The Measurement And Comparison Of Antarctic Krill Capacity Utilization In 48.1, 48.2 And 58.4 Subareas

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Abstract. In this paper, the fishing data of Longteng vessel in 48.1, 48.2 and 58.4 subareas in 2018 are analyzed by the DEA method. Taking times of operation, operating time and wrap tension as input factors, the catch as output factor for the analysis. The capacity utilization and target input are obtained, pure technology efficiency and scale efficiency are summarized in time series, no-deflection capacity utilization are calculated, the rationality of input allocation and the input impact on capacity utilization are evaluated. It is conducted by comparison analysis: in 58.4 subarea, the pure technology efficiency fluctuates obviously and has no growth trend, the production scale is on the rise, but the capacity utilization does not increases proportional to the growth of scale efficiency. There exists a large proportion of input waste, the scale needs to be optimized continually. In 48.1 subarea, capacity utilization and the scale efficiency trend gradually decreases, and the technical efficiency also has some low value. The resources of the subarea are sufficient, and the capacity utilization is influenced by the technology level and the allocation of input. The rational allocation of input and improving the technical level is the key. In 48.2 subarea, the capacity utilization and the technical efficiency trend firstly increases then decreases, the capacity utilization is greatly influenced by the technical level. The production scale and variable input allocation are most reasonable in the three subareas, but the production input still has some room for adjustment.

1. Introduction

The current objectives of the Antarctic fishery are Patagonian toothfish (Distothiks nematode), Antarctic fish (Dysosikut-MWSONI), mackerel fishes (PosioPopalas-GunNai) and Antarctic krill (Epopasia Sub). Antarctic krill are known as the largest single biological resource[1], which occupies a special position in Antarctic ecosystem[2]. As a potential and huge reservoir of protein, the Antarctic krill fishery has attracted people's attention. It began in 1960s and then was developed by commercial development. So far, the total catch of krill has exceeded 6 million tons. At present, the Antarctic krill fisheries mainly occur in the 48 and 58 area of the South Ocean, which are set by the FAO (United Nations Food and Agriculture Organization) in the Southern Ocean, and the 48 area is specifically divided into 6 subareas, while commercial fisheries are mainly concentrated in the 48.1-48.4 subareas.

Since 1980s, the Conservation Committee of the Antarctic marine living resources (CCAMLR) has started managing fisheries of biological resource in the Southern Ocean[3]. In order to control and prevent overfishing, provide scientific basement for the quantitative management and structural adjustment of krill fishing, and offer guidance for future practical production, making analysis of Antarctic krill fishing data is very important. At present, the basis of CCAMLR's management for Antarctic krill still remains on the early years of resource survey[4-5]. Therefore, it is necessary to reassess the fishing capacity of the Antarctic krill for the correction of related management measures.

After 2000, FAO firstly proposed a quantitative method [6-7] for fishing capacity, and then Zhou Yingqi and Chen Xinjun[8-9] explored a set of quantitative method of fishing capacity in accordance with the situation of China, based on the research work of FAO experts and the advanced foreign methods and experiences. Zheng Yi [10] firstly applied the data envelopment analysis (DEA) to the quantitative practice of fishing capacity. In twenty-first Century, the domestic researchers have measured and analyzed the fishing capacity of all provinces and the ocean , among them Fang ShuiMei[11-12] carried out the specific fishing capacity study of different fishing areas and operation modes in Fujian Province, compared the difference in order to evaluate their performance effectively, and made a decision analysis on various input factors.

Rao Xin [13] analyzed the systematic fishing capacity utilization and obtained irrational fishing input based on the data in the year of 2009-2014 of fishing yearbook. Labor force was set as variable input, fishing vessels, total power and total tonnage were set as fixed inputs, total catch as output ,the DEA model was applied to analyze the capacity utilization and target input in Chinese waters(the east China sea, the yellow sea and the south China sea), pure technology efficiency and scale efficiency were summarized in time series, no-deflection capacity utilization was calculated, the rationality of input allocation and the input impact on capacity utilization were evaluated.

