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Problems identification and improvement path of China's marine ecological compensation legal system

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In China's marine industry, which has been growing quickly over the past few years, marine ecological compensation has been a critical framework for safeguarding the marine environment. Through the text analysis of the China's marine ecological compensation legal system, this study found that there are multiple defects in it, including institutional supply shortage leads to lack of coordination and dispersion in China's marine ecological compensation legislative system, the absence of legislative concept of 'land-sea overall planning' in China's marine ecological compensation legal system, limited scope of China's marine ecological compensation, lack of clear standards for marine ecological compensation, the relationship between marine planning and the marine ecological compensation system is not straightforward, and insufficiency of regulation on the marine ecological compensation. The paper suggests that priority should be given to developing a multi-level legal system for compensating marine ecological damage, the legal method of achieving 'land-sea overall planning' and a compensation mechanism that combines a variety of compensation methods with a scientific and reasonable standard should be established within China's ecological compensation legal system, marine ecological compensation should be incorporated into marine planning and the separation of powers and implementation of the marine ecological compensation regulation should be enhanced.

KEYWORDS

marine ecological compensation, legal system, problems identification, improvement path, compensation method, compensation standard

1 Introduction

The sea supplies the physical underpinning for human existence and growth. A marine ecosystem is a community of creatures living in the ocean environment (Kingsford, 2023). Dealing with the interaction of marine life with its immediate surroundings and other elements is the key to sustaining the Ocean Ecosystem Equilibrium (Dipper, 2022), which is

strategically significant for preserving the environment and fostering economic growth. China is a major maritime power. In recent years, China has devoted significant resources to enhancing the institutional framework for conserving ocean habitats and constructing an ecoculture in the ocean. As a means of balancing the advantages of various parties involved in ocean ecology, ocean ecology compensation plays a crucial role in enhancing the sea's carrying capacity and promoting the ocean's sustainability. The Marine Environmental Protection Law of the People's Republic of China establishes the marine ecological protection compensation system, which is recognized as a fundamental framework for safeguarding the marine environment. It was suggested in the Report of the 20th CPC National Congress that the building of a maritime power be expedited (Xi, 2022). In the process of enlarging the area for marine economic development in China, how to jointly support marine ecological protection, marine economic development, and the protection of marine rights and interests has become an urgent matter to be solved. China's marine ecosystem is currently stable and improving, and the overall quality of the marine environment is also improving, but pollution is still a major problem in coastal areas like Liaodong Bay, Bohai Bay, the Yangtze River Estuary, Hangzhou Bay, the Zhejiang Coast, and the Pearl River Estuary (Ministry of Ecology and Environment of the People's Republic of China, 2022). The preservation of the marine ecology is a necessary condition for China's social and economic sustainability. The Chinese government places a high value on marine work. From the 11th to the 14th Five-Year Plans, the Chinese Government recommended a strong development of the marine economy, emphasizing the rational use of marine resources and the protection of the marine natural environment (National People's Congress of the People's Republic of China, 2006; National People's Congress of the People's Republic of China, 2011; National People's Congress of the People's Republic of China, 2016; National People's Congress of the People's Republic of China, 2021). Establishing and improving a marine ecological compensation system is an important way to maintain the marine ecological environment, thoroughly protect coastal space, improve the operation of marine ecological services, and promote the optimization of marine industry layout. Because the 14th five-year Plan period represents an important potential for marine development, it is critical to safeguard marine ecological security. The plan for the protection and restoration of the coastal zone in the 14th five-year Plan is to renovate 400 km of coastline and 20,000 hectares of coastal wetlands, and build 110,000 hectares of shelterbelt, focusing on the coasts of the Yellow Sea, Bohai Sea, Yangtze River Delta, Guangdong, Fujian and Zhejiang, Guangdong-Hong Kong-Macau Greater Bay Area, Hainan Island and Beibu Gulf (National People's Congress of the People's Republic of China, 2021). Ecological compensation should be market-oriented and diverse, and social capital of all kinds should be encouraged to participate in ecological protection and restoration. As a result, it is of the utmost importance to accelerate the development of China's marine ecological compensation system, to concentrate on determining the primary obstacles to its implementation, and to

discuss potential solutions. The following are the research questions addressed in this paper: (a) What issues can be identified with China's Marine Ecological Compensation Legal System? (b) How to enhance China's legal framework for marine ecological compensation. The structure of the remainder of this paper is as follows: Section 2 is devoted to reviewing important aspects of the existing literature and highlighting the paper's potential impact on China's marine ecological compensation system in the future. The main issues with China's marine ecological compensation system are highlighted in Section 3. As a result, the suggestions for improving China's marine ecological compensation system are discussed in Section 4.

2 Literature review

“regulationThe Marine ecological compensation system in China is supported by pertinent laws and regulations such as the *Marine Environment Protection Law of the People's Republic of China* and the *Law of the People's Republic of China on the Administration of Sea Areas* (Jiang et al., 2019). These laws and regulations define the principles, scope, procedures, and subjects of responsibility for Marine ecological compensation, laying the groundwork for the implementation of scientific and rational compensation measures (Cui and Xu, 2020). According to China's legal system, the primary goals of marine ecological compensation are to protect the marine ecological environment, prevent and control marine pollution, maintain the marine ecological balance, and achieve sustainable use of marine resources (Tan, 2019).

In terms of implementing legal mechanisms for marine ecological compensation, China has made some progress. For instance, the Chinese government has formulated a number of policies and measures to achieve the sustainable use of marine resources, preserve the ecological environment, and protect national marine interests (Miao, 2020). China has implemented a number of marine ecological compensation projects, such as tidal flat restoration, fishery resource recovery, coral reef protection, and a focus on preserving the marine environment during the development of marine mineral resources (Chang et al., 2020; Guo, 2020). These projects aim to mitigate the ecological and environmental harm caused by human activities, resource extraction, and marine pollution in order to achieve sustainable marine development.

However, the actual implementation process of China's legal system for Marine ecological compensation still faces obstacles. First, lack of accountability is a significant issue. Under the current legal system, governments and departments at all levels have deficiencies in the distribution and coordination of responsibilities for Marine ecological compensation, making it difficult to clarify compensation standards, methods, and subjects of responsibility (Zhang et al., 2019). The implementation of the Marine ecological compensation system is also hampered by the absence of an effective monitoring and regulation mechanism. Due to technical, human, and monetary constraints, the government

faces numerous challenges in monitoring marine ecological damage, evaluating compensation effects, and implementing compensation measures (Huo et al., 2016). Inadequate intersectoral cooperation is also a significant factor impeding the effective implementation of the Marine ecological compensation system. There are numerous departments involved in Marine ecological compensation in China, such as environmental protection, fisheries, transportation, etc., which hinders the sharing of information, integration of resources, and coordination of policies between departments (Li, 2020).

To address these issues, China must in the future enhance its legal compensation system for marine ecology. First, the rights and responsibilities of governments and departments at all levels should be clarified in Marine ecological compensation, and coordination and cooperation should be strengthened to ensure the effective implementation of compensation measures (Liu, 2020). The second crucial link is the strengthening of ecological damage assessment and oversight. The government should increase its investment in monitoring and evaluation technology, enhance its regulatory capacity, and guarantee the implementation effect of Marine ecological compensation (Li, 2020).

In addition, increasing public awareness and participation is an important method to achieve sustainable ocean development. The government should enhance the public's understanding of the Marine ecological compensation system through publicity and education, encourage the public to participate in ecological protection activities, and form a Marine ecological protection pattern with the participation of the whole society (Li, 2020). In terms of international cooperation, China should learn from international experience, strengthen cooperation with other countries in Marine ecological compensation, and jointly deal with global Marine ecological problems (Fang, 2021). By participating in international organizations and initiatives, China can promote the improvement of the global Marine governance system and elevate the level of international cooperation on the Marine ecological compensation system.

