ISSN 2616-5902 Vol. 6, Issue 4: 24-30, DOI: 10.25236/AJBM.2024.060405

A study on decision-making problems in fish selection for aquaculture projects

Yujie Wang

Department of Industrial Engineering, Business School, Shanghai, China
University of Shanghai for Science and Technology, 516 Jungong Road, Shanghai, 200093, China
13585657868@163.com

Abstract: *In recent years, with the development of society and the improvement of material living standards, aquatic products consumption in people's lives occupies an increasingly important position, more productive and marketable aquatic products have also become the common goal of the farms. Fish species, as an important part of aquaculture, is the key to determine the success or failure of aquaculture business, so the selection of good fish species is of great significance to the scale and supply of fish farming in the society. In this paper, we find the recommended fish species for aquaculture by simulating the demand of fish using a management decision model.*

Keywords: *Aquaculture; Management decision-making; decision model*

1. Introduction

Fish constitute important high protein products to meet the demands of an increasing global population[1]. Aquaculture is a productive enterprise that utilizes suitable waters to raise aquatic economic plants and animals. It is an important part of the fisheries industry. Human beings have been engaged in aquaculture for a later period than in capture fisheries for natural aquatic resources. The emergence and development of aquaculture marks the enhancement of human's ability to influence and control waters. Aquaculture can economically provide humans with high-quality animal protein food. And with the rapid growth of the world's population and economic development, human needs for animal protein are increasing, but the catch is limited by the renewal of natural fishery resources. Sustainable aquaculture is one of the systems that reveal the food problem in the world [2]. Fishery forecasts indicate that the trend of increasing annual catches has reached its peak, and that demand will not be met by fishing natural fishery resources alone in the future. Aquaculture is needed to make up for the shortfall in fishing.

For aquaculture, the most important and basic thing is the selection of fish species for aquaculture, and this selection is to select the most suitable fish species for aquaculture in the context of expanding the scale of aquaculture.

The target fish species of this selection are mainly mackerel, tilapia, blackfish, snapper and eel.

2. The methods

2.1 Regression analysis

Regression analysis refers to a method of statistical analysis that identifies interdependent quantitative relationships between two or more variables. Revealing hidden dynamics from the stochastic data is a challenging problem as the randomness takes part in the evolution of the data[3]. However, there is still regularity in the evolution of the data between years, and in this paper the main method chosen is linear regression, a technique in which the dependent variable is continuous, the independent variables can be either continuous or discrete, and the nature of the regression line is linear.

2.2 Setting basic model

The decision index system and decision model together constitute the decision framework[4]. The decision indicator system of this paper will be given first.

ISSN 2616-5902 Vol. 6, Issue 4: 24-30, DOI: 10.25236/AJBM.2024.060405

In this paper, there are five target species, and the target species will be screened by six factors: culture cost, production, consumption, market price, ease of transportation, and taste.

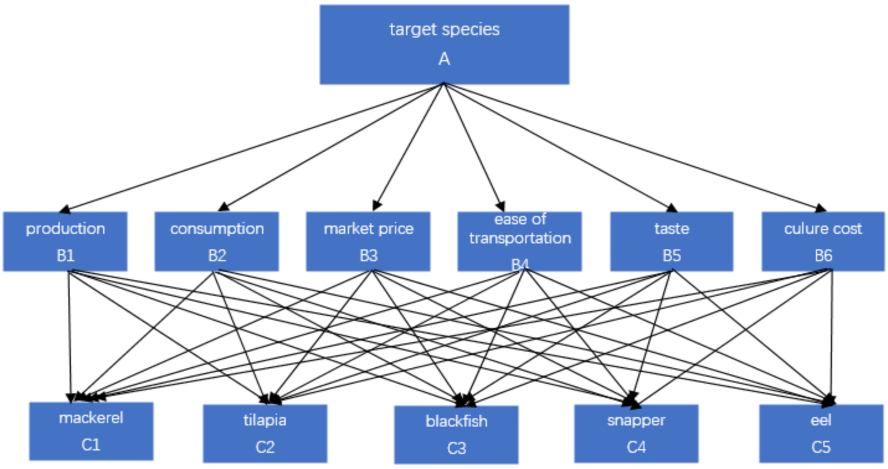

Figure 1: System of indicators for decision-making

Figure 1 shows the system of decision-making indicators in this paper. The first top-down level is the target level, the second is the indicator level, and the third is the program level.

