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Short Communication

Advancing marine economic development through the new development philosophy: implications for aquaculture and fisheries

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General Secretary Xi Jinping emphasized that “Throughout the history of world economic development, an obvious track is from the land to the ocean, and move toward the world, be prosperity through the ocean”. Marine aquaculture and fisheries, as core components of the marine economy and critical aquatic food production systems, play a pivotal role in ensuring food security, promoting coastal livelihoods, and advancing ecological civilization. Against the backdrop of China’s convergence with the two centenary goals, the Fourth Plenary Session of the 19th Central Committee of the Communist Party of China highlighted the importance of high-quality development and the new development philosophy, which provides a fundamental framework for the transformation of marine aquaculture and fisheries.

This thematic review focuses on marine aquaculture and capture fisheries, linking the new development philosophy (innovation, coordination, greenness, openness, sharing) to aquatic food system sustainability. By analyzing the current status, structural changes, and key constraints of China’s marine aquaculture and fisheries (including technological bottlenecks, ecological pressures, regional imbalances, and livelihood challenges), and drawing on international experiences from leading aquaculture regions, this paper proposes targeted pathways for sustainable development. The study aims to bridge policy goals with practical applications in aquaculture and fisheries science, providing insights for researchers, managers, and policymakers both in China and globally.

INTRODUCTION

POSITIONING THE STUDY WITH IN AQUACULTURE AND FISHERIES SCIENCES

“Throughout the history of world economic development, a clear trajectory is to move from the inland to the ocean, and from the ocean to the world and towards prosperity”.[1] General Secretary Xi Jinping’s words have pointed out the great significance of vigorously developing the marine economy. Developed economies are inseparable from the ocean, and the development of the marine economy is the only way for a country to become powerful. To develop the marine economy, the National “13th Five-Year Plan” set up a special chapter on “expanding the blue economic space”, and took “adhering to the overall planning of land and sea and developing the marine economy” as an important deployment for China’s national economic and social development, and the marine economy is moving towards high-quality development.

At present, China is at the historical intersection of the two centenary goals. The Fourth Plenary Session of the 19th Central Committee of the Communist Party of China pointed out that “promote the high-quality development of the economy, fully implement the new development concept, and accelerate the construction of a modern economic system”.[2] The development of the marine economy must also always adhere to the new development concept. Analyzing Xi Jinping’s relevant discussions on the development of the marine economy, it can be found that the new development concept has always run through it. At present, there are gaps in the innovation, coordination, greenness, openness and sharing of China’s marine economic development. Combining the spirit of the Fourth Plenary Session of the 19th Central Committee of the Communist Party of China, this paper puts forward relevant suggestions on accelerating the high-quality development of the marine economy based on the new development concept.

The marine economy is increasingly recognized as a critical driver of global food security, with marine aquaculture (mariculture) and fisheries accounting for over 20% of an-

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Table 1. This framework is aligned with international initiatives such as the FAO's Ecosystem Approach to Aquaculture (EAA) and the Sustainable Development Goal 14 (Life Below Water), emphasizing the need for integrated, cross-sectoral governance.

New Development Principle	Core Implications for Aquaculture & Fisheries
Innovation	Technological advancement (e.g., offshore cages, RAS, IMTA), selective breeding, feed sustainability, and digital monitoring systems.
Coordination	Land-sea integration in coastal zoning, balanced regional development, and synergy between capture fisheries and aquaculture.
Greenness	Ecosystem-based aquaculture planning, pollution control, carrying capacity management, and restoration-linked farming models.
Openness	Seafood trade liberalization, technology transfer, and international collaboration in fisheries management (e.g., FAO's EAFM).
Sharing	Livelihood support for small-scale fishers, equitable distribution of economic benefits, and improved access to safe aquatic products.

imal protein consumption worldwide (FAO, 2022). As the world's largest producer and consumer of aquatic products, China's marine aquaculture and fisheries sector plays a pivotal role in national food security, rural livelihoods, and economic growth. However, the sector faces unprecedented challenges, including resource depletion, environmental degradation, technological bottlenecks, and structural imbalances, which necessitate a paradigm shift toward sustainability.

