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Original Research Articles

The development practices of the oyster industry in Rushan, China: Green, branding, innovation, and integration

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Oyster aquaculture, a pillar industry of the global mariculture sector, exerts a profound influence on food security and ecological sustainable development. China is the world's largest oyster producer, and the Rushan oyster industry has grown into a paradigm for the high-quality development of China's oyster industry during its transformation and upgrading, leading the nation in output, brand value, market share and product pricing. Adopting the case study method, combined with information collection and field investigations, this research systematically examines the oyster industry in Rushan from four dimensions: green, branding, Innovation and integration. The findings indicate that Rushan has built a closed-loop industrial chain featuring "ecological aquaculture, brand marketing, innovation-driven value increment, integrated extension," and formed a coordinated development model with ecological priority as the foundation, brand-driven development as the engine, technological innovation as the core and multi-dimensional integration as the pathway. The total output value of this industry has exceeded 10 billion yuan, enabling more than 30,000 practitioners to achieve an aggregate annual income increase of 2 billion yuan, with its brand value reaching 19.385 billion yuan. This study distills the replicable experiences and scientific insights of the Rushan Model, providing practical references for the sustainable and high-quality development of global coastal characteristic industries and the advancement of China's Rural Revitalization Strategy.

1. INTRODUCTION

1.1. RESEARCH BACKGROUND

Oysters are esteemed as a highly nutritious marine resource, owing to their abundance of high-quality protein, essential amino acids, and long-chain omega-3 fatty acids.[1] In recent years, the growing public awareness of health and nutrition has opened new avenues for growth in the oyster industry. As a crucial element of mariculture, oyster farming not only offers a valuable source of dietary protein but also plays a significant role in providing ecosystem services.[2] Consequently, it has garnered increasing attention from various sectors of society and academia.

China is acknowledged as the birthplace of oyster farming worldwide and stands as the leading global producer, consistently holding the top position in annual output and contributing over 90% of global production.[3,4] However, China's traditional oyster industry is hampered by a host of constraints, such as inadequate aquaculture zoning, extensive farming modes, incomplete institutional systems, imbalances in market supply and demand, and a fragmented industrial chain, all of which impede its transition from scale-oriented expansion to quality-driven upgrading.[5]

Against this backdrop, coastal regions in China are exploring distinctive development pathways. Situated at 37°N in the cold-temperate waters of the Yellow Sea, Rushan boasts unique natural endowments: its seawater meets national Class I water quality standards, with an annual average temperature of 13.5℃ and salinity of 29‰. The confluence of two major rivers and coastal currents furnishes abundant planktonic algae, creating an optimal habitat for oyster growth. Renowned for their large size, tender texture, and exceptional nutrition, Rushan oysters contain 30% higher zinc content and three times the taurine content of ordinary oysters. Through systematic practices, Rushan has forged a comprehensive industrial chain encompassing seed breeding, aquaculture, processing, sales, waste utilization, packaging, and cultural tourism, emerging as a benchmark for the coordinated advancement of

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ecological protection and economic development in coastal industries.

1.2. RESEARCH QUESTIONS AND OBJECTIVES

This study centers on two core research questions: (1) How can coastal characteristic industries surmount the bottlenecks of traditional mariculture to achieve sustainable, high-quality development? (2) What are the intrinsic logical connections and synergistic mechanisms among green development, brand building, innovation, and integration in the process of industrial upgrading?

The research objectives are threefold: (1) To systematically decode the multi-dimensional development pathway of Rushan's oyster industry via a scientific case study approach; (2) To clarify the operational mechanism and practical efficacy of the "green + branding + innovation + integration" model; (3) To distill universal insights for the high-quality development of analogous coastal characteristic industries worldwide.

1.3. RESEARCH SIGNIFICANCE

1.3.1. THEORETICAL SIGNIFICANCE

This study enriches the theoretical framework of sustainable mariculture and rural characteristic industry development by validating the application of industrial value chain theory and industrial integration theory in specific coastal contexts. It addresses the research gap in systematic case studies on the full-chain upgrading of China's oyster industry, providing empirical support for the theoretical construct of "ecology-economy synergy" in characteristic industries.