The quantitative work of fishing capacity in the Antarctic fishing area is still in a blank state. In this paper, the fishing data of Longteng vessel in 48.1, 48.2 and 58.4 subareas in 2018 are analyzed using the DEA method. Taking times of operation, operating time and wrap tension as input factors, the catch as output factor for the analysis.

This paper summarizes the capacity utilization and capacity production of each fishing subarea, obtains the adjustment direction of input. Through the comparison and analysis of the scale efficiency of each fishing subarea, and the impact analysis of the input factors , in order to provide the basis for the future fisheries management and structural optimization for China.

2. Material and Method

2.1. material

In this paper, the observers fishing data in 48.1, 48.2 and 58.4 subareas of the Southern Ocean in 2018 are selected, times of operating is taken as variable input, operating time and wrap tension as fixed input factors, the catch as output factor for the analysis. The fishing statistics are shown in Tab 1.

2.2. method

The DEA model used in this paper is a method to calculate the relationship between production input and output. In the DEA model, if there are N series of K input and M output data, that is called N decision making units (DMU). For the i DMU, it are represented by x_i and y_i respectively. The input matrix X is K ×N, and the output matrix Y is $M \times N$.

The DEA model involves the use of linear programming methods to construct a non-parametric piece wise surface over the data, so as to be able to calculate efficiency relative to this surface[14-15].It is assumed that the scale returns constant (CRS), the linear equation[16-20] of each DMU for the output direction (output-oriented DEA model) is obtained:

$$\begin{aligned}&\max_{\Phi,\lambda}\Phi,\\ &s.t.\\ &\quad -\Phi y_i + Y\lambda \geq 0\\ &\quad x_i - X\lambda \geq 0\\ &\quad \lambda \geq 0\end{aligned} \tag{1}$$

$$P/(\Phi P)=1/\Phi=TE \tag{2}$$

Tab 1. Antarctic krill fishing statistics of three southern ocean subareas in 2018

subarea	date	Statistics			
		catch/t	Times of operating	Operating time	wrap tension/t
58.4 Subarea	2018-01-05	4	1	70	9.8
	2018-01-09	5	2	155	9.55
	2018-01-10	2	2	130	9.65
	2018-01-11	4	1	55	8.4
	2018-01-12	13	4	350	9.08
	2018-01-13	66	10	822	9.45
	2018-01-14	19	5	475	9.4
48.1 Subarea	2018-01-28	95	5	332	9.28
	2018-01-29	238	13	645	9.13
	2018-01-30	225	12	715	9.68
	2018-01-31	295	12	495	9.31
	2018-02-01	252	12	518	9.23
	2018-02-02	173	11	580	8.90
	2018-02-03	148	12	615	8.78
	2018-02-04	108	7	550	9.20
	2018-02-05	213	10	735	9.53
	2018-02-06	194	12	715	9.37
	2018-02-07	20	1	85	8.60
	2018-02-08	37	6	395	8.63
	2018-02-09	51	4	240	10.18
	2018-02-10	20	2	110	8.50
48.2 Subarea	2018-02-15	63	3	170	9.87
	2018-02-16	63	8	440	9.46
	2018-02-17	54	7	445	10.00
	2018-02-18	156	11	651	9.32
	2018-02-19	173	9	525	9.08
	2018-02-20	238	12	762	9.52
	2018-02-21	286	12	560	10.00
	2018-02-22	295	11	515	9.08
	2018-02-23	287	14	550	9.23
	2018-02-24	345	14	630	9.67
	2018-02-25	243	13	660	9.03
	2018-02-26	202	10	560	8.88
	2018-03-01	145	11	560	9.15
	2018-03-02	168	11	700	8.55
	2018-03-03	90	8	435	9.00

