quickly differentiate between assessed and unassessed species. The implementation of this system has provided a scientifically effective approach to invasive alien species management in Australia and offers valuable lessons for other countries.

4.4. United States

The United States is located in the Northern Hemisphere and spans multiple climatic zones and geographic formations, making its natural environment extremely diverse. This diversity provides a home for a wide range of plants and animals, making the United States one of the most species-rich countries in the world. Historically, the U.S. has also experienced a significant introduction of exotic species with the arrival of European colonizers and subsequent waves of mass immigration. However, the U.S. has also faced the daunting challenge of invasive alien species. Some non-native species, lacking natural enemies or suitable competitors, have rapidly multiplied and spread in their new environments, causing serious damage to native ecosystems, affecting biodiversity, and even threatening the survival of some species. For example, invasive water hyacinth clogs waterways, affecting shipping and water quality, while the spread of fire ants poses a threat to crops, ecosystems and human health. To address this challenge, the United States has also established a relatively well-developed system of laws and policies. From the federal level to state governments, relevant laws and regulations have been enacted with the aim of preventing the introduction of exotic species, controlling their spread, and repairing damaged ecosystems. For example, federal laws such as the Alien Harmful Aquatic Organisms Prevention and Control Act and the Invasive Species Act provide the legal framework for the management of alien species.

In the legal system, the United States attaches great importance to public participation. Executive Order 13,122 of 1999 proposes to fund research, provide information to guide the management of species invasions, establish a species invasion

assessment and monitoring network, as well as implement relevant public education activities and cooperate in international education activities. The National Invasive Species Act specifies that the public must be provided with methods to protect against invasive alien species, and that public education on relevant knowledge and prevention programs must be strengthened. To implement this legal requirement, the U.S. government has taken a series of measures, including organizing a variety of public education activities to raise public awareness of prevention, encouraging the public to actively prevent invasive alien species in their daily lives, and enhancing public awareness of the problem of invasive alien species through the planning and implementation of public education programs, as well as the provision of related educational materials. In addition, the government has ensured, through earmarked funding, that sufficient resources are allocated for public education, monitoring, prevention and management of invasive species.

5. Improvement of the legal regulation of invasive alien species

5.1 Development of specialized laws to prevent and control invasive alien species

Although China from the twentieth century has begun to formulate the prevention and control of invasive alien species laws and regulations to cope with the increasingly serious situation of invasive alien species, but compared with some developed countries, China is still in a relatively lagging behind in legal regulation, the existing laws and regulations are complex and numerous and a lot of repetitive content, in the whole process of prevention and control of the effectiveness of the lack of good, there are a lot of legal loopholes and gaps. The reason for this is that China has not yet formulated a special law on the prevention and control of invasive alien species. In this regard, as mentioned above, we can learn from Japan's practice, combined with our own situation, without repealing the existing relevant laws and regulations on the basis of the introduction of the "People's Republic of China Prevention and Control of Invasive Alien Species Law", and identified as our basic law, so as to build a strict legal system for the prevention and control of invasive alien species.

On the conception of the content of this specialized law, the author suggests that the overall structure can be based on the "Hunan Province Invasive Species Management Regulations", divided into the General Provisions, the source of prevention, monitoring, prevention and restoration, legal responsibility for the five major parts. In the first part of the General Principles should be clear that the purpose of the legislation, no longer the purpose of the legislation is limited only to the protection of agriculture, forestry, animal husbandry and fisheries development, and promote economic development as the primary goal, but the purpose of the legislation to the level of national security to protect biodiversity, safeguard human health, and promote sustainable development for the purpose of the legislation. Only by prioritizing the protection of ecological security and biodiversity and incorporating them into the legislative process can we draw great attention to them and achieve the desired results. The second part, prevention at source, stipulates that the introduction of exotic species should comply with the requirements of the list and implement a

licensing system, and at the same time stipulates that units and individuals can introduce exotic species under specific conditions. The third part is monitoring, which requires the relevant authorities to strengthen the daily monitoring of alien species and regularly assess their status and development trend by providing a complete risk assessment system, so as to provide accurate and reliable monitoring data and evaluation information for the effective management of alien species. The fourth part of the prevention, control and restoration shall determine the types and areas to be prevented and controlled according to the hazards of invasive alien species, stipulate that the competent authorities shall carry out the prevention and control of harmful alien species, formulate programs for the restoration and reconstruction of ecosystems, and strengthen the infrastructure for prevention and control, the construction of professional teams and the stockpiling of materials such as pharmaceuticals and instruments. Part V on legal liability should provide for civil, administrative and criminal liability. In terms of civil liability, compensation or indemnity shall be made for damage to the environment or personal and property damage caused to others; in terms of administrative liability, administrative compensation, suspension of production and business, revocation of business license and other administrative penalties shall be imposed on administrative counterparts who violate the mandatory provisions of the law or fail to fulfill their legal obligations; and in terms of criminal liability, suspected crimes such as illegal introduction of alien species shall be investigated for criminal liability. Criminal liability.