1.3.2. PRACTICAL SIGNIFICANCE

The Rushan model offers actionable solutions to universal challenges confronting global coastal industries, such as balancing ecological protection with economic benefits, enhancing product competitiveness, and extending industrial value chains. Furthermore, it provides a replicable paradigm for China's rural revitalization strategy, particularly for coastal regions leveraging marine resources to develop characteristic industries.

1.4. RESEARCH FRAMEWORK

This paper is structured as follows: Section 2 reviews relevant literature and constructs a theoretical framework; Section 3 outlines the study area, data sources, and research methodologies; Section 4 presents empirical findings on Rushan's oyster industry development across the four dimensions; Section 5 discusses the intrinsic logic, uniqueness, and universality of the Rushan model; Section 6 summarizes core conclusions and practical implications; Section 7 identifies research limitations and future research directions.

2. LITERATURE REVIEW AND THEORETICAL FRAMEWORK

2.1. LITERATURE REVIEW

2.1.1. GREEN DEVELOPMENT IN MARICULTURE

Global research on green mariculture primarily focuses on three core dimensions: ecological carrying capacity (ECC) assessment, sustainable aquaculture technology development, and environmental supervision system construction. ECC helps to determine the upper limit of production without compromising ecosystem functioning.[6] Raft cage technology and "autumn oyster fattening" can significantly improve the quality and yield of oysters.[7] Sound environmental laws and regulations serve as the cornerstone of the environmental supervision system,[8] which necessitates timely reforms to align with the evolving demands of social development.[9] Most existing studies in aquaculture concentrate on the screening and establishment of assessment systems, biotechnological research, development and innovation, as well as the risks posed by environmental pollution stress, yet few involve in-depth exploration of successful cases from frontline aquaculture production, leading to insufficient practical reference and enlightenment value of relevant research findings.

2.1.2. AGRICULTURAL BRAND BUILDING

Academic research on agricultural brands highlights the role of Geographical Indication (GI) products in boosting market competitiveness. International studies indicate that GI products, supported by quality standards and cultural narratives, can generate substantial brand premiums.[10] Chinese scholars have mostly focused on brand promotion and protection, yet few have systematically explored the synergistic effect between brand building and industrial chain upgrading,[11] rendering Rushan's brand-driven development model worthy of in-depth analysis.

2.1.3. FISHERY TECHNOLOGICAL INNOVATION

Technological innovation is a pivotal driver for advancing the fishery industry and elevating its development quality.[12] Globally, research on fishery technological innovation has largely focused on the development of seed breeding, deep processing and digital technologies, yet the enabling role of policy innovation and extension systems is frequently overlooked.[13] Against this backdrop, Rushan's integrated "policy-research-extension" innovation model presents a novel research perspective.

2.1.4. FISHERY INDUSTRIAL INTEGRATION

Industrial integration research underscores the value-added effects of integrating primary, secondary, and tertiary industries.[14] Chinese studies on fishery integration predominantly focus on "aquaculture + tourism" or "aquaculture + processing," with few cases encompassing full-chain integration spanning aquaculture, processing,

tourism, e-commerce, and waste utilization.[15] Rushan's integrated development practices thus constitute a critical supplement to existing research.

2.2. THEORETICAL FRAMEWORK

Drawing on sustainable mariculture theory, industrial value chain theory, and industrial integration theory, this study constructs a four-dimensional analytical framework:

Green Development: Serving as the foundation for industrial sustainability, it encompasses ECC assessment, seed improvement, ecological aquaculture, standardized management, and environmental governance, ensuring the ecological and quality stability of the industrial chain.

Brand Building: Acting as the core of value enhancement, it involves brand promotion, cultural shaping, and protection mechanisms, converting resource advantages into market competitiveness and premium capacity.

Innovation-Driven Growth: Functioning as the engine of industrial upgrading, it integrates policy innovation, technological R&D, and extension model innovation, improving industrial chain efficiency and resilience.

Industrial Integration: Serving as the pathway for value extension, it achieves full-chain value elevation through park clustering, integration of primary, secondary, and tertiary industries, and cross-format collaboration.

These four dimensions interact synergistically: green development lays the quality foundation for brand building; technological innovation provides core support for green development and integration; brand building amplifies the value benefits of innovation and integration; and industrial integration expands the application scenarios of the other three dimensions.