2018-03-04	113	11	570	9.12
2018-03-05	146	8	455	9.44
2018-03-06	211	10	675	9.87
2018-03-07	202	13	895	9.32
2018-03-08	181	13	660	9.65
2018-03-09	236	13	883	9.52
2018-03-10	275	12	875	10.04
2018-03-11	183	12	815	9.43
2018-03-12	30	4	250	9.35

In equation (1)-(2), λ is a constant vector of N×1, Φ is the growth ratio of maximum output under a certain input, the reciprocal of Φ is the technical efficiency (TE) of the DMU i. In the study of fishing capacity, the technical efficiency is equivalent to the fishing capacity utilization[5], P is the current output ,ΦP is capacity output.

When the technical efficiency is calculated, there are two different models: if the scale returns to the constant, all DMU operates on the same scale to get the CRS efficiency, which indicates the capacity utilization. In actual production, especially when analyzing long time series of data, not all DMU operate on a fixed scale. Supposed that the scale returns variable value, the variable scale efficiency (VRS) is obtained. Added constraints in the CRS linear programming model: $N1\lambda = 1$,we can get the model equation in VRS case[13]:

$$\begin{aligned} & \max_{\Phi,\lambda}\Phi, \\ s.t.\ & \\ & -\Phi y_i + Y\lambda \geq 0 \\ & x_i - X\lambda \geq 0 \\ & N1\lambda = 1 \\ & \lambda \geq 0 \end{aligned} \tag{3}$$

In equation (3),N1 is a matrix of N×1, λ is a constant vector of N × 1, Φ is the growth ratio of maximum output under a certain input. The frontier of the VRS model is a piece wise surface, which more closely envelopes all the data than CRS, so the technical efficiency is higher or equal than the CRS model, and the efficiency of CRS is the product of VRS efficiency and scale efficiency.

From the above concept of technical efficiency, we can see that technical efficiency is the ratio of actual output to capacity output. In actual production, since the constraints of various conditions, the actual production is the output when input has not been fully converted. So the technical efficiency cannot be reflection of the relationship between the allocation and output under the existing conditions are fully played. Therefore, a concept of no-deflection capacity utilization is proposed, which is the ratio of output under full efficiency and under variable input could always be satisfied[10].

The input is divided into variable input and fixed input. Under the condition that the variable input is fully satisfied, for the DMU i, the equation (1) can be written as [11]:

$$\begin{aligned}
&\max_{\Phi,\lambda,k} \Phi_1, \\
&s.t. \\
&\Phi_1 y_i \le \sum_{j=1}^{N} \lambda_j y_j \\
&\sum_{j=1}^{N} \lambda_j x_{jn} \le x_{in} (n \in a) \\
&\sum_{j=1}^{N} \lambda_j x_{jn} \le k_{in} x_{in} (n \in \hat{a}) \\
&\lambda_j \ge 0
\end{aligned} \tag{4}$$

λ_j is the component of vector λ , k_{in} is the ratio of the corresponding variable input and current input in the full efficiency production, a is the set of fixed inputs, $\hat{a}$ is the set of all variable inputs, x_{in} and x_{jn} are DMU I and DMU J . Φ_1 is the maximum growth ratio of full efficiency production under the variable input is fully satisfied. P is the current output, $\Phi_1 P$ is the capacity output of full efficiency production under the variable input is fully satisfied. Assumed that the existing allocation of variable input remains unchanged, the equation (4) can be rewritten as follows:

$$\begin{aligned}
&\max_{\Phi,\lambda} \Phi_2, \\
&s.t. \\
&\Phi_2 y_i \le \sum_{j=1}^{N} \lambda_j y_j \\
&\sum_{j=1}^{N} \lambda_j x_{jn} \le x_{in} \\
&\lambda_j \ge 0
\end{aligned} \tag{5}$$