Marine ecological compensation research conducted abroad focuses on marine ecological scale, marine ecology, and environmental management. Medjo (2008); Medjo (2009a), and Medjo (2009b) studied the state restrictions of marine ecology. Yogui and Sericano (2009) and Choueri et al. (2009) simultaneously researched the sources of marine ecological contamination and discovered that metals, polycyclic aromatic hydrocarbons, and polychlorinated biphenyls were significant contributors to marine pollution. Lau (2012) notes that the research scope of marine ecological compensation is constantly expanding, encompassing Marine reserves, Marine ecological management, Marine ecosystems, compensation scope, coastal areas, and environmental legislation, amongst other factors. Coastal zones and coastal ecosystems are degrading or being destroyed at an alarming rate, while human dependency on marine ecosystem services is increasing. Friess et al. (2016) found that research on 'blue forest' coastal ecosystems has produced essential references for, among other things, coastal preservation, fish nursery, water purification, and marine biodiversity. Five blue carbon ecosystem

environmental services were proposed by Lau (2012): carbon sequestration, coastal protection, habitat, biodiversity, and water quality. Assessing the value of these ecological services in order to connect the human economic system with the natural system is the current substantial policy challenge. Payment for ecosystem services is a successful economic tool, according to Bladon et al. (2016); nevertheless, the fluid and transboundary nature of the marine environment offers challenges for the design and implementation of marine ecosystem compensation.

Major coastal nations are devoting to the study of marine ecological compensation mechanisms in light of the developing global expertise in marine ecological compensation management. Kemp et al. (2023) found that the development of compensation mechanisms was primarily focused on the creation of an ecological compensation legal framework, the quantification of ecological compensation costs, an ecological tax and compensation fund, and marine ecological management and oversight. According to Puig and Villarroja (2013), marine compensation management actions include regulatory measures, catch quotas, wastewater disposal, and discharge control. The rapid rise of industrialization and urbanization, according to Medjo (2010), has resulted in the destruction of marine habitats in key coastal nations. Hence, the number of sites for land reclamation should be reduced and land utilization should be optimized. Harold et al. (2012) proposed realistic solutions to enhance diverse ecological compensation and increase market-oriented Marine ecological compensation mechanism development based on key elements such as the purpose, mode, and method of Marine ecological compensation mechanism development.

The research of domestic and international experts' research on China's marine ecological compensation program reveals the following characteristics: (a) The research findings above focus primarily on economics and management, especially compensation cost accounting and compensation mechanisms. The legal analysis is merely one of the methodologies utilized in the aforementioned research, the legal analysis is brief, and there is a dearth of system-oriented research on China's marine ecological compensation legal system. (b) Legal research on China's marine ecological compensation legal system has made limited progress, focusing primarily on the 2011 oil spill accident in Bohai Bay and the ecological compensation mechanism in the development of offshore oil and gas resources. Insufficient research has been conducted on the legal complexities of ecological compensation between land and sea. In addition, it disregards the systematic nature of legislation, as well as the coordination and significance of numerous departmental laws and regulations within China's overall legal structure for environmental protection. (c) Earlier studies focused on the ecological scale of the marine environment and marine pollution; later, the direction of research expanded to include marine ecosystem, marine ecological compensation management, marine ecological compensation mechanism, and protection of marine biodiversity, among others. Future trends will include research on the variety of marine ecological civilization, and the coordination of global marine ecological compensation management.

3 Identification of problems in China's marine ecological compensation legal system

The purpose of China's marine economic construction during the 14th five-year Plan period is to jointly support ecological protection, economic development, and the preservation of maritime rights and interests, as well as to accelerate the establishment of a marine power (National People's Congress of the People's Republic of China, 2021). The legal system of marine ecological compensation, as an important tool for regulating the relationship between marine economic development and ecological protection, is plagued by flaws in system, concept, and standard, posing challenges to the achievement of China's marine economic construction goal during the 14th five-year Plan period. Examining China's marine ecological compensation legal system and identifying flaws in the legal system has become an important topic for this study to investigate.

3.1 Institutional supply shortage leads to lack of coordination and dispersion in China's marine ecological compensation legislative system

The existing Chinese legislative system for the development, use, and conservation of environmental resources includes provisions for ecological compensation (see Table 1). However, there is a lack of coordination and dispersion among these measures in various laws and regulations regulating marine ecological compensation. The aforementioned factors essentially illustrate the absence of a comprehensive and operational legislative mechanism for marine ecological compensation.

First, the fragmented legal structure for marine ecological compensation in China is not conducive to enhancing advice from superior laws. As the country's founding document, the Constitution of the People's Republic of China essentially stipulates that 'the state preserves and enhances the living environment and ecological environment, as well as prevents and manages pollution and other public risks.' There is no basis for ecological compensation in the constitution; the only basis is ecological protection. Article 31 of the 2014-revised Environmental Protection Law of the People's Republic of China requires the establishment and improvement of an ecological protection compensation system. However, this just specifies that a macroscopically designed ecological compensation mechanism is necessary. The ecological compensation system is impractical since there are no precise provisions regarding its content, management system, compensation standards, or operation mode. It is difficult to immediately apply it directly to the job of marine ecological compensation. Despite the fact that the third chapter of the Marine Environmental Protection Law of the People's Republic of China's contains quite extensive rules pertaining to China's marine ecological protection, the topic is somewhat broad (Zhang et al., 2014). The two sectors of China's marine ecological compensation

legal system encompass the laws and regulations governing the development and utilization of marine resources, the preservation of the maritime environment, and marine ecological compensation. The structure of fragmented law hinders the improvement of the marine ecological compensation legal framework (Wang and Zou, 2021). The State Council has not yet officially adopted Regulations on Ecological Compensation, and the majority of legal documents pertaining to marine ecological compensation in various provinces and cities are policies, which are less effective than laws and regulations and can only apply to specific regions.

Second, incoherency between laws and policies. Although each of China's coastal provinces has established its own policies on marine ecological compensation, no national regulations on marine ecological compensation have been drafted. The Maritime Environmental Protection Law offers compensation for marine ecosystems in principle, but its flexibility is limited. Coastal provinces develop marine ecological compensation requirements, financing sources, and oversight in accordance with local conditions. Despite its wide applicability and adaptability, this strategy lacks authority and has a weak binding force (Wan et al., 2021). However, the marine ecological compensation policy system has a dispersed structure due to the obvious variations in compensation criteria and procedures between locations, as well as its limited scope of application. In the absence of effective internal convergence, not only is it difficult to form a single policy force, but it also increases the likelihood of conflicts and reduces the policy's overall effectiveness. From the perspective of policy system reconstruction, a solution must be found to the challenge of fostering convergence and coordination of local policies while also increasing the central government's policy guidance to the local government and provide local governments with systematic and actionable policy guidance. As the federal government focuses on macro-guidance and financial support, the specific compensation method is neglected (Jiang et al., 2022). Currently, local governments are consolidating their knowledge of specific practices and enhancing the ecological compensation mechanism. Hence, the local government's emphasis on the compensation mechanism exceeds that of the central government, resulting in a diversity of local compensation plans and the absence of central control over the entire policy (Jiang et al., 2022). On the long term, local policies can easily develop their own doors, and the central government loses its leadership role in directing local policies and becomes the principal source of compensation funds.