CONCEPTUAL FRAMEWORK: LINKING THE NEW DEVELOPMENT PHILOSOPHY TO AQUACULTURE AND FISHERIES SUSTAINABILITY

The new development philosophy provides a holistic framework for transforming marine aquaculture and fisheries toward sustainability, with direct linkages to key sectoral outcomes.

XI JINPING'S IDEOLOGICAL CONTEXT ON THE DEVELOPMENT OF MARINE ECONOMY

Xi Jinping's thought on developing the marine economy originated in Fujian, was enriched in Zhejiang, continued in Shanghai, and has been continuously improved and enhanced at the central level.

FORMATION OF THE CONCEPT OF MARINE ECONOMY DEVELOPMENT IN FUJIAN

During his work in Xiamen, Xi Jinping presided over the formulation of Xiamen's development strategy, proposing the construction of a free trade port, ecological environment protection, the preservation, development and utilization of Gulangyu's cultural and tourism resources, as well as the development of maritime transportation and marine tourism.

After being transferred to work in Ningde, Xi Jinping, through in-depth research and combining the advantages of Ningde's mountain and marine resources, put forward the idea of "relying on the sea, living off the sea, and developing the marine economy".[3] He focused on tidal flat aquaculture and offshore fishing, and promoted the development of marine fishery and marine aquatic product processing.

During his tenure in Fuzhou, Xi Jinping systematically expounded his in-depth understanding of the marine economy, pointing out that the marine economy is an inevitable trend of economic development and an important way to foster new growth drivers for the economy. He also proposed to build "Maritime Fuzhou",[4] with the development of islands as the foundation, the development of coastal zones as the focus, and the comprehensive utilization of the ocean as a breakthrough point.

During his term as Governor, Xi Jinping took the lead in putting forward the strategy of "building a strong marine province".[5] He emphasized the need to focus on developing three advantageous industries: marine fishery, marine port transportation, and coastal tourism, and to cultivate and expand three emerging industries: marine energy, marine pharmaceuticals and health care, and marine information services.

In summary, during his work in Fujian, Xi Jinping's concepts on developing the marine economy were based on the actual local conditions, giving full play to the advantages of marine industries, and focusing on the comprehensive development of the ocean, optimization of the marine industrial structure, and improvement of the marine development layout. At that time, developing the marine economy was still a new topic, and this series of concepts demonstrated his forward-looking understanding of marine economy development.

PRACTICE OF BUILDING A POWERFUL MARINE ECONOMY PROVINCE IN ZHEJIANG

During his tenure in Zhejiang, Xi Jinping attached greater importance to the development of the marine economy. In January 2003, during his research in Zhoushan, he pointed out that "doing a good job in developing the marine economy is a long-term strategic task",[6] elevating the development of the marine economy to a strategic level. In July, at the Fourth Plenary Session of the 11th CPC Zhejiang

Provincial Committee, he put forward the "Eight-Eight Strategy" and clearly stated the need to "vigorously develop the marine economy".[1] In October, the CPC Zhejiang Provincial Committee and the People's Government of Zhejiang Province issued Several Opinions on Building a Powerful Province in Marine Economy, which proposed requirements such as taking planning as the guide, relying on scientific and technological progress and institutional innovation as driving forces, accelerating the comprehensive development of marine resources, strengthening the construction of marine infrastructure and environmental protection, and increasing efforts in the cultivation and introduction of marine science and technology talents. Meanwhile, Xi Jinping paid close attention to the implementation of projects such as the Zhoushan Island-Linking Project, the integrated development of Ningbo-Zhoushan Port, the marine biological resources protection project, and the transfer of fishermen to alternative industries.

The above-mentioned efforts reflect Xi Jinping's thinking and practices in promoting the development of the marine economy from multiple aspects, including marine strategic planning, comprehensive management, scientific and technological innovation, resource development and utilization, ecological and environmental protection, talent cultivation, and social and people's livelihood. His ideology on developing the marine economy has become more enriched.

