

Article

Research on Legal Risk Identification, Causes and Remedies for Prevention and Control in China's Aquaculture Industry

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Abstract: Aquatic products fulfill the protein needs of people and play an important role in food safety. And aquaculture is prized for its high productivity, sustainability and environmental friendliness. Considering the importance of aquaculture, the legal risks exposed during the aquaculture process deserve attention in order to prevent them from hindering the development of the aquaculture industry. Through online research, literature analysis and practical communication, it is shown that the current legal risks with commonalities include land use violations, lack of legal documents, failure to meet tailing water criteria, unquarantined fry and misuse of prohibited agricultural pharmaceuticals through online research, literature analysis and practical communication. By analyzing the reasons for the formation of legal risks and combining the experiences in sustainable development of three major aquaculture countries, which are Korea, Norway and Chile, this paper provides targeted preventive remedies and suggestions for aquaculture operators, administrative parties, legislators and other parties on legal risks. It includes promoting the improvement of the rule of law in multiple aspects, clarifying the positioning of the aquatic breeding certificates, improving and propagating the standards for wastewater discharge, increasing the self-sufficiency rate of aquatic fry and fingerlings, as well as making use of the synergy of soft law and hard law.

Keywords: aquaculture; legal risks; land use regulation; the right to use sea areas; wastewater discharge

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Key Contribution: First, this paper emphasizes the impact of the law on the aquaculture economy. Focusing on legal risks that are of low concern and providing remedies for prevention and control can help prevent aquaculture operators from undermining their production and development dynamics due to the loss of financial interests, which would consequently affect the market and the industry. Second, based on the analysis of common legal risks in practice, this paper responds to the needs of foreign scholars who want to learn about the current situation in China and provides warnings and references for other countries that are developing aquaculture industries. Third, this paper focuses on the transition between former and new legal provisions and the separation between law and practice and uncovers a phenomenon that has received limited attention but is in urgent need of remedy. It includes the legal connection in terms of property rights, the update of regulatory provisions for the discharge of wastewater and the illegal use of non-pharmaceuticals. It also provides doctrinal explanations of disputes over aquatic breeding certificates and offers complementary recommendations for the issue of quarantine of aquatic fry or fingerlings beyond the general perspective. This helps highlight the important role of the law in the green development of the aquaculture industry.

1. Introduction

Fish provide 17% of animal protein and 7% of total protein consumed globally. Moreover, based on an analysis of potential mariculture production, it is projected that oceans

can provide almost two-thirds of the total protein demand of the world population [1]. It is predicted that production from the oceans could provide nearly two-thirds of the total protein needs of the world's population, based on an analysis of potential mariculture production. The fisheries and aquaculture sectors have been increasingly recognized for their essential contributions to global food security and nutrition in the twenty-first century. However, the FAO's long-term monitoring of assessed marine fishery stocks confirms that marine fishery resources have continued to decline [2]. Consequently, aquaculture, both mariculture and freshwater aquaculture, has been suggested as a possible alternative for fisheries towards mitigating food security problems and preventing the loss of wild fish supplies [3]. According to the data provided by the FAO for the period 2017–2020, it is known that aquaculture accounts for about half of the world's fish supply and is expected to grow further, which makes it an important part of the supply of high-quality protein for the global population [4]. Moreover, aquatic foods have a lower environmental footprint than other animal-sourced proteins [5]. Joseph Poore et al. suggest that farmed fish have been estimated to have 87% smaller carbon footprints than beef, use 49% less land than poultry, and require 84% less stress-weighted fresh water than pigs [6]. In conclusion, aquaculture is prized for its high productivity, sustainability and environmental friendliness.

However, there are legal risks associated with the production stage of aquaculture, which directly affect the production and development viability of aquaculture operators and consequently affect the expansion of the industry. At the production stage, aquaculture operators are inclined to focus on technical issues directly related to actual output and trends towards market prices, while paying insufficient attention to legal issues. Currently, increasing legal provisions for administrative orders have diluted their close relationship with morality. It is difficult for aquaculture operators to fulfil legal obligations beyond their perception based on general public morality in the absence of an objective and comprehensive knowledge of the law. And that is where the legal risk exists. Whereas the perception of illegality is the basis for the establishment of a crime in the liability doctrine, the establishment of an administrative penalty does not require illegality or subjective intent as a necessary condition. In other words, aquaculture operators are responsible for legal risks that they cannot identify.

The resulting significant losses, including the clearance of fishponds and high fines, have affected operators' ability to continue their production and development, with further impacts on the market and industry. Legal risks, on the other hand, arise internally and are, therefore, controllable. Therefore, there is an important practical significance on how to identify, analyze and prevent the legal risks in the aquaculture field for the economic interests of the operators, the stability of the market, and the expansion of the industry. This article's theoretical significance also lies in the fact that it takes into account the inability of many aquaculture and food policy scholars to access literature in the Chinese language [7]. By researching the basis of the current status of China, this paper is able to increase scholars' understanding of the aquaculture aspect of Chinese aquacultural practices. And it also takes into account the current state of affairs in China, where 57% of the total aquaculture volume and 59% of the global value of its output is produced, and where changes in its policies can have a significant impact on the state of aquaculture in the world [2]. This paper analyzes the legal risks prevalent throughout China to be able to provide a warning to other countries interested in developing aquaculture and may even be able to provide some new legal insights for other countries in terms of preventive and control measures.

Based on the literature, it is clear that the above impacts of law on the aquaculture economy have not received sufficient attention in the academic field. As a whole, up to September 2023, 8185 articles can be searched by using Web of Science as the search platform and "aquaculture" and "risk" as the keywords. Its content focuses on natural disciplines, such as environmental sciences, fisheries, marine freshwater biology, and so on, with less literature on the social sciences. In particular, there are only five articles under the law classification. In the following, the research will adopt the methods of literature analysis and comparative study on the basis of analyzing the relevant results of domestic

and foreign scholars. On a specific level, respectively, legal risks in aquaculture mainly exist in property rights, licensing, discharge, fry or fingerlings and pharmaceuticals.

First, as a matter of consensus, stable property rights are the legal basis for developing long-term aquaculture and achieving economic growth [8–12]. And the reason for the instability of property rights is that the value of aquaculture is in conflict with other values. As noted by the FAO in its review of aquaculture development in the Near East and North Africa, conflicts of interest can occur among different authorities involved in governance and regulation, which may lead to poor management, strategies and policies [13]. In Norway, this conflict also exists between coastal zones and aquaculture management [14,15]. In this regard, policy integration can reduce the incidence of conflict [16]. And in the face of national issues in food security, the value of aquaculture (mainly freshwater aquaculture on land) takes a back seat and cannot be safeguarded. For example, Myanmar, which now ranks among the top 10 global aquaculture producers, has strictly enforced laws against converting rice fields to fishponds in smallholder areas, despite potential employment and income gains [17–19].

With regard to the risk of unsecured property rights resulting from low-value parity in aquaculture, the existing literature has focused on providing advice on site selection to avoid negative policy-induced impacts [20–24]. Little attention has been paid to the interface between the former and new laws or policies. Therefore, this paper will provide additional research in a targeted manner.

Second, access permits are the legal threshold for engaging in aquaculture. Due to the overlap in geographic space, the right to use waters and mudflats for aquaculture (including mariculture and freshwater aquaculture) is manifested as the simultaneous utilization of the right to use the sea areas and the right to practice aquaculture in the case of mariculture and as the simultaneous utilization of the right to use the lands contracted for management and the right to practice aquaculture in the case of freshwater aquaculture. Acquiring the right to use non-private sea areas or lands becomes, in essence, a license for access to aquaculture. The particularity of mariculture is that the operator is required by law to obtain both a certificate for the right to use the sea area and a certificate for aquaculture.

