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Blue Food Trade Governance and Sustainable Seafood Rules: From Fisheries Subsidy Disciplines to Traceable Value Chains

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Abstract

Blue food has an increasingly significant strategic role in global food security, nutritional supply, and marine sustainability governance, while seafood trade rules are shifting from traditional border regulation toward value chain governance covering capture, aquaculture, processing, cold chains, certification, and consumption. Using literature analysis, rule analysis, and normative analysis, this paper examines the institutional transformation of blue food trade governance and sustainable seafood rules. The study finds that global seafood trade rules are undergoing four important shifts: fisheries subsidy disciplines are incorporating industrial support into the framework of trade rules and marine resource governance; sustainable aquaculture is gradually becoming a condition for international market access; value chain traceability is being transformed from a food safety tool into a foundation for IUU fishing governance and green compliance; and private certification and digital sustainability assurance are changing the governance structure of global seafood value chains. For China, the high-quality development of seafood trade requires a transition from scale and cost advantages toward subsidy compliance, green aquaculture, digital traceability, and participation in international rule-making.

Keywords

Blue Food; Seafood Trade; Fisheries Subsidies; Sustainable Aquaculture; Traceability; Trade Governance

1. Introduction

Blue food is becoming a frontier issue in agricultural economics and food system research. For a long time, food security research has mainly focused on grains, livestock products, and land-based agriculture, while seafood has often been placed within sectoral discussions of fisheries management, marine resources, or food consumption. With population growth, changes in dietary structure, increasing constraints on land-based agricultural resources, and the growing complexity of nutrition problems, aquatic foods from oceans and inland waters have been

reintroduced into the global food system governance agenda. In The State of World Fisheries and Aquaculture 2024, the Food and Agriculture Organization of the United Nations (FAO) takes "Blue Transformation" as its theme and emphasizes that fisheries and aquaculture are not only protein supply sectors, but also important components of nutrition security, employment and livelihoods, and ocean governance [1].

The strategic value of blue food is first reflected in nutritional supply. Aquatic foods can provide high-quality protein, long-chain fatty acids, and various micronutrients, and thus have important significance for improving nutritional deficiencies [2]. At the same time, blue foods also connect multiple objectives such as nutrition, ecology, livelihoods, and culture. Therefore, they should not be understood merely as ordinary commodities, but should be incorporated into an analytical framework of transnational allocation of blue food, nutritional accessibility, and food system resilience [3]. Demand growth and trade globalization have further increased the importance of seafood trade governance. Blue food demand is jointly affected by income, population, prices, preferences, and regional consumption habits, while trade is also changing global aquatic food consumption patterns and nutritional distribution [4][5]. From a trade network perspective, seafood is a highly traded food category, and trade expansion can improve food availability while also potentially weakening ecological feedback between production and consumption locations [6].

Against the background of the rising status of blue food and the deepening globalization of seafood trade, trade rules are undergoing structural change. Traditional seafood trade rules mainly focus on border measures such as tariffs, sanitary inspection and quarantine, customs facilitation, cold-chain transportation, and technical barriers to trade. At present, the focus of rules is gradually extending to resource status, capture legality, aquaculture practices, environmental performance, certification credibility, and supply chain transparency during product formation. Different blue foods vary in greenhouse gas emissions, nitrogen and phosphorus emissions, land use, and freshwater use, making environmental footprint an important dimension in seafood market evaluation [7]. Existing studies have separately discussed the nutritional value of blue foods, seafood trade networks, fisheries subsidies, and private certification, but relatively few have examined, from the perspective of "trade governance rule transformation," how public rules, private standards, digital traceability, and China's response can be incorporated into the same analytical framework. This paper addresses three questions: why the concept of blue food pushes seafood trade research from commodity trade analysis toward food system governance analysis; how World Trade Organization (WTO) fisheries subsidy disciplines, sustainable aquaculture, value chain traceability, private certification, and digital sustainability assurance jointly reshape seafood trade rules; and how China, as an important producer,

consumer, processor, and trader, should adapt to the new trends in blue food trade governance.

2. Blue Food and Seafood Trade Governance

Blue food is the conceptual starting point for understanding the object of this study. Compared with the traditional concepts of "aquatic products" or "seafood," blue food has stronger food system attributes and governance attributes. Generally speaking, blue food includes fish, shellfish, crustaceans, aquatic plants, seaweeds, and other edible aquatic organisms from oceans, rivers, lakes, reservoirs, and other inland waters. It includes both capture fishery products and aquaculture products. The traditional concept of aquatic products places more emphasis on commodity attributes and market transaction attributes, whereas the concept of blue food emphasizes the composite attributes of nutrition, safety, ecology, livelihoods, and institutional governance. Under globalization, the production, processing, and consumption spaces of wild-capture and farmed aquatic foods are highly separated, further increasing the complexity of blue food trade governance [8].