2.3 Data Acquisition

With the progress of science and technology, big data has become an indispensable part of our lives[5]. In big data environments, many problems become more huge and complex[6]. Therefore, this paper obtains the national aquatic production and consumption data from the China Statistical Yearbook from 2011 to 2021, and uses regression analysis to forecast the national aquatic production and consumption in 2022 and 2023 in order to obtain the most appropriate data for analysis. Scattered trend plots were also utilized. Visualization and visual analytic tools amplify one's perception of data, facilitating deeper and faster insights that can improve decision making[7]. The scatterplot represents the general trend of the dependent variable with respect to the independent variable, whereby a suitable function can be selected to fit the data points. Two sets of data are used to form multiple coordinate points, and the distribution of the coordinate points is examined to determine whether there is some association between the two variables or to summarize the pattern of distribution of the coordinate points. A scatterplot displays a sequence as a set of points. Values are indicated by the position of the points on the chart. Categories are represented by different markers in the chart.

2.4 Hierarchical Analysis

Hierarchical analysis, or AHP for short, is a decision-making method that breaks down the elements that are always relevant to a decision into levels such as objectives, guidelines, and options, on the basis of which qualitative and quantitative analyses are conducted.

AHP methodology is employed to structure the problem into a hierarchical model, with criteria, sub-criteria, and alternatives.[8] Then use the method of solving the eigenvectors of the judgment matrix to obtain the priority weight of each element of each level to an element of the previous level, and finally the final weight of each alternative to the total objective by the method of weighted sum, and the one with the largest final weight is the optimal solution.

ISSN 2616-5902 Vol. 6, Issue 4: 24-30, DOI: 10.25236/AJBM.2024.060405

3. Results

3.1 Aquaculture production and consumption

serial number	particular year	Farming production (tons)	Production forecast (y = 1496e0.0369x)	Aquatic consumption (tons))	Consumption forecasts (y = 1229e0.0433x)
1	2011	1551.3	1552.23	1290.9	1283.38463
2	2012	1575.2	1610.58	1353	1340.175842
3	2013	1664.7	1671.12	1415.1	1399.480128
4	2014	1732.4	1733.94	1477.2	1461.408696
5	2015	1796.6	1799.12	1539.5	1526.077672
6	2016	1915.3	1866.74	1576.2	1593.608323
7	2017	2000.7	1936.91	1598.5	1664.127281
8	2018	2031.2	2009.72	1590.7	1737.766783
9	2019	2065.3	2085.26	1904	1814.664915
10	2020	2135.3	2163.65	1962.8	1894.965875
11	2021	2211.1	2244.98	2005.8	1978.820244
12	2022		2329.36		2066.385262
13	2023		2416.92		2157.825131

Figure 2: Aquaculture and consumption 2011-2023

Figure 2 shows aquaculture data and projections based on aquaculture data. As can be seen in this figure, both aquaculture and consumption are on the rise.

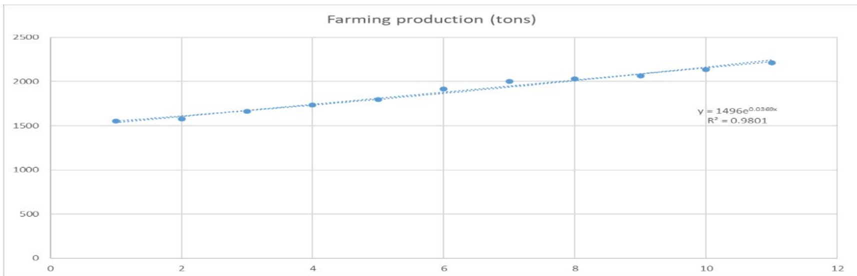

Figure 3: Scattered Trend of Aquaculture Production, 2011-2023

Figure 3 shows the scattered trend of aquaculture production from 2011 to 2023. It can be seen that aquaculture is rising year by year.

