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Study on Measuring the Level of High-Quality Development of China's Marine Economy

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Abstract： At present, China's economy has shifted from a stage of rapid growth to a stage of high-quality development.The ocean is a strategic place for high-quality development, and the promotion of high-quality development of the marine economy is a fundamental requirement for determining the thinking on the development of the marine economy, formulating routes and implementing macro-control policies in the current and future periods.Based on the five new development concepts, it has constructed an evaluation index system for the high-quality development of the marine economy that includes the five dimensions of "innovation, coordination, greenness, development and sharing".For the panel data of marine economy of 11 coastal provinces from 2017 to 2021, the entropy weight TOPSIS model is applied to construct the evaluation index of high-quality development of marine economy,and conduct quantitative research and assessment analysis.The results show:(1)In 2017-2021, the level of high-quality development of China's regional marine economy as a whole fluctuated upward, and inter-regional differences in the first narrowing and then expanding trend.(2)There were significant differences in the level of high-quality development of the marine economy in the three major ocean economic zones during the study period.

Keywords： Maritime economy； High-quality development； Entropy weight TOPSIS model； Horizontal measurement

I. Introduction

Since the 1990s, with the development of marine resources and the development of the marine economy, the pressure on land-based resources and the environment has been alleviated, and it has played an important role in supporting and leading economic growth as well as promoting sustainable economic and social development.China's gross domestic product (GDP) for the oceans was 285.5 billion yuan in 1996, and will grow to 990.97 billion yuan by 2023, with an average annual growth rate of 14.38 per cent, which is higher than the GDP growth rate for the same period by 0.8 percentage points, and accounts for 7.9 per cent of the GDP.However, with the rapid development of the marine economy, the overexploitation of marine resources has brought about the depletion of marine resources,The degradation of the functions of marine ecosystems and the lack of momentum for marine economic growth are also becoming increasingly evident. These problems have a direct impact on the quality of marine economic growth.

In his report to the 19th National Congress, General Secretary Xi Jinping pointed out that China's economy has shifted from a stage of rapid growth to a stage of high-quality development,During the first session of the National People's Congress, it was stated that "the oceans and seas are a strategic location for high-quality development".It can be seen that the high-quality development of the marine economy is of great practical significance to our country's realization of the goal of a strong marine power and the construction of a modernized economic

system.The ocean is a strategic location for high-quality development, a bridge connecting regional development, and an important area for nurturing new industries, developing new energies and leading new growth.The report of the 20th CPC National Congress clearly puts forward "developing the marine economy, protecting the marine ecosystem and accelerating the construction of a strong marine country", reflecting the great importance that the State attaches to the high-quality development of the marine economy.

II. Literature review

Defining the scientific connotation of high-quality development of the marine economy is the first and foremost task in measuring and benchmarking the current level of high-quality development of the marine economy.High-quality development is responsive to the people's need for a steady rise in the standard of living for a better life, and its connotation has been gradually enriched with the development of productive forces and the economy and society,It has been continuously extended to many fields such as economy, society and ecology.Existing literature mainly defines the connotation of high-quality development from the perspectives of the main contradiction in society [1], the new development concept[2][3], the "five-in-one" layout[4], the three levels of macro, meso, and micro[5], and the comparison with high-speed growth[6].Although the meaning of high-quality development has not yet been finalized, the mainstream view is that high-quality development is development that can well meet the growing needs of the people for a better life.It is a development that embodies the new development concept, one in which innovation becomes the first driving force, coordination becomes an endogenous feature, green becomes a universal form, openness becomes the way to go, and sharing becomes the fundamental purpose.Although the connotation of high-quality development is rich, the connotation of high-quality development of the marine economy cannot be made in the same way.Although the marine economy has certain commonalities with the national economy, it has its own characteristics, given the restorative power of marine ecology and the dynamic nature of marine resource endowment.High-quality development of the marine economy involves complex linked systems such as the marine economic system, the marine resources and environmental system and the marine social system, as it encompasses a wide range of relationships, including the development and utilization of marine resources.Consequently, high-quality development of the marine economy does not refer only to high-quality development of the marine economic system, but rather to the integration of the systems and the harmonization of their interrelationships,To realize high-quality development in synergy with all systems and to achieve the unified development of the marine economy in an innovative, coordinated, green, open and shared manner.