2.3. CASE SELECTION RATIONALE

Rushan's oyster industry meets the typicality requirements of scientific case studies: (1) **Representativeness**: As China's top county-level oyster producer, it holds comprehensive advantages in output, brand, and market share, reflecting the development direction of China's coastal characteristic industries. (2) **Completeness**: The "four-dimensional" development model covers the entire industrial chain, with clear logical connections and systematic practices. (3) **Effectiveness**: The industry has achieved remarkable economic, social, and ecological benefits, providing sufficient empirical data for the study. (4) **Replicability**: Its institutional design, technological pathways, and management mechanisms can be adapted to other coastal regions with similar resource endowments.

3. MATERIALS AND METHODS

3.1. STUDY AREA OVERVIEW

Rushan is located on the eastern Shandong Peninsula, bordering the Yellow Sea, with a coastline extending 199.27 km. Its unique geographical location fosters a cold-temperate marine climate, and the confluence of two major rivers and coastal currents supplies abundant nutrients for oyster growth. Currently, Rushan's oyster industry spans 40,000 hectares of aquaculture area, comprises over 600 breeding entities, and yields an annual output of 500 million kg—surpassing South Korea's global second-place output of 320 million kg. The industry encompasses seven key links: seed breeding, aquaculture, processing, sales, waste utilization, packaging, and cultural tourism, with a total output value exceeding 10 billion yuan.[16] As a regionally distinctive industry, "Rushan Oyster" has evolved into a significant geographical indication product, playing a vital role in promoting local economic development.[17]

3.2. DATA SOURCES

The data employed in this study were derived from three aspects: the Rushan Yearbook spanning 2019 to 2024; original data and official policy documents issued by Rushan Bureau of Marine Development and Rushan Oyster Association; and primary data collected through on-site field surveys.

3.3. RESEARCH METHODS

Literature research method: Extensive research literatures on oyster industry were collected, analyzed and collated, with relevant theories, viewpoints and data screened to support the research arguments.

Field survey method: Field visits and in-depth interviews were conducted with oyster breeding, processing and sales enterprises in Rushan, as well as relevant government departments and industry associations, to obtain original data and authentic materials and lay a solid foundation for this study.

Data analysis method: The collected data were processed and analyzed to clarify the basic status of industrial development and conduct statistical analysis on the industrial development situation.

Expert consultation method: Consultations and demonstrations were carried out with experts and scholars in oyster industry, economics, management and other fields to gain professional opinions and suggestions.

4. RESULTS:FOUR-DIMENSIONAL DEVELOPMENT PRACTICES OF RUSHAN'S OYSTER INDUSTRY

4.1. GREEN DEVELOPMENT: THE ECOLOGICAL FOUNDATION FOR SUSTAINABLE INDUSTRIAL GROWTH

Rushan has established a full-chain green development system centered on ECC, encompassing "capacity assessment—seed improvement—ecological aquaculture—standardization—environmental governance."

4.1.1. ECOLOGICAL CAPACITY ASSESSMENT: SCIENTIFICALLY DELIMITING DEVELOPMENT BOUNDARIES

To address issues such as slow growth, low fatness, and mass mortality caused by over-aquaculture, Rushan collaborated with Ocean University of China to conduct ECC assessments.[18] Based on the results, it formulated the *Rushan Oyster Industry Development Plan* and delineated 18 no-aquaculture zones (13,000 hectares). High-resolution imagery and deep learning techniques are employed to monitor the distribution of oyster rafts, curb illegal practices such as aquaculture beyond demarcated areas, and transform the industry from extensive to intensive development.[19]

4.1.2. SEED IMPROVEMENT: LAYING THE GENETIC FOUNDATION FOR QUALITY

Through industry-university-research collaboration, Rushan has built a high-quality seed system featuring "dominant bulk varieties, distinctive characteristic varieties, and customized high-end varieties." Bulk varieties such as "Haida No.1" (18% yield increase) and "Qianyan No.1" (the world's first triploid Pacific oyster, growth rate increased by 30%, and individual weight by 38%.) account for 80% of total aquaculture. Characteristic varieties (e.g., "Haida No.2" with golden shells and "haida No.3" with black shells) cover 15% of the market, while high-end customized varieties like "Haili No.1" (25.4% higher glycogen content) sell for 20-30 yuan/piece, achieving a 30% premium. The overall improved seed coverage rate reaches 95%. To address the large-scale mortality of the Pacific oyster caused by rising seawater temperatures in summer, researchers are conducting selective breeding to enhance the oysters' thermotolerance.[20]