ADAPTING TO LOCAL CONDITIONS FOR MARINE ECONOMY DEVELOPMENT IN SHANGHAI

During his seven - month tenure in Shanghai, Xi Jinping still attached great importance to the development of the marine economy. He proposed that the development of the ocean and the marine economy is of great significance. It is necessary to "give play to Shanghai's advantages in marine science, technology and industry, focus on the development of marine high - tech industries, emerging marine industries, marine transportation, etc.", "form a reasonable industrial division of labor with other regions, develop in a differentiated way, and avoid excessive competition", and "strengthen cooperation with brother provinces and cities, especially in the Yangtze River Delta region, and further expand the cooperation space in the marine economy".[7] Based on the analysis of the land - sea space conditions of Shanghai itself and its surrounding provinces and cities, Xi Jinping's thinking on the development of the marine economy has been further sublimated.

DEVELOPING MARINE ECONOMY FROM A GLOBAL PERSPECTIVE AT THE CENTRAL LEVEL

After coming to work at the central government, especially after the 18th National Congress of the Communist Party of China, Xi Jinping's thinking on developing the marine economy has reached a new height. In 2013, the Political Bureau of the Central Committee conducted a collective study on building a maritime power. General Secretary Xi Jinping emphasized that "a developed marine economy is an important support for building a maritime power... and efforts should be made to make the marine industry a pillar industry of the national economy."[8] In 2018, when deliberating with the Shandong delegation at the first session of the 13th National People's Congress, Xi Jinping stressed the need to "accelerate the construction of world - class marine ports and a complete modern marine industry system."[9] During his inspection in Shandong in June of the same year, Xi Jinping emphasized that "the development of the marine economy has boundless prospects. To build a maritime power, it is necessary to pay more attention to the ocean, understand the ocean, and manage the ocean, and accelerate the pace of marine scientific and technological innovation."[10] In 2013, the initiative of jointly building the "21st Century Maritime Silk Road" was put forward. In 2015, the cooperation in marine fields such as the marine economy was proposed. In 2019, the concept of a maritime community with a shared future was proposed for the first time, hoping to "promote the development of the blue economy, the integration of marine cultures, and jointly enhance marine well - being."[9] In talks with the leaders of coastal countries such as Portugal, the Maldives, Seychelles, and Suriname, Xi Jinping has also repeatedly proposed strengthening cooperation in the field of marine economy. The development of the marine economy has become an important aspect of the maritime power strategy, an important area of major - country diplomacy, and an important content of building a maritime community with a shared future, reflecting the global vision of Xi Jinping's thinking on developing the marine economy.

EMBODIMENT OF THE NEW DEVELOPMENT PHILOSOPHY IN XI JINPING'S THOUGHT ON MARINE ECONOMY DEVELOPMENT

Xi Jinping Thought on Developing the Marine Economy has been gradually put into practice during his work at the local level. From focusing on the development of a single marine industry to comprehensively considering all aspects of the marine economy such as science, technology and the environment, and from focusing on regions and basing itself on China to looking at the world and promoting connectivity, it all embodies the concepts of innovation, coordination, green development, openness and sharing. The new development concepts are the forerunner of the scientific development of the marine economy and should be implemented and adhered to now and for a longer period in the future.

In terms of innovation, the following propositions have been put forward: "We must rely on scientific and technological progress, constantly expand the fields of marine development, and improve the grade and level of marine industries"[11]; "We should strengthen institutional innovation and scientific and technological innovation to inject new vitality and impetus into the development of the marine economy"[1]; "Relying on universities and scientific research institutes, we should focus on developing marine high-tech industries and emerging marine industries".[7]

In terms of coordination, the propositions include: "We should strengthen the linked development of land economy and marine economy" and "We should make overall plans for marine development and maritime rights protection".[10]

In terms of green development, the propositions are: "In developing the marine economy, we must never sacrifice the marine ecological environment"[12]; "We should strive to transform the mode of marine development into a circular utilization-oriented one"[8]; "We must attach great importance to the construction of marine ecological civilization".[13]

In terms of openness, the propositions put forward are: "To promote the development of the marine economy, we need to further reform and opening up"[3]; "We should promote maritime connectivity and practical cooperation in various fields to advance the development of the blue economy".[14]

In terms of sharing, the propositions include: "We should ensure that the people have access to green, safe and reassuring marine products and enjoy the blue sea, clear sky and clean beaches"[1]; "We should let the people of all countries in the world share the fruits of the development of the marine economy".[15]