Third, the incoherence of laws. Marine ecological compensation encompasses not only the protection of the marine environment, but also the utilization of marine resources. The Marine Environmental Protection Act of the People's Republic of China alone cannot alleviate all the problems associated with the degradation of the marine ecosystem. The exploitation and protection of marine resources must be combined. (Liu and Li, 2020). China now lacks a comprehensive law on marine ecological compensation due to the diverse formulation subjects, adjustment objects, and goals of many special rules. For example, according to article 7 of the *Fisheries Law of the People's Republic of China*, both marine fisheries and fisheries in rivers and lakes are considered adjustment objects; consequently, fishery resources in the ocean,

TABLE 1 Policies and Laws Regarding Marine Ecological Compensation in the People's Republic of China.

Document Type	Document Name	Related Provisions
Laws	Environmental Protection Law of the People's Republic of China (2014 Revision)	According to Article 31, the State shall establish and improves eco-compensation system. The State will increase fiscal transfer to areas of ecological environment protection and provides guidance to the governments of beneficiary areas and ecological protection areas to implement eco-compensation <i>via</i> consultation or market rules.
	Marine Environment Protection Law of the People's Republic of China (Amendment 2017)	According to Article 12, All entities and individuals directly discharging pollutants into the sea must pay pollutant discharge fees, environmental pollution tax and dumping fees. According to Article 24, the state shall establish and improve the marine ecological protection compensation system.
	Agriculture Law of the People's Republic of China (2012 Amendment)	According to Article 63, the State shall provide guidance to and supports farmers (fishermen) and the agricultural (fishery) production and operation organizations engaged in fishing to take up aquaculture or other occupation.
	Fisheries Law of the People's Republic of China (2013 Amendment)	According to Article 28, Departments of fishery administration at and above the county level shall work out overall plans and take measures to increase fishery resources in the fishery waters under their jurisdiction.
	Law of the People's Republic of China on the Administration of Sea Areas (2002)	According to Article 33, any entity or individual that uses a sea area shall pay royalties for the use.
Administrative Regulations	Regulations of the People's Republic of China on the Protection of Aquatic Wild Animals (2013 Revision)	According to Article 10, those who suffer losses resulting from protection of aquatic wild animals under State priority protection and local priority protection may require fishery administrative departments to make compensation.
	Regulation of the People's Republic of China on the Exploitation of Offshore Petroleum Resources in Cooperation with Foreign Enterprises (2013Revision)	According to Article 10, all Chinese enterprises and foreign enterprises participating in the cooperative exploitation of offshore petroleum resources shall pay taxes in accordance with law.
Local Regulations	Measures of Shandong Province on the Administration of Marine Ecological compensation (2020)	In this policy, the marine ecological compensation is further subdivided into sea water quality compensation, pollutant control compensation and coastal ecosystem protection compensation, and the fund source of ecological compensation and the calculation formula and standard of each compensation method are stipulated.
	Measures of Xiamen Municipality on the Administration of Marine Ecological compensation (2018)	In this policy, the compensation for marine ecological damage shall be based on the principle of 'who uses it, who compensates'. Where units and individuals who have obtained the right to use sea areas in accordance with the law in the sea areas under the jurisdiction of Xiamen cause damage to marine ecology while engaging in marine development and utilization activities, the marine ecological damage caused by it shall be compensated by means of carrying out ecological restoration projects or paying marine ecological compensation.
	Regulations on Marine Environmental Protection of Hainan Province (2008) and Regulations on Coral Reef Protection of Hainan Province (2009)	In these policies, units and individuals who have made obvious contributions to the protection of the marine environment and coral reef ecosystems should be commended and rewarded.

rivers, and lakes are objects in marine ecological compensation; and, under article 2 of *the Wild Animal Conservation Law of the People's Republic of China*, the conservation of aquatic wild animals other than rare and endangered species is prohibited. Another example is that Mangroves are subject to the provisions of forest ecological compensation under *the Forest Law of the People's Republic of China*. However, mangroves are an essential component of the marine ecosystem and should be protected under *the Marine Environmental Protection Law of People's Republic of China*. In addition, the provisions of various laws governing marine administrative departments are conflicting. *The Marine*

Environmental Protection Law of the People's Republic of China, for instance, holds administrative departments of environmental protection accountable for marine ecological restoration and compensation, whereas *the Fisheries Law of the People's Republic of China* holds administrative departments of fisheries accountable for ecological compensation for fisheries expansion. The above legislative provisions demonstrate that the objectives of marine ecological compensation and the responsible agencies sometimes overlap with those of other single laws. It will be difficult to coordinate the various laws if these overlapping provisions are not effectively resolved.

3.2 Absence of legislative concept of 'land-sea overall planning' in China's marine ecological compensation legal system

While regulating land and sea operations, the government must conform to the legislative concept of 'overall planning of land and sea.' This concept should be fully reflected in China's environmental pay overall set of laws because it not only focuses on the security of the marine natural climate but also, from a fantastic and open-minded perspective, on sending and organizing the interests of land and ocean financial and social developments and biological climate security (Li, 2021). The phrase 'overall planning of land and sea' is now lacking from China's legal framework for ecological compensation.

First, the key principles of the current environmental basic law do not adequately reflect land and water preservation. Article 5 of the *Environmental Protection Law of the People's Republic of China* outlines the principles of 'giving priority to protection,' 'focusing on prevention,' 'conducting comprehensive treatment,' 'engaging the general public,' and 'enforcing accountability for damage,' but does not highlight 'convergence,' 'co-governance and win-win,' or 'land and sea life community.' In addition, the idea of 'complete planning of land and water' cannot be entirely captured by these principles. The separation of land and water is the central premise of China's ecological compensation laws and policies, and the absence of the concept of 'overall planning of land and sea' directly contributes to the separation of these laws and policies into two different systems.

Second, China's legislative framework for compensating terrestrial and marine ecosystems does not overlap. The split of land and water, or marine and the terrestrial ecological compensation, into two reasonably distinct sectors is the linchpin of China's ecological compensation policy and regulation (Li and Cheng, 2021). Despite the fact that a significant portion of the sources of pollution that impair marine ecosystems originate on land and are discharged into the sea *via* rivers, it is typically difficult to pinpoint the actual subject of responsibility due to the expansive river basins and numerous branches. It is obvious that neither basin ecological protection nor marine ecological protection can meet the ecological protection requirements of the coastal zone. Regional environmental governance that considers neighboring drainage basins and coastal seas as a whole is advantageous. Currently, the ecological compensation system of basin and the Marine ecological compensation system are separated, resulting in the following issues: First, because the environmental protection agency and the marine department have jurisdiction close to where the river empties into the sea, there are numerous overlapping problems that are difficult to divide and coordinate. Due to the absence of a drainage - marine ecological compensation system, the ecological harm produced by river pollution cannot be compensated properly. Second, ecological protection has not yet been implemented in the basin-sea region, which represents the 'transitional period between land and water.' The river estuary area faces the challenge of ecological compensation due to the unidirectional ecological compensation system, the lack of a scientific authority division system, and the absence of a regional linking system. Using planning as an example, the planning of coastal areas exemplifies

the conflict between land development and protection of the marine natural environment. Coastal planning is the focal point of the conflict between the development and the preservation of the marine ecological environment, to use coastal planning as an example (Zhu et al., 2019; Kong et al., 2021). Planning frequently entails excessive shoreline use and land reclamation to boost the economy. The end effect of these excessive land activities is the degradation of the marine ecological environment, including the loss of mangroves, the extinction of biological species, altered habitats, pollution of the water, and other problems.