The concept of blue food makes agricultural trade research no longer limited to land-based agricultural products, but further directs attention to the trade allocation and governance of marine and inland water foods within the global food supply system. Seafood trade governance differs from general agricultural trade management. General agricultural trade mainly faces issues such as land resources, agricultural subsidies, food safety, tariff protection, and market access. Seafood trade also involves marine common resources, transboundary fish stocks, distant-water fishing, illegal, unreported and unregulated (IUU) fishing, regional fisheries management organizations, coastal community livelihoods, and marine ecosystem protection. The separation of production locations, processing locations, export locations, and consumption locations makes it difficult for traditional border-based trade management to fully cover product risks and ecological responsibilities.

The core of blue food trade governance is not to restrict trade itself, but to reshape the conditions of trade. Trade can improve the spatial allocation efficiency of seafood supply and alleviate local supply shortages. However, when resource constraints and compliance supervision are lacking, demand from high-income markets, price signals, and industrial subsidies will amplify fishing pressure or promote unsustainable aquaculture expansion. Therefore, blue food trade governance needs to establish an institutional balance among market efficiency, nutrition security, resource sustainability, and equitable distribution. From the perspective of governance objects, traditional seafood trade governance mainly targets final products, such as product quality, sanitary safety, import inspection, labeling, and customs procedures. Blue food trade governance, by contrast, incorporates production processes, resource status, and value chain responsibility

into regulation, requiring capture products to prove legal origin, aquaculture products to prove process compliance, and processed products to prove that raw material sources, species identity, processing records, and cold-chain processes are verifiable.

Based on these characteristics, this paper constructs a four-dimensional analytical framework of "resources-institutions-value chains-markets." The resource dimension focuses on fishing pressure, fish stock status, overfishing, and marine ecological protection. The institutional dimension focuses on WTO fisheries subsidy disciplines, the FAO governance framework, regional fisheries management rules, import-country IUU regulation, and domestic fisheries policies. The value chain dimension focuses on origin traceability, processing compliance, cold-chain records, certification systems, and digital data. The market dimension focuses on consumer sustainability preferences, transnational buyer standards, private certification, green premiums, and market access thresholds. The four dimensions interact with one another: resource pressure promotes the strengthening of institutional rules; institutional rules change the organization of value chains; value chain transparency affects market trust; and market preferences in turn influence the compliance incentives of producers and export enterprises. Accordingly, the essence of blue food trade governance is to internalize externalities in traditional seafood trade through public rules, private standards, and digital data mechanisms, so that trade expansion is built on resource sustainability, verifiable production, and traceable value chain responsibility.

3. The Rule Turn in Global Seafood Trade

First, fisheries subsidy disciplines under the WTO framework are changing the legitimacy basis of seafood trade competitiveness. The WTO Agreement on Fisheries Subsidies brings subsidies related to IUU fishing, overfished stocks, and unregulated high-seas fishing within the constraints of multilateral trade rules, which means that fisheries subsidies are no longer only a matter of domestic industrial policy, but a problem jointly faced by trade rules, marine resource governance, and sustainable development [9]. Fisheries subsidies have become a focus of international rules fundamentally because some subsidies distort fishing behavior. Fuel subsidies, vessel construction subsidies, support for distant-water fishing, and port service subsidies, if they reduce fishing costs and stimulate the expansion of fishing capacity, will allow fishing activities that were not economically viable to continue. Disciplines on harmful fisheries subsidies are crucial for reducing overfishing and restoring marine resources [10]. At the same time, special and differential treatment for developing countries remains an important issue in subsidy disciplines, and rule design needs to establish an operational coordination mechanism between sustainability objectives and development rights [11]. Therefore, seafood trade competitiveness can no longer continue to be built on resource depletion and

subsidy expansion, but must shift toward resource conservation, green production, compliance proof, and value chain transparency.

Second, sustainable aquaculture is becoming a new trade condition. FAO data show that in 2022 total global fisheries and aquaculture production reached 223.2 million tonnes, and aquaculture animal production exceeded capture fisheries animal production for the first time [1]. This change means that future seafood trade rules cannot focus only on the resource management of wild capture fisheries, but must also incorporate aquaculture production methods into governance. While global aquaculture increases supply capacity, it also faces multiple constraints related to feed, ecology, disease, space use, and governance systems [12]. Traditional trade rules mainly examine whether final products are safe, whereas sustainable aquaculture rules pay more attention to whether production processes meet environmental and social requirements, including wastewater treatment, drug use, feed sources, stocking density, ecological impacts of farming areas, and labor conditions. These factors enter trade contracts through import-country standards, third-party certification, and transnational procurement rules, making "verifiable processes" a prerequisite for "marketable products." Export enterprises need not only to ensure that final products meet sanitary and safety requirements, but also to make production processes recordable, environmental impacts explainable, and compliance data auditable.