At present, research on high-quality economic development is relatively abundant, and research on the definition and connotation of high-quality development of the marine economy has been carried out mainly from three aspects:The first is based on the perspective of the quality and effectiveness of marine economic growth.Wang Zeyu (2015) and others believe that the quality of the marine economy is a comprehensive reflection of the growth capacity and operational effectiveness of the marine economy,Including the optimization and upgrading of the structure of the marine economy, the renewal of science and technology, the intensive use of resources, the sustainability of the ecological environment and the stability of its own operation,It also constructed a system of indicators in four dimensions: structural excellence, scientific and technological support, resource utilization and ecological environment[7]； Li Bo (2017) and others believe that the quality of marine economic growth includes the improvement of the comprehensive strength of the oceans, the optimization of the structure of marine industries, the improvement of the distribution of marine social welfare, and the harmony of the marine ecological environment,Result of the dynamic equilibrium of the "economy-society-resource-environment" system of the oceans and seas[8].Li Bo (2019) and others point out that the quality of marine economic growth is stimulated by the constraints of externalities such as social, economic, environmental, institutional, cultural, and policy conditions,Measurement of the performance of marine economies and the quality of life of coastal people by integrating the effects of endogenous conditions such as the structure, mode and process of marine economic growth[9].Secondly, it elaborates the connotation of high-quality development of the marine economy based on the

perspective of the five development concepts.Ruayun (2019) and others summarize and generalize the concept of high-quality development of the marine economy,is the ability to meet people's needs for a better life in the process of production activities and in the distribution of the impacts and results of the outcomes of production related to the development of the oceans and seas,Sustainable development with a high ratio of factor inputs to outputs, high efficiency in resource allocation, high technological content, adequate regional and industrial development, balanced market supply and demand, and high quality of products and services,It is a development model that focuses on innovation, coordination, greening, openness and sharing, and involves the balanced development of the marine economy, marine ecology, marine culture and socio-political aspects[10]; Cheng Manman (2022) and others believe that the high-quality development of the marine economy is capable of enhancing the comprehensive strength of the oceans, optimizing the industrial structure, raising the level of openness, promoting the harmony of the ecological environment, improving the distribution of social welfare,Synergistic and high-quality development involving the five systems of the ocean economy, resources, environment, science and technology and society[11].Third, it is defined based on the system object dimension of high-quality development of the marine economy.Di Qianbin (2022) and others defined the high-quality development of the marine economy as keeping innovation-driven, scientific research-led, and promoting the transformation of the kinetic energy of the marine industry on a micro level,Maintaining a stable and upgraded industrial structure at the meso level, with a view to optimizing the industrial structure and encouraging inter-island industrial integration, and improving the efficiency of the marine economy in terms of capital, energy and labour at the macro level,A series of ways to improve market stability and policy management on market regulation to meet the new normal economic development needs of the marine economic development model[12].

There is a wealth of research on evaluation measures of high-quality development of the marine economy,Most scholars use the new development concept of innovation, coordination, greenness, openness and sharing as the standard to construct the evaluation index system,and using different methods to measure the level of high-quality development of the marine economy.Liu Bo (2020) and others used linear weighting method, coupled coordination model and kernel density method to study the spatial and temporal characteristics of high-quality development of Jiangsu's marine economy[13]; Zhao Hui (2020) and others measured the index of high-quality development of Tianjin's marine economy by constructing a judgment matrix and applying the AHP method, and made a longitudinal comparison of its development trend[14]; Di Qianbin (2022) and others used subjective and objective comprehensive evaluation method and TOPSIS modeling,Evaluation of marine economic development in Tianjin, Shandong and Liaoning[15]; Qiu Rongshan (2023) et al. Using AHP-EW combined weight optimization model to measure the level of high-quality development of China's marine economy,and analyze their spatial differences and dynamic evolutionary trends[16].In addition to the new development concept, some scholars have proposed different research perspectives.Liu, Guichun (2019) and others used set-pair analysis,to measure marine economic growth driving factors,It was further decomposed and compared with spatio-temporal differences using the LMDI method[17]; Gao Sheng (2022) and others constructed an evaluation index system from six aspects, such as quality and efficiency improvement, structural optimization and production and life,And using TOPSIS model to measure the high-quality development of China's marine economy[18].