In equation (5), λ_j is the component of vector λ , x_{in} and x_{jn} are DMU I and DMU J under the current input stays unchanged(including variable input and fixed input). Φ_2 is the maximum growth ratio of full efficiency production under the current input. P is the current output, $\Phi_2 P$ is the capacity output of full efficiency production under the current input. No-deflection capacity is calculated:

$$\Phi_2 P/(\Phi_1 P) = \Phi_2/\Phi_1 \tag{6}$$

The difference between the traditional capacity utilization and no-deflection capacity utilization is the influence of variable input allocation, and then the rationality of input allocation can be analyzed. In this paper, the DEAP 2.1 software compiled by Coelli is used to carry out the calculation and analysis. In the model, the output direction is chosen, and the target output is the capacity output. The technical efficiency is the fishing capacity utilization, and the target input value is the ideal production input without redundancy.

3. Results

3.1. Fishing capacity utilization and target input analysis of three subareas

It is assumed that the scale returns constant, according to the statistics of Tab 1, the CRS model is selected and the capacity utilization and capacity output of the 3 fishing subareas are analyzed, are shown in Tabs 2- 4.

It is shown as Tab 2 that the peak of capacity utilization in the 58.4 subarea appeared on January 13th, since the input achieve the maximum value of 100%.The capacity utilization was lowest value of 19.2% on January 10th and the capacity output was 10.42t, which was 5 times more than the actual output. In the whole period of operation, the production scale showed tendency to ascend, but capacity utilization is not directly proportional to the input. The high input does not bring high utilization, causes unnecessary waste of production instead. For example, on January 11th, less input was achieved, but higher capacity utilization was obtained. On January 10th 、12th and 13th, more input bought lower capacity utilization, even though the lowest utilization appeared on January 10th. The main influenced factors of fishing capacity utilization are pure technical level, production input, and rationality of input allocation and so on, which are related to other invisible resource and environmental conditions, such as fish group depth and fish group distribution.

It can be seen that the scale efficiency is stable and high, so in this time series, the resources is not enough to spare, the input is basically enough to meet the production demand, and the increase of the production cannot bring increase output, which is consistent with the actual performance. The main factor which leads to the low utilization is low technical efficiency. It can be seen that in the area, the most important thing to achieve capacity production is improving the fishing technology level, and rationally allocating the production input to avoid unnecessary waste.

The lowest fishing capacity utilization of 48.1 subarea is 25.1% on February 8th, reaching a peak of 100% on January 31st, the peak capacity output is 295t on January 31st, and the lowest value is 24.57 t on February 7th. In this time series, although the capacity utilization has been fluctuating, the overall trend has been declining, compared with descended production input, this is consistent. It can be seen that there is a certain relationship between input and output when resources is sufficient. The reasons of low capacity utilization in the 48.1 subarea were analyzed: there appeared low value in both technical efficiency and scale efficiency. it is proved that the low capacity utilization is caused by the fishing technology level and the rationality of input allocation collectively. The resource of this subarea is relatively abundant, so a reasonable increase and adjustment proportion of input is the most important, but at the same time, increasing could not be blind in order to prevent the destruction of the ecological environment.

The lowest fishing capacity utilization of 48.2 subarea was 28% on March 12th, reaching a peak of 100% on February 22nd and February 24th , the peak capacity output is 345t on February 24th , and the lowest value is 80.46 t on February 15th.In the time series, the capacity utilization increases first and then decreases. The input is relatively stable more, so the scale efficiency is also stable and high . Only a slight fluctuation occurs when the input suddenly decreases. It can be seen that the low capacity utilization is caused by the technical level not the input, but the production input remains the existing scale is not conducive to the protection and restoration of resources.