Some Chinese scholars have raised objections to such provisions. Jianyuan believes that different rights existing in the same sea area are prone to conflict and that the system of rights to use the sea areas should be abolished [25]. Hui believes that “double certificates” are duplicated contrary to the principle of efficiency, and it should be legal aquaculture even if the operator only has the certificate of the right to use the sea area [26]. Wanzhong believes that the conflict between the two rights raises another conflict of interest between the subject of the right to use the sea area and the subject of the right to participate in aquaculture, which results in a chaotic status quo of the management system of sea use for aquaculture [27].

Some scholars have raised objections. Ying believes that the certificates of the rights to use the sea areas confer the right to use the sea areas on the users, while the aquaculture certificate is a license for the industry, and the two certificates could co-exist at the same time in practice [28]. And in the face of the issues in practice, the abolition of certificates conveying rights to use the sea areas is not an effective way. Lifeng suggested that the current role of aquaculture certificates has not been effectively played, mainly because of the unclear relationship between the nature of aquaculture certificates and other certificates, which needs to be clarified in the legislation and issuance of certificates [29]. Shiling and others proposed that the violations should be distinguished into administrative violations and civil violations, and the right to use the sea areas for aquaculture and the property rights of aquaculture should be distinguished in the trial process and reflected in the judgment results [30].

The relevant literature focuses on the domestic context, as the system of the right to use sea areas is unique to China. However, there is also literature abroad that addresses the problem of the unclear expression of provisions. Engle argues that if regulations are compli-

cated and lack clarity, aquaculture producers must spend more time and financial resources identifying what rules apply and how to comply with them [31]. It was a common view that complex provisions would undermine the effectiveness of implementation [32–35]. In support of this view, this paper focuses on the specific system in China and clarifies the law's dual-certification requirements for aquaculture, which will help operators to carry out their activities and help scholars from other countries conduct comparative research in the case of China.

Third, the strength of the regulation of wastewater is related to the sustainability of the aquaculture industry. The law, as a regulation of behavior, should update the regulatory measures in concert with the development of practice. For example, for the Contaminants of Emerging Concern (CECs), a number of countries have taken proactive measures. The EPA developed a Contaminant Candidate List (CCL) of chemicals that may contaminate public drinking water [36,37]. The European Environment Agency (EEA) assists with relevant assessments to improve the environment in European Union (EU) member states [38]. Chinese scholars also call for a new response based on existing provisions. The internal structure of the mariculture sector in China is changing fast [39], and the laws should be implemented and updated in line with the changes in the structure of mariculture [40]. Lack of effective monitoring and legislation on effluent discharge are the main bottlenecks that are currently limiting appropriate aquaculture site selection and carrying capacity management in China [41].

To update the regulations, Wang suggested that the relevant authorities need to establish standards, including emission limit values (ELVs) and environmental quality standards (EQSs), in the mixing zone for important contaminants present in the effluent, which apply to the water quality at the end of point-source and within the receiving environment, respectively [42]. For monitoring after standards have been established, Ottinger et al. proposes expanding the monitoring area by using remote sensing techniques to acquire and analyze environmental data at various spatial and temporal scales [43]. This paper will also put forward institutional proposals in response to this issue, so as to alleviate legal lags.

Fourth, aquatic fry and fingerlings may carry viruses or pathogens, which may adversely affect production safety, personal health and the environment.

It is important to detect the ability of the host to carry the virus at an early stage so that the continued spread of the virus can be prevented [44–46]. Existing perspectives from abroad focus on strengthening import quarantine. Ortega proposed in his study to develop stricter prevention methods to prevent the introduction of diseases, even while acknowledging the dependence of Mexican rainbow trout aquaculture on imported trout eggs [47]. Based on the importance of aquatic fry and fingerlings, the Animal Health Protection Act (AHPA) in the U.S. gives the United States Department of Agriculture (USDA) a great deal of discretion in dealing with disease [48]. And using its discretionary power provided by the AHPA, the USDA could limit or ban imports, exports and interstate movement; impose importation quarantines; or order the destruction of certain imported aquatic species, their parts, and articles [49]. The environmental threats of non-native aquatic animals motivated the European Commission to pass. Council Regulation No. 708/2007, which requires that approval to introduce non-native species be supported by a risk assessment [50]. However, quarantine cannot offer a high likelihood of disease detection. Whittington et al. even suggest limiting the number of ornamental species and their country of origin [51].

In China, the self-sufficiency of some imported aquatic fry and fingerlings, such as South American white shrimp, is low [52,53]. One of the incentives for operators to avoid quarantine procedures is the mismatch between the quantity of imported aquatic fry and fingerlings brought in and the efficiency of quarantine. Therefore, this paper starts with the origin of the issue and offers suggestions beyond mainstream viewpoints to provide an adjunctive role.

Fifth, aquaculture pharmaceuticals are an unavoidable means of production in the aquaculture process. Although antibiotics are illegal, other uses are common in the aquaculture industry [54]. For example, antibiotics banned for use in livestock feed in the United States are misused as growth promoters and prophylactics to avoid disease in fish mangrove production in Vietnam [55–58]. Albert Tacon suggested that animal feed contamination (including veterinary drug residues) could be passed along the food chain to consumers through contaminated aquaculture products [59]. In response, the *Code of Practice for Fish and Fishery Products* issued by WHO contains provisions such as that products should be registered with the appropriate national authority and that those should only be prescribed or distributed by authorized personnel authorized [60]. However, in China, the illegal use of aquaculture pharmaceuticals can also be seen in their illegal use under the name of non-pharmaceuticals [61]. This results in massive mortality of aquatic creatures [62,63], and even safety hazards [64].

2. Legal Risk Identification in Aquaculture

2.1. Status of Administrative Penalties in Aquaculture

Article 329 of the *Civil Code of the People's Republic of China* provides that mineral exploration rights, mining rights, water intake rights and the right to use water areas or intertidal zones for aquaculture or fishery, which are obtained in accordance with the law, shall be protected by law [65]. However, the civil right to practice aquaculture is also subject to administrative law. If an aquaculture operator violates the relevant legal provisions, it would be liable, even if the violation was not subjectively intentional, but rather due to ignorance of the law. Considering that aquaculture operators may not possess complete legal knowledge and professional capacity, coupled with minimal legal literacy campaigns and policy changes, there is a possibility that aquaculture operators are aware of the legal provisions only after they have been held legally liable. The current situation is analyzed below based on the number of administrative penalties.

As of 8 September 2023, a total of 5017 decisions on administrative penalties were displayed on the PKULaw platform by searching for settings in which the name of the target of the penalty included “aquaculture”. According to the classification of penalty results, there are 2145 cases of fines, confiscation of illegal gains, and confiscation of illegal property, 1608 cases of temporarily detaining the license, lowering the qualification level, and revoking the license; and 522 cases of restricting the development of production and business operation activities, ordering suspension of production and business, ordering closure, and restricting employment. According to categorization by topics, a total of 1781 cases are related to market supervision, 120 cases are related to agriculture, forestry, animal husbandry and fisheries, and 27 cases are related to food products, medicines and medical treatments.

2.2. Legal Risks in Aquaculture

Based on the above search content and combined with communication with practitioners, the following five legal risks can be summarized for aquaculture, including freshwater aquaculture and marine aquaculture.