In summary, studies on the measurement of the level of high-quality development of the marine economy have attracted the attention of some scholars, but the existing studies still have certain singularities and limitations.To promote the high-quality development of the marine economy, first of all, we need to have a profound and comprehensive understanding of the actual level of high-quality development of China's marine economy,Understanding the shortcomings and deficiencies in the current process of high-quality development of the marine economy, and accurately hitting the pain points in order to truly realize high-quality development of the marine economy.At the same time, China has a vast territory and a long coastline, and the coastal provinces and cities have different geographic locations,Their resource endowments and industrial layout are very different, so

there are certain regional differences in the process of high-quality development of the marine economy,Scientific identification of the differences in the high-quality development of the marine economy in various regions and the reasons for them can provide effective ideas for the future high-quality development of the marine economy and the adjustment of policies for regional coordinated development.Therefore, based on the five new development concepts, this paper constructs a high-quality development evaluation index system for the marine economy that includes the five dimensions of "innovation, coordination, green, development and sharing",Quantitative analysis of marine economic panel data for 11 coastal provinces from 2017 to 2021 to study the comprehensive level of high-quality development of China's marine economy and the differences among regions.

III. Research design

(i) Data sources

The scope of this paper is the 11 coastal provinces and cities of China (excluding Hong Kong, Macao and Taiwan),Data from China Marine Statistical Yearbook, China Statistical Yearbook, China Environmental Statistical Yearbook, China Science and Technology Statistical Yearbook, and Statistical Yearbooks of Coastal Provinces, etc., 2017-2021.Individual missing data are filled in using exponential smoothing based on previous years' data.

(ii) Measurement of variables

This article refers to the Opinions of the Central Committee of the Communist Party of China and the State Council on Promoting High-Quality Development and other relevant documents,Based on the scientific connotation and basic characteristics of high-quality development of the marine economy, such as high efficiency, stability, sustainability, coordination and long-term development,Following the principles of systematicity, scientificity, dynamism and operability, based on economic aggregates and guided by the five development concepts,and refer to the research of scholars such as Ruyayun (2019)[10],Constructing an evaluation index system for the high-quality development level of China's marine economy from the five dimensions of innovation, coordination, greenness, development and sharing.

(iii) Determination of weights

The study in this paper draws on the calculations of scholars such as Yin Peng (2021)[19],Applying the entropy method,Calculate the weight of each indicator,And construct a comprehensive index evaluation model to calculate the level of high-quality development of urban-rural integration.The steps are as follows：

Step 1: Programmability of data,Adoption of formulas (1) and (2).

$$x_{ij}' = \frac{x_{ij} - x_j^{min}}{x_j^{max} - x_j^{min}} \quad (1)$$

$$x_{ij}' = \frac{x_j^{max} - x_{ij}}{x_j^{max} - x_j^{min}} \quad (2)$$

Step 2: Calculate the share of the ith evaluated subject in year j.

$$y_{ij} = \frac{x_{ij}}{\sum_{i=1}^{n} x_{ij}} \quad (3)$$

Step 3,suppose that $\theta = \frac{1}{\ln(n)}$,n represents the year of measurement,Measuring the information entropy of evaluation metrics using equation (4).

$$e_j = -\theta \sum_{i=1}^{n} (y_{ij} \times \ln y_{ij}) \quad (4)$$

Step 4,Calculate the entropy weight vector of the evaluation indicators using equations (5) (6)w=[w_1, w_2,…, w_k]

$$d_j = 1 - e_j \quad (5)$$

$$w_j = \frac{d_j}{\sum_{j=1}^{k} d_j} \quad (6)$$

Step 5,Measurement of the corresponding level of integrated development using the statistical formula (7).

$$S_{ij} = w_j \times x_{ij}' \quad (7)$$

In accordance with the design of the indicator system described above,and the collection and processing of relevant data.After scientific calculations and comprehensive analyses, the weighted values of the indicators were obtained,As shown in table 1.

