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Forecast and Analysis of the Main Indicators for the Development of Ocean Fishery in China during the Twelfth Five-Year Plan Period

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Abstract The ocean fishery is an important part of the marine economy and an important source of human food. The leaders at all levels attach great importance to the development and utilization of ocean fishery resources. Using the regression analysis method, we forecast the main indicators for the development of ocean fishery during the Twelfth Five-Year Plan period. Through the study, it is found that in 2015, the value added of ocean fishery in China is expected to exceed 360 billion yuan, and the output of marine products will exceed 30 million tons. The marine products make stable contribution to the marine economy and the residents' nutrient composition, conducive to maintaining the stable supply of the market and meeting the residents' daily needs for marine products.

Key words Ocean fishery, Indicator forecast, Marine products

1 Current situation and problems concerning the development of ocean fishery in China during the Eleventh Five-Year Plan period

1.1 Current situation of development During the Eleventh Five-Year Plan period, China vigorously promoted the construction of modern fishery, constantly optimized and upgraded the industrial structure, so that the aquaculture production was steadily increased, and resource conservation achievements were remarkable^[1]. In 2010, the value added of ocean fishery was 281.3 billion yuan^[2]. Annually 26 million tons of aquatic products are provided, accounting for a quarter of the world's ocean fishery production, making China become the world's largest producer, trading power of aquatic products, and the major offshore fishing country. China has made important contribution in ensuring food safety of China, promoting ecological civilization construction, and maintaining marine rights and interests.

1.1.1 The strategic adjustment of inshore fishing promotes the orderly and reasonable development and utilization of marine biological resources. During the Eleventh Five-Year Plan period, driven by the party's policy guidelines and technological progress, fishery in China developed by leaps and bounds, and achieved the historic change from "catching-based" to "raising-based". Since the new century, China's coastal fishery production has been maintaining negative growth, and during the Eleventh Five-Year Plan period, it was basically around 13 million tons.

1.1.2 The rapid development of mariculture industry becomes an important source of effective supply of aquatic products. In the 1980s, China set off a climax of aquaculture development. The aquaculture production increased from 2.84 million tons in 1990 to nearly 14 million tons in 2009, an increase of four times, becoming the main channel of the effective supply of aquatic products.

Especially during the Eleventh Five-Year Plan period, the aquaculture advanced to healthy ecological farming; the mechanization, organization and intensification of farming was significantly improved.

1.1.3 The offshore fishery expands constantly and the share of the international marine biological resources continues to increase. Now there are more than 1 500 fishing vessels and the operating waters are throughout the Atlantic, Indian Ocean, Pacific, and waters under the jurisdiction of 32 countries; the total offshore fishing production is over 1 million tons, with the output value of 10 billion yuan. In recent years, China is making every effort to improve development quality, optimize offshore fishing structure, accelerate the development of pelagic fishery in high seas, introduce and absorb international advanced fishing boats and practices, to improve the international competitiveness of offshore fishing^[3]. Now China's share of fishery resources in the high seas has been increased to 6%.

1.1.4 The processing of aquatic products and emerging marine industry make great strides, and the development and utilization of marine biological resources is increasingly deepened. At present, China has become the world's major processing and export base of aquatic products, with nearly ten thousand processing enterprises and the annual processing volume over 1 300 tons, forming some important processing bases such as the Shandong Peninsula, Liaodong Peninsula and Leizhou Peninsula. In the processing and utilization of the marine resources, the foreign marine living resources are used to form the processing bases of aquatic products with Dalian and Qingdao as the center. Meanwhile, using seaweed to produce diesel and other fields also make breakthrough; the development and utilization of marine resources is pushed forward.

1.2 The existing problems Although China's marine economy has entered the transition period from rapid development stage to the "good and fast" development stage^[4], the development of ocean fishery still faces some problems. Some experts predict that by 2050, the global fish catch in almost all the waters will decline

with the reduction of fishery resources^[5].

Specific issues include the following aspects:

(i) The offshore fishery resources suffer a severe recession. The offshore fishery resources are used excessively, and the fishing intensity exceeds the regeneration capacity of resources.