The depletion of resources is a difficult problem in world fisheries. Although the fishing and exploitation of the Antarctic krill is still in the first stage, the reserves are still very rich, but the reasonable adjustment of the input proportion is the most important in the future fisheries management. According to the results of the DEA model, on the date of the fishing capacity utilization less than 100%, the partial input generated redundant. The target input (actual input minus redundant input) in the three subareas is analyzed, are shown in table 2-4, which provides the basis for the adjustment of production input in the future. It can be seen from Tabs 2-4, the proportion of redundant input in 58.4 subarea is obviously higher than others, and the redundancy is almost fifty percent, and the fishing production has quite a few waste. In 48.1 subarea, redundancy is around ten percent with approaching 50% on a few dates. The redundancy is acceptable. This is consistent with the analysis of capacity utilization. In 48.2 subarea, the redundancy ratio is mostly around ten percent, very few approaches thirty percent, which is the smallest in the three subareas. It is worth noting that on the date of no redundant, which can only indicate that the input is more reasonable than the other dates of the time series, does not mean that there is absolutely no waste in the actual production.

3.2. Analysis of input allocation rationality in 3 subareas

From the analysis of the capacity utilization and other efficiency, it is shown that under certain technical level, the adjustment direction of fishing in the future is optimizing the production scale, adjusting the production input, and increasing the rationality of input allocation. In order to explore the rationality of the three subareas, especially the variable input, the production input is divided into variable input and fixed input. According to the concept of no-deflection capacity utilization, the results of DEA model are included in Table 6 to table 8. From table 6 to table 8, the no-deflection capacity utilization in 58.4 subarea are all 100%; in 48.1 subarea, the no-deflection capacity utilization on January 29th, February 1st and February 3rd are respectively 90.5% and 99.1% and 94.4%, and the others are 100%; the no-deflection utilization in 48.2 subarea are above 90%, and two-thirds reach the peak 100%. It is shown that variable input allocation of the three subareas is ideal, no need to make too much adjustment.

To analyze the fixed input, we ignore operation time and times of operation in proper order. The other input and output factors stay unchanged. The "capacity utilization" TE1 and TE2 can be obtained, and the results are included in Table 6 to table 8. From table 6 to table 8, it can be seen that when any fixed input factors were not taken as constraint condition, the results of capacity utilization of the three subareas will be greatly affected: in 58.4 subarea, TE1 stays less than 60%, the change of TE2 is relatively small, so the influence of the operation time is relatively larger than the other fixed input. The trend of TE1 and TE2 in 48.1 subarea increases firstly and then decreases, and the numerical fluctuation is obvious. This is consistent with the trend of capacity utilization and scale efficiency. It can be seen that the two fixed input have greater influence on capacity utilization and scale efficiency. Compared between the two fixed inputs, the influence of times of operation on the capacity utilization is relatively more than the other. The trend of TE1 and TE2 in 48.2 subarea is similar as 48.1 subarea, but the fluctuation is more intense. It can be seen that the two fixed inputs have greater influence on the capacity utilization and scale efficiency, but they are not the only influence factors. The influence of times of operation on the capacity utilization is relatively more than the other.

3.3. Summary

On the basis of the above calculation and analysis results, the fishing production in the three subareas is summarized: in 58.4 subarea, the pure technology efficiency fluctuates obviously and has no growth trend, the production scale is on the rise, but the capacity utilization does not increases proportional to the growth of scale efficiency. There exists a large proportion of input waste; the scale needs to be optimized continually. The allocation of variable input is relatively reasonable. The influence of operation time on the capacity utilization is relatively larger, and the factor can be considered when the production input is adjusted.

In 48.1 subarea, capacity utilization and the scale efficiency trend gradually decreases, and the technical efficiency also has some low value. The resources of the subarea are sufficient, and the capacity utilization is influenced by the technology level and the allocation of input. The rational allocation of input and improving the technical level is the key, and consider times of operation firstly when adjusting the fixed input.

In 48.2 subarea, the capacity utilization and the technical efficiency trend firstly increases then decreases, the capacity utilization is greatly influenced by the technical level. The production scale and variable input allocation are most reasonable in the three subareas, but the production input still has some room for adjustment,also consider times of operation firstly when adjusting the fixed input.