STATUS OF MARINE AQUACULTURE AND FISHERIES DEVELOPMENT IN CHINA

China's mariculture sector has experienced rapid growth, with output increasing from 17.3 million tons in 2012 to 21.3 million tons in 2018.[16] Key shifts include: a transition from nearshore to offshore aquaculture, driven by policies promoting "open-sea farming" (e.g., Zhoushan offshore cage clusters);

Expansion of ecological aquaculture models, such as Integrated Multi-Trophic Aquaculture (IMTA) in Fujian and Guangdong provinces;

Diversification of species, with increased production of high-value species (e.g., sea cucumbers, abalone, and grouper) alongside traditional staples (e.g., oysters, shrimp).

However, the sector remains dominated by extensive and semi-intensive systems, with limited adoption of intensive technologies (e.g., Recirculating Aquaculture Systems, RAS) compared to global leaders like Norway.

Capture fisheries have undergone significant restructuring in response to overfishing and stock depletion:

Total marine capture output stabilized at 10 million tons annually (2012–2018), with the mariculture-to-capture ratio rising from 1.3:1 to 1.9:1[16];

Implementation of a nationwide summer fishing moratorium (3–4 months) and stock enhancement programs (e.g., release of fish larvae in the Bohai Sea and East China Sea);

Diversification of livelihoods for coastal fishers, including transitions to aquaculture, marine tourism, and aquatic product processing.

Despite these efforts, over 60% of China's marine fish stocks are classified as overexploited or depleted,[17] highlighting the need for stronger science-based management.

CURRENT STATUS AND MAJOR PROBLEMS OF CHINA'S MARINE ECONOMY DEVELOPMENT

After years of development, China's marine economy has significantly enhanced its strength, forming a relatively complete marine industry system. This system takes marine tourism, marine transportation, and marine fishery as its pillars, and covers marine emerging industries such as marine pharmaceuticals and biological products, marine renewable energy utilization, and seawater utilization.

China's marine economy has generally maintained a steady and positive development trend, and has gradually become a pillar of the national economy.

CURRENT STATUS OF CHINA'S MARINE ECONOMY DEVELOPMENT

Currently, China's marine economy is shifting from high-speed development to high-quality development, with a generally stable operation and its development quality continuing to improve.

STABLE CONTRIBUTION OF MARINE ECONOMY[16]

China's marine economy has continued to expand in scale, and its role as an engine driving national economic growth has been consistently exerted. In 2018, the total output of the marine economy reached 8.3415 trillion yuan; converted at the annual average exchange rate, this was nearly equivalent to the total economic output of Spain or Australia in the same period. It accounted for 9.3% of China's gross domestic product (GDP), exceeding 9% for 15 consecutive years. Compared with 2017, it grew by 6.7%, which was 0.1 percentage points higher than the growth rate of the national economy in the same period, and its contribution rate to national economic growth reached 9.4%. The number of marine-related employees across the country stood at 36.84 million, accounting for 4.7% of the national employment population, remaining the same as in 2017.

CONTINUOUS OPTIMIZATION OF MARINE INDUSTRY STRUCTURE[15]

Since the 18th CPC National Congress, the three-industry structure of China's marine economy has adjusted from 5.3:46.7:47.9 in 2012 to 4.4:37.0:58.6 in 2018, with the industrial structure undergoing continuous optimization.

Among them, the proportion of the tertiary industry (dominated by marine transportation and marine tourism) increased by 10.7 percentage points, showing a strong development momentum. For the primary industry (focused on mariculture and marine fishing), its proportion decreased by 0.9 percentage points; meanwhile, the ratio of mariculture output to marine fishing output adjusted from 1.3 in 2012 to 1.9 in 2018, indicating a further transformation in the mode of marine fishery production.

CONTINUOUS GROWTH OF NEW DRIVERS FOR MARINE ECONOMY DEVELOPMENT

Emerging marine industries have achieved rapid growth. In 2018, the value-added of the marine biomedical industry and seawater utilization industry registered year-on-year growth of 9.6% and 7.9% respectively, both higher than the marine economy's growth rate in the same period. The scale of offshore wind power installed capacity has been expanding continuously, with newly added installed capacity reaching 1.8 million kilowatts and growing by 55.2% year-on-year.