Third, it is difficult to coordinate conflicts of interest in multiple land and maritime zones with China's ecological compensation policies and legislation. Due to the disparities between marine and land management units, they are unable to use the same criterion and compensation technique (Wan et al., 2021). China continues to employ administrative demarcation for regional government, using the land for ecological preservation and the waters for administration. Yet, administrative delimitation, however, will not distinguish between the terrestrial and marine ecosystems because to their interdependence (Oikonomou and Dikou, 2008). Regional development and environmental protection will eventually come into conflict due to the general preservation of the land and marine natural environments as well as the partition of administrative areas. In various administrative regions, rivers combine and diverge into the ocean, while ocean currents distribute marine pollution throughout the sea. It is challenging to provide timely and efficient assistance for the implementation of ecological compensation using eco-environmental monitoring data, because land and sea environmental monitoring technologies and monitoring standards have not yet effectively converged (Levrel et al., 2012; Hooper et al., 2021). The marine environments, for instance, of the Guangdong-Hong Kong-Macau Greater Bay Area, Beihai in Guangxi, Zhanjiang in Guangdong, and Haikou in Hainan close to the Beibu Gulf interact with one another, causing pollution and destruction in one area to frequently spread to other areas or even the entire sea area, which is impacted by the accumulated effects of economic and social activities on the land (Wan et al., 2021). The absence of an all-encompassing environmental picture within the policy of marine ecological compensation hinders the implementation of ecological compensation responsibilities.

Forth, China's policies and laws governing ecological compensation are challenging to coordinate due to the competing interests of the many administrative departments on land and at sea. Frequently, administrative decisions reflect the interests of multiple departments. As a result, some administrative measures are done with departmental interests in mind, rather than the interests of the government as a whole. For example, it can be difficult for different departments to agree on economic development or special programs, and some departments flout environmental protection regulations. Numerous law enforcement agencies operation in isolation and segregation to safeguard the biological habitats of land and sea (Luo, 2020). The environmental regulation of the land-based jade sea area differs from that of the marine environment, and the marine nature reserve has not been administered for an extended period of time. All of these could result in disagreements between different administrations about the control of land and sea operations.

3.3 Lack of clear standards for marine ecological compensation in China

The standard of marine ecological compensation is the core component of the marine ecological compensation system and the technical support for the execution of marine ecological compensation, which has a direct impact on the effectiveness of marine ecological compensation. China currently lacks a unified standard for marine ecological compensation, as well as a foundation for their formation and a method for their accounting (Chen et al., 2021). Currently, Shandong Province's Assessment Technique of Marine Ecological Damage and Loss Compensation can be used as a provincial standard that cannot be applied to the entire country. There are still no national standards in place. Article 5 of the Measures for the Collection and Use of Fishery Resources for Proliferation and Protection states that 'the fishery resources fee shall be determined by the people's governments at all levels along the coast within the range of 1% of the average total output value of aquatic products collected and caught during the first three years of fishing vessels.' Article 3 of the decision on revising the interim measures for the Collection and use of Protection Fees for the Proliferation of Fishery Resources in the Yellow Sea, Bohai Sea, East China Sea, and South China Sea was promulgated by the Ministry of Agriculture of People's Republic of China specifies that it shall be levied proportionately, and Article 5 further states that the rated total power (horsepower) of the main engine of fishing vessels shall be taken as the unit of calculation and levy, and that differential. These regulations establish a defined compensation standard for marine fishing ecological compensation, however, there are no guidelines for marine ecological compensation stakeholders. *The Measures for the Management of Marine Nature Reserves*, for instance, does not provide compensation for those whose interests have been lost or contributed to as a result of the establishment of marine nature reserves, and there is no subordinate law on the marine nature reserves. Articles 9 and 30 of *the Law of the People's Republic of China on the Administration of Sea Areas*, as well as Article 5 of the *Fisheries Law of the People's Republic of China*, state that 'reward' or 'compensation' to individuals is too abstract and lacks clear and concrete execution standards. In addition to compensating fisheries resources, marine ecological compensation involves compensating various biological populations, abiotic resources, marine ecosystems, etc.

3.4 Limited scope of China's marine ecological compensation

Ecological compensation is mainly composed of three parts: 'who compensates', 'how to compensate' and 'whom to compensate', among which 'how to compensate' is to explain the channels and ways of ecological compensation. The public goods attribute of marine ecosystem determines that the subject of marine ecological compensation should be the government, but it does not

mean that the government can only be the only subject of ecological compensation. According to Article 31 of *the Environmental Protection Law of the People's Republic of China*, the way of marine ecological compensation can be divided into government compensation and market compensation, but because of the low degree of market compensation, at present, marine ecological compensation in China mainly depends on government financial allocation, including financial transfer payment and local government funds, which is a typical way of dependence compensation. However, there are obvious deficiencies in social compensation funds, such as investment by enterprises and institutions, preferential loans and donations by social organizations, so it is difficult to form a sustainable financial support mechanism. According to the 2021 China Marine Ecological Environment Quality Bulletin, the sea area under China's jurisdiction that does not meet the Class I seawater quality standards is 70000 square kilometers, of which Class IV and Class IV are 28400 square kilometers, accounting for 40.71% (Ministry of Ecology and Environment of the People's Republic of China, 2022). The complexity of the marine ecosystem and the seriousness of the current marine ecological environment pollution are bound to speed up the process of marine ecological compensation in China, while the narrow source of funds for marine ecological compensation will increase the funding gap of marine ecological compensation in China. In terms of marine ecological compensation, the most common ways of marine ecological compensation in the world are economic compensation, resource compensation and habitat compensation. At present, China mainly depends on economic compensation and resource compensation to promote marine ecological compensation. In terms of habitat compensation, although marine nature reserves have been established in China, other ways of habitat compensation have not been effectively utilized. In terms of resource compensation, although China has implemented resource compensation in some sea areas, there are some deficiencies in the intensity of compensation and the types of fish fry released. In addition, in terms of economic compensation to marine ecological environment protectors, we seldom play the role of industrial incubation, technical support, personnel training, employment training and so on. Due to the imbalance of various compensation methods and the narrow sources of funds, the process of marine ecological environment protection in China is limited.

3.5 The relationship between marine planning and the marine ecological compensation system is not straightforward

Marine planning is a strategic and guiding plan that makes long-term arrangements for the development, utilization, administration, and preservation of the marine environment (Liu and Li, 2011). Marine planning is a type of administrative planning that consists of

general planning, special planning, regional planning, and spatial planning. On one hand, marine planning is an essential foundation for establishing an ecological compensation system. Marine planning can provide the foundation for formulating marine ecological compensation policies, including regional ecological carrying capacity, marine economic development architecture, marine exploitation intensity, and development potential. On the other hand, Marine planning can play a pivotal role in advancing the development of the Marine ecological compensation system. Marine planning is a consensus reached by Marine administrative organs at various levels and regions, which ensures that laws and policies pertaining to Marine ecological compensation can be effectively implemented by administrative organs, thereby facilitating the institutionalization of Marine ecological compensation. Currently, the following issues exist in the relationship between Marine planning and Marine ecological compensation:

First, there is inadequate coordination exists between the marine planning system and laws and regulations pertaining to ecological compensation. In China's marine planning system, numerous departments and disciplines are involved in the planning process, including coastal zone planning, fishery resources protection planning, and offshore energy development planning. However, the content and requirements of ecological compensation are not considered during the formulation of these marine plans, resulting in a lack of coordination between the implementation of the plan and ecological compensation. Despite the fact that the 12th Five-Year Plan for the Development of the National Marine Industry explicitly provides for an ecological compensation system, it is only recommended and not required. This may not only have an effect on the actual efficacy of ecological compensation policies, but also create difficulties for the preservation of the marine ecosystem.

Second, uncertainty surrounds the status of marine ecological compensation in planning implementation. Although *the Marine Environmental Protection Law of the People's Republic of China* and *the Law of the People's Republic of China on the Administration of Sea Areas* clearly stipulate the principles and requirements of ecological compensation, the status and function of ecological compensation may not be fully reflected in the process of implementing specific Marine planning. During the planning approval, implementation, and regulation processes, ecological compensation may not receive sufficient consideration, making it more difficult to put ecological compensation policies into practice.