5.2. Improvement of the alien species listing system

There are currently some problems with our exotic species listing system. The irrational categorization of the list of exotic species makes it impossible for us to quickly understand and identify all kinds of exotic species, which poses a challenge to the ecological environment and the protection of biodiversity in our country. In this regard, we can actively learn from Japan's alien species listing system in the Invasive Alien Species Act.

First of all, in addition to subdividing the list of alien species into plants, animals and micro-organisms on the basis of the morphological structure of living organisms, our categorization of the list can also draw reference from the listing system stipulated by Japan in the Invasive Alien Species Act. Japan has adopted a hierarchical classification method to manage the list of alien species, whereby alien species are categorized according to the degree of harm they pose to the ecosystem and management measures are taken accordingly. The advantage of this is that the possible risks posed by each alien species can be assessed more accurately so that more targeted prevention and control measures can be taken. In this regard, we can categorize alien species into three groups. The first category is the black list, i.e. alien species that pose a known or potential threat to the ecosystem and whose introduction is strictly limited. The second category is the gray list, that is, there is not yet sufficient scientific evidence to prove that it will cause harm, if the assessment of the risk of invasion is determined to be within an acceptable range, the appropriate introduction through the approval process, and real-time tracking and monitoring, and once found to be harmful to the environment, it will be immediately removed and included in the black list. The

third category is the white list, i.e., species with basically no invasive potential can be introduced without restriction. However, these three lists are not static, and they can be changed and updated at any time based on the progress of research. If scientific evidence shows that alien species on the gray list are threatening, they can be placed on the black list; conversely, if they are shown to be non-threatening, they will be placed on the white list. And exotic species on the white list can also be reclassified to the black list once they are shown to be threatening or potentially threatening (Yang and Cheng, 2016). This dynamic adjustment ensures that these lists remain in place. This dynamic adjustment ensures that the lists are kept up to date with the reality of the situation in order to respond in a timely manner to the ecological imbalances that may be caused by exotic species.

5.3. Optimizing the inspection and quarantine system for alien species

The scope of adjustment of our current inspection and quarantine system is relatively limited, focusing mainly on infectious diseases, microorganisms and other pests. In order to safeguard the security of our national gates and border control, we urgently need to further expand the object and scope of inspection and quarantine.

China's current inspection and quarantine objects, in addition to known dangerous alien species, does not include potentially threatening alien species into the scope of quarantine, which also means that, once the new unknown organisms have been discovered, we can only take temporary isolation measures to deal with them (Wang et al., 2022). In respect of this system, we can make reference to the Biosafety Act enacted by New Zealand, which has the conservation of biodiversity as its core purpose and aims at strictly preventing the entry of harmful species into the New Zealand territory. For harmful species that have already entered the country, timely control and removal measures are required. Under the Act, the scope of quarantine targets has been significantly expanded to include species that have not yet been monitored for potential hazards, ensuring that no species are left out, and a corresponding list has been compiled based on the results, which is updated in real time to ensure real-time and scientific validity. These provisions have played an important role in the protection of biodiversity in China. In this regard, we should expand the regulatory scope of the inspection and quarantine system to include potentially dangerous exotic species as well. The Entry and Exit Animal and Plant Quarantine Law and its implementing regulations only provide for the implementation of quarantine and epidemic prevention and disinfection for means of transport from animal and plant infected areas, but not for the implementation of animal and plant quarantine for ship ballast water, so we should also include ship ballast water in the scope of animal and plant quarantine. At the same time, the scope of animal and plant quarantine for inbound and outbound means of transportation should be expanded to require that all inbound means of transportation from non-diseased areas should also be subject to animal and plant quarantine.

5.4. Robust risk assessment system for alien species

A sound risk assessment system is relevant to our country's ability to provide timely early warning of invasive alien species, a system that can quickly help to

identify potential hazards and take the necessary preventive measures, which can minimize the losses and negative impacts of alien species on ecosystems and the economy at the source.

First of all, the scope of risk assessment of exotic species should be expanded to include all exotic species, whether they are introduced intentionally, unconsciously or by natural dispersal, into the scope of risk assessment, and recorded in different levels of lists according to the results of the assessment, so as to ensure that the level of risk of the introduced species can be quickly recognized, and that corresponding preventive and control strategies can be adopted. In addition, in order to make the risk assessment system work effectively, we can learn from Australia and set up risk assessment research departments overseas, so as to ensure that prospective studies are conducted before the introduction of alien species into the country, instead of passively waiting until the alien organisms are introduced into the country to conduct risk assessments, so as to formulate subsequent prevention, control and management plans.