2.2.1. Legal Risk I: Property Rights Legal Risk

Contrary to fishing, which involves the capture of fish in a public, open location, aquaculture involves the preservation of the production infrastructure and ownership of the products produced. In order for markets to operate effectively and for economies to run efficiently, clear property rights are considered to be essential [66]. The issue of land used for aquaculture is highly influenced by legal policies (the risks associated with land-use regulation are examined here, whereas the functional zoning of the oceans is more stable; therefore, mariculture is not included in this section). In particular, the use of land, including the use of cropland for any purpose other than agriculture, is one of the focuses of government efforts to implement regulations [67]. However, policies are influenced by

the reality of unstable environments and can change. Operators will bear the legal risk of being ordered to demolish the aquaculture facilities for a limited time or being charged with a crime if they fail to become aware of the relevant rules in a timely manner and fail to comply with the use of land.

There are various legal risks regarding the use of land. The first is the legal risk of non-compliance with land use in substance. Here is an illustration of the policy change of using permanent basic farmland for facility agricultural land. *Document No. 4* states that land for aquaculture facilities is allowed to use permanent basic farmland, and the notice is currently effective. On 17 December 2019, the Ministry of Natural Resources and the Ministry of Agriculture and Rural Affairs issued the *Notice on Issues Related to the Management of Land for Facility Agriculture* (Nature Resource Regulation [2019] No. 4). However, *Document No. 166* has made adjustments to the provisions of *Document No. 4*, stating that the new occupation of permanent basic agricultural land for the construction of aquaculture facilities is absolutely forbidden. On 27 November 2021, the Ministry of Natural Resources, the Ministry of Agriculture and Rural Affairs, and the State Forestry and Grassland Administration issued a *Notice on Issues Related to Strict Control of Arable Land Use* (Natural Resources Development [2021] No. 166). Meanwhile, *Document No. 166* mentioned that the provisions of previous documents of the Ministry (Department), which are inconsistent with this notice, are not effective. It is not appropriate to presume that the operators are good law-seekers. It must be aware of the possibility that the operators only find *Document No. 4* instead of *Document No. 166*, and this causes the legal risk that the land for farming facilities occupies permanent basic agricultural land and needs to be demolished.

Second, a situation that is consistent with the use of land but against the scale of the site is also considered to not meet the requirements of land management. And this carries legal risks. The land for agricultural facilities used for the construction of farms contains two parts: land for production facilities and land for auxiliary facilities. *Document No. 4* states that various types of land for agricultural facilities are determined by the departments of natural resources and the departments of agriculture and rural areas in each province (autonomous region and municipality), with reasonableness based on the scale of production and construction standards.

Third, in addition to the substance, there are also risks of procedural illegality faced by operators. For example, *Document No. 166* states that new rural roads, livestock and poultry breeding facilities, aquaculture facilities and planting facilities that destroy the cultivation layer and other agricultural facilities are strictly controlled in using general arable land for construction. If such facilities are required, they should be approved and comply with the relevant standards. In other words, aquaculture facilities on general arable land must follow relevant procedures for review and recording. Compared to the requirements for recording in *Document No. 4*, the current procedures put forward higher requirements. However, in practice, there is a legal risk of procedural illegality by operators who are not aware of the exact operating policies of approval.

2.2.2. Legal Risk II: Licensing Legal Risks

An aquatic breeding certificate is the statement of an administrative licensing decision indicating that the certificate holder is allowed to practice aquaculture. Whereas the interests to which the certificate points are drawn from an analysis of laws and jurisprudence, there are no explicit legal provisions in practice. As a result, non-legal professionals are prone to misunderstand the certificate, which may lead to disputes.

Specifically, the law stipulates that the term “the right to practice aquaculture” refers to the right obtained in accordance with the law to use waters and tidal flats for aquaculture. (Article 3 of *Measures for Licensing and Registration of Aquaculture in Waters and Tidal Flats*) This provision is supposed to ensure that obtaining the right to practice aquaculture requires an application. Although the original text also refers to the use of waters and tidal flats, the acquisition of the right to use sea areas or the usufruct on rural land is stated separately in

other laws. The term “conventional usufruct on rural land for agricultural operation” is a legal term that approximates the right to use the land. Article 3 of the *Law of the People’s Republic of China on the Administration of Sea Areas* states that the sea areas shall belong to the state and that the State Council shall exercise ownership over the sea areas on behalf of the state. No entity or individual may usurp on, buy, sell or by any other means transfer sea areas. Article 6 stipulates that the state shall establish a system for registering the right to use sea areas. The lawfully registered rights to use sea areas shall be protected by law. Article 24 of the *Law of the People’s Republic of China on the Contracting of Rural Land* states that the state implements the unified registration of arable land, forest land, and grassland, among others, and a registration body shall issue a certificate of a conventional usufruct on rural land for agricultural operations or a certificate of a forest right, among others, to a grantee, and maintain a register thereof, to confirm the conventional usufructs on rural land for agricultural operations. Thus, there is no practical meaning to the expression “use waters and tidal flats” in this provision, which cannot be the legal basis for the right to use sea areas. However, it is difficult for a non-legal professional to accurately access all the relevant legal provisions and perform the above analysis. In addition to the geographical space overlap, the public is prone to be confused and wrongly believes that applying for an aquatic breeding certificate means jointly claiming the sea area or land involved [68]. In fact, both aquatic breeding certificates and the certificate of right to use sea areas or the certificate of a conventional usufruct on rural land for agricultural operations are required, especially the certificate of right to use sea areas. The law states that the right to use sea areas comes upon application and the origin of the right is the granting of public authority. Article 3 of *Measures for Licensing and Registration of Aquaculture in Waters and Tidal Flats* states that where waters and tidal flats are used for aquaculture, the aquaculture rights of waters and tidal flats shall be identified by licenses issued by the local people’s government at or above the county level. Article 5 states that where state-owned waters and tidal flats are to be used for aquaculture, an application shall be filed to the fishery administration department of the local people’s government at or above the country. A conventional usufruct on rural land for agricultural operation could originate from a contract, and the public authority’s registration is merely an administrative confirmation without involving a grant of the right. In contrast, the lack of a certificate of the right to use sea areas carries a heavier legal responsibility.

2.2.3. Legal Risk III: Legal Risk No. 3: Wastewater Discharge Legal Risks

The abuse of inputs can lead to problems such as eutrophication in aquaculture water and drug residues [69]. These are not only related to the quality and safety of aquatic products but will also pollute the ecological environment in the form of illegal discharge of wastewater. Article 7 of the *Aquaculture Quality and Safety Management Regulations* stipulates that the inlet and outlet systems of a culture farm or pond should be separated. The discharge of wastewater products from aquaculture should reach national discharge standards. In terms of discharge standards, the relevant standards currently in effect include the Integrated Wastewater Discharge Standard [70], Freshwater Pond Culture Water Discharge Requirements [71] and Mariculture Water Discharge Requirements [72]. Moreover, there are different relevant standards based on the category of water in which such waste is discharged. If wastewater is used for agricultural irrigation, it should comply with the stricter standards for agricultural water use, which are the Water Quality Standards for Agricultural Irrigation [73]. If it is to be discharged into the surface water system, the standard of “Environmental Quality Standard for Surface Water” needs to be implemented [74]. If the site is in the vicinity of drinking water sources, the primary A standard of “Discharge Standards for Pollutants from Urban Sewage Plants” must be implemented [75]. In terms of application, there should be no conflicts in the implementation of national integrated discharge standards and natural industrial discharge standards. If a national industry standard for water pollutant discharge exists, the standard should be followed. At the same time, a distinction should be made between mandatory national standards and rec-

ommended national standards. Operators may discharge wastewater that does not satisfy particular criteria due to erroneous understanding of the rules when confronted with a sophisticated and complex set of standards. Article 85 of the *Water Pollution Prevention and Control Law of the People's Republic of China* provides that the local people's government administrative protection department at or above the county level shall order violators to stop breaking the law and adopt treatment measures within a prescribed time limit to eliminate pollution and impose a fine on it. If it fails to take treatment measures within the prescribed time limit, the administrative environmental protection unit may designate an entity capable of such treatment to do so with the required expenses borne by the violator. In summary, the stage of discharge of wastewater produced by aquaculture presents the legal risk of operators being fined for the misapplication of relevant standards.