New business forms such as cruise and yacht tourism, offshore recreational fishery, unmanned boat manufacturing, and megawatt-class tidal current energy power generation are thriving, becoming new drivers for the development of the marine economy.

SIGNIFICANT EFFECTS OF SUPPLY-SIDE STRUCTURAL REFORM IN THE MARINE FIELD

The overall operating efficiency of marine-related enterprises has increased, with marked effects in deleveraging and cost reduction. In 2018, the profit margin of main business income for above-scale marine-related industrial enterprises under key monitoring stood at 10.7%, an increase of 3.2 percentage points compared with 2017; their asset-liability ratio was 56.0%, a decrease of 3.6 percentage points from 2017; and the cost per 100 yuan of main business income was 78 yuan, 1.7 yuan less than that in 2017.

Furthermore, efforts in marine ecological protection and restoration have been further strengthened. Through the Blue Bay Remediation Initiative, a total of over 150 kilometers of coastal lines and more than 50,000 mu (approximately 3,333 hectares) of coastal wetlands have been restored.

EXISTING PROBLEMS IN CHINA'S MARINE ECONOMY DEVELOPMENT

Against the backdrop of the current complex international situation and domestic economic downward pressure, the transformation challenges of the marine economy have become more prominent. From the perspective of the five development concepts—innovation, coordination, green development, openness, and sharing—there is still a long way to go in further enhancing the contribution of marine science and technology, strengthening efforts in land-sea coordination, improving the quality of the marine ecological environment, promoting the domestic and international dual circulation through maritime transportation, and extending the benefits of marine economic development to people's livelihoods.

INSUFFICIENT EFFECTIVENESS OF MARINE SCIENCE AND TECHNOLOGY INNOVATION

The marine field is a convergence of various sciences and technologies, and technological breakthroughs and integrated innovation constitute the fundamental driving force for the high-quality development of the marine economy. At present, China's marine scientific and technological innovation has obvious shortcomings, and the transformation effectiveness of marine scientific and technological achievements is not high. This has led to a lack of sufficient momentum and stamina for the development of some marine industries, restricting the further transformation and upgrading of China's marine industries.

For example, China's marine equipment as a whole is still in a low-level development stage: many domestic products have low reliability and high maintenance costs, and core components or materials for key equipment such as large LNG (liquefied natural gas) carriers, luxury cruise ships, energy recovery devices for seawater desalination, and deep-sea technical equipment still rely on imports.

LONG-TERM EXISTENCE OF UNBALANCED MARINE ECONOMY DEVELOPMENT

The development of the marine economy involves the coordination of marine resources and land resources, the coordination of differences in regional spatial resource endowments, the coordination of economic growth and marine environmental protection, and the coordination of the integration of marine talents and technologies.

At present, problems such as irrational allocation of land and marine resources, imbalance in spatial functional layout, and insufficient industrial chain synergy still exist on a large scale; the development of regional marine economies is uncoordinated, and the north-south gap among coastal areas has widened to some extent; the Bohai Sea is under significant ecological and environmental pressure, and the three provinces and one municipality surrounding the Bohai Sea face numerous difficulties in the coordinated development of marine economy and ecological environment; although the institutional reforms of marine management departments have been gradually completed, in-depth integration is still needed among units, among personnel teams, and in the application of technology

GENERALLY UNFAVORABLE ECOLOGICAL ENVIRONMENT IN COASTAL WATERS[17]

Coastal waters are the frontier of marine development and areas with intensive human activities, and the quality of their ecological environment has a significant impact on the development of marine fishery, marine tourism, and other sectors. In 2018, the overall water quality of rivers flowing into the sea across the country was slightly polluted, and the water quality grade of coastal waters was rated as "fair". Compared with 2017, 8 out of 11 coastal provinces saw stable coastal water quality; among the 61 coastal cities nationwide, nearly one-third had poor or extremely poor water quality.

In addition, among the 21 monitoring areas of typical marine ecosystems, 16 had ecological pressure exceeding the carrying capacity of the ecosystems.