Third, the responsibility for compensating the marine ecosystem is not explicitly defined. In the process of promoting ecological compensation in our Marine planning system, the topic of defining ecological compensation's responsibility remains significant. Presently, there are no distinct provisions regarding the subject, scope, and standard of ecological compensation responsibility, making it challenging to define the subject and scope of compensation in practice. This may result in compensation resources not being invested accurately in the actual requirements of the field, affecting the ecological compensation's implementation effect.

3.6 Insufficiency of regulation on the marine ecological compensation

Article 5 of *China's Marine Environmental Protection Law* stipulates that the competent department of environmental protection under The State Council shall be responsible for unified regulation and management of the environmental protection work of the entire country and shall implement guidance, coordination, and regulation of the marine environmental protection work of the entire country. Regulation and management of the marine environment shall be the responsibility of the appropriate marine administration department. According to *the 2018 Plan for Deepening the Reform of Party and State Institutions*, the former State Oceanic Administration's marine environmental protection functions were transferred to the Ministry of Ecology and Environment, and its marine resource management functions were transferred to the Ministry of Natural Resources. In accordance with *the Decision of the Standing Committee of the National People's Congress on the Exercise of Maritime Rights Protection and Law Enforcement Powers by the China Sea Police Station*, the police station was transferred to the Chinese People's Armed Police Force to carry out law enforcement for marine ecological and environmental protection. At the local level, the people's governments of provinces, autonomous regions, and municipalities directly under the Central Government shall determine the responsibilities of departments exercising the power of marine environmental regulation in accordance with *the Marine Environmental Protection Law* and relevant State Council regulations. In practice, provincial and local administrative bodies for ecological environmental protection have undertaken responsibility for marine environmental regulation. The administrative function and regulatory structure of marine ecological compensation have undergone significant transformations. However, after the implementation of institutional reform, it has become problematic for the various administrative authorities to enforce their joint regulation in the field of Marine ecological compensation.

First, the administrative departments concerned in marine ecological compensation must have their powers and responsibilities separated and implemented. On March 17, 2018, the first session of the thirteenth National People's Congress deliberated and approved The State Council's Institutional Reform Plan. The new ministries of Natural Resources and Ecology and Environment have been established, and the governing body for Marine ecological compensation has been modified accordingly. On the one hand, it is essential to define the powers and responsibilities of the newly established supervisory departments. The Ministry of Natural Resources is responsible for 'ecological protection and restoration' in environmental protection, which emphasizes the protection, restoration, and comprehensive management of the ecosystem in the development and utilization of natural resources. The Ministry of Ecology and Environment is responsible for 'strengthening environmental pollution control' by emphasizing the regulation, law enforcement, and control of

environmental pollution, reflecting the government's responsibilities and obligations in environmental pollution control (Zhao, 2021). There are management conflicts between the two, and they must establish appropriate boundaries. On the other hand, the division of powers and responsibilities must be carried out with precision. The division of the Ministry of Natural Resources and the Ministry of Ecology and Environment, in terms of organizational structure, separated the decision-maker from the executor and the executor from the superintendent. The primary responsibilities of marine ecological compensation regulation have been incorporated into the Ministry of Natural Resources and the Ministry of Ecological Environment, and the concept of regulation has shifted from departmental decentralized regulation to systematic comprehensive management. In this context, political interference in the management of the 2011 ConocoPhillips oil spill accident in the Bohai Sea and the 2018 Sanchi accident will be reduced (Wang and Zou, 2021; Jiang and Faure, 2022). However, marine pollution incidents are frequently unanticipated and frequently involve resource development, environmental protection, foreign law enforcement, and other issues. It challenges the definitions of authority and responsibility within the Ministry of Natural Resources, Ministry of Ecology and Environment, Ministry of Emergency Management, and the respective local government departments.

Second, it is imperative to strengthen regulation at the source in the field of marine ecological compensation. Marine pollution caused by the exploitation of marine natural resources, such as offshore oil and gas resources, is fluid, trans-regional, and systematic, and the ecological harm is harder to control or even irreversible (Lu and Jiang, 2019). In order to prevent ecological damage from the exploitation of Marine natural resources at their source, it is necessary to adhere to stricter regulatory standards, with prevention and protection as the primary goals. Currently, Chapter VI and Chapter VIII of the *Marine Environmental Protection Law of the People's Republic of China* govern the regulation of offshore oil and gas extraction and oil spill damage caused by ships. However, the latter is predominantly addressed after the fact, and preventative and prospective regulation should be strengthened. The ocean is fluid and interconnected, and oil pollution will travel to other sea areas along with monsoon currents, negatively impacting a wide variety of marine animals and plants as well as the marine ecosystem as a whole, which is difficult to control. Therefore, strengthening regulation at the source is the fundamental solution.

4 Suggestions on improving China's legislative system of marine ecological compensation

A legal system that is scientific and systematic can increase the effectiveness and efficiency of law enforcement. To construct the marine ecological compensation mechanism, we must establish a comprehensive, systematic, methodical, standardized, and

coordinated legal framework. In order for marine ecological compensation to provide long-term benefits for society, the environment, and the economy, legislators and policymakers should revise prior legislative notions and analyse the fundamental elements of legislation in light of practice.

4.1 Priority should be given to developing a multi-level legal system for compensating marine ecological damage

The aim of ecological compensation is to take physical management measures that benefit the impaired local ecosystems so that no net ecological loss happens once a project is set up. For achieving this, ecological compensation measures are commonly implemented on a regulatory basis, especially based on laws and policies (Haraldsson et al., 2016). A strong and comprehensive legal basis is a key factor for a successful adoption of ecological compensation (Blicharska et al., 2021). Restrictive regulatory systems have been identified as an important factor that limits possibilities of ecological compensation for infrastructure projects also in other studies from France and Sweden (Persson et al., 2015; Guillet and Semal, 2018). Legislation at all levels, including laws, regulations, rules, and local normative documents, must collaborate to enable the successful implementation of China's marine ecological compensation system. First and foremost, China's marine ecological compensation legislation should select the legislative mode of marine ecological compensation that is appropriate for China's national circumstances in light of the complexity of the marine ecosystem and its emphasis on the service function of the entire ecosystem. Using the legislative model's overarching concept as a guide, we should then develop laws and regulations that define the legal status, legal basis, and connotation of legal marine ecological compensation at the legal level. For improving China's legislative system of marine ecological compensation, it is necessary to include systematic regulations and strong constraints regarding principles, scope, standards, techniques, regulation, and evaluation. Considering the high cost of time associated with the promulgation of the Law on Ecological compensation, it is recommended that the revision of the *Environmental Protection Law of the People's Republic of China* and the *Marine Environmental Protection Law of the People's Republic of China* be used as an opportunity to incorporate the concept and measures of 'overall planning of land and sea' into the legal and policy framework of marine ecological compensation in China.

First, ecological compensation provision should be included in the Constitution. The Constitution's ecological protection provisions serve as fundamental law and the foundation for ecological compensation legislation. According to the current Constitution, the state owns natural resources, but there is no clear ownership of ecological resources. As a vital natural resource, China's Constitution should clearly define who owns ecological resource property rights, as well as dominance, use,

and income derived from them. Based on this, governments at all levels are expressly authorized to exercise the derived rights of control, use, and income in order to create a mechanism for equal rights and responsibilities at all levels.