2.2.4. Legal Risk IV: Aquatic Fry and Fingerlings Legal Risk

Aquatic fry is located at the core of the aquaculture industry chain. China is able to carry out the breeding of some of the fry independently, but current operations are mainly stuck in the promotion and demonstrate stages. Moreover, some species of fry still rely on imports. Article 17(1) of the *Fisheries Law* provides that quarantine must be executed for the import and export of aquatic fingerlings in order to prevent disease from passing into or out of the territory. Specific quarantine work shall be carried out in accordance with regulatory provisions on the quarantine of imported and exported animals and plants. Aquaculture operators must go through the process of applying for the use of the development of isolation quarantine sites and applying for a quarantine permit for imported animals and plants. In practice, however, there are countries that prohibit the export of certain aquatic fry, such as eel fry. The information is derived from interviews with people from the industry. Some aquaculture operators have turned to smuggling eel fry because they cannot obtain specific aquatic fry legally. This not only breaks the regulatory order of entry and exit but also has legal risks, as the imported fry is not quarantined and may be prone to genetic and viral risks.

2.2.5. Legal Risk V: Pharmaceutical Legal Risks

Due to the restricted policy on land use and other reasons, areas used for aquaculture are decreasing [76]. Operators have responded by adopting high-density aquaculture methods. However, aquatic animals are prone to sensitivity to high-density aquaculture [77]. Moreover, higher feed intake tends to worsen water quality and increase fish diseases. Controlling fish diseases is more difficult than livestock disease control since aquatic animals live underwater and changes in their behavior in response to disease are difficult to detect before the diseases have advanced beyond the stage at which they are most easily treated. It is also difficult for drugs to reach the disease site directly due to the complex water environment of aquaculture, the large number of aquatic animals and the difficulty in capturing them [78]. In order to avoid serious losses caused by diseases, some operators are indeed using drugs abusively and blindly abusing antibiotics and other drugs, leading to excessive drug residues in aquatic products and raising concerns among domestic and international consumers [79–82]. In order to strengthen the quality and safety supervision of aquatic products, in early 2021, the Ministry of Agriculture and Rural Affairs issued a *Notice on Strengthening the Regulation of Inputs Used in Aquaculture*, which clearly implemented a pilot white-list system for the usage of inputs for aquaculture. It also carried out three-year special rectification of irregularities related to veterinary drugs, forage and forage additives for aquaculture. However, a category of inputs used in large quantities to regulate water quality and aquaculture substrates cannot be added to the white list due to a lack of standards. These products cannot be banned because of need, in spite of long-term issues such as vague definitions of their efficacy [83]. Consequently, some producers take advantage of this regulatory vacuum to sell substances containing components of drugs that meet national standards under the guise of water adjustment products [84]. Some even add banned or restricted drugs illegally [85]. Producers purposefully omit the terms

“prevention, treatment, diagnosis of diseases in aquaculture animals” and “purposeful adjustment of physiological functions of aquaculture animals” from their product instructions and give inaccurate product information in order to avoid supervision [86]. While there is a lack of guidance for operators, the improper use of such products can easily lead to excessive drug residues in aquatic products, pollution of the ecological environment and other problems. And this leads to the legal risk of the operator being fined or even held criminally liable.

3. Causes of Legal Risk in Aquaculture

3.1. Objective Reasons

In general, the above risks can be objectively attributed to the problem of industrial structure. China’s aquaculture methods are still relatively mature and are mainly decentralized, small scale and lack systematic planning and not forming large-scale [87]. The disadvantages of decentralized aquaculture include low economic efficiency, as well as a lack of resilience to risk. In a competitive situation, it is easy to induce moral hazard in the production management of the operators, that is, to act detrimentally in terms of property rights, licenses, discharges, aquatic fry and fingerlings and pharmaceuticals, which appears as a violation of the law in the result.

The series of actions taken by the government also reflects that the industrial structure is the cause of the problems. The large number of violations in the aquaculture field has not only triggered heated debates in the community but has also attracted the attention of the government. For example, in November 2015, the central government made it clear in the *Overall Proposal for the Reform of the Ecological Civilization System* that the protection and environmental restoration of areas producing aquatic products will be strengthened, their aquaculture will be controlled, and mechanisms will be established for the protection of aquatic plants and animal life. After research, in January 2019, the Ministry of Agriculture and Rural Development and others issued *Several Opinions on Accelerating the Green Development of Aquaculture*. The document is a programmatic document to guide the green development of aquaculture in China in the current and future period [88]. The document pointed out that in recent years, China’s aquaculture industry has been characterized by both irrational layout and industrial structure, and excessive aquaculture density in some regions and suggested strengthening the scientific layout and transforming aquaculture modes [89]. Data from the Food Safety Incident Big Data Monitoring Platform show that during the 10-year period from 2009–2018, the number of quality and safety problems of aquatic products and their products showed a trend of increasing and then decreasing, with a rapid increase from 1643 to 3943 in 2013 and then a rapid decrease to 636 in 2018 [90]. In 2018, the qualification rate of routine monitoring of aquatic products increased from 94.4 percent in 2013 to 97.1 percent, an increase of 2.7 percentage points in five years. Although the qualification rate of routine monitoring of aquatic products has been lower than the overall qualification rate of routine monitoring of agricultural products during 2013–2018, the gap between the two has been gradually narrowing, from 3.1 percentage points in 2013 to 0.4 percentage points in 2018 [91].

3.2. Subjective Reasons

The subjective awareness of aquaculture operators to understand and comply with the law is not high, and their scientific literacy and food safety awareness also need to be improved. Some scholars, after on-site investigations, have found that aquaculture operators are deficient in terms of professionalism. For example, among the 982 aquaculture operators in the port town of Zhongshan City, none graduated from aquaculture-related majors, and most of the operators were aged 50 to 60, with many of them having only primary or junior high school education [92]. Many scholars have also suggested that aquaculture operators have a reserve of specialized knowledge that needs to be improved [93], a poor ability to innovate [94], and a weak concept of the law [95]. These factors make it easy for operators to create incentives to violate the law.

4. Related Beneficial Experiences

As Korea has experienced a shift from extensive to environmentally friendly aquaculture, its experience offers valuable lessons [96]. Norway's aquaculture was its second largest export industry [97], and the government put in place a series of safeguards to ensure the sustainable development of the industry [98]. Its experience is worth learning from. As one of the more economically developed countries in Latin America, the progress of Chile's aquaculture industry is a successful case of the industrial upgrading of the fishery economy in developing countries [99]. Therefore, the relevant experiences of Korea, Norway and Chile are described below.

4.1. Korea

In August 2019, Korea's Ministry of Maritime Affairs and Fisheries consolidated the relevant issues stipulated in the *Fisheries Act* and the *Inland Waterways Fisheries Act* to form the *Aquaculture Industry Development Act* and its enforcement measures. The aim is to contribute to the sound development of the aquaculture industry and the national economy by enhancing aquacultural productivity. This reflects Korea's attitude toward strengthening the competitiveness of aquaculture. In addition, Korea has one of the world's fastest-growing aquaculture industries [100]. The problems it has encountered, and its solutions could inspire China.