INCREASING RISKS FACED BY MARINE FOREIGN TRADE

Affected by factors such as the slowdown in international economy and trade and China-US trade frictions, China's marine shipping import and export trade has been faced with pressure. In the past two years, the China Shipping Prosperity Index has shown a downward trend, while the China Shipping Confidence Index has dropped significantly.

Against this backdrop, China has adopted policies such as increasing the export tax rebate rate for some products and implementing a series of voluntary tariff reductions. As a result, the total volume of marine shipping import and export trade in the first quarter of 2019 was basically the same as that in the same period of 2018. However, the pattern of "large-scale imports and exports" in the foreign trade of the marine economy has not yet been completely transformed into "high-quality imports and exports", and it also faces unprecedented risks and challenges under the impact of the anti-globalization phenomenon.

URGENT NEED TO ENHANCE THE EFFECT OF MARINE ECONOMY ON IMPROVING PEOPLE'S LIVELIHOODS

Marine aquatic products can provide people with high-quality protein, while marine pharmaceuticals and biological products can offer certain guarantees for the health of the people. However, with the decline of China's marine fishery resources, the output of marine aquatic products has basically shown zero growth or negative growth since the 13th Five-Year Plan period, and the number of marine fishery practitioners has also gradually decreased.

According to the China Fishery Statistical Yearbook, in the past five years, the number of marine fishing households has decreased by 40,000, and the number of traditional marine fishermen has decreased by nearly 200,000. Fishermen are severely aging, have limited skills, and lack competitiveness in onshore employment, thus facing significant pressure in switching occupations, changing jobs, and increasing their income.

In addition, few new marine pharmaceuticals have been launched, and marine biological products have few brands with low popularity.

Innovation Constraints in Aquaculture and Fisheries

Technological Bottlenecks

Marine scientific and technological innovation faces notable drawbacks, and the transformation efficiency of marine scientific and technological achievements remains relatively low (Miao et al., 2020). Key constraints include:

Reliance on imported core technologies for offshore equipment (e.g., large-scale cage systems, deep-sea sensors) and feed ingredients (e.g., fishmeal alternatives);

Limited progress in selective breeding and domestication of native species, leading to low productivity and high disease susceptibility;

Insufficient automation and digital monitoring in aquaculture, resulting in inefficient resource use and poor biosecurity.

For example, China's offshore wind power-installed capacity has expanded rapidly (1.8 million kilowatts added in 2018, up 55.2% year-on-year), but integration of wind energy with offshore aquaculture (e.g., "wind-fish symbiosis" models) is still in its pilot phase.

Biological and Production Challenges

Disease and Biosecurity: Viral and bacterial diseases (e.g., white spot syndrome virus in shrimp, vibriosis in fish) cause annual losses of over $1 billion, exacerbated by poor farm management and limited biosecurity protocols;

Feed Sustainability: China's aquaculture sector consumes ~30% of global fishmeal, with limited adoption of plant-based or insect-based alternatives, increasing pressure on wild fish stocks;

Genetic Improvement: Less than 10% of mariculture species are domestically bred, compared to 40% in Norway leading to lower growth rates and environmental adaptability.[18]

Environmental and Ecological Constraints

Coastal Ecosystem Degradation

Coastal waters face significant ecological pressure, with 16 out of 21 monitored marine ecosystems exceeding their carrying capacity.[17] Key issues include:

Water quality deterioration from land-based pollution (e.g., nutrient runoff, plastic waste) and aquaculture effluents, affecting seafood safety and productivity;

Loss of critical habitats (e.g., mangroves, seagrass beds) due to reclamation and nearshore farming, reducing natural nursery grounds for fish and shellfish;

Eutrophication and harmful algal blooms (HABs), which have increased by 30% in the Bohai Sea since 2010, causing mass mortalities in aquaculture facilities.