Second, to broaden the current environmental protection law's specific provisions regarding marine ecological compensation. *The Environmental Protection Law of the People's Republic of China* is China's fundamental environmental protection law. Its objectives are to protect and improve the environment, to prevent and control pollution and other public hazards, to protect public health, to build an ecological civilization, and to encourage long-term economic and social development. The current environmental protection Law, on the other hand, makes explicit provisions for the two primary components of the ecological protection system and the prevention of environmental pollution. It focuses primarily on the overall prevention and control of environmental pollution, ignoring ecological compensation almost entirely (Qu et al., 2016). *The Environmental Protection Law of the People's Republic of China* should be amended to clarify its legislative purpose, prioritize improving the ecosystem's service function and ecological value, and define the meaning and scope of ecological compensation specifically. Only in this way can we awaken and strengthen the ecological protection consciousness of all stakeholders. *The Marine Environmental Protection Law of the People's Republic of China* has been amended to maintain, improve, and enhance the service function of marine ecosystems in order to realize the intergenerational compensation of marine ecology. Even though administrative liability is harsh, it is insufficient to deter those who harm marine ecology. After-the-fact relief is the nature of civil liability for compensation. In order to effectively prevent the occurrence of ecological damage, it is therefore recommended that the current *Marine Environmental Protection Law of the People's Republic of China* be amended to make it clear that the exploiters and users of marine ecological resources must bear the responsibility of managing the environment and restoring ecology, and correspondingly to improve the criminal responsibility of marine ecological damage in *the Criminal Law of the People's Republic of China*.

Third, the Regulation of Ecological Compensation should be drafted and promulgated to provide local policymakers with systematic and practical guidance. Despite the fact that coastal governments at all levels have carried out compensation trial projects, there are many issues with the marine ecological compensation process. The meaning, subject, aim, and extent of 'marine ecological compensation' are all very different from one another due to the lack of standardized national standards and the lack of coordination between different forms of compensation. In addition, there is not enough financial resources available from the single, iffy compensation source. The State Council is urged to enact and promulgate the Regulation of Ecological Compensation in accordance with Article 31 of *the Environmental Protection Law of the People's Republic of China* (2014 Revision) and Article 12 of *the Marine Environment Protection Law of the People's Republic of China* as soon as possible in order to clarify the objects of the legal relationship of the rights and obligations associated with ecological

compensation. This will provide a more solid legal basis for governments at all levels to collaborate on ecological compensation policy and to standardize the practice of ecological compensation. The purpose and underlying philosophy of ecological compensation will be laid out in detail, as will the financing sources, how they will be managed and put to use, and the strategies and procedures that will be used to put it into action. Finally, in order to ensure that marine ecological compensation is carried out in accordance with legislation, coastal provincial governments should create 'implementation measures of marine ecological compensation mechanism' and provide an explanation of the nature, goal, and scope of marine ecological compensation.

Fourth, since the particular marine ecology may not be covered by the general rules for ecological compensation, it is necessary to develop more specific, operational, and targeted legislative norms. As stated previously, *the Forest Law of the People's Republic of China* and *the Land Administration Law of the People's Republic of China* already apply ecological compensation criteria to the mangrove ecosystem; however, mangroves are also an essential component of the marine ecological environment. The Forest Law's provisions on ecological compensation cannot resolve the ecological role of coastal mangroves or the ecological compensation of marine resources. Similarly, the problems of ecological compensation such as islands and surrounding territorial waters and coral reefs cannot be solved adequately by *the Land Administration Law of the People's Republic of China*. As a result, a distinct subordinate strategy must be developed in order to resolve the compensation issues that arise in particular marine ecosystems. Special regulations, rules, and other subordinate laws are also required to support the ecological compensation system of some unique marine ecosystems. By perfecting the contents of marine ecological compensation in 'regulations on the Management of the Proliferation and release of Aquatic organisms' and 'measures for the Management of Marine Nature reserves,' for instance, the special compensation for the marine ecological environment can be controlled.

All localities should promptly implement local legislation to cooperate with national legislation on marine ecological compensation based on the revision of existing laws and regulations. While coastal cities and provinces have made some progress investigating local legislation for marine ecological compensation, the effectiveness of the laws that have been passed is low and their application is limited at the moment. The scope of marine ecological compensation should also include ecological compensation in nature reserves and compensation for contributors and victims of marine ecological protection. In addition, the scope of marine ecological compensation should include marine ecological damage caused by marine pollution accidents, illegal exploitation and utilization of marine resources, and changes in the marine ecological environment caused by marine engineering, coastal engineering construction, and marine dumping. The scope of Shandong Province's interim measures for the Administration of Compensation for Marine Ecological Damage and Compensation for Ecological Losses must be further expanded. Other provinces and cities should also formulate feasible

local legislation on marine ecological compensation based on local reality under the guidance of the superior law.

4.2 Establishing the legal method of achieving 'land-sea overall planning' within China's ecological compensation system

The true meaning of 'land-sea overall planning' is to coordinate the interests of diverse elements of land and sea, economic development and environmental protection, different regions and various administrative departments. Although it is still based on the 'separation of land and sea' legal system, enhancing the current legal system can assist coordinate the conflict of interest between the protection of the ecological environment and the development and utilization of land and sea resources. Thus, it is difficult to fully grasp 'land and sea coordination.' To build a dual ecological compensation mechanism between land and sea, it is required to integrate the laws and policies governing marine and terrestrial ecological compensation in a rational, efficient and effective manner. In addition, the organic connection and coordination of marine and land ecological compensation laws can serve as a reference for suitable marine ecological protection policies within the context of land and sea planning as a whole. From a macro perspective, it assists China in developing coordinated land and sea ecological environment governance. Thus, China's policy and legislative framework for marine ecological compensation must account for the coordinated development of land and sea areas and construct a coordinated for ecological compensation process.

First, the principle of 'systematic protection' should be added to the *Environmental Protection Law of the People's Republic of China*. 'land-sea overall planning' is a legal principle that the government should uphold when managing land and sea. It not only pays attention to the protection of the marine ecological environment but also coordinates the economic and social development of land and sea with the protection of the ecological environment from a broader perspective. Therefore, the 'land-sea overall planning' should be reflected in the legal principles of the *Environment Protection Law of the People's Republic of China*. It should be noted that reflecting the concept of 'land-sea overall planning' in the *Environmental Protection Law of the People's Republic of China* does not mean that this concept is directly stipulated in the Law. 'Land-sea overall planning' is essentially a concept of protecting the ecological environment of land and sea in a systematic and holistic way. Bringing 'systematic protection' into Article 5 of the *Environmental Protection Law of the People's Republic of China* as a basic principle can expand the scope of the application of this principle.

Second, streamlining the management logic of land-sea ecological compensation and establishing a cooperative system for land-sea ecological compensation based on coastal zones in the *Marine Environment Protection Law of the People's Republic of China*. Long-term land and sea division has resulted in disparities between

land and marine biological compensation mechanisms in terms of compensation subject, standard, and scope. Before establishing the ecological compensation coordination mechanism under the new space view of land and sea coordination, it is necessary to first align the two original mechanisms and then effectively connect up and integrate the land and sea ecological compensation mechanism. The coastal zone is a land-sea interaction zone having both land and sea characteristics, and its environmental elements, including plants and animals, are influenced by both the land and water environment. On the one hand, focusing on the creation of the land-sea ecological compensation synergistic mechanism in the coastal zone is conducive to swiftly identifying an efficient method for streamlining the land-sea ecological compensation management mechanism. In addition, it provides a reference and demonstration for the creation of a joint land-sea ecological compensation mechanism in a broader spatial context. Therefore, we suggest that article 9 of the *Maritime Environmental Protection Law of the People's Republic of China* shall be amended to include the following 2 aspects: 1) To achieve this objective, the first step is to establish an ecological compensation system for the ocean and land at the national level, conduct a comprehensive assessment of ecological compensation for coastal zones in the 'basin-sea area,' and establish a land-sea collaborative mechanism for ecological compensation at the confluence of rivers and seas. Second, based on the principle of protecting the integrity of the coastal zone ecosystem, we should eliminate traditional administrative jurisdictional boundaries, encourage domestic coastal provinces to engage in consultation and cooperation on coastal zone ecological compensation, and reach consensus on the mechanisms, standards, and scope of land and sea ecological compensation.