Korea considers China's non-pharmaceuticals as pharmaceuticals, since they are substances that are directly applied to moving water and are absorbed into the bodies of animals to be effective. Schedule 1 of *Related provisions on the scope and designation of aquatic and veterinary non-pharmaceuticals*, which is named *Scope of Non-Pharmaceuticals for Aquatic and Veterinary* (Article 2, paragraph 1 related) listed, antibiotics, inhibitors, repellents and pesticides for aquatic animal pests. None may keep or use toxic chemicals prescribed in subparagraph 7 of Article 2 of the *Chemical Substances Control Act* for the purpose of cultivating fishery resources or removing foreign substances attached to fishing implements or fishing nets. The term "hazardous chemical substances" includes substances requiring permits, restricted substances or prohibited substances, substances requiring preparation for accidents, or other chemical substances that present or are likely to present a hazard or risk. The *Aquaculture Foster Act* was enacted in January 2002 by the Ministry of Agriculture, Food and Rural Affairs of the Republic of Korea to establish a disease treatment system for aquatic creatures, which stipulates financial supports, aquatic creature treatment, and so on.

In addition to support measures, the management of pharmaceuticals for aquatic use in Korea is characterized by diversification. The management system for aquatic pharmaceuticals in Korea is shown below (Figure 1).

The regulations for aquatic pharmaceuticals in Korea are scattered in several laws and are shown below (Table 1). Above all, with technical and financial support and the regulation of the pharmaceutical management system, the abuse of pharmaceuticals in Korean aquaculture is not common.

Regarding the discharge of aquaculture, Article 6 of the *Fishing Grounds Management Act* provides for the inspection of the fishing ground environment in Korea. The Minister of Oceans and Fisheries establishes and operates a network for regularly inspecting fishing ground environments. Whenever necessary, the Minister of Oceans and Fisheries assesses the need to urgently inspect the environment of fishing grounds in the event of serious environmental pollution. Regarding the specific contents, the Ministry of Environment in Korea issued *Guidelines for Setting and Managing Water Quality Standards for Discharge Water from Aquaculture Facilities* and set enforcement rules for the same act. The *Guide* is divided into three categories: general fish farms, eel farms, and tank-type land-based aquaculture facilities, with different water quality standards to design their programs. General fish farms with flowing water allow continuous water flow through the breeding pond, characterize by quite high water consumption, low pollutant concentrations, and a rapid rise in pollutant concentrations in discharge water due to loss of feed and sediment

disturbance caused by fish activity during feeding. Therefore, the usual standard (average value), standard at feeding (maximum value), and standard at cleaning (maximum value) are used to set management standards for flowing water farms. The amount of water in and out of eel farms changes according to the seasons, and there is almost no wastewater discharge on weekdays, just intermittent discharges during the time of screening and releasing eels. Therefore, the discharge concentration is set as the instantaneous concentration to determine the optimal discharge concentration. The concentration of pollutants in the water discharged from a tank-type, land-based aquaculture facility sharply increases during feeding, and it discharges 20% to 30% of the sediment in the tank at once after supply. Therefore, the standards are set and managed using the normal standard (average value) and the standard at feeding (maximum value).

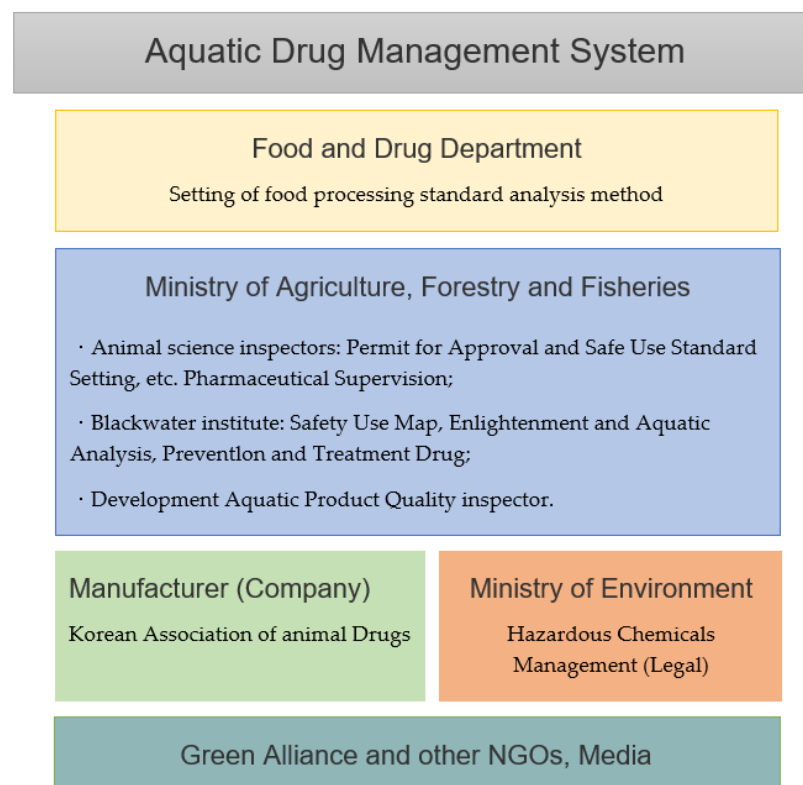


Figure 1. Drug management system for aquatic use in Korea.

Table 1. Legal system for aquatic drug management in Korea.

Law	Content
Article 85(3) of the <i>Pharmaceutical Affairs Law</i>	A person who intends to use animal drugs shall observe the standards.
Article 3 of the <i>Standard for the Safe Use of Veterinary Drugs</i>	The matters to be observed by the user, including the target animals prescribed in the declaration license or the objects and usage and dosage.
Article 40(1) of the <i>Aquatic Organism Disease Control Act</i>	No aquaculture business entity and its worker shall use animal drugs which have not been approved or reported under Article 31(2) of Pharmaceutical Affairs Act and Article 85(1) of the same Act or hazardous chemical substances under subparagraph 7 of Article 2 of Chemical Substances Control Act: Provided, That the same shall not apply where he or she has obtained approval for use under other Acts, such as approval for use under the proviso of Article 25(2) of the Fishery Resources Management Act.

Table 1. Cont.

Law	Content
Article 98(10) of the <i>Pharmaceutical Affairs Act</i>	Any of the following persons shall be subject to an administrative fine of not more than one million won: a person who fails to observe the standards for use of drugs, etc. for animals, in violation of Article 85(3).
Article 53(9) of the <i>Aquatic Animal Disease Management Act</i>	Those who use veterinary drugs or dangerous chemicals in violation of Article 40(1) shall be punished by imprisonment of up to three years or a fine of up to 30 million won, and their crimes shall be prosecuted by the judicial police.

4.2. Norway

One of the direct impacts of land-use regulations on the aquaculture sector is the reduction in the area for aquaculture. The development of freshwater aquaculture in China is already constrained, and near-shore mariculture is overloaded [101]. Thus, the only way to maintain the sustainable development of the aquaculture industry is to explore the deep sea. Reference can be made here to the Norwegian deep-sea netting aquaculture practices, which can be used to increase fish farming capacity and contribute to the restoration of near-shore agricultural lands or wetlands that were previously used for mariculture [102].

Like many countries, Norway has a licensing system, and fishing is a highly regulated industry with stringent licensing requirements. Both the specific and general rights and obligations associated with the license can be regarded as part of that license. Article 5(1) of the Norwegian *Aquaculture Act*, an aquaculture license, permits the production of specific species in limited geographic areas (sites) subject to any prescribed restrictions on the license scope that may apply at any given time. Norway also has specific aquaculture licenses for certain species—in particular, for salmon, trout and rainbow trout—as stipulated in Article 7 of the same *Aquaculture Act*.