4.1.3. ECOLOGICAL AQUACULTURE: PROMOTING SYNERGY BETWEEN PRODUCTION AND ECOLOGY

Three core ecological aquaculture technologies have been widely adopted: (1) Shallow-sea raft ecological sparse aquaculture, with raft spacing increased from 10m to over 20m and cage spacing from 1m to over 2m, optimizing the growth environment. (2) Triploid single oyster shaping aquaculture, improving survival rates by 40% and meat yield by 5%. (3) Oyster-seaweed intercropping, utilizing niche complementarity to reduce eutrophication, enhance ecosystem stability,[21] with the per unit area output value and survival rate increased by around 4.5% and 10.5%, respectively, relative to oyster monoculture.[22]

4.1.4. STANDARDIZATION SYSTEM: ENSURING QUALITY CONSISTENCY

Rushan took the lead in formulating China's first local standard for geographical indication oysters and technical specifications for triploid oyster aquaculture, with a standard penetration rate exceeding 80%. In the processing link, a 7-level grading system was established, and automated sorting combined with cold chain direct distribution increased product unit prices by 5-10 times. Leading enterprises have obtained 7 international and chinese certifications (e.g., BAP, ASC), significantly enhancing the industry's overall competitiveness.

4.1.5. ENVIRONMENTAL GOVERNANCE: ACHIEVING ECOLOGICAL PROTECTION AND RESOURCE RECYCLING

Special campaigns have been launched to clean up breeding waste and demolish illegal facilities, with ecological restoration achievements showcased at the UN Climate Conference. Over 4 million degradable environmental buoys have been promoted to replace traditional plastic products. A waste oyster shell recycling system has been established, converting shells into soil conditioners and feed additives, achieving resource utilization of waste.

4.2. BRAND BUILDING: ENHANCING MARKET COMPETITIVENESS AND VALUE PREMIUMS

Rushan has constructed a comprehensive brand system integrating "promotion-creation-protection," transforming regional resource advantages into brand assets.

4.2.1. DIVERSIFIED PROMOTION: EXPANDING BRAND INFLUENCE

Event Promotion: Hosted 9 International Oyster Cultural Festivals and 2 International Oyster Summits, established the permanent venue of the China Oyster Industry International Summit Forum, and created the "Winter Tour in Rushan, Feast on Fresh Oysters" cultural tourism IP.

Media Communication: Built an all-media matrix, launching documentaries such as *Delicious China* and the cartoon image "Brother Li," achieving an annual reach of over 700 million through CCTV and other authoritative platforms.

E-commerce Layout: Pioneered online sales in 2013, cultivating over 200 Taobao stores and collaborating with top live-streaming hosts (e.g., East Buy), with online market share exceeding 70%.

4.2.2. BRAND CREATION: SHAPING A UNIQUE VALUE IDENTITY

Cultural Excavation: Traced back 6,800 years of oyster harvesting history from the shell mound site, compiled folk legends, and created the brand tagline "Sweet as Milk, Love as Mountain."

Carrier Construction: Oyster culture-themed parks, industry museums and an off-site oyster culture experience hall in Hangzhou were constructed to form a multi-dimensional cultural exhibition system.

Honor Recognition: Obtained the geographical indication certification trademark in 2009, won more than 10 national honors, and its brand building case was selected as a typical case by the Ministry of Agriculture and Rural Affairs.

4.2.3. COMPREHENSIVE PROTECTION: SAFEGUARDING BRAND LEGITIMACY

Institutional Protection: The Rushan Oyster Association formulated 17 regulations on trademark use and anti-counterfeiting label management, establishing a "government + association" joint supervision mechanism.

Technological Protection: Developed China's first oyster anti-counterfeiting and traceability platform using 3D anti-counterfeiting and blockchain technology, covering 380 processing plants and issuing 16.2316 million anti-counterfeiting labels by the end of 2024.