Tab 2. Capacity utilization, pure technical efficiency, Scale efficiency ,capacity output, target input and input redundancy in 58.4 subarea

date	DEA output oriented value			DEA model target input				Input redundancy ratio		
	Capacity utilization /%	Pure technical efficiency /%	Scale efficiency /%	Capacity output /t	Operation time/minute	Times of operation	Wrap tension/t	Operation time/minute	Times of operation	Wrap tension/t
2018-01-05	71.2	100	71.2	5.62	55.00	1.00	8.40	21.4%	0.0%	14.3%
2018-01-09	40.2	45.9	87.5	12.44	67.40	1.00	8.42	56.5%	50.0%	11.8%
2018-01-10	19.2	19.9	96.4	10.42	55.00	1.00	8.40	57.7%	50.0%	13.0%
2018-01-11	90.6	100	90.6	4.42	55.00	1.00	8.40	0.0%	0.0%	0.0%
2018-01-12	49.2	52.7	93.4	26.42	166.30	2.00	8.55	52.5%	50.0%	5.8%
2018-01-13	100	100	100	66.00	822.00	10.00	9.45	0.0%	0.0%	0.0%
2018-01-14	57.6	60.2	95.6	32.99	240.60	3.00	8.65	49.3%	40.0%	8.0%

Tab 3. Capacity utilization, pure technical efficiency, Scale efficiency ,capacity output, target input and input redundancy in 48.1 subarea

date	DEA output oriented value			DEA model target input				Input redundancy ratio		
	Capacity utilization /%	Pure technical efficiency /%	Scale efficiency /%	Capacity output /t	Operation time/minute	Times of operation	Wrap tension/t	Operation time/minute	Times of operation	Wrap tension/t
2018-01-28	77.3	79.2	97.6	122.90	214.32	5.00	8.72	35.4%	0.0%	6.0%
2018-01-29	82.3	97.1	84.7	289.19	541.53	12.00	9.10	16.0%	7.7%	0.3%
2018-01-30	76.3	76.3	100.0	294.89	506.15	11.00	9.07	29.2%	8.3%	6.3%
2018-01-31	100	100.0	100.0	295.00	495.00	12.00	9.31	0.0%	0.0%	0.0%
2018-02-01	86.2	92.4	93.3	292.34	514.06	12.00	9.16	0.8%	0.0%	0.8%
2018-02-02	64	98.2	65.2	270.31	532.78	11.00	8.89	8.1%	0.0%	0.1%
2018-02-03	53.2	100.0	53.2	278.20	615.00	12.00	8.78	0.0%	0.0%	0.0%
2018-02-04	62.8	63.5	98.8	171.97	321.25	7.00	8.73	41.6%	0.0%	5.1%
2018-02-05	86.6	86.9	99.7	245.96	409.96	10.00	9.06	44.2%	0.0%	4.9%
2018-02-06	65.8	65.8	100.0	294.83	545.09	11.00	8.96	23.8%	8.3%	4.3%
2018-02-07	81.4	100.0	81.4	24.57	85.00	1.00	8.60	0.0%	0.0%	0.0%
2018-02-08	25.1	48.6	51.7	147.41	177.07	3.00	8.54	55.2%	50.0%	1.1%
2018-02-09	51.9	53.7	96.6	98.27	168.44	3.00	8.59	29.8%	25.0%	15.6%
2018-02-10	40.7	100.0	40.7	49.14	110.00	2.00	8.50	0.0%	0.0%	0.0%

Tab 4. Capacity utilization, pure technical efficiency, Scale efficiency ,capacity output, target input and input redundancy in 48.2 subarea