Third, exploring a cross-regional linking mechanism for ecological compensation in the *Marine Environment Protection Law of the People's Republic of China*. Land and water are integrated. Legislators must systematically consider the three-stage trans-regional ecological compensation linkage mechanism of 'basin - basin,' 'basin - sea,' and 'sea - sea' from two dimensions of space and technology in order to realize trans-regional land-sea linkage of ecological compensation. In terms of space, rivers flow into the sea after diverging and pooling in numerous administrative regions, and under the impact of ocean currents, marine pollution will spread across the sea. Currently, land and marine environmental monitoring technologies and standards cannot be properly integrated, and it is difficult to provide timely and effective help for the implementation of ecological compensation using ecological monitoring data. In the *Marine Environmental Protection Law of the People's Republic of China*, it is vital to build a collaborative system for ecological compensation between rivers and oceans, between land and sea, and between cross-regional units for significant locations such as estuaries and bays. Particularly, it is necessary to increase the development of the land-sea ecological compensation coordination mechanism in critical sea areas, bays, and estuaries where environmental ecological issues are prevalent. Current local ecological compensation mechanisms for contaminants entering the sea and Marine water environmental quality, along with regional ecological restoration compensation schemes, have

enhanced and developed ecosystem-based ecological compensation approaches. Article 9 of the *Marine Environmental Protection Law of the People's Republic of China* should be amended as follows: We should integrate and connect trans-regional environmental protection mechanisms from river basins to sea areas, coastlines (belts), offshore waters and bays, coordinate organizational and technical support forces from land, sea, and trans-administrative regions, and establish a coordinated development pattern of regional linkages and coherent mechanisms.

Forth, it is required to strengthen the planning system and incorporate the legal objectives of marine ecological compensation into marine environmental protection decisions made by various areas and agencies. We should encourage dialogue and collaboration among China's coastal provinces and departments in the field of marine ecological compensation, based on the idea of maintaining the integrity of the coastal ecosystem. The mechanism, standard, and extent of land and sea ecological compensation have been agreed upon. In order to meet the requirements of coordinating land-sea relations in significant decisions regarding ecological compensation, it is necessary to continuously improve the processes of land and sea space planning, sea area planning, economic development planning, and various special plans, such as environmental assessment, expert consultation, public participation, and so on.

4.3 Establishing a compensation mechanism that combines a variety of compensation methods with a scientific and reasonable standard of marine ecological compensation

When it comes to strengthening the ways of marine ecological compensation, concerns such as the government-led single compensation mechanism's lack of compensation funds create a hurdle. How to properly coordinate the roles of society, the market, and the government in the marine ecological compensation system in order to establish a positive interaction is an urgent concern. The following are the suggestions: First, study the establishment of horizontal compensation systems between administrative regions, departments, and industries, and land and sea. We can, for instance, acquire insight into the horizontal compensation mechanism that occurs between the upstream and downstream regions of the basin, evaluate the water quality of the inter-provincial sea area as ecosystem services, and gradually improve detection indicators and calculation procedures. Second, encourage the participation of social capital's participation in the marine ecological compensation mechanism by increasing social capital in marine ecological compensation. For example, credits, compensation pools and habitat banking have been used in some states in Australia, in Germany, UK and South Africa (Koh et al., 2017). Under the background of achieving the goal of 'carbon peak, carbon neutral' in China, we hereby suggest China government take measures as follows: creating a national marine carbon sequestration trading

market, increasing the level of market competition for seawater emission rights and sea area use rights, and issuing a marine ecological compensation lottery.

The establishment of compensation standards for all kinds of marine resources, marine habitats, and contributors to the protection of the marine environment should be included in scientific marine ecological compensation standards (Chen et al., 2021). It is difficult to operate and implement marine ecological compensation at the moment because there are no standards in place. The input of the marine ecological protector, the profit of the beneficiary, the restoration cost of ecological damage, the value of ecosystem service function, and so on should all be taken into account in the definition of the compensation standard. The sum of the input of the marine ecological protector, the opportunity cost of marine ecological destruction, and the cost of restoration ought to serve as the marine ecological compensation standard's lower limit, while 'the value of marine ecosystem service function' ought to serve as its upper limit. The State Council is tasked with formulating the measures for the Evaluation of Marine Ecological Value. These measures should specify the qualifications of evaluators, the regulation of assessment institutions and personnel, the conditions and procedures for the establishment of professional assessment institutions for quantifying the functional value of marine ecosystem services, and the associated legal responsibilities.

4.4 Incorporate marine ecological compensation into marine planning

In light of the numerous issues between the Marine planning system and the Marine ecological compensation system, we can propose the following countermeasures and suggestions:

First, enhance the framework of laws and regulations governing marine ecological compensation. To address the issue of insufficient coordination between the marine planning system and the laws and regulations governing ecological compensation, we must improve the extant legal and regulatory framework. This includes revising and improving existing laws and regulations such as the *Marine Environmental Protection Law of the People's Republic of China* and the *Law of the People's Republic of China on the Administration of Sea Areas*, clarifying provisions about responsibility, scope, and standard of ecological compensation, and ensuring that ecological compensation policies are effectively reflected in the marine planning system. (a) Amend the *Law on the Protection of the Marine Environment* and the *Law of the People's Republic of China on the Administration of Sea Areas* to require the inclusion of content related to ecological compensation in coastal zone planning, including the protection of ecologically sensitive areas, the restoration of ecosystems, and the prevention of illegal construction. This content must be consistent with the ecological compensation requirements of extant laws and regulations to establish a strong connection between law and planning. (b) The *Law of the People's Republic of China on the Administration of Sea Areas* explicitly stipulates that the demand for ecological compensation must be considered when planning the use of

sea areas. For example, the impact of marine development initiatives on the marine ecological environment should be evaluated in accordance with the ecological compensation standards established by laws and regulations, and appropriate compensation measures should be formulated. This will help ensure that sea area planning is consistent with ecological compensation laws. (c) *The Marine Environmental Protection Law* mandates that the relevant requirements of ecological compensation be considered in the regionalization of Marine functions. Particularly, stricter ecological compensation standards should be established for ecologically sensitive areas and key ecological function areas. During the implementation of functional zoning, it should also be made plain that projects that do not meet the requirements of ecological compensation will be restricted or prohibited. (d) *The Marine Environmental Protection Law* requires that marine environmental protection plans include specific measures and implementation plans for ecological compensation, such as implementation subjects, funding sources, and technical requirements for ecological restoration projects. In the meantime, a monitoring and evaluation system for ecological compensation should be established to assure the connection between planning and laws and regulations governing ecological compensation (Wan et al., 2021). (e) The guiding function of ecological compensation in national, regional, and special Marine planning should be strengthened. This includes the formulation of clear regulations on the assessment of ecological damage, the confirmation of responsibility subjects, the formulation of compensation plans, the payment of compensation, and the implementation of ecological restoration projects, as well as the formulation of detailed operational guidelines for the implementation of ecological compensation. In addition, consideration should be given to the operational effect of the ecological compensation policy, as well as its timely adjustment and development, so as to enhance the guidance effect of the Marine planning system on the implementation of ecological compensation.