Most Norwegian sea-farms are cage systems located in the deep, sheltered fjords [103]. For example, in April 2017, CIMC Raffles, an ocean technology group, signed an agreement with Norway's Ocean Aquafarms AS, and the construction of five Hex Box tanks would enable Norwegian salmon aquaculture to escape the geographical limitations of the fjord. The Hex Box platform is the most recent development in deep-sea fish aquaculture complexes, with a platform diameter of 90 m, a total height of 35.5 m, an empty vessel weight of 5400 t, and a farming capacity of 2 million fish. This method of aquaculture can clearly increase farming capacity. As deep-sea netting has the advantages of being free from land and near-shore restrictions and improving aquaculture efficiency, aquaculture operators could consider switching to deep-sea netting for their aquaculture practices [104–106].

Norway has also designated mariculture genetic breeding as a top priority research area. The Norwegian government launched a selection program for Atlantic salmon and rainbow trout in the early 1970s and invested in a genetic research center [107]. With government support and the involvement of private breeding companies, Norway's social and commercial breeding industry system is becoming increasingly mature, with good salmon and trout breeding stock for aquaculture, which decisively supports those industries in Norway and worldwide [108]. According to a 2012 study, farmed Atlantic salmon showed a 115% increase in growth rate and a 23% decrease in bait coefficient (feed conversion rate) compared with farmed stocks in the 1970s [109]. This reflects the government's active role in the industry.

4.3. Chile

Chile attaches great importance to the development of the marine economy, and its aquaculture production reached a record high of 1.48 million tons in 2020. Globally, Chile is the second largest producer of salmon and mussel products, although salmon is not a native fish in the Southern Hemisphere [110]. Chile's success in aquaculture stems from its strong

support for the introduction of aquatic fry and fingerlings and the protection of property rights, among other aspects. In the late 1960s, commercial fresh fish farming in Chile began with experimental activities in the lakes, rivers and fjords of southern Chile through a national and international cooperative effort [111]. At the beginning of the development of the Atlantic salmon aquaculture industry, the Chilean government took the initiative to fund the introduction of foreign fry and encouraged operators to experiment while also promoting imports of net tanks through financial assistance. In its *Penal Code*, Chile declared that all waters are national assets and available for public use. If aquaculture involves the installation of aquaculture centers in marine, lake or river waters, exclusive use rights are required. Aquaculture concessions also apply to public beaches within 80 m of the highest tide line on the coast [112]. The license holder has the right to use the water surface and the space under it. The aquaculture operator can fully exercise its right to possession of farmed salmon throughout the entire farming process, from hatching to the final catch [113]. After the development of the industry, the government privatized the relevant public enterprises, allowing them to play their full role in the market economy, while the government focused on emergency responses to large-scale epidemics, anti-dumping, and other issues [114]. After the government withdrew its control of the aquaculture industry, the industrial structure shifted toward private capital, with a high degree of commercial organization. Risk management is an explicit goal of aquaculture companies and the salmon aquaculture association called Salmon Chile [115]. In addition to ecological and economic risks, the companies not only implement technological improvements and safety measures but also mobilize their social technologies—that is, adaptive political strategies to shape social and cultural life according to the company's objectives [116].

5. Preventing and Controlling Legal Risks in Aquaculture

5.1. Promote an Improved Rule of Law

5.1.1. Raise Legal Awareness among Operators

Agricultural land involves the country's food security, and the regulation of such land is a legal system in which public power intervenes to ensure the efficient allocation of land resources. Article 4 of the Land Administration Law of the People's Republic of China provides that the State is to place strict control on the usages of land. Given this strict regulation, operators must clarify the properties and usage of the land in question. They need to be aware of land classifications and naming to avoid violating land use regulations, according to which agricultural land includes paddy fields, reservoir water surfaces, pond water surfaces, and ditches, among others [117]. It is worth noting that, influenced by land-centrism, watersheds fall into the category of land [118]. Classification of agricultural land also includes land for facilities and ancillary facilities for the production of aquaculture, such as manure disposal, inspection and quarantine, although excluding land for processing sites. Aquaculture operators must also pay attention when transferring land, as some provinces are carrying out the work of "retiring ponds for cereal". If the price of land for transfer is low, operators have to pay attention to land use regulations to avoid losses caused by illegal acts.

Operators must retrieve the relevant legal provisions and apply them with references based on an awareness of land classifications and naming practices. There are several key regulations relevant to aquaculture in the laws on land use regulation, depending on the nature of the land in question. First, for permanent basic agricultural land, aquaculture operators may not dig ponds for aquaculture, build aquaculture facilities or otherwise destroy the cultivation layer. Article 37(3) of the Land Administration Law provides that it is forbidden to occupy permanent basic farmland to develop horticulture or dig ponds to breed fish. Document No. 166 stipulates that it is strictly forbidden to newly occupy permanent basic agricultural land to build livestock and poultry breeding facilities, aquaculture facilities and planting facilities that destroy the cultivation layer. Second, if general arable land—which encompasses the arable land outside the permanent basic agricultural land—belongs to the overall plan for balancing occupation and supplement,

operators must be approved and accepted by the village collective, as well as changing the contract for land management rights and the certificate of ownership in a timely manner [119]. If the land does not belong to the plan, the aquaculture operators must obtain approval to build aquaculture facilities that meet the relevant standards. Third, for integrated three-dimensional farming—this would include, for example, rice and a fishery, rice and shrimp, or rice and crab integrated farming—the aquaculture operators cannot destroy permanent basic farmland if that is the land subject to use. Where general cropland is used, more than 10% of land cannot be used for ditch pits. It is stated in the Technical Specification for Integrated Rice-Fishery Farming: 4. Technical indicators, the proportion of ditch-pits: the proportion of ditch-pits shall not exceed 10% (referring to general arable land).

Operators also need to fulfill the necessary procedures in advance instead of starting work without authorization; otherwise, they may be liable for breaching the relevant plans. In general, the rules differ slightly from place to place, but they can be broadly divided into three aspects.

First, the location and scope of the land sought for the construction of agricultural facilities by the operators should be in line with spatial, agricultural development and rural planning modalities, as well as the provisions for the scale of land for the construction of agricultural facilities issued by the local natural resources departments. Use of inefficient, idle or unused land is recommended, such as barren hills, land and beaches, to prevent the occupation of arable land.

Second, operators should sign land-use agreements with collective economic organizations to clarify the conditions for land use. In some places, construction plans and land-use agreements must be announced on township governments and village public affairs boards, and agreements can only be signed after the announcement period has expired without objection.

Third, the operators or rural collective economic organizations should file the land-use agreements in a timely manner with the township government after signing. After completing the filing, the township government must remit the filing information to the county-level natural resources departments and the agricultural and rural departments in charge [120]. In addition to the value of the procedure itself, the operator can also learn about the conditions related to the use of the land, such as its length, usage, time limits for land reclamation requirements, the surrender of the land and the liability for breach of contract. This may help operators avoid the risk of substantial violations of land-related laws.

5.1.2. Follow the Principle of Proportionality and the Principle of Reliance Interests

Administrative subjects should follow the principle of proportionality in the enforcement of law and consider the circumstances of the violations related to land use to make the appropriate administrative decision based on those facts. For example, in the case of a project involving agricultural facilities for which no relevant formalities have been completed, the person concerned should be ordered to complete the formalities within a certain period and not be subject to heavier penalties. In practice, however, an administrative subject may order the cancelation of the deadline due to procedural violations that violate the principle of proportionality [121]. Administrative subjects should also follow the principle of proportionality in operating public affairs. For example, aquaculture plants in some rivers or lakes were all outlawed by the relevant authorities because of the requirements to construct an ecological civilization and protect the environment. A case in point is the right to use Taihu Lake for aquaculture, which was withdrawn by Jiangsu Province in April 2018 [122]. The penalties clearly did not match the severity of the circumstances and instead increased the legal liability of the aquaculture operators.