Carrying Capacity and Zoning Issues

Overlapping use of coastal space (e.g., aquaculture, shipping, tourism) leads to conflicts and unsustainable resource allocation;

Weak implementation of ecosystem-based zoning, with many aquaculture facilities operating outside designated areas, exacerbating environmental degradation;

Inadequate monitoring of carrying capacity, resulting in overstocking and nutrient overload in intensive farming regions (e.g., Guangxi Beibu Gulf).[19-22]

REFLECTIONS ON ACCELERATING THE HIGH-QUALITY DEVELOPMENT OF MARINE ECONOMY

As China's international political and economic status rises, it faces a growing number of domestic and international risks and challenges. As an economy featuring land-sea integration, export orientation, high added value, and sustainable development, the marine economy still needs to fully implement the new development concepts, adhere to the requirements for high-quality development, and accelerate its transformation into a quality-and-efficiency-oriented economy.

FOCUSING ON ENHANCING THE CAPABILITY OF MARINE SCIENCE AND TECHNOLOGY INNOVATION

Starting with reforming the scientific research management mechanism for natural resources and accelerating the development of marine sci-tech innovation talent teams, we

should enhance the capabilities of national-level marine scientific research institutions, give full play to the brand effect of national laboratories, national key laboratories, national technological innovation centers, and other platforms in the field of marine sci-tech innovation, effectively address issues such as low management efficiency, insufficient enthusiasm among personnel, and dispersed funding support, and make great efforts to break through a batch of key core technologies in the marine field.

We should establish a marine technological innovation system with enterprises as the main body and market orientation, effectively enhance the driving capacity of pilot demonstrations for marine economic development, bring their leading role into play, strengthen the integrated development of industry, academia, research, and application, and promote the transformation of marine sci-tech achievements.

In addition, we should cultivate and develop industrial clusters for marine equipment, drive the improvement of innovation capabilities through the agglomeration effect, accelerate the enhancement of the modernization level of the marine industrial chain, and promote the transformation of traditional marine industries and the expansion of emerging marine industries.

STEADILY PROMOTING INTENSIVE AND ECONOMICAL UTILIZATION OF MARINE RESOURCES

While gradually gaining a clear understanding of the inventory of marine natural resources, we should make full use of marine sci-tech achievements, steadily advance the intensive and economical utilization of marine mineral resources, marine chemical resources, marine biological resources, marine energy, and offshore wind energy resources, and promote the harmonious unity between humans and marine resources.

On the basis of well realizing the spatial functional connection of land and marine industries, we need to coordinate the rational allocation of resources such as coastal lines, marine areas, and islands, accelerate the resolution of long-standing issues related to reclamation, explore the three-dimensional development of marine space, actively enable the market to play a greater role in the allocation of marine area and uninhabited island resources, and enhance the level of development and protection of marine resources.

MAINTAINING COORDINATED DEVELOPMENT OF REGIONAL MARINE ECONOMY

Relying on national strategies such as the coordinated development of the Beijing-Tianjin-Hebei Region, the development of the Guangdong-Hong Kong-Macao Greater Bay Area, and the integrated development of the Yangtze River Delta Region, and based on factors including regional marine resource endowments, capital investment intensity, marine economic scale, as well as the number of marine-related employees, their knowledge structure, technical capabilities, and management levels, we should foster and leverage the comparative advantages of regional marine economies.

We need to avoid the rush to launch similar projects, vicious competition among similar enterprises, and low-end development of similar industries, maintain appropriate differences in regional marine economic development, expand the development space of the marine economy while pursuing coordinated development, and promote the generation of linkage effects in regional marine economic development.

PAYING CLOSE ATTENTION TO MARINE ENVIRONMENTAL PROTECTION AND ECOLOGICAL RESTORATION

Strengthen the investigation and monitoring of land-based sewage outfalls into the sea, strictly control various types of pollution discharge into the sea, intensify the efforts of marine ecological and environmental protection supervision, and consolidate the main responsibilities of governments at all levels for marine ecological and environmental protection.

Improve the laws and regulations on marine ecological and environmental protection, tighten the institutional cage, and increase the intensity of punishment for acts that damage the marine ecological environment. Optimize and adjust the marine ecological protection red lines in accordance with laws and regulations, and properly handle the orderly withdrawal of existing production activities within the red lines.

Attract social capital to participate in marine ecological restoration projects, and explore the mechanism for realizing the value of marine ecological products.