Table 1 Indicator system and weights of indicators for measuring the level of high-quality development of the marine economy

	Level 1 indicators	Secondary indicators	Indicator properties	Indicator weights
Ocean Economy The level of high-quality development of the ocean economy	blaze new trails	Number of R&D projects in marine research and development organizations	forward	0.0745
		R&D personnel in marine research and development organizations	forward	0.0686
	trade-off	Coastal GDP growth rate	forward	0.2242
		Coastal GDP	forward	0.0779
	greener	Per capita water use in coastal areas	forward	0.0442
		Area of marine nature reserves nationwide	forward	0.3175
	liberalization	Cargo throughput at coastal ports	forward	0.0349
		International standard container throughput at coastal ports	forward	0.0763
	enjoy together	Number of undergraduate marine majors in higher education	forward	0.0424
		Coastal travel agency	forward	0.0395

IV. Analysis of results

(i) Analysis of the results of the level of high-quality development of the marine economy by province

This paper is based on panel data from 11 coastal provinces in China,Measurement of specific research data selected from China Marine Statistical Yearbook, China Marine Statistical Bulletin, China Statistical Yearbook and China Science and Technology Statistical Yearbook, etc.According to the evaluation index system for the level of high-quality development of China's marine economy constructed above,The entropy weight TOPSIS model was used, taking into account both subjective and objective weights,Calculation of the index of the level of high-quality development of the marine economy in 11 coastal provinces, 2017-2021,As shown in table 2.

Table 2 Index of high-quality development of the marine economy in coastal provinces

Region	provinces	2017	2018	2019	2020	2021
North	Tianjin	0.0752	0.2513	0.0686	0.0635	0.0789
	anhui	0.0773	0.0902	0.0914	0.0644	0.0785
	Liaoning	0.1217	0.1227	0.1184	0.0981	0.1128
	Shandong	0.2257	0.2624	0.2717	0.2554	0.2919
	Mean value	0.1250	0.1817	0.1375	0.1204	0.1405
Eastern	Shanghai	0.1585	0.1617	0.1695	0.1986	0.2214
	Jiangsu	0.2213	0.2165	0.2387	0.1607	0.1947
	Zhejiang	0.1725	0.1761	0.1875	0.1511	0.1698
	Mean value	0.1841	0.1848	0.1986	0.1701	0.1953
South	Fujian	0.1113	0.1188	0.1276	0.1011	0.1149
	hillsides	0.3298	0.3439	0.3723	0.3106	0.3401
	Guangxi	0.0598	0.0684	0.0722	0.0553	0.0673
	Hainan	0.1551	0.1660	0.3671	0.3640	0.3871
	Mean value	0.1640	0.1743	0.2348	0.2078	0.2274
National average		0.1553	0.1798	0.1895	0.1657	0.1870

On the whole, the level of high-quality development of China's marine economy has shown a fluctuating upward trend,Overall index except for a small decline in 2019,The rest of the years show a steady increase.It may be due to the fact that during the epidemic, the high quality development of China's marine economy showed a certain downward trend.In terms of the latest level of high-quality development of the marine economy in China's coastal provinces and cities in 2021,Guangdong (0.3401), Jiangsu (0.1947), Shanghai (0.2214), and Shandong (0.2919) as the PRD Economic Zone,Major coastal provinces and cities in the Yangtze River Delta and Bohai Rim Economic Zones, which are strategically located,Reasonable industrial structure,As a large economic province with a strong foundation of marine economy； At the same time, the four provinces and cities have a large number of colleges and universities specializing in the field of marine science and technology and scientific research institutions, which provide strong personnel and technical force for the development of marine science and technology innovation.And Zhejiang Province (0.1698) is also in the Yangtze River delta,In the radiation and driving role at the same time, focusing on building the economic development of the Bay Area of Zhejiang, the pioneer area,Many research institutes in the province provide sufficient public services in marine science and technology, and therefore its level of high-quality development of the marine economy is also at the forefront.