date	DEA output oriented value			DEA model target input				Input redundancy ratio		
	Capacity utilization /%	Pure technical efficiency /%	Scale efficiency /%	Capacity output /t	Operation time/minute	Times of operation	Wrap tension/t	Operation time/minute	Times of operation	Wrap tension/t
2018-02-15	78.3	100	78.3	80.46	170.00	3.00	9.87	0.0%	0.0%	0.0%
2018-02-16	29.4	30.3	96.9	214.29	419.96	8.00	9.03	4.6%	0.0%	4.6%
2018-02-17	28.8	30.2	95.4	187.50	401.49	6.00	9.08	9.8%	14.3%	9.2%
2018-02-18	52.9	52.9	100	294.90	609.21	10.00	8.72	6.4%	9.1%	6.4%
2018-02-19	71.7	85.9	83.5	241.28	499.21	9.00	9.98	4.9%	0.0%	0.0%
2018-02-20	75.4	76.4	98.8	315.65	598.03	11.00	8.84	21.5%	8.3%	7.1%
2018-02-21	89.2	91.8	97.2	320.63	508.65	11.00	9.09	9.2%	8.3%	9.1%
2018-02-22	100	100	100	295.00	515.00	11.00	9.08	0.0%	0.0%	0.0%
2018-02-23	92.6	93.3	99.3	309.94	526.65	11.00	9.05	4.2%	21.4%	1.9%
2018-02-24	100	100	100	345.00	630.00	14.00	9.67	0.0%	0.0%	0.0%
2018-02-25	75.7	85.9	88.1	321.00	590.75	11.00	8.86	10.5%	15.4%	1.9%

2018-02-26	75.3	100	75.3	268.26	560.00	10.00	8.88	0.0%	0.0%	0.0%
2018-03-01	49.2	49.2	100	294.72	541.48	9.00	8.85	3.3%	18.2%	3.2%
2018-03-02	58.7	100	58.7	286.20	700.00	11.00	8.55	0.0%	0.0%	0.1%
2018-03-03	41.9	100	41.9	214.80	435.00	8.00	9.00	0.0%	0.0%	0.0%
2018-03-05	68.1	70.2	96.9	214.39	550.27	9.00	8.80	6.1%	0.0%	3.6%
2018-03-06	78.7	79.3	99.2	268.11	427.42	8.00	9.10	30.3%	10.0%	8.0%
2018-03-07	62	64.1	96.8	325.81	470.72	9.00	9.08	27.3%	15.4%	6.8%
2018-03-08	54.7	55.1	99.1	330.90	650.47	11.00	8.69	9.1%	23.1%	9.1%
2018-03-09	71.7	71.9	99.8	329.15	599.85	10.00	8.77	31.9%	15.4%	7.2%
2018-03-10	85.5	88.2	96.8	321.64	600.95	11.00	8.83	39.9%	8.3%	10.1%
2018-03-11	58.3	58.7	99.2	313.89	525.88	11.00	9.03	17.2%	8.3%	8.5%
2018-03-12	28	100	28	107.14	675.22	11.00	8.62	0.0%	0.0%	0.0%

Tab 5. Various capacity utilization in 58.4 subarea

date	Fixed input		Variable input	Capacity utilization		
	Operation time/minute	Times of operation	Wrap tension/t	No-deflection capacity utilization /%	TE1/%	TE2/%
2018-01-05	70	1	9.8	100.0	60.6	71.2
2018-01-09	155	2	9.55	100.0	37.9	40.2
2018-01-10	130	2	9.65	100.0	15.2	19.2
2018-01-11	55	1	8.4	100.0	60.6	90.6
2018-01-12	350	4	9.08	100.0	49.2	46.3
2018-01-13	822	10	9.45	100.0	100	100
2018-01-14	475	5	9.4	100.0	57.6	49.8

Tab 6. Various capacity utilization in 48.1 subarea

date	Fixed input		Variable input	Capacity utilization		
	Operation time/minute	Times of operation	Wrap tension/t	No-deflection capacity utilization /%	TE1/%	TE2/%
2018-01-28	332	5	9.28	100.0	77.3	40.8
2018-01-29	645	13	9.13	90.5	82.3	82.3
2018-01-30	715	12	9.68	100.0	76.3	73.4
2018-01-31	495	12	9.31	100.0	100.0	100.0
2018-02-01	518	12	9.23	99.1	86.2	86.2
2018-02-02	580	11	8.90	100.0	64.0	61.3
2018-02-03	615	12	8.78	94.4	53.2	53.2
2018-02-04	550	7	9.20	100.0	62.8	37.0
2018-02-05	735	10	9.53	100.0	86.6	70.5
2018-02-06	715	12	9.37	100.0	65.8	65.3
2018-02-07	85	1	8.60	100.0	81.4	39.5
2018-02-08	395	6	8.63	100.0	25.1	15.7
2018-02-09	240	4	10.18	100.0	51.9	35.7