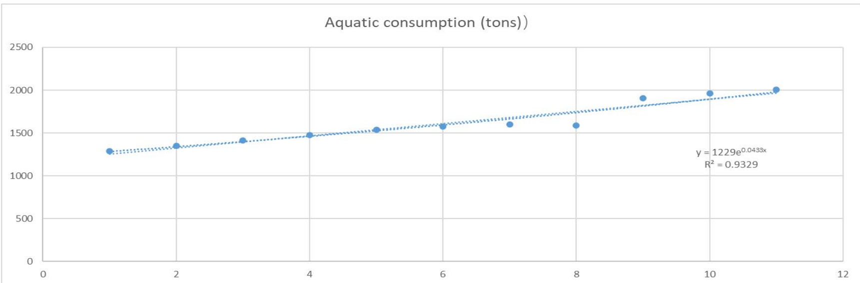

Figure 4: Scattered trend of aquatic consumption, 2011-2023

Figure 4 shows the Scattered trend of aquatic consumption from 2011 to 2023. It can be seen that aquatic consumption is rising year by year.

SUMMARY OUTPUT								
regression statistics								
Multiple R	0.998136339							
R Square	0.996276151							
Adjusted R Square	0.99593762							
standard error	17.87489939							
observed value	13							
analysis of variance								
	df	SS	MS	F	Significance F			
regression analysis	1	940302.5229	940302.5229	2942.933098	1.02927E-14			
residual	11	3514.63231	319.5120281					
total	12	943817.1552						
	Coefficients	standard error	t Stat	P-value	Lower 95%	Upper 95%	lower limit 95.0%	upper limit 95.0%
Intercept	1452.277069	10.51666855	138.092882	3.59659E-19	1429.130038	1475.424101	1429.130038	1475.424101
X Variable 1	71.87835125	1.324975696	54.24880734	1.02927E-14	68.96209941	74.7946031	68.96209941	74.7946031

Figure 5: Regression statistics for aquaculture production

ISSN 2616-5902 Vol. 6, Issue 4: 24-30, DOI: 10.25236/AJBM.2024.060405

Figure 5 shows the regression statistics for aquaculture production.It can be seen that aquaculture production forecasts have been tested and have credibility.

SUMMARY OUTPUT								
regression statistics								
Multiple R	0.997438212							
R Square	0.994882987							
Adjusted R Square	0.994417803							
standard error	21.1848279							
observed value	13							
analysis of variance								
	df	SS	MS	F	Significance F			
regression analysis	1	959838.1549	959838.1549	2138.69143	5.91453E-14			
residual	11	4936.766265	448.7969332					
total	12	964774.9211						
	Coefficients	standard error	t Stat	P-value	Lower 95%	Upper 95%	lower limit 95.0%	upper limit95.0%
Intercept	1177.704866	12.46405971	94.48806351	2.32908E-17	1150.271655	1205.138076	1150.271655	1205.138076
X Variable 1	72.62118159	1.570323921	46.24598826	5.91453E-14	69.16492195	76.07744124	69.16492195	76.07744124

Figure 6: Regression statistics for aquatic consumption

Figure 6 shows the regression statistics for aquaculture consumption.It can be seen that aquaculture consumption forecasts have been tested and have credibility.