Looking at the whole research cycle,Guangxi marine economic development level of high quality has been in a relatively backward position, the reason for this is mainly due to the lower level of industrial structure,Still dominated by marine primary industries with low labor productivity,Inadequate marine science, technology and innovation capacity due to poor levels of education and social welfare； Hainan's tertiary industry is developing well and there is less damage to the marine ecosystem, but the overall level of social development is low and the population size is small,The number of research institutes, higher education institutions and research funding are insufficient to support Hainan's significant progress in the field of marine science and technology innovation,As a result, the level of high-quality development of its marine economy is low； Tianjin has outstanding marine environmental resource problems, small economic scale and slow upgrading of industrial structure, and the gap is more obvious when compared with provinces and cities with high level of high-quality development of marine economy； Hebei Province mainly focuses on traditional marine industries with high energy consumption and serious environmental pollution, and the high-quality development of the marine economy has been at a relatively

low level.

(ii) Analysis of the results of the level of high-quality development of the marine economy by region

To further explore the evolutionary pattern and regional differences in the level of high-quality development of China's marine economy,Based on the measurement of the composite index of high-quality development of the regional marine economy,Mapping the trends in the level of high-quality development of the marine economy in China's three major marine economic zones[1], as well as in the country as a whole, from 2017 to 2021,See figure 3.

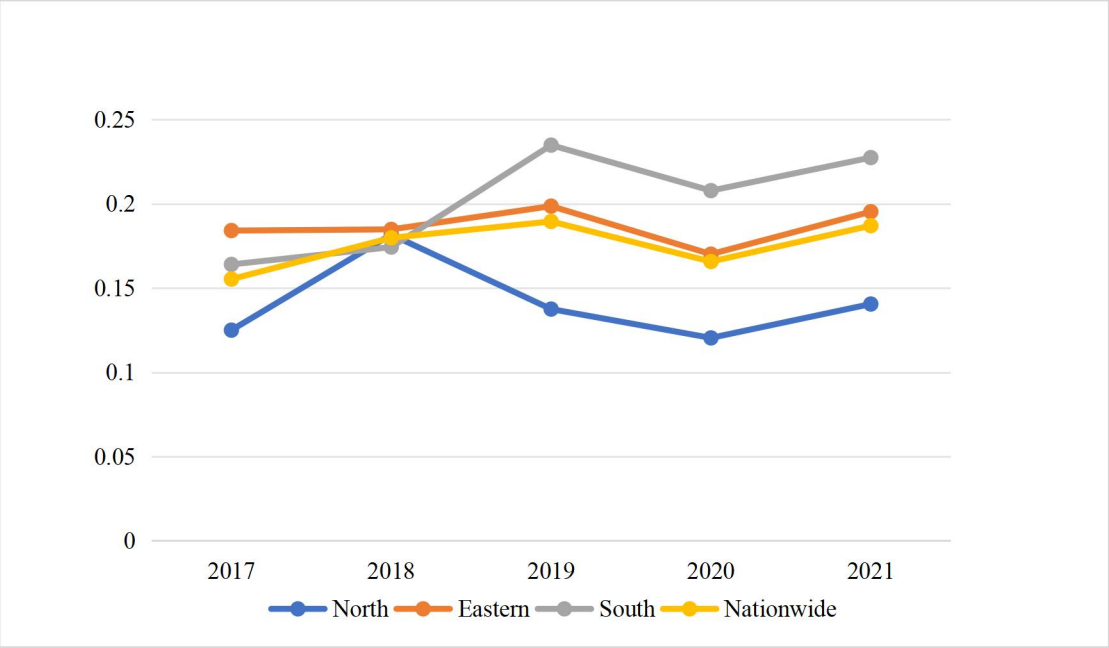

Figure 3 Trends in the index of the level of high-quality development of the marine economy at the national level and in the three major marine economic circles, 2017-2021