The suggestion to enhance legal awareness among operators is a call for operators to comply with the law consciously, but it is not meant to eliminate the obligation of the administrative organs to promote the law and the relevant approval and filing procedures.

The administrative subject is the organization that has administrative functions and powers, as well as the independent responsibility for doing so; it should abide by the spirit of the law when enforcing that law. For example, an aquaculture operator is generally required to complete several steps to build an aquatic breeding farm. This process includes an application to the township government where the construction is taking place, a site survey of the fish farm by the relevant departments (e.g., the Department of Land, Agriculture, and Environmental Protection) in the district or county, approval by the district or county government, and a review of the site design by the relevant departments organized by the land department. The operators trust the administrative subject as their authority. After fulfilling the necessary procedures, the operators act based on policy guidelines or administrative guidance due to this trust. The legitimate interests arising from such behavior should be protected.

5.1.3. Clear Guidance from Legislators

In addition to compliance and enforcement efforts, improvements should also be made at the legislative level. Regulatory documents are universally and repeatedly applied within a certain period [123], and their reform could improve administrative efficiency, as well as support enforcing and improving laws, regulations and higher-level policies. It is important to maintain consistency between laws and policies to maintain the unity of the national legal system and the smooth flow of government orders. Regulatory documents that cannot be applied should be cleaned up or organized in a timely manner. Consider the case of *Document No. 4*, which was mentioned earlier in this paper. It is a regulatory document based on a more liberal land policy that was current at the time of its promulgation. The later *Document No. 166* indicated a change in policy as a result of a change in circumstances. It obviously does not align with the spirit of *Document No. 4*, yet both documents are currently in effect and there has been no sound transition. *Document No. 166* states, of course, that the provisions of previous documents that are inconsistent with the current document are no longer in force, but the contradiction remains. Lawmakers (including policymakers) should therefore clean up the content of regulatory documents that cannot be applied because there is no guarantee that operators have a high level of legal literacy necessary to face such complicated changing land regulations. The authorities should consolidate effective regulatory content and provide clear guidance to all other parties in the administrative legal relationship.

5.1.4. Upgrade of Government-Supported Aquaculture

Land use controls are based on considerations of food security. The related policy advocacy is thus dictated by the reality of the situation. Food harvests are difficult to predict due to a combination of market, climate and other factors, so it is difficult to maintain a stable land policy, and it is therefore difficult to maintain the area for aquaculture within a stable range on a certain amount of land. High-density aquaculture does not increase capacity but is counterproductive. To escape this dilemma, authorities should encourage aquaculture operators to make full use of the sea area and adopt new modes of aquaculture, such as deep-water nets, marine pastures, and aquaculture work boats, which are indeed encouraged by the 2023 *Central Document No. 1*.

This promotion of new aquaculture modes will naturally be constrained by a variety of factors, including production philosophy, technology level, and production costs. There are currently many small enterprises and aquaculture operators in China's mariculture industry that can hardly afford the costs and risks inherent in such transformation and upgrading. It would thus be useful to refer to Chile's experience in providing financial subsidies. The government should consider introducing similar preferential policies to support aquaculture operators in upgrading their methods based on the comprehensive local situation.

5.2. Clarify the Positioning of Aquatic Breeding Certificates

Some aquaculture operators do not understand the relationship between an aquaculture license and other certificates, such as the sea area use right certificate. They may believe that there is an inclusive or overlapping relationship between such documents. They may, therefore, fail to complete the necessary documentation and are thus penalized. The root of the above legal risks lies in the unclear positioning of the breeding certificate. This is essentially a problem of overlap between administrative licensing and administrative confirmation, which may seem to strengthen its legal effect, but its scope is limited to aquaculture and may not be broadly construed as the right to use the land or sea. The relevant regulations state that the aquaculture certificate confirms the right to engage in aquaculture in waters and tidal flats. However, the aquaculture certificate is subject to an application and issuance process, and it is also within the scope of authorization by the public power to engage in aquaculture production. Article 11 of the *Fisheries Law* provides that where a unit or an individual uses a water area or beach with ownership by the whole people, which is determined by the State programming to be used for aquatic breeding industry, the user shall apply to the department in charge of fishery administration of the local people's government at the county level or above for the aquatic breeding certificate, which shall be checked and issued by the people's government at the same level.

Up to this point, it is possible to distinguish the difference between the aquaculture license and other tenure certificates based on content. This can perhaps best be explained in the judicial case. The *Fisheries Law* sets up an administrative license for aquaculture, so the right to engage in aquaculture is divorced from the right to use water and mudflats. It is thus a special right that can only be obtained through an administrative license. The legal aquaculture license and the certificate indicating legal land (or sea) use rights involve different rights and thus do not conflict. The same aquaculture water surface can be issued both a land (sea) use right certificate and an aquaculture license. However, the doctrinal clarification is opaque to the public and requires legislative recognition. Policymakers should thus further clarify the positioning of the aquaculture license in the *Fisheries Law*.

5.3. Improve and Popularize Wastewater Discharge Standards

The discharge standards for aquaculture wastewater are complicated and obsolete, while failing to fit local conditions. If the local authorities set standards for the discharge of aquaculture wastewater, it would help provide clear and scientific guidelines for operators and prevent the above-mentioned legal risks. The development of such local standards is currently underway. The *Implementation Plan for Agricultural Non-point Source Pollution Control and Supervision Guidance (Trial)*, jointly issued by the Ministry of Ecology and Environment and the Ministry of Agriculture and Rural Development, proposes to guide localities in setting standards and regulations for the discharge of waste water from aquaculture. *Opinions of Strengthening the Supervision of Ecological Conditions of Marine Culture*, also jointly issued by the same, require coastal provinces (autonomous regions and municipalities) to set relevant standards for the discharge of waste water from aquaculture by the end of 2023 in accordance with the relevant requirements of the *Technical Guidelines for the Formulation of Local Standards on Controlling the Discharge of Waste Water from Aquaculture*. *Technical Guidelines for the Formulation of Local Standards on Controlling the Discharge of Waste Water from Aquaculture* (HJ 1217-2023, hereinafter referred to as *Technical Guidelines*), issued by the Ministry of Ecology and Environment in February 2023, is used to guide and regulate the formulation of relevant local pollutant discharge standards in a more scientific, precise and standardized manner.

To guarantee that local standards are scientific, formulators should increase basic research to provide effective direction for practical implementation. In this formulation, they should clarify the standards for calculating emissions. The condition of aquaculture wastewater discharged from ponds under different species varies, so the water quality index measured by water samples collected at a time point within the whole discharge cycle does not accurately reflect water quality as a whole. Regulators should set the time point

for collecting wastewater at a suitable point in the discharge cycle close to the average mass concentration of water quality indicators in the total discharge [124]. The Korean experience mentioned above can be combined to set up different plans to supervise the quality of wastewater based on the different aquaculture methods for the various fish species. This is in line with 6.2.4 of the *National Technical Guidelines for the Formulation of Standards for the Discharge of Water Pollutants* (HJ 945.2), which is cited in the *Technical Guidelines*. It contains that emission monitoring data should be collected, mainly including online monitoring, law enforcement monitoring, emission unit self-monitoring, environmental protection acceptance monitoring data at the completion of construction projects, which includes instantaneous, hourly and daily average emission concentrations of pollutants, discharge volume, as well as the capacity designed by the enterprise, actual capacity, production load, and so on. It also contains an analysis of the level of pollutant emissions, the proportion of compliance, and the emission characteristics of various production processes.