(ii) Most of the processing of seafood industry is in the state of simple processing, with low added value. There are few high – quality products, high-end products, few deep-processed products, and few high value-added products.

(iii) The coastal ecological environment is deteriorated, leading to increased risk of farming and decline in the quality of aquatic products^[6].

(iv) The basic security system for the development of marine biological resources is weak. In recent years, the extreme weather and climate events have been increased, posing a great threat to the development of marine biological resources; fishing port construction, fishing boats communications and security facilities, and maritime rescue forces lag behind, unable to meet the needs for withstanding a variety of risks.

(v) The development capacity of international marine biological resources needs to be strengthened. At present, the equipment level of pelagic fishing boat in China is low; the base construction lags far behind, with no international resources exploratory fishing vessels and survey vessels; the development capacity of new fishing grounds and new resources is weak.

(vi) The technological level for development and utilization of marine resources is not high, lacking a number of major scientific and technological achievements and key technologies able to promote the industrial development^[6]. Meanwhile, the existing extension system is weak, and the conversion rate of technological achievements is low.

2 Forecast of main indicators on the development of ocean fishery during the Twelfth Five-Year Plan period

2.1 Forecast theory and methods The forecast of the development of ocean fishery indicators needs to consider the fishery resource environment, the impact of the relevant policies, price fluctuations and other factors. From the current situation, during the Twelfth Five-Year Plan period, the state will strengthen resource conservation, the resource environment will continue to improve, and the state's support to fishery will be the same as previous. In this favorable situation, we mainly use the mathematical reasoning method, and take different prediction methods according to difference in the forecast duration and purpose. However, since the price index and other factors are not considered, the value added of ocean fishery may be underestimated.

2.1.1 Regression analysis. In statistics, regression analysis is a statistical technique for estimating the relationships among variables. It includes many techniques for modeling and analyzing several variables, when the focus is on the relationship between a dependent variable and one or more independent variables. More

specifically, regression analysis helps one understand how the typical value of the dependent variable changes when any one of the independent variables is varied, while the other independent variables are held fixed^[7].

This method is used to forecast the ocean fishery data. We must first determine the number of independent variables, then select the appropriate regression model, use the existing marine economic statistics to calculate the specific form of regression equation, and finally forecast the data during the Twelfth Five-Year Plan period.

2.1.2 Trend extrapolation. It is a forecasting technique which uses statistical methods (such as exponential smoothing or moving averages) to project the future pattern of a time series data^[8]. Trend extrapolation is one aspect of the larger field of trend (or trendline) analysis. It attempts to extend known data points to regions beyond the timeframe of known datapoints, almost always in an attempt to predict future values with some degree of probability.

When the forecast object shows a trend to rise or fall with the changes in time and we can find an appropriate function curve to reflect this trend, time t can be used as independent variable, and time series value y can be used as dependent variable, to establish the trend model.

$$y = f(t) \quad (1)$$

If we have reason to believe that this trend can be extended into the future and a specific value is assigned to the variable t in the future period in formula (1), we can get the future value of time series in the corresponding time. It is the trend extrapolation.

Trend extrapolation method mainly uses scatterplot depiction (pattern recognition) and differential method for model selection. Its main advantage is that it can reveal the future development of things, and quantitatively estimate its functional properties. Trend extrapolation forecasting method is more suitable for medium and long-term forecast.

2.1.3 Review of forecast method. Regression analysis is a classic statistical forecasting method, with mature theory and wide application scope^[9], which can be used for short-term and long-term forecast. It is one of ways for the forecast of marine economy. Trend extrapolation applies to the forecast of time series with small sample size. After analysis, this paper selects regression analysis and trend extrapolation for forecast.

On the one hand, the simple regression analysis is used to analyze the association between the dependent variable and the independent variable; by the regression analysis, the regression equation of their causal relationship is established to describe the average varied quantitative relations between them; the forecast of several indicators uses logarithmic, polynomial regression equation for forecast. On the other hand, taking the average growth rate of ocean fishery indicators within a period of time as trend, trend extrapolation is a way to forecast the future scale and output of ocean fishery.

