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RESEARCH ARTICLE

The Investigation of the Amount of Blue Crab Production Regarding Other Crustaceans and Molluscs' Farming in Türkiye

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ABSTRACT

The aim of this study was to examine the factors affecting the catch rate of crustaceans and molluscs and to determine the effect of factors affecting the catch rate of blue crab. In this study, data of 14 variables (octopus, lobster, black mussel, etc.), total crustacean and mollusc content and total freshwater fish were examined from the crustaceans and molluscs caught from the TUIK website between 2012-2021. In addition to the comparison of these amounts, variables such as renewable water resources per capita, renewable surface water, total water withdrawal per capita, and water withdrawal for aquaculture were included in the study. Finally, the study was concluded by comparing seafood, aquaculture and freshwater products. The relationships between blue crab and other crustaceans and molluscs, water related statistics, aquaculture statistics were examined by regression analysis. As a result of the analyzes made, other creatures that affect the hunting rates of the blue crab; It was concluded that there is a category of jumbo shrimp, cuttlefish and other. At the same time, it was concluded that the total amount of fresh water and the amount of freshwater products affect the catch rate of the blue crab.

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1. Introduction

The blue crab, characterized by its superior meat quality and elevated market value, holds prominence within regions of cultivation, notably within Western nations. Additionally, the blue crab demonstrates commercial viability within Türkiye, with its significance exhibiting an upward trajectory (Millikin & Williams, 1984; Ağbaş et al., 2008; Kaya & Yalçın, 2018). Blue crabs live mostly in the Western Atlantic Ocean and the Gulf of Mexico (Jivoff et al., 2017; Weatherall et al., 2018). In later periods, they were transported to European and Far Eastern waters around large fishing ships and through the ships' ballast water. Over time, the blue crabs that continue their lives here have come to the fore as an important commercial product. (Havens et al., 2008; Nehring et al., 2008). The confluence of its meat's exceptional attributes and its commensurate premium pricing has induced a discernible escalation in global crab capture rates, prompting commensurate investments within the domain of aquaculture (Atar et al., 2001). Within the Turkish context, blue crabs, which densely populate the Beymelek, Akyatan, and Yumurtalık regions, have attained escalating significance (Enzerob et al., 1997).

Blue crabs, inhabitants of various locales, notably the Mediterranean and Aegean coastlines, exhibited a catch of 2.1 tons in the year 2012, as documented by the Turkish Statistical Institute (TUİK). Subsequent years witnessed a notable surge, with figures reaching 8.8 tons in 2017 and approximately 10.5 tons in 2018. However, a discernible decline ensued, as

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evidenced by a reduced capture of 1.5 tons by the year 2021. An assessment of the cumulative haul of crustaceans and molluscs extracted within the territorial waters of Türkiye reveals a discernible trend. Specifically, the aggregate capture amounted to 80,685 tons in 2012, a metric that saw a consequential contraction to approximately 32,728.30 tons by the year 2021 (TUİK, 2023).

Crustaceans and molluscs, distinguished by their prominence as consumable sustenance, owe their dietary appeal to their elevated protein quotient, mineral abundance, and fatty acid composition (Reichmuth et al., 2009; Bembe et al., 2017). The present endeavor embarks on a scrutiny of the causal factors underlying the fluctuations in the cultivation and capturing of aquaculture produce within environments tainted by contamination. This pursuit further entails a comprehensive inquiry into the repercussions these perturbations wield upon the yields of analogous crustacean and mollusc species. The methodology employed herein encompasses rigorous statistical analyses, applied to the dataset at hand.

The aim of this study was to determine the relationship between blue crab production amounts and the catch rate of other crustaceans and molluscs in Türkiye. In this context, other factors affecting the amount of blue crab production are also wanted to be included in the analysis. In addition, as a result of the study, it is aimed to estimate the blue crab production amounts for the coming years.

2. Materials and Methods

Within the ambit of this study, analytical methodologies were diligently applied to the corpus of data culled from the official online repository of TUİK. Complementing the meticulous examination of the quantum of blue crab extractions spanning the years 2012 to 2021, a comprehensive ensemble of marine organisms was subjected to meticulous analysis. These encompassed, inter alia, octopuses, insect species, sea crayfish, lobsters, calamari, male and jumbo shrimp, karabiga shrimp, cockles, black mussels, cuttlefish, mackerel, as well as sundry other members of the crustacean and mollusc taxa. In parallel to these entities, an assortment of additional variables were seamlessly integrated into the analytical framework. These encompassed the collective volumes of crustaceans and molluscs (10^9 m^3), total freshwater fish (10^9 m^3), renewable water resources per capita (10^9 m^3), renewable surface water (10^9 m^3), total water withdrawal per capita (10^9 m^3), and water allocation designated for aquacultural purposes (10^9 m^3). Moreover, the finalization of the analytical phase was effectuated by means of a comparative investigation. This investigation facilitated the discernment of patterns and dynamics by juxtaposing the quantities of marine produce, aquaculture-derived products, and freshwater commodities across identical temporal intervals.

Statistical computations were performed, founded upon the assemblage of accumulated data. Subsequently, variables affiliated with diverse biological entities identified as crustaceans and molluscs, in conjunction with volumetric measurements pertaining to water quantities, were systematically identified. The relationships between blue crab and other crustaceans and molluscs, water related statistics, aquaculture statistics were examined by regression analysis. The reason for using regression analysis between dependent and independent variables is that the variables are continuous.

3. Results and Discussion

The dataset harnessed for the purposes of this investigation was procured from the online repository maintained by TUİK. Comprising a comprehensive compendium, the dataset enlists a total of 23 distinct variables, encompassing the blue crab among others, spanning the temporal scope from 2012 to 2021.

Table 1. Basic statistics of the data.

	Median	Standard Deviation	Minimum	Maximum
Octopus	259.230	55.507	162.70	361.00
Insect	4.120	3.835	.50	11.50
Crayfish	2.570	2.551	.10	6.90
Lobster	3.450	2.407	1.40	8.00
Calamari	487.550	91.869	367.20	631.40
Male Shrimp	85.610	85.626	26.60	255.10
Jumbo Shrimp	586.900	117.717	451.80	758.80
Karabiga	251.660	72.326	171.60	383.90
Cockles	21.840	27.110	.80	83.40
Black Clam	499.930	296.000	48.70	887.40
Cuttlefish	846.980	126.727	696.80	986.00
Scallop	7.580	6.088	1.30	21.60
Blue Crab	3.570	3.456	.60	10.50
Other	271.170	216.075	25.00	761.90

Table 1. (continued)

	Median	Standard Deviation	Minimum	Maximum
Total Shelled Mollusks	49266.020	14753.546	32728.30	80685.00
Total Freshwater	33549.940	1939.994	30139.00	36134.00
Per Capita Renewable Water Supply	2836.335	125.603	2691.52	3040.81
Renewable Surface Water	171.800	.000	171.80	171.80
Total Water Extraction Per Person	56.307	5.039	48.28	62.21
Water Extraction for Aquaculture	706.388	34.965	646.68	744.08
Seafood	336404.100	54975.635	266078.00	431572.00
Aquaculture Products	303215.800	89632.605	212410.00	471686.00
Freshwater Products	33549.900	1939.959	30139.00	36134.00

Upon reviewing the data presented in Table 1, it becomes evident that blue crabs exhibited an average catch of 3.57 tons (±3.456) over the past decade. The year of least catch yielded 0.6 