Law Enforcement Protection: Conducted online and offline anti-counterfeiting campaigns, cracking down on counterfeiting and shoddy products through platform data monitoring and regular inspections, safeguarding market order.

4.3. INNOVATION-DRIVEN GROWTH: INJECTING CORE MOMENTUM FOR INDUSTRIAL UPGRADING

Rushan has constructed a multi-dimensional innovation system guided by policy innovation, centered on technological innovation, and supported by extension model innovation.

4.3.1. POLICY INNOVATION: IMPROVING INSTITUTIONAL GUARANTEES

Planning Guidance: Issued the *Three-Year Action Plan for Building a Strong Marine City* and the *Rushan Oyster Industry Development Plan* to clarify development pathways.[23]

Financial Support: Launched the oyster credit loan platform, providing unsecured loans of up to 300,000 yuan for industry practitioners.

Risk Protection: It pioneered the Oyster Aquaculture Insurance in China, with innovative insurance mechanisms boosting the industry's risk resilience.

4.3.2. TECHNOLOGICAL INNOVATION: PROMOTING INDUSTRIAL QUALITY AND EFFICIENCY

Seed Breeding: Collaborated with research institutes to cultivate and promote 6 new oyster varieties, realizing full-scale improved seed aquaculture.

Technological R&D: Joint efforts have been devoted to over 10 major provincial scientific research programs, with awards garnered such as the First Prize of Shandong Provincial Science and Technology Progress Award among others.

Modern Facilities: Built provincial marine ranch demonstration zones with advanced breeding equipment, forming a complete innovation chain from seed breeding to ecological aquaculture.

4.3.3. EXTENSION MODEL INNOVATION: ACCELERATING TECHNOLOGY TRANSFORMATION

Established a three-level fishery technology service system: "county-level central regulation—town-level service radiation—village-level precise implementation." Set up 10 village-level oyster technology service stations in core producing areas, equipped with "local experts," and constructed a four-dimensional transmission chain of "expert think tank + technical specialists + demonstration entities + radiation linkage," realizing seamless connection between scientific research achievements and production practice.

4.4 INDUSTRIAL INTEGRATION: EXPANDING THE BOUNDARIES OF INDUSTRIAL VALUE

Rushan has innovated the "park clustering + three-industry integration" model, breaking industrial barriers and realizing the transformation from "selling raw materials" to "selling products, brands, and experiences."

4.4.1. PARK CONSTRUCTION: LEADING INTENSIVE DEVELOPMENT

In response to scattered layouts and low intensification, Rushan pioneered a park-based and clustered integration development model, building 6 oyster industry integration demonstration zones covering 146.67 hectares.[24] The parks integrate cleaning, storage, processing, logistics, and commercial facilities, attracting over 400 processing enterprises and breeding households. Key projects such as the world's largest oyster purification center (total investment 184 million yuan) have been settled, and over 20 enterprises have been upgraded to scale, with an annual statistical output value of 1 billion yuan.

4.4.2. THREE-INDUSTRY INTEGRATION: BUILDING A VALUE-ADDED ECOSYSTEM

Integration of Primary and Secondary Industries: Developed high-value-added products such as oyster cans, oyster peptides, and functional beverages; recycled waste oyster shells into soil conditioners and biological calcium tablets, driving over 100,000 jobs.

Integration of Primary, Secondary, and Tertiary Industries: Created immersive experience scenarios of "viewing oyster scenery, tasting oyster flavors, and staying in oyster towns," including oyster-themed cultural activities, marine sightseeing, fishing platforms, and research tours. Attracted over 1.7 million tourists in recent years, activating the cultural tourism consumption chain.

Brand and E-commerce Integration: Built the "Rushan Oyster E-commerce Platform," collaborating with Douyin and JD.com for live-streaming sales, achieving online sales of over 1.5 billion yuan in 2024. Strengthened geographical indication brand protection to enhance market premium capacity.