2.2 Forecast results According to the above method, we fore-

cast the indicators of physical output of the development of ocean fishery in 2015 (seafood production, *etc.*), the magnitude of value (marine fishery value added), the contribution of marine fish-

Table 1 The national marine fish production during the period 2000 – 2015
Unit: 10^4 t

Year	Marine products	Marine fishing	Offshore fishery	Mariculture
2000	2 203.91	1 189.43	86.52	927.96
2001	2 233.51	1 155.64	88.49	989.38
2002	2 298.45	1 128.34	109.64	1 060.47
2003	2 332.83	1 121.20	115.77	1 095.86
2004	2 404.48	1 108.08	145.11	1 151.29
2005	2 465.90	1 111.28	143.81	1 210.81
2006	2 509.63	1 136.40	109.07	1 264.16
2007	2 550.89	1 136.03	107.52	1 307.34
2008	2 598.28	1 149.63	108.33	1 340.32
2009	2 681.55	1 178.61	97.72	1 405.22
2010	2 797.53	1 203.59	111.64	1 482.30
2015	3 025.27	1 270.38	126.82	1 731.41
The average growth rate during the Twelfth Five-Year Plan period	1.58%	1.09%	2.58%	3.16%

Data source: *China Fishery Statistical Yearbook*^[10].

Table 3 The protein yield of marine product and its contribution to the supply of animal protein

Year	Protein yield of marine products 10^4 t	Animal protein production// 10^4 t			The proportion of protein yield of marine products to protein yield of aquatic products//%	The proportion of protein yield of marine products to protein yield of animal products//%
		Total	Protein yield of aquatic products	Protein yield of livestock products		
1980	58.6	233.6	80.1	153.5	73.1	25.1
1990	121.6	705.2	212.8	492.4	57.2	17.2
1995	237.3	1384.3	423.0	961.2	56.1	17.1
2000	396.3	1794.6	651.6	1143.0	60.8	22.1
2001	398.4	1835.3	664.5	1170.8	60.0	21.7
2002	408.5	1895.4	690.3	1205.1	59.2	21.6
2003	417.2	1972.0	714.0	1258.1	58.4	21.2
2004	428.6	2044.3	742.0	1302.3	57.8	21.0
2005	440.3	2145.2	773.0	1372.2	57.0	20.5
2006	386.8	2144.3	739.3	1405.0	52.3	18.0
2007	392.6	2175.6	765.5	1410.0	51.3	18.0
2008	426.7	2305.4	816.7	1488.6	52.2	18.5
2009	438.6	2396.5	853.4	1543.0	51.4	18.3
2010	408.1	2432.2	846.6	1585.6	48.2	16.8
2015	415.1	2098.7	748.9	1349.8	55.4	19.8

Data Source: *China Marine Statistical Yearbook* (2000 – 2010), *China Statistical Yearbook* (1996, 2009 – 2011)^[12].

Table 4 Net income of fishermen in coastal areas during the period 2006 – 2015

Unit: yuan

Areas	2006	2007	2008	2009	2010	2015	The average growth rate during the Twelfth Five-Year Plan period
Coastal areas	8026.82	8 828.64	9 513.51	10174.8	11 292.1	15 080.9	5.96%
Tianjin	11 779	12 360	12 780.3	13188.9	13 700	16 030.9	3.19%
Hebei	7 150	7 722	8 100	8 300	8500	10 249	3.81%
Liaoning	8 700	9 500	10 500	11 500	12 300	16 940	6.61%
Shanghai	10 219	11 239	12 700	13 335	14 400.1	19 699.2	6.47%
Jiangsu	7 500	8 170	9 020	9 872	11 110.6	15 380.8	6.72%
Zhejiang	8 598	9 722	10 938	12 022	13 350	19 188.8	7.53%
Fujian	6 808	7 230	7 759.33	8 290.75	9 167.93	11 897.6	5.35%
Shandong	7 520	8 136	8 816	9 565.04	10 416	13 945.3	6.01%
Guangdong	7 651	8 560	8 891.18	9 412.02	9 698	12 304.6	4.88%
Guangxi	5 366	6 840	6 973.72	7 613.29	12 172.9	17 864.1	7.97%
Hainan	7 004	7 636	8 170	8 823.59	9 397.56	12 388.5	5.68%