3.2 Weighting and consistency test

	Production(Pounds per acre)	Consumption(tons)	Market price (Yuan/kg)	Ease of transportation	Taste	Cluture cost(Yuan/punds)
mackerel	4000	60	10	2	5	5
tilapia	6000	160	5.4	1	3	2.3
blackfish	7500	600	20	3	4	3
snapper	7000	33	15	4	1	2.8
eel	3330	30	30	5	2	9

Figure 7: Evaluation data sheet for 5 species

Figure 7 shows the evaluation data sheet for 5 species. With this data, it is possible to compare and sort fish species.

	ProductionB1	ConsumptionB2	Market priceB3	Ease of transportationB4	TasteB5	Culture costB6	Sum vector	Weights	AW	AW/W
ProductionB1	1	0.71	0.56	0.625	0.83	1.25	4.975	0.13	0.77	6.003477387
ConsumptionB2	1.4	1	0.78	0.875	1.17	1.75	6.975	0.18	1.08	6.002587814
Market priceB3	1.8	1.29	1	1.125	1.5	2.25	8.965	0.23	1.39	6.0021193
Ease of transportationB4	1.6	1.14	0.89	1	1.34	2	7.97	0.21	1.23	6.00170012
TasteB5	1.2	0.86	0.67	0.75	1	1.5	5.98	0.15	0.92	6.0037709
Culture costB6	0.8	0.57	0.44	0.5	0.67	1	3.98	0.1	0.61	5.997977387
							38.845	Eigenvector		36.01163291
									landa max	6.001938828
									CI	0.000387766
									RI	1.26
									CR	0.0003077

Figure 8: Chart for calculating the weights of the indicators in the second tier

Figure 8 shows the chart for calculating the weights of the indicators in the second tier. This is the second tier of indicator weights calculated from the above data.

	mackerelC1	tilapiaC2	blackfishC3	snapperC4	eelC5	Sum vector	Weights	AW	AW/W
mackerelC1	1	0.67	0.53	0.57	1.2	3.97	0.1435	0.717734	5.0024433
tilapiaC2	1.5	1	0.8	0.85	1.8	5.95	0.215	1.075623	5.0021008
blackfishC3	1.9	1.25	1	1.07	2.27	7.49	0.2707	1.35239	4.9960881
snapperC4	1.75	1.17	0.93	1	2.1	6.95	0.2512	1.2568	5.0036978
eelC5	0.83	0.56	0.44	0.48	1	3.31	0.1196	0.59879	5.0056495
						27.67	Eigenvector		25.00998
								landa max	5.0019959
								CI	0.000499
								RI	1.12
								CR	0.0004455

Figure 9: Calculation table for weighting of production indicators

Figure 9 shows the calculation table for weighting of production indicators in the third tier.

ISSN 2616-5902 Vol. 6, Issue 4: 24-30, DOI: 10.25236/AJBM.2024.060405

	mackerelC1	tilapiaC2	blackfishC3	snapperC4	eelC5	Sum vector	Weights	AW	AW/W
mackerelC1	1	0.375	0.1	1.82	2	5.295	0.068	0.339711	4.9991124
tilapiaC2	2.67	1	0.27	4.85	5.33	14.12	0.1812	0.908151	5.011551
blackfishC3	10	3.75	1	18.2	20	52.95	0.6795	3.397112	4.9991124
snapperC4	0.55	0.21	0.055	1	1.1	2.915	0.0374	0.187483	5.0115609
eelC5	0.5	0.19	0.05	0.9	1	2.64	0.0339	0.169935	5.0156439
						77.92	Eigenvector		25.036981
								landa max	5.0073961
								CI	0.001849
								RI	1.12
								CR	0.0016509

Figure 10: Calculation table for weighting of consumption indicators

Figure 10 shows the calculation table for weighting of consumption indicators in the third tier.