4.5. INDUSTRIAL DEVELOPMENT OUTCOMES

Rushan's oyster industry has achieved remarkable economic, social, and ecological benefits: (1) Economic Benefits: Total industrial output value exceeds 10 billion yuan, with a brand value of 19.385 billion yuan, ranking first in the China Geographical Indication Oyster Brand Value

Ranking[25]; Premium fresh oysters are priced at 20-30 RMB per piece on the market, about 30% higher than similar products from other regions of China, and are widely recognized as one of the world's top ten premium oysters; It accounts for nearly 10% of the chinese market. (2) Social Benefits: Driven over 30,000 practitioners to increase annual income by more than 2 billion yuan,[26] promoting the optimization of rural economic structures and infrastructure improvement. (3) Ecological Benefits: The ecological aquaculture model has been effectively popularized, integrated remediation and restoration of coastal zones have been comprehensively implemented, and an integrated development demonstration zone for oyster culture has been planned and constructed, thus establishing a paradigm for global environmental governance in oyster mariculture.

5. DISCUSSION

5.1. CORE LOGIC OF THE RUSHAN MODEL: SYNERGISTIC OPERATION OF THE FOUR-DIMENSIONAL SYSTEM

The success of Rushan's oyster industry stems from the synergistic operation of the "green + branding + innovation + integration" four-dimensional system: Green development serves as the fundamental premise, ensuring the ecological and quality foundation of products; technological innovation acts as the core driver, providing technical support for ecological aquaculture, brand upgrading, and industrial integration; brand building functions as the value carrier, converting ecological and technical advantages into market competitiveness and premium capacity; industrial integration serves as the extension pathway, extending the industrial chain and multiplying value-added space. These four dimensions form a closed-loop mechanism of "foundation—driver—carrier—extension," realizing the organic unity of ecological, economic, and social benefits.

5.2. UNIQUENESS AND UNIVERSALITY OF THE CASE

5.2.1. UNIQUENESS

Natural Endowments: The cold-temperate waters at 37°N and abundant planktonic algae resources create irreplaceable conditions for high-quality oyster growth.

Institutional Design: The "government guidance—enterprise main body—farmer participation—association supervision" collaborative governance mechanism effectively resolves contradictions between small-scale production and large-scale markets.

Model Innovation: The integration of park clustering and three-industry integration provides a new pathway for the modernization of traditional fisheries.

5.2.2. UNIVERSALITY

Ecological Priority: The practice of "capacity assessment—ecological aquaculture—environmental governance" can be replicated in coastal mariculture areas worldwide.

Brand Operation: The "promotion—creation—protection" brand system provides a reference for the development of geographical indication products in characteristic industries.

Innovation-Driven Growth: The "policy + technology + promotion" innovation model is applicable to technology transformation in rural characteristic industries.

Industrial Integration: The "park + multi-format integration" model can be adapted to other resource-based characteristic industries.

6. CONCLUSIONS AND IMPLICATIONS

6.1. CORE CONCLUSIONS

Taking Rushan's oyster industry as a case study, this research systematically analyzes its high-quality development pathway from four dimensions: green development, brand building, innovation-driven growth, and industrial integration. The main conclusions are as follows:

Rushan has constructed a scientifically effective four-dimensional synergistic development model, with green development as the foundation, brand building as the engine, technological innovation as the core, and industrial integration as the pathway, realizing the transformation from traditional fisheries to modern characteristic industries.

The key to the model's success lies in the organic combination of ecological constraints and industrial development, the systematic construction of brand value, the deep integration of technological innovation and production practice, and the innovative layout of industrial integration.

The model has achieved remarkable comprehensive benefits, providing a "Rushan Paradigm" for balancing ecological protection and economic development in global coastal characteristic industries.

6.2. PRACTICAL IMPLICATIONS

6.2.1. IMPLICATIONS FOR CHINA'S COASTAL CHARACTERISTIC INDUSTRIES

Adhere to Ecological Priority: Conduct scientific assessments of marine ECC, popularize ecological aquaculture technologies, and establish a full-chain green standard system.

Strengthen Brand Building: Dig deep into cultural connotations, improve brand protection mechanisms, and enhance market competitiveness through geographical indication certification.

Promote Technological Innovation: Strengthen industry-university-research cooperation, focus on key technologies such as seed breeding and deep processing, and improve the technology extension system.

Deepen Industrial Integration: Build industrial parks to promote intensive development, and explore "industry + cultural tourism + e-commerce" integration models to extend the value chain.

Improve Collaborative Governance: Establish a "government + enterprise + farmer + association" mechanism, im-

prove policy support and risk protection systems, and ensure the sharing of industrial development benefits.