Looking at the macro level,Composite index of high-quality development of the marine economy in China's coastal provinces during the overall study period,Showing a fluctuating upward trend.This trend demonstrates the remarkable progress made by our marine economy on the path to high-quality development.With the exception of the Northern Maritime Economic Circle, which has seen more pronounced fluctuations over a period of time,The marine economies of the other regions have maintained a steady upward trend.This trend has undoubtedly injected strong confidence and momentum into the future development of China's marine economy.

In detail, from 2017 to 2019, the comprehensive index of high-quality development of the marine economy in China's coastal provinces has continued to grow.This shows that during this period, China's marine economy has achieved remarkable results on the road to high-quality development.However, by 2019 to 2020, this index showed a slight decline.This could be due to changes in the external environment, policy adjustments or other factors.However, it is encouraging to note that from 2020 to 2021, the index begins to rise steadily,This shows that after a brief period of fluctuation, China's marine economy has returned to a track of steady growth.

In terms of regional differences:: The level of high-quality development of the marine economy in China's eastern ocean economic circle is significantly higher than the national average.This fully demonstrates that the Eastern Ocean Economic Circle plays a leading and driving role in the development of the national ocean economy.At the same time, the Southern Ocean Economic Circle also shows a high level of high-quality development of the marine economy,It also shows that the marine economy of the southern region has made significant progress in recent years.In contrast, the Northern Ocean Economic Circle has the lowest composite index of high-quality development of the marine economy,This suggests that we in the North need to step up our efforts to catch up in terms of quality development of the marine economy.

In general, with the development of the national economy and the in-depth implementation of the five development concepts,The level of high-quality development of China's marine economy continues to rise.All

coastal provinces have achieved remarkable results on the road to high-quality development of the marine economy,At the same time, however, there are a number of challenges and difficulties.In the future, we need to continue to increase investment and efforts to promote the marine economy on the road to high-quality development.

V. Conclusions of the study and recommendations for countermeasures

(i) Conclusion

This article is based on the five development concepts,A comprehensive evaluation index system for the high-quality development of the regional marine economy, consisting of five subsystems and 10 specific indicators for innovation, coordination, greening, openness and sharing, has been constructed,Comprehensive index of high-quality development of China's regional marine economy from 2017 to 2021 was measured using entropy weight TOPSIS modeling,and at different levels of spatial scales, including the whole country, the three major ocean economic zones and the 11 coastal provinces,Comprehensive description of the spatial differences in the level of high-quality development of China's regional marine economy and the trend of its dynamic evolution,Based on the measurement results and taking into account the actual situation of high-quality development of the marine economy in each region,Analyzing the level of high-quality development of China's marine economy.The findings of the relevant studies are as follows：

From the composite index,Overall fluctuating upward trend of China's comprehensive index of high-quality development of regional marine economy, 2017-2021,and the absolute differences between regions show a trend of narrowing followed by a small increase,of which the composite index continues to rise from 2017-2019,Small decline in the composite index in 2019-2020,Continued steady increase in the composite index in 2020-2021.Viewed on the scale of the three major ocean economic zones,Higher composite index of high-quality development of the marine economy in the Eastern Ocean Economic Circle than in the Northern and Southern Ocean Economic Circle, 2017-2018,Differences between the three are gradually narrowing； Eastern and Southern Maritime Economic Circle consistently above the national average, 2018-2021,The northern maritime economic zone, on the other hand, is developing more slowly and is significantly below the national average； The three major ocean economic zones show the same trend of change as the national average in 2019-2021, with a decline followed by a sustained rise.