Data source: *China Fishery Statistical Yearbook* (2007 – 2011)^[13].

ery (marine protein contribution rate) and other key indicators, as well as the growth rate of the relevant indicators during the Twelfth Five-Year Plan period. The results are as follows:

Table 2 The value added of ocean fishery during the period 2001 – 2015

Year	Value added of ocean fishery 10^8 yuan	Marine GDP 10^8 yuan	The share of ocean fishery production in total marine fishery GDP//%
2001	966.0	9 518.4	10.15
2002	1 091.2	11 270.5	9.68
2003	1 145.0	11 952.3	9.58
2004	1 271.2	14 662.0	8.67
2005	1 507.6	17 655.6	8.54
2006	1 708.1	21 260.4	8.03
2007	1 910.0	25 073.0	7.62
2008	2 228.6	29 718.0	7.50
2009	2 440.8	32 277.6	7.56
2010	2 813.0	38 439.0	7.32
2015	3 642.9	51 755.6	7.04
The average growth rate during the Twelfth Five-Year Plan period	5.31%	6.13%	—

Data source: *China Marine Statistical Yearbook* in 2010^[11].

The marine product output and marine aquaculture production in Table 1 use linear regression method for forecast; the marine fishing output shows a rising trend after a falling trend, so according to industry trends and the basic data during the period 2004 – 2010, the linear regression method is used for forecast; the offshore fishing yield is forecasted using the average annual growth rate. The value added of ocean fishery and the national oceanic GDP in Table 2 are forecasted using linear regression method.

According to the basic data on the contribution of protein supply of marine products during the period 2006 – 2010, we use linear regression, logarithmic method and polynomial method for forecast^[14]. The forecast data is determined according to the polynomial with the highest R^2 , but from the prediction result, it is overall higher than during the Eleventh Five-Year Plan period; based on the experience, the contribution of protein supply of marine products remaining close to the level of 17.0% is more appropriate.

3 Conclusions

Prediction results show that during the Twelfth Five-Year Plan period, the development of ocean fishery will be stable, and based on the above forecast, we draw the following conclusions:

(i) During the Twelfth Five-Year Plan period, China's marine fishery will steadily advance, and the yield of marine products will grow steadily, with the average annual growth rate of 1.58%, conducive to maintaining the stability of the market supply and residents' demand for daily seafood.

(ii) The contribution of ocean fishery to the marine economy and the residents' nutrient composition is relatively stable. In 2011, ocean fishery achieved value added of 328.7 billion yuan^[15]. Projections show that during the Twelfth Five-Year Plan period, the value added of ocean fishery will experience the average annual growth rate of 5.31%, and the contribution to the national marine GDP will remain at about 7%; the contribution of protein supply of marine products will remain close to the level of 17.0%.

(iii) The prediction results of composition of marine product yield show that during the Twelfth Five-Year Plan period, China's industrial structure adjustment of ocean fishery will continue to adhere to the guideline of "raising-based, supplemented by fishing, vigorously developing offshore fishing", contributing to carrying out the work of resource conservation and fishery management.

(iv) The net income of fishermen in coastal areas will maintain an average annual growth rate of 6%, and there will be a steady increase in the income of fishermen, which will help to improve the quality of life. However, income levels are affected by many factors, so this indicator is only based on the viewpoint of mathematical reasoning. Considering the expected indicators of national fishery planning during the Twelfth Five-Year Plan period,

coupled with seeking the views of relevant experts, the indicator may be grossly underestimated.

In addition, during the Twelfth Five-Year Plan period, to promote the development of ocean fishery, we should pay the primary attention to safety; firmly hold onto security, structural adjustment, mode transfer and income increase; pay more attention to the safety of industrial development, the quality safety of aquatic products and ecological security, resource conservation and environmental protection, the fishermen's livelihood, technological innovation and application, functional and spatial expansion of fishery, and improvement of international competitiveness to actively develop modern fishery^[16].

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