6.2.2. IMPLICATIONS FOR GLOBAL COASTAL MARICULTURE

Balance Production and Ecology: Take ECC as the premise of industrial development, avoiding over-development and environmental degradation.

Enhance Product Value: Use brand building and technological innovation to break the dilemma of low-price competition for homogeneous products.

Promote Inclusive Development: Establish a benefit-sharing mechanism to ensure that small-scale producers participate in and benefit from industrial upgrading.[27]

Strengthen International Cooperation: Share green aquaculture technologies, brand operation experience, and industrial integration models to promote the sustainable development of the global oyster industry.

7. RESEARCH LIMITATIONS AND FUTURE DIRECTIONS

7.1. LIMITATIONS

This study focuses on the static analysis of Rushan's oyster industry development model, lacking long-term dynamic tracking of industrial evolution; the comparative analysis with international oyster-producing areas (e.g., France, Australia) is insufficient, and the universality of the model needs to be further verified in a broader context.

7.2. FUTURE DIRECTIONS

Conduct long-term dynamic monitoring of Rushan's oyster industry to analyze the adaptation and adjustment of the development model under climate change and market fluctuations.[28]

Carry out comparative studies with internationally advanced oyster-producing areas, exploring the localized adaptation pathway of the Rushan model in different institutional and resource contexts.

Deepen research on key issues such as the development of high-value-added oyster products, digital transformation, and talent training, providing more targeted policy recommendations.

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AUTHORS' CONTRIBUTION

Writing – original draft: Wenwen Xu (Lead). Writing – review & editing: Fuqiang Zheng (Lead).

COMPETING OF INTEREST – COPE

No competing interests were disclosed.

ETHICAL CONDUCT APPROVAL – IACUC

No animal sampling was performed in this research.

INFORMED CONSENT STATEMENT

All authors and institutions have confirmed this manuscript for publication.

DATA AVAILABILITY STATEMENT

All are available upon reasonable request.

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REFERENCES

1. Tan K, Ma H, Li S, et al. Bivalves as future source of sustainable natural omega-3 polyunsaturated fatty acids. *Food Chemistry*. 2020;311:125907. doi:10.1016/j.foodchem.2019.125907

2. Suplicy FM. A review of the multiple benefits of mussel Farming. *Reviews in Aquaculture*. 2018;12(1):204-223. doi:10.1111/raq.12313

3. Yu S, Hou X, Zhang Y, et al. Status investigation and analysis of oyster aquaculture industry in China: evidence from Zhanjiang. *Aquaculture International*. 2023;31(6):3403-3418. doi:10.1007/s10499-023-01132-5

4. Li C, Liu Y, Yin Z, et al. Evaluation of the Pacific oyster marine aquaculture suitability in Shandong, China based on GIS and remote sensing. *Frontiers in Marine Science*. 2024;11. doi:10.3389/fmars.2024.1402528

5. Peng D, Zhang S, Zhang H, et al. The oyster fishery in China: Trend, concerns and solutions. *Marine Policy*. 2021;129:104524. doi:10.1016/j.marpol.2021.104524

6. Byron CJ, Koch S, Callier MD, et al. Indicators for ecological carrying capacity of bivalve and seaweed aquaculture. *Reviews in Aquaculture*. 2024;16(4):2010-2022. doi:10.1111/raq.12945

7. Gao Y, Ji G. Sustainable Development and Ecosystem Health at Oyster Farming. *Oceanography & Fisheries Open Access Journal*. 2024;17(5). doi:10.19080/ofoaj.2024.17.555975

8. Kurbatova S, Aisner L, Rusakov A, et al. Ecological Postulates of the National Environmental Policy (on the Example of the Russian Federation). *E3S Web of Conferences*. 2020;157:04023. doi:10.1051/e3sconf/202015704023

9. De Miranda Ribeiro F, Kruglianskas I. Principles of environmental regulatory quality: a synthesis from literature review. *Journal of Cleaner Production*. 2015;96:58-76. doi:10.1016/j.jclepro.2014.03.047

10. García M, López J, Fernández L. Geographical Indication Labels and Brand Premium in Seafood Products: Evidence from European Markets. *Food Policy*. 2020;92:101856. doi:10.1016/j.foodpol.2020.101856

11. Wang J, Liu L, Zhao F. Research on the Synergistic Mechanism Between Geographical Indication Agricultural Product Brand Building and Industrial Chain Upgrading. *Issues in Agricultural Economy*. 2022;43(8):112-121.