Secondly, in order to scientifically assess the harmfulness of alien species, it is essential to establish a specialized risk assessment body and ensure its independence, which is crucial to improving the risk assessment system for invasive alien species. Only by building such a specialized risk management institution can we effectively break through the limitations of multiple management and avoid the inefficiency of prevention and control caused by the different interests of different departments. In this way, all relevant departments can receive unified command and coordination within their respective areas of competence, thus ensuring that the risk of invasive alien species is managed and controlled in a timely and effective manner.

5.5. Improvement of public participation mechanisms for alien species

Strengthen public awareness and education. Public awareness and understanding of the issue of exotic biological invasions can be enhanced through the media, social networks and public education campaigns. In terms of the media, this can be done through news coverage and raising awareness of the issue. Secondly, social networks play a crucial role in today's society, and platforms such as microblogging, weibo, and jitterbugging can be utilized to carry out discussions on relevant topics or release popular science knowledge to promote information dissemination and interactive exchanges, so as to form a consensus among the entire population. Meanwhile, in terms of public education activities, special lectures, exhibitions, promotional film screenings and other activities can be organized, and experts and scholars in related fields can be invited to participate, so as to deepen the public's understanding of the problem of invasive alien species through interactive teaching and immersive experience. Through these means, not only can we effectively expand the coverage and influence of publicity, but also stimulate the public's awareness of participation and action. At the same time, it also helps to guide more people to actively participate in the prevention and control of invasive species, thus realizing a positive interaction mechanism among the government, enterprises, experts and the general public in the management of invasive species.

Lastly, incentives for public participation should be established. In the United States, it is worthwhile for us to learn from the law that provides for a special

appropriation to ensure that the government can devote sufficient resources to the work of invasive alien species. Specifically, our government can set up a special fund through legislation (Chen et al., 2020). These funds can be used to reward those who have done a good job in preventing invasive species. These funds can be used to reward individuals, social organizations or business units that have achieved remarkable results in preventing, monitoring, controlling or eradicating invasive alien species. To ensure the fair use of the special funds, the government needs to set clear criteria for evaluation and reward. For those individuals and groups that have made positive contributions to the prevention and control of invasive species, the government and relevant agencies can take various forms of encouragement and commendation measures to show their recognition. Officially certified certificates and trophies should be awarded to active participants, and a certain amount of prize money or project implementation grants could be offered to individuals or groups with outstanding performance.

6. Conclusion

With the acceleration of globalization, the invasion of alien species has long been a social problem that needs to be solved on a global scale, posing a serious threat and causing great losses to biodiversity, public health and economic development. Although China has made certain achievements in the prevention and control of invasive alien species in recent years, it still faces a number of problems that need to be solved.

At the present stage, the lack of a specialized law on the prevention and control of invasions of exotic organisms has led to a fragmented distribution of laws on the prevention and control of invasions of exotic species and a narrow scope of adjustment, making it impossible to achieve comprehensive prevention and control of invasions of exotic species. The lack of specialized laws and the loopholes in the legal system have made it impossible for our country to comprehensively and effectively prevent and curb the invasion of alien species. Therefore, I should speed up the revision of relevant legislation and summarize and improve it with the experience of developed countries, so as to build up a special basic law on the prevention and control of invasion of alien species, in order to coordinate the existing laws and regulations and make up for the shortcomings in the application of laws. The specific legal system should be further improved, the list system should be classified and managed, and the timeliness and foresight of the list should be guaranteed to ensure that it is updated regularly; the scope of risk assessment of alien species should be expanded and a specialized risk assessment agency should be set up; the scope of inspection and quarantine should be expanded in the border control, and the scope of the inspection and quarantine should be expanded to include the public. In addition, public participation is essential to prevent and control the invasion of alien species, so that public knowledge can be disseminated through the media, social networks and public education activities to arouse public awareness. Through the media, social networks and public education activities, relevant knowledge should be disseminated to arouse the public's understanding of and attention to the problem of invasive alien species, and public participation incentive mechanisms should be set up to reward individuals

or groups with outstanding performance. In the future, China's work in the field of prevention and control of invasive alien organisms still requires continuous efforts and exploration. Only by strengthening legislation, improving the system and promoting international cooperation can we better cope with the challenges posed by invasive alien species, protect China's ecological environment and biodiversity, and promote sustainable socio-economic development.

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