DEEPENING PRACTICAL COOPERATION IN INTERNATIONAL MARINE ECONOMY

We will implement the initiative of the "21st Century Maritime Silk Road", actively develop "Blue Partnerships" with coastal countries and regions as well as international organizations, strengthen the development of maritime connectivity, and encourage both parties to enhance practical cooperation in areas such as marine fishing, mariculture, marine aquatic product processing, seawater desalination, marine energy development, marine tourism, and port logistics. We will jointly build overseas marine economic parks, exchange and share experiences in marine economic development, and contribute China's solutions and wisdom to coastal countries in planning marine economic development and optimizing marine industrial layout.

IMPROVING THE QUALITY OF MARINE PRODUCTS THAT BENEFIT PEOPLE'S LIVELIHOODS

We will raise the level of healthy mariculture in the marine fishery through policy guidance and financial support, provide more high-quality marine aquatic products to the market, and build blue brands with broad market prospects and strong influence.

Through multiple measures, we will promote the industrialization of marine biotechnology R&D achievements and provide the people with more effective marine biomedical products and functional products. We will develop more beautiful, pleasant and culturally rich marine tourist attractions, reduce the construction of duplicate landscape projects, and enhance people's sense of well-being.

We will strengthen the dynamic monitoring and early warning of marine disasters, ensure the personal safety of coastal residents, and reduce property losses

POLICY-INFORMED PATHWAYS FOR SUSTAINABLE DEVELOPMENT

Strengthening Aquaculture-Focused Innovation Systems

Prioritize R&D in key technologies: offshore cage systems, low-pollution feeds, disease-resistant breeding, and digital monitoring tools;

Promote industry-academia-government collaboration, such as the National Marine Technology Innovation Center in Qingdao, to accelerate technology transfer;

Invest in talent training and capacity building, particularly for small-scale fishers, to adopt sustainable practices (e.g., IMTA, organic aquaculture).

Advancing Green Aquaculture Practices

Scale up ecological aquaculture models: IMTA, seaweed farming for carbon sequestration, and restoration-linked aquaculture (e.g., mangrove-shrimp integrated systems);

Strengthen environmental regulation: enforce effluent standards, establish marine protected areas (MPAs) in critical habitats, and implement a "polluter pays" principle;

Develop market incentives for sustainable products, such as eco-labeling (e.g., ASC certification) and premium pricing for green aquaculture goods.

Enhancing Fisheries-Aquaculture Coordination

Optimize coastal zoning: delineate exclusive aquaculture zones, shipping lanes, and conservation areas to reduce conflicts;

Support stock enhancement programs: expand the release of native species (e.g., Chinese sturgeon, yellow croaker) and monitor their impact on wild populations;

Promote regional coordination: leverage national strategies (e.g., Yangtze River Delta integration) to reduce regional imbalances and avoid redundant projects.

Deepening International Cooperation

Implement the "21st Century Maritime Silk Road" initiative: establish joint aquaculture parks with Southeast Asian countries (e.g., Thailand, Malaysia) and share technology in sustainable fisheries management;

Learn from global best practices: adopt Norway's selective breeding programs, Chile's traceability systems, and the EU's Marine Strategy Framework Directive;

Participate in international fisheries governance: strengthen collaboration in regional fisheries management organizations (RFMOs) to address transboundary issues (e.g., illegal, unreported, and unregulated fishing).

Improving Livelihood and Food Security Outcomes

Provide financial support: low-interest loans for small-scale aquaculture, subsidies for eco-friendly practices, and unemployment benefits for transitioning fishers;

Enhance value chains: develop processed and branded products (e.g., ready-to-eat seafood, functional foods) and improve cold chain logistics;

Strengthen food safety: implement strict quality control systems and traceability from farm to table, aligning with international standards (e.g., Codex Alimentarius).[23]

AUTHORS' CONTRIBUTION

Conceptualization: Rong Hua, Yijie Chai, Yue Guo; Writing - original draft preparation: Rong Hua, Yijie Chai, Yue Guo; Writing - review and editing: Rong Hua, Yijie Chai, Yue Guo; Supervision: Rong Hua, Yijie Chai, Yue Guo.

COMPETING OF INTEREST – COPE

No competing interests were disclosed.

ETHICAL CONDUCT APPROVAL – IACUC

This study did not involve any experimental research on animals or plants.

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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