2018-02-10	110	2	8.50	100.0	40.7	30.5

Tab 7. Various capacity utilization in 48.2 subarea

date	Fixed input		Variable input	Capacity utilization		
	Operation time/minute	Times of operation	Wrap tension/t	No-deflection capacity utilization /%	TE1/%	TE2/%
2018-02-15	170	3	9.87	100.0	78.3	54.7
2018-02-16	419	8	9.03	100.0	29.4	25.0
2018-02-17	401	6	9.08	100.0	28.8	21.2
2018-02-18	609	10	8.72	100.0	52.9	46.9
2018-02-19	499	9	9.98	100.0	71.7	57.9
2018-02-20	598	11	8.84	98.1	75.4	70.1
2018-02-21	508	11	9.09	100.0	88.9	89.2
2018-02-22	515	11	9.08	100.0	100	100.0
2018-02-23	526	11	9.05	98.4	87.2	92.6
2018-02-24	630	14	9.67	95.6	100.0	100.0
2018-02-25	590	11	8.86	92.1	75.7	75.4
2018-02-26	560	10	8.88	100.0	75.3	65.2
2018-03-01	541	9	8.85	100.0	49.2	46.4
2018-03-02	700	11	8.55	96.9	58.7	55.1
2018-03-03	435	8	9.00	100.0	41.9	36.1
2018-03-04	550	9	8.80	100.0	38.3	35.7
2018-03-05	427	8	9.10	100.0	68.1	56.0
2018-03-06	470	9	9.08	100.0	78.7	59.9
2018-03-07	650	11	8.69	93.4	62.0	60.7
2018-03-08	599	10	8.77	94.9	54.7	52.6
2018-03-09	600	11	8.83	94.4	71.7	69.5
2018-03-10	525	11	9.03	100.0	85.5	76.8
2018-03-11	675	11	8.62	97.6	58.3	54.4
2018-03-12	250	4	9.35	100.0	28.0	20.9
2018-03-05	427	8	9.10	100.0	78.3	54.7

4. Discussion

The study of the time series analysis of fishing capacity in different areas can master the overall input level and output capacity of each area [10]. Even taking the same vessel, the fishing technology level is stable and the fishing object is fixed, but the difference of environment, resource level and the production input will affect the fishing capacity. The resource level as a potential environmental factor, affects the rationality and efficiency of production scale. In the analysis of time series, capacity utilization is greatly influenced by the fluctuation of production scale. In the future, the resource level can be considered as an input factor which impacts the accuracy of the fishing capacity positively. However, there are too many methods of resource level assessment; the meaning of data and results is different, and difficult to obtain detailed data, so it is hard to list resource level as input factor.

The time series selected in this paper are based on date, and the study could obtain the change level of the fishing capacity in 2018. In the future research, we can analyze the change trend of the fishing capacity based on year, could obtain the change level of the fishing capacity in years. At the same time, the production data of more countries can be adopted for the analysis to show the differences in production technology and the capacity utilization of krill fishing worldwide.

In the calculation of fishing capacity utilization, the selection of input factors affects the fishing capacity precision, especially the analysis of the production input allocation. In this paper, the production cycle of 2018 is the research object, so only three items are selected as input factors, and others such as the amount of net gear, the perimeter of the net, the labor force, the number of fishing vessels which are no changes in the same year, will be important in other case, and play a positive role in the change trend and the accuracy of fishing capacity.

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