Third, digital sustainability assurance and value chain traceability are becoming the institutional basis of seafood trade governance. Seafood supply chains involve many links and actors, cross-border processing is common, and product forms can also change during processing. After raw materials move from capture or aquaculture into procurement, primary processing, deep processing, cold-chain transportation, re-export, and retail, origin, species names, fishing methods, and processing responsibility are easily diluted. Without a reliable traceability system, IUU fishing, species mislabeling, food fraud, and responsibility transfer will spread along the trade chain. Private standards and certification have become important institutional arrangements affecting international fish trade, and they directly involve traceability, credibility assessment, cost sharing, and participation by developing countries [13]. FAO research on end-to-end traceability emphasizes that traceability has changed from an internal quality management tool for enterprises into a comprehensive governance tool covering legal origin, food safety, trade compliance, and consumer information disclosure [14]. Digital technologies further change the way sustainable rules are implemented. Compliance no longer consists of submitting paper certificates or completing one-time certification, but requires the continuous generation, preservation, transmission, and verification of data. Data standards, audit mechanisms, and accountability systems therefore become important components of seafood trade governance [15].

Fourth, market access, green standards, and private certification are jointly shaping

the conditions of seafood trade. Government regulation and market governance both cooperate and compete with each other, and they are not simply substitutes [16]. Government rules provide a minimum compliance baseline, private certification responds to consumers' and buyers' sustainability requirements through higher standards, and non-governmental organizations influence market behavior through information disclosure and reputation supervision. Fishery Improvement Projects (FIPs), as a supply-chain-based private governance tool, have diffused in ways that show market actors and non-governmental organizations are influencing fisheries sustainability governance through orders, improvement plans, and certification pathways [17]. The greening of market access rules is also reflected in the layering of government standards and procurement standards. Import-country IUU regulation, food safety systems, and labeling rules constitute mandatory baselines, while the procurement norms of transnational retailers and brand firms form higher-level market requirements. For export enterprises, entering high-end markets no longer depends only on whether products meet requirements at customs clearance, but on whether they can continuously satisfy buyers' comprehensive requirements concerning origin, environment, labor, certification, and data. This layering effect gives private standards the practical binding force of quasi-public rules.

4. Mechanisms through Which Sustainable Rules Reshape Seafood Trade and China's Response

Sustainable rules first affect seafood trade through the compliance cost mechanism. In order to meet fisheries subsidy disciplines, sustainable aquaculture standards, private certification, and traceability requirements, enterprises need to invest in certification applications, audits, testing, production records, information system construction, wastewater treatment, cold-chain data records, and supplier management. For enterprises with larger scale and higher levels of organization, these costs can be absorbed through brand premiums, stable orders, and long-term market access. For small-scale fishers, small and medium-sized aquaculture households, and small processing enterprises, fixed compliance costs will significantly raise the threshold for entering high-standard markets. Second, sustainable rules change enterprise competition through the market selection mechanism. High-standard import markets usually screen suppliers through government regulation, retail procurement standards, third-party certification, and brand reputation. Enterprises that can provide proof of legal origin, sustainable certification, digital traceability data, and stable quality control are more likely to enter high-end markets, while enterprises that fail to meet requirements are forced to turn to lower-standard markets or remain in lower value-added segments.

Sustainable rules also affect trade patterns through supply chain reorganization and risk transmission mechanisms. To meet traceability and certification requirements,

importers and transnational retailers often reduce the number of suppliers and choose partners that have long-term cooperation, complete records, auditability, and lower risk. Export enterprises also need to move from fragmented procurement toward production-base-based, contractual, and standardized management, forming controllable chains by organizing aquaculture bases, fishing cooperatives, processing enterprises, cold-chain logistics, and testing institutions. The rule transformation does not simply add compliance obligations for individual enterprises; it promotes a transformation of supply chains from loose transactional relationships toward organized governance relationships. Cross-border intermediary trade and re-export may also obscure the real dependence between producers and end markets, making it more difficult for local economies to identify distant market shocks [18]. Therefore, seafood trade governance needs to shift from a single compliance mindset toward a risk governance mindset, and establish continuous monitoring mechanisms for rule changes, market dependence, and supply chain vulnerability. At the same time, sustainable rules have clear distributional effects. Economies and large enterprises with stronger rule capacity are more likely to enter high-standard markets, while countries, small and medium-sized enterprises, and small-scale producers with weaker rule capacity face higher access costs. Blue food trade governance therefore needs to balance environmental effectiveness and development equity.