	mackerelC1	tilapiaC2	blackfishC3	snapperC4	eelC5	Sum vector	Weights	AW	AW/W
mackerelC1	1	1.86	0.5	0.67	0.33	4.36	0.1245	0.621848	4.9933257
tilapiaC2	0.54	1	0.27	0.36	0.18	2.35	0.0671	0.335838	5.0032766
blackfishC3	2	3.71	1	1.33	0.67	8.71	0.2488	1.24489	5.0038576
snapperC4	1.5	2.78	0.75	1	0.5	6.53	0.1865	0.933033	5.0023737
eelC5	3	5.56	1.5	2	1	13.06	0.373	1.866067	5.0023737
						35.01	Eigenvector		25.0052073
								landa max	5.0010414
								CI	0.0002604
								RI	1.12
								CR	0.0002325

Figure 11: Calculation table for weighting of market price indicators

Figure 11 shows the calculation table for weighting of market price indicators in the third tier.

	mackerelC1	tilapiaC2	blackfishC3	snapperC4	eelC5	Sum vector	Weights	AW	AW/W
mackerelC1	1	2	0.67	0.5	0.4	4.57	0.1334	0.667615	5.0049234
tilapiaC2	0.5	1	0.34	0.25	0.2	2.29	0.0668	0.334807	5.008952
blackfishC3	1.5	3	1	0.75	0.6	6.85	0.1999	1.000423	5.0035766
snapperC4	2	4	1.33	1	0.8	9.13	0.2665	1.333231	5.0029025
eelC5	2.5	5	1.67	1.25	1	11.42	0.3333	1.668039	5.0041156
						34.26	Eigenvector		25.0244701
								landa max	5.004894
								CI	0.0012235
								RI	1.12
								CR	0.0010924

Figure 12: Calculation table for weighting of ease of transportation indicators

Figure 12 shows the calculation table for weighting of ease of transportation indicators in the third tier.

	mackerelC1	tilapiaC2	blackfishC3	snapperC4	eelC5	Sum vector	Weights	AW	AW/W
mackerelC1	1	1.67	1.25	5	2.5	11.42	0.3333	1.668039	5.0041156
tilapiaC2	0.6	1	0.75	3	1.5	6.85	0.1999	1.000423	5.0035766
blackfishC3	0.8	1.33	1	4	2	9.13	0.2665	1.333231	5.0029025
snapperC4	0.2	0.34	0.25	1	0.5	2.29	0.0668	0.334807	5.008952
eelC5	0.4	0.67	0.5	2	1	4.57	0.1334	0.667615	5.0049234
						34.26	Eigenvector		25.0244701
								landa max	5.004894
								CI	0.0012235
								RI	1.12
								CR	0.0010924

Figure 13: Calculation table for weighting of taste indicators

Figure 13 shows the calculation table for weighting of taste indicators in the third tier.

ISSN 2616-5902 Vol. 6, Issue 4: 24-30, DOI: 10.25236/AJBM.2024.060405

	mackerelC1	tilapiaC2	blackfishC3	snapperC4	eelC5	Sum vector	Weights	AW	AW/W
mackerelC1	1	2.17	1.67	1.79	0.56	7.19	0.2267	1.134095	5.0032684
tilapiaC2	0.46	1	0.77	0.82	0.26	3.31	0.1044	0.522661	5.0087009
blackfishC3	0.6	1.3	1	1.07	0.33	4.3	0.1356	0.67703	4.9942791
snapperC4	0.56	1.22	0.93	1	0.31	4.02	0.1267	0.633121	4.9956716
eelC5	1.8	3.9	3	3.2	1	12.9	0.4067	2.03389	5.0011628
						31.72	Eigenvector		25.0030828
								landa max	5.0006166
								CI	0.0001541
								RI	1.12
								CR	0.0001376

Figure 14: Calculation table for weighting of culture cost indicators

Figure 14 shows the calculation table for weighting of culture cost indicators in the third tier.

From the obtained consistency test results, it is known that all the above CR values are less than 0.1 and their consistency tests are passed.

3.3 Calculation of total indicator weights

(1) C1 to A has 6 paths: C1-B1-A, C1-B2-A. C1-B3-A, C1-B4-A, C1-B5-A, C1-B6-A.