(ii) Recommendations

Based on the above findings,To effectively promote the realization of high-quality development of the marine economy in China's coastal areas,and fully integrating the development characteristics of each region,This paper makes the following recommendations：

(1) Deepening openness and cooperation and setting up development benchmarks.Shanghai should further accelerate the construction of the whole industrial chain base of the marine industry,Relying on its openness,Cultivate and promote a number of sea-related brand enterprises with international long-term competitiveness,Deeper integration into domestic and international economic cycles,Promote the supply chain, value chain and industrial chain to be in line with international standards.Guangdong should seize the opportunity of the times,Fully utilize the multiple policy advantages of the "Belt and Road" construction, the Guangdong-Hong Kong-Macao Greater Bay Area, and the Pilot Free Trade Zone,Promoting the rapid development of sea-related industries,Expansion of sea-related employment,Enabling people to share in the fruits of the ocean economy,and to play a leading role in demonstrating the high-quality development of the marine economy.

(2) Mending the shortcomings of development and tapping the potential for growth.Shandong and Tianjin should capitalize on their resource and location advantages,Adhere to land and sea integration and promote the integrated development of the Bohai Rim,Enhancing the radiation-driven role of the marine economy for neighboring non-coastal regions.At the same time, the pace of research and development should be accelerated in the fields of marine biomedicine and new marine materials,Improving efficiency in the utilization of marine resources.Jiangsu and Zhejiang should seize the opportunity of environmental management in the Yangtze River

Basin,In-depth promotion of ecological restoration of key sea areas and bays,Actively develop marine strategic emerging industries with high technological content and environmental friendliness,Enhancing green productivity in the marine economy.Liaoning and Fujian should build on their strengths in industries such as marine fisheries, marine engineering equipment manufacturing, etc,Extending the industry chain,Enhancement of the efficiency-generating capacity of the whole industrial chain,and strengthening the interregional division of labor in the marine industry,Promoting the free flow of factors such as logistics, people, capital, information and technology flows.Hainan should take full advantage of free trade port,Deepening open cooperation in the marine high-tech industry,Actively introduce large marine scientific research institutions, research institutes and science and technology innovation-oriented enterprises,Enhancement of independent innovation capacity.

(3) Improving the quality of development and strengthening the drive for innovation.Hebei and Guangxi provinces should improve the quality of marine economic development on all fronts,Transforming the development of the marine economy,Promoting the transformation and upgrading of the marine industry.The two provinces should phase out low-efficiency, high-energy-consumption and high-pollution sea-related industries and technologies,Optimizing the layout and structure of marine industries based on the comparative advantages of coastal cities,Enhancement of factor and energy utilization efficiency in traditional marine industries,Improving the structure of human capital supply,Comprehensively improving the quality of marine economic development.

(4) Adhere to the sharing of the fruits of marine economic development for the purpose of enhancing the well-being of the people.Jiangsu, Guangdong, Guangxi and Hainan should fully utilize the conditions of sea resources,Promoting the construction of modernized sea ranches,Enhancing the supply of seawater products,Ensuring food security,At the same time actively explore "oil, gas, electricity and hydrogen" multi-energy complementary integration development,Promoting the scale development of offshore wind power,Building an offshore wind power base.Coastal areas should actively develop and improve all kinds of coastal tourism infrastructure facilities and play products,Enriching the supply of tourism products such as marine sports, marine recreation, coastal vacation, etc.High-quality leisure and tourism economic development zones that are pleasant to live in, work in and visit, etc., to meet market demand.Regions other than Guangdong, Zhejiang and Jiangsu should fully learn from the experience of their gradient cultivation of sea-related market players,Actively creating a favorable business environment,To create a group of sea-related leading enterprises to lead, specializing in new enterprises to attack small and medium-sized enterprises to build the foundation of the enterprise group,Cultivate new marine industries and grow new marine industries,Creating sea-based employment opportunities and increasing the income of coastal residents.Tianjin, Hebei, Fujian, Guangxi and other regions rely on the foundation of sea-related specialties in local universities,Integration of the actual needs of the development of the marine economy,Formation of specialized marine universities or colleges with distinctive features,Cultivating Composite, Professional and Skilled Marine Talents.

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