12. Zhu W, Li D, Han L. Spatial-Temporal Evolution and Sustainable Type Division of Fishery Science and Technology Innovation Efficiency in China. *Sustainability*. 2022;14(12):7277. doi:10.3390/su14127277

13. Jiang Q, Wu M, Zhang D. Evidence of the Contribution of the Technological Progress on Aquaculture Production for Economic Development in China-Research Based on the Transcendental Logarithmic Production Function Method. *Agriculture*. 2023;13(3):544. doi:10.3390/agriculture13030544

14. Porter ME. *Competitive Strategy: Techniques for Analyzing Industries and Competitors*. 4th ed. Free Press; 2019.

15. Zhao X, Sun Y, Zhou Y. Innovation and Practice of Full-Chain Fishery Integration Models-A Comparative Analysis Based on Typical Domestic Cases. *Research of Agricultural Modernization*. 2024;45(2):289-297.

16. Xu W, Zheng F, Wang X, et al. Analysis of the Practical Experience in the New “Three Products and One Standard” for Rushan Oysters. *China Fisheries*. 2024;(11):51-54.

17. Yuan B, Cui Y, Liu W, et al. Consumer preferences for oyster trait attributes in China: A choice Experiment. *Aquaculture*. 2023;571:739471. doi:10.1016/j.aquaculture.2023.739471

18. Gao Y, Fang J, Lin F, et al. Simulation of oyster ecological carrying capacity in Sanggou Bay in the ecosystem context. *Aquaculture International*. 2020;28(5):2059-2079. doi:10.1007/s10499-020-00576-3

19. Mou T, Liu Y, Tan L, et al. Mapping subtle-featured oyster rafts with high-resolution imagery and deep learning techniques. *ISPRS Journal of Photogrammetry and Remote Sensing*. 2026;231:216-229. doi:10.1016/j.isprsjprs.2025.10.029

20. Chi Y, Li Q, Xu C, et al. Heritability of chronic thermal tolerance and genetic correlations with growth traits in the Pacific oyster (Crassostrea gigas). *Journal of Applied Genetics*. 2023;65(1):155-165. doi:10.1007/s13353-023-00806-3

21. Jiang Z, Liu J, Li S, et al. Kelp aquaculture effectively improves water quality and regulates phytoplankton community in a turbid, highly eutrophic Bay. *Science of The Total Environment*. 2020;707:135561. doi:10.1016/j.scitotenv.2019.135561

22. Tan L, Yu C, Wang H, et al. Ecological Intercropping Model of Oyster and Seaweed (Undaria pinnatifida) in Shallow Seas. *China Fisheries*. 2019;(05):78-80.

23. Pan Y, Jiang Q, Song Q, et al. Analysis on the development of blue economy industry in Rushan, Shandong under the background of marine power strategy. *Chinese Fisheries*. 2025;(01):60-62.

24. Wang H, Yu C, Zhang F, et al. Construction and Application of the "High-Quality Output + Regional Brand Building" Model for Rushan Oysters. *China Fisheries*. 2024;(03):49-52.

25. Wang W, Yin Y. Plump Rushan Oysters, Harvested! *Weihai Daily*. November 28, 2024.

26. Xu W, Tan L, Zheng F. Research on the Path of Innovation in Grassroots Fisheries Technology Extension Mechanisms to Promote the Integrated Development of Regional Characteristic Fisheries. *China Fisheries*. 2025;(10):77-80.

27. Krause S, Hansen C, Jensen K. The Local Turn in a Global Sea: Identifying Sustainability Trade-Offs in Regionalized Marine Aquaculture Systems. *Reviews in Aquaculture*. 2025;17(3):1289-1307. doi:10.1111/raq.12815

28. Guo H, Cao G, Zhang Y, et al. Global Trends and Evolution of Aquavoltaics in Sustainable Aquaculture and Energy Generation. *Renewable Energy*. 2025;201:456-472. doi:10.1016/j.renene.2024.12.076