Second, enhance the standing and function of ecological compensation within the Marine Planning System. To ensure that Marine ecological compensation plays a larger role in different types of Marine planning and to protect the Marine ecological environment, we must adopt a series of specific measures for different types of Marine planning to enhance the standing and function of ecological compensation. The following are specific recommendations for Marine planning: Planning for the national marine environment. In the national Marine planning, the significance of ecological compensation in the overall planning framework should be explicitly articulated. We will establish national goals for the ecological preservation of the marine environment and formulate compensatory policies. Concurrently, cross-regional cooperation and coordination should be bolstered in order to effectively implement ecological compensation on a national scale. Regional marine planning should develop ecological compensation schemes based on the characteristics of various sea areas and the ecological protection requirements of each (Liu, 2020). Planning must explicitly define the regional characteristics, implementation methods, and standards of ecological compensation to ensure that ecological compensation is

effectively implemented within the region. Specialized Marine planning. For specific sectors (such as offshore wind power, Marine fisheries, coastal zone protection, etc.), corresponding ecological compensation requirements must be formulated in a special Marine planning document. Special ecological compensation schemes are designed based on the characteristics of different fields to guarantee the effective implementation of ecological compensation policies in all fields.

Third, define clearly who is responsible for ecological compensation. In terms of the Marine planning system and Marine ecological compensation, the responsibility for ecological compensation must be clearly defined. This will help marine planners implement ecological compensation measures more effectively and safeguard the ecological environment. Specific measures to elucidate the definition of ecological compensation responsibility include the following: (a) Define the precise subject matter and scope of responsibility. In national, regional, and special Marine planning, the primary entities accountable for ecological compensation, such as the government, businesses, and individuals, should be clarified. According to their own duties, rights, and interests, each responsible subject should shoulder the corresponding ecological compensation obligation. In addition, the scope of ecological compensation should be clarified, including direct damage, indirect damage, and potential damage, in order to compensate for all types of damage in a comprehensive manner. (b) Clarify the implementation of ecological compensation. In national, regional, and special Marine plans, the primary entities responsible for implementing ecological compensation must be outlined. Individuals should assume the responsibility of compensation for ecological damage caused by their own actions. (c) Clarify the ecological compensation regulatory mechanism. In national, regional, and specialized Marine plans, the regulatory mechanisms for ecological compensation will be clarified. We will establish a robust mechanism for interdepartmental coordination oversight and strengthen the oversight and implementation of ecological compensation policies. In the meantime, the reporting and reward system for ecological compensation should be enhanced, and social oversight should be encouraged to ensure that the responsibility for ecological compensation is carried out effectively. (d) Periodic evaluation of ecological compensation's efficacy. In national, regional, and special marine planning, the efficacy of ecological compensation work must be evaluated on a regular basis (Fu, 2013), and the evaluation results must be made public. Through the evaluation work, the implementation effect of the ecological compensation policy is supervised and inspected, providing the foundation for the policy's further improvement. A precise definition of ecological compensation responsibility in the Marine planning system facilitates the effective implementation of ecological compensation work as a result of the aforementioned measures. This will assist in promoting the further integration of our marine planning system and marine ecological compensation, the protection of the marine ecological environment, and the promotion of the ocean's sustainable development.

4.5 Enhance the separation of powers and implementation of the marine ecological compensation regulation

First, delimit authority explicitly. First, expedite the revision of laws governing compensation for marine ecological damage and environmental regulation. The State Oceanic Administration, as the original main department of Marine environmental regulation, was eliminated, and the pollution environmental regulation agency underwent significant changes, with the Ministry of Ecology and Environment assuming responsibility for Marine environmental protection. To achieve legal regulation, *the Marine Environmental Protection Law of the People's Republic of China* and other pertinent laws should clarify the status, powers, and responsibilities of the departments involved in Marine environmental regulation, such as the Ministry of Natural Resources, the Ministry of Ecological Environment, and the Ministry of Transport, in light of institutional reform. Second, encourage the implementation of the reform of central and local Marine environmental regulation and associated institutions. On the one hand, it is imperative to clarify specific issues such as the attribution of the Oceanic Administration's extant maritime law enforcement force and whether the Ministry of Environmental Protection will continue its vertical reforms. To eradicate the 'empty window' of reform, local governments should expedite the approval and implementation of the 'Sanding scheme' plan in accordance with local conditions (Jiang and Faure, 2022).

Second, we must coordinate the relationship between regulators effectively. First, we should develop a comprehensive plan for the regulation of marine ecological compensation, as well as manage the relationship between marine environmental governance and regulation, as well as professional regulation and comprehensive regulation of marine environmental pollution. Second, in the division of functions and powers between the central and local governments, the responsibilities and regulatory authority for marine environmental protection should be strengthened for coastal local governments (Jiang et al., 2019). The central government should make environmental regulation the primary responsibility of local governments, provide them with management authority and financial support, and encourage their participation in marine environmental regulation. Lastly, we should make good use of the system of central environmental regulation and the administrative means of environmental protection interviews, combine with the reform of the vertical management system of monitoring, inspection, and law enforcement of environmental protection agencies at and below the provincial level, establish and enhance the Marine environmental regulation system at the local level, and promote local governments and the relevant departments.

Thirdly, the source regulation of the development of marine natural resources should be strengthened. On the one hand, strict market access for companies developing marine natural resources. By strengthening the administrative licensing system for the exploitation of marine natural resources, the environmental impact assessment and the 'three simultaneous' system, as well as the qualification examination and approval and archival

management system for the exploitation of marine natural resources, we will strictly implement the market access barrier, promptly eliminate enterprises that do not meet the environmental standards or do not conform to the quality of joint ventures, and ensure that the quality of joint ventures is maintained (Zhang, 2018). On the other hand, the value of compensation and compensation expenses for potential ecological damage are estimated in advance. At this time, the ecological compensation value assessment of the development of marine natural resources must reinforce the prevention and source regulation of the ecological damage risk posed by the development of marine resources.

5 Conclusion

The purpose of this paper was to investigate the problems in China's legal system for marine ecological compensation and propose solutions. China's marine ecological compensation legislative system suffers from institutional supply shortages, lack of coordination and dispersion, lack of legislative concept of 'land-sea overall planning', lack of clear standards for marine ecological compensation, limited scope of China's marine ecological compensation, the relationship between marine planning and the marine ecological compensation system is not straightforward, insufficiency of compensation regulations for the marine ecosystem.

To address these issues, we proposed a number of enhancements. First, we proposed enhancing institutional supply and coordination mechanisms to facilitate departmental cooperation. Second, we suggested the establishment of a legal method for attaining 'land-sea overall planning' within China's ecological compensation system. Third, we suggested that when determining marine ecological compensation standards and establishing corresponding evaluation systems, various types of damage be considered. Forth, we suggested incorporating marine ecological compensation into marine planning as a final step. Finally, we suggest enhancing the separation of powers and implementation of the marine ecological compensation regulation.

This paper has significant implications for the improvement of China's marine ecological compensation legal system. Through our analysis and discussion, we can gain a better understanding of the problems in China's legal system for marine ecological compensation and propose commensurate improvement measures. These measures have the potential to advance the development of China's legal system for marine ecological compensation, safeguard the marine ecosystem environment, and promote sustainable development.

Nevertheless, this paper has some limitations. First, our research was limited to a literature review and analysis, without considering any other variables that may affect the marine ecosystem environment. Second, we did not execute a comprehensive analysis of the status of marine ecological compensation under China's legal system. To further enhance China's legal system for marine ecological compensation, future research should focus more on empirical data and other relevant factors. In addition, additional research is required to evaluate its efficacy and identify any extant problems.

This paper proposed several enhancements to China's legal system for marine ecological compensation to address existing issues. These measures have the potential to advance the development of China's legal system for marine ecological compensation, safeguard the marine ecosystem environment, and promote sustainable development. We will continue to investigate these issues and pursue improved solutions in future studies."

Data availability statement

The original contributions presented in the study are included in the article/supplementary material. Further inquiries can be directed to the corresponding author.

Author contributions

The author confirms being the sole contributor of this work and has approved it for publication.

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Conflict of interest

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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