Before the launch of the local rules, operators should also raise awareness and understand the conditions for applying the standards, such as being able to distinguish between mandatory (GB) and voluntary national standards (GB/T). Article 2 of the *Standardization Law of the People's Republic of China* stipulates that compulsory standards must be implemented while the state merely encourages the adoption of voluntary standards. The Integrated Wastewater Discharge Standard (GB 8978–1996) is a mandatory national standard to control water pollution and protect the quality of surface water, such as rivers, lakes, canals, channels, reservoirs and oceans, as well as groundwater. The “Freshwater Pond Culture Water Discharge Requirements” (SC/T 9101–2007) and “Marine Culture Water Discharge Requirements” (SC/T 9103–2007), meanwhile, are voluntary standards, and their application is encouraged but not mandatory [125].

5.4. Increase the Self-Sufficiency Rate of Aquatic Fry and Fingerlings

Individual aquaculture is currently common in China. Without formulating a scalable situation, it is difficult to supervise the quarantine of aquatic fry comprehensively and rigorously. Instead of monitoring after the event, it is better to solve the problem at the root in advance. The lack of quality fry at present restricts the sound development of mariculture in China. By only emphasizing the legal introduction of fry through regulation without taking into account the various operator costs, positive enforcement results remain elusive. China should therefore consider the experience of diversification of industrial inputs in Norway. The government, joint research institutes, large aquaculture enterprises and other related parties should thus form a consortium to collectively solve the problem of aquaculture fry breeding. The government should take the lead in organizing and defining research and development needs, incentive mechanisms, supervision and management. The institutes could provide scientific and talent support, while the enterprises could provide financial support and promote the transformation of scientific and technological achievements through the power of the market.

5.5. Make Use of the Synergy of Soft Law and Hard Law

The lack of product standards is the main reason why water adjustment products are in a gray area and cause many legal risks, which makes such products difficult to supervise. The National Fisheries Technology Extension Center and the China Society of Fisheries issued a notice in response to this problem. According to this notice, they will focus on water adjustment products in need of regulation and develop a group standard for the China Society of Fisheries. The work will be based on surveys, and experts will determine the recommended group standard catalog of water adjustment products for aquaculture through research. A multi-sector group will then draft the standard and seek the views of the relevant parties. They will then submit the draft to the China Society of Fisheries for review and approval. During the development of the group standard, the relevant departments must adjust the white list scientifically. Indeed, one scholar noted that the formulation and dosage of some national standard fishery pharmaceuticals have

not changed for a long time. Considering the resistance of disease-causing organisms, the pharmaceuticals currently in use may not effectively inhibit or destroy disease-causing organisms in the future [126]. To ensure the operability of the white list system, the departments concerned should take into account the reasonable needs of the operators to detect bacterial resistance, in addition to strengthening the supervision of water regulation products. They can then adjust the white list to achieve scientific use. At the legal level, the standard must make a distinction between non-pharmaceuticals and water adjustment products that use the name of non-pharmaceuticals but are essentially pharmaceuticals; for example, it is possible to absorb the provisions of Korea and determine that substances absorbed into the animal and effective are not non-pharmaceuticals.

Operators should also avoid buying inputs that lack critical product information, such as manufacturers, production licenses, product labels and product quality inspection certificates. They must follow Article 5 of the *Provisions on the Quality Safety Management of Aquaculture*, which provides that aquaculture water should comply with the Ministry of Agriculture regulations for “Pollution-free Food Seawater Aquaculture Water Quality” (NY5052-2001), “Pollution-free Food Freshwater Aquaculture Water Quality” (NY5051-2001), and other standards. The state prohibits the use of water sources that do not meet the water quality standards for aquaculture.

6. Discussion

Although the above issues are focused on China, much of the information is relevant to other countries as well. Property rights, licensing of access, food safety, environmental pollution and fry quarantine are all unavoidable issues in the aquaculture industry. Such common problems are not only concerns in China but are also worthy of attention in other countries. In addition to the interests of the operators, aquaculture is also related to human health, the environment and other social issues that are closely related to public life. In the 1990s, the public began to become aware of the potential problems of aquaculture, and acceptance of aquaculture practices and its products declined [127]. In the present era of advanced information and globalized trade, the situation of the aquaculture industry in a single country will positively and negatively influence multiple countries that do frequent trade transactions with it.

The following insights can be drawn from this study. First, from the perspective of aquaculture operators, pursuing only short-term economic benefits is not desirable in the context of increasing public attention to social issues. They should therefore pay attention to long-term benefits and comply with legal requirements on issues such as inputs and fry to avoid legal risks. They must make even greater efforts, above the legal minimum, to assume social responsibility by developing environmentally friendly aquaculture and joint efforts with the government to promote the regional economy.

Second, from the perspective of the government, urging aquatic operators to comply by strengthening enforcement and inspection is not the only possible solution. In addition to post-event monitoring, it is important to solve the problem at the root by, for example, developing production standards for inputs based on pharmaceutical resistance testing and introducing and breeding aquatic fry adapted to the local environment. The government should also pay attention to the role of private subjects, such as joint self-regulatory associations, and use favorable policies (among other tactics) to guide the participation of multiple parties in social governance.

Third, from the perspective of the legislator, the legal protection system for aquaculture should be improved. This could include removing and integrating the legal codification of relevant policies or clarifying the positioning of aquaculture licenses at the legal level. Moreover, regarding the preventive measures for related risks, China can learn from the experiences of other countries, and likewise, other countries can also implement countermeasures used by China or draw inspiration from Chinese practices or transformed experiences. In other words, this research on the legal risks of and preventive measures in aquaculture in China is also beneficial to other countries.

Understanding the legal risks and prevention of aquaculture in China is valuable not only in the proactive approach described above, in which other countries can learn from or draw inspiration from China, but also in a reactive sense, in which the trade dealings of other countries with China can be affected. Although China is a major aquaculture producer, it is also an important consumer. One scholar has pointed out that China's huge imports are related to Chile's "blue transition", defined as the shift from a reduction in fish biomass caused by aquaculture to the exploitation of aquatic resources for recovery [128]. As the transformation and promise of Chilean aquaculture depend greatly on China, the question of how China will develop its aquaculture industry and whether this development will relieve pressure on wild fisheries is a key question for the blue transition and the future of the ocean [129]. There is also a space for the theory discussed here to be applied to countries with similar trade relations. China's perceptions and standards for aquaculture will not only influence its domestic industry but will also influence other countries through the power of the market based on the public's evaluation of aquaculture in each country. Thus, the development of aquaculture in China is relevant to the blue transition of all countries.

7. Conclusions

Land use violations, lack of legal documents, sub-standard wastewater, unquarantined aquatic fry and fingerlings, and misuse of prohibited aquatic pharmaceuticals are five of the common current legal risks. Their occurrence is linked not only to the economic loss incurred by aquaculture operators but is also closely related to food safety, the environment, and even the economic development of China and other countries, which will counteract aquaculture operators through market forces. Operators, as stakeholders and participants in risk management, must take this into account. A complete legal framework, improved legal awareness among aquaculture operators, reasonable enforcement in accordance with the law, and resistance to and supervision of unlawful elements in the aquaculture industry by other parties are all necessary to prevent these risks. Currently, China has abandoned its once-expensive approach to aquaculture and is actively transforming and upgrading toward ecologically friendly and healthy aquaculture. The green development of aquaculture will make significant progress through the collaboration of public and private parties, which will ultimately result in the high-quality, sustainable development of the aquaculture economy.

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