Total weight of C1 over A =0.13x0.1435+0.18x0.068+0.23x0.1245+0.21x0.1334+0.15x0.3333+0.1x0.2267=0.1602

(2) C2 to A has 6 paths: C2-B1-A,C2-B2-A.C2-B3-A,C2-B4-A,C2-B5-A,C2-B6-A.

Total weight of C2 over A =0.13x0.215+0.18x0.1812+0.23x0.0671+0.21x0.0668+0.15x0.1999+0.1x0.1044=0.1305

(3) C3 to A has 6 paths: C3-B1-A,C3-B2-A.C3-B3-A,C3-B4-A,C3-B5-A,C3-B6-A.

Total weight of C3 over A =0.13x0.2707+0.18x0.6795+0.23x0.2488+0.21x0.1999+0.15x0.2665+0.1x0.1356=0.3102

(4) C4 to A has 6 paths: C4-B1-A,C4-B2-A.C4-B3-A,C4-B4-A,C4-B5-A,C4-B6-A.

Total weight of C4 over A =0.13x0.2512+0.18x0.0374+0.23x0.1865+0.21x0.2665+0.15x0.0668+0.1x0.1267=0.1609

(5) C5 to A has 6 paths: C5-B1-A,C5-B2-A.C5-B3-A,C5-B4-A,C5-B5-A,C5-B6-A.

Total weight of C5 over A =0.13x0.1196+0.18x0.0339+0.23x0.373+0.21x0.3333+0.15x0.1334+0.1x0.4067=0.2382

3.4 Discussion

Based on the above calculations the candidate sequences can be ranked (Fig.15).

blackfish	1
eel	2
snapper	3
mackerel	4
tilapia	5

Figure 15: Ranking of Candidates

4. Conclusion

From the results, it can be seen that among the five target species, the highest weight is given to blackfish and the lowest is given to tilapia, but on the whole, sablefish and mackerel have similar weights. It can be seen that the species that is currently worth putting into culture in the community is blackfish, but if there are changes in the market environment and in culture, the model should change accordingly and other results may be obtained.

ISSN 2616-5902 Vol. 6, Issue 4: 24-30, DOI: 10.25236/AJBM.2024.060405

References

[1] J. N R. The role of digital technologies in supporting and improving fishery and aquaculture across the supply chain – Quo Vadis? Aquaculture and Fisheries, 2023, 8(4):365-374.
[2] Khaled M , A.O. M D , Hani S .The Use of Artemia for Aquaculture Industry: An Updated Overview. Annals of Animal Science, 2023, 23(1):3-10.
[3] Lu L, Zeng Z, Jiang Y, et al. Weak collocation regression method: Fast reveal hidden stochastic dynamics from high-dimensional aggregate data. Journal of Computational Physics, 2024, 502: 112799.
[4] Lijun L, Wenjie X, Bo L, et al. Research on the decision framework of an energy storage traction system plan for rail transit from the low-carbon perspective—based on the interval-value Pythagorean intuitionistic fuzzy environment. Frontiers in Energy Research, 2023, 11
[5] Guo J, Wu C. Research on Big Data Acquisition Method Based on Mapreduce Algorithm. Academic Journal of Mathematical Sciences, 2023, 4(5)
[6] Tang H, Sun D. A multi-factor prediction algorithm in big data computing environments. Int. J. of Computing Science and Mathematics, 2016, 7(4):312-322.
[7] Etemadpour R, Shintree S, Shereen D A. Brain Activity is Influenced by How High Dimensional Data are Represented: An EEG Study of Scatterplot Diagnostic (Scagnostics) Measures. Journal of healthcare informatics research, 2024, 8(1):19-49.
[8] Luo C, Liu Y, Pan L, et al. Navigating mineral policy development challenges in the global south using analytic hierarchy process. Resources Policy, 2024, 90:104797.