China is an important global producer, consumer, processor, and trader of seafood. FAO data show that in 2022 China accounted for 36% of global aquatic animal production and was also a major seafood exporter and an important import market [1]. This position indicates that China's role in global blue food trade is not that of a single exporter, but one with multiple identities, including production, processing, import, re-export, and consumer market. China's domestic policies also provide an institutional background for blue food trade governance. The document issued by the General Office of the State Council on practicing the greater food approach and building a diversified food supply system proposes expanding from cultivated land resources to all territorial resources, and obtaining food, calories, and protein from forests, grasslands, rivers, lakes, seas, facility agriculture, and plants, animals, and microorganisms [19]. This policy orientation is internally consistent with the concept of blue food, and also provides a domestic policy basis for developing seafood, deep-sea aquaculture, green and healthy aquaculture, and aquatic food resources.

Facing the transformation of international sustainable rules, China's seafood trade mainly confronts four challenges. First, pressure for fisheries subsidy compliance is rising. China needs to use fiscal policies to support fishers' livelihoods, fishing port construction, resource conservation, vessel upgrading, and industrial transformation, and the key is to distinguish support that is conducive to resource protection and green transformation from support that may stimulate the expansion

of fishing capacity. Second, the pressure for sustainable aquaculture transformation is increasing. China has scale advantages in aquaculture, but levels of green development are uneven across regions, species, and farming models. Problems related to wastewater treatment, stocking density, disease prevention and control, drug-use records, and standardization may be transformed into certification, traceability, and market access issues in international trade. Third, traceability systems and digital governance face pronounced pressure. China's seafood industry chain involves many actors, and some links are characterized by small scale, fragmentation, and multi-level procurement. Without unified coding and whole-chain data records, it will be difficult to meet import markets' traceability requirements for origin, species, production methods, and processing processes. Fourth, international rule participation capacity still needs to be strengthened. Blue food trade governance involves WTO fisheries subsidy rules, FAO's Blue Transformation agenda, regional fisheries management organizations, import-country IUU regulation, private certification, and global value chain standards. China needs to move from passive adaptation toward active participation.

China's strategic response should focus on rule adaptability, green production capacity, and digital governance capacity. First, China should reconstruct a sustainability-oriented fisheries subsidy system, conduct compliance assessments of subsidies that incentivize the expansion of fishing capacity, gradually strengthen support for resource surveys, ecological restoration, vessel reduction, fishers' occupational transition, production safety, and green technology application, and improve subsidy transparency and the explainability of ecological effects. Second, China should improve the green aquaculture standards system, promote the standardization of wastewater treatment, drug use, feed sources, stocking density, disease prevention and control, and ecological impact assessment, and incorporate fragmented producers into a recordable, auditable, and traceable management system. Third, China should build a digital traceability system oriented toward trade compliance, form unified data standards for species, origin, aquaculture actors, capture information, processing batches, cold-chain records, testing results, and export flows, and enhance mutual recognition with major import markets and third-party certification systems. Finally, China should strengthen its capacity for international rule participation and standards transformation, and put forward rule proposals on fisheries subsidies, green aquaculture, IUU governance, private certification, and digital traceability that reflect the interests of developing members, a major aquaculture country, and a major processing-trade country.

5. Conclusion

This paper places seafood trade within the framework of blue food governance and analyzes the transformation of global sustainable seafood rules and its implications

for China. The study argues that the concept of blue food promotes a shift in seafood trade research from commodity circulation analysis toward food system governance analysis. Global seafood trade rules are shifting from border regulation toward value chain governance. Fisheries subsidy disciplines, sustainable aquaculture, digital traceability, private certification, and green market access are jointly changing the mechanisms through which seafood trade competitiveness is formed. Trade advantages are no longer determined only by production scale, processing capacity, and prices, but increasingly depend on resource conservation, green production, compliance proof, value chain transparency, and digital governance capacity.

Sustainable rules reshape the global seafood trade pattern through compliance costs, market selection, supply chain reorganization, risk transmission, and distributional effects. For China, the high-quality development of seafood trade requires coordination among securing stable supply, upgrading its position in export value chains, and strengthening resource and environmental sustainability. In policy terms, fisheries subsidies should shift from capacity-expansion-oriented support toward support for resource conservation and green transformation; aquaculture should move from a scale-oriented model toward a green-standards-oriented model; traceability systems should evolve from internal enterprise management tools into trade compliance infrastructure; and China should enhance its institutional voice in blue food trade governance through participation in international rules.

This paper is mainly based on literature analysis, rule analysis, and normative analysis, and focuses on explaining the institutional logic of the transformation of sustainable seafood rules. Future research may further combine country cases, enterprise surveys, and trade data to examine the specific effects of different types of sustainable rules on seafood export costs, market entry, value chain position, and the welfare of small and medium-sized producers, thereby providing more empirically grounded policy evidence for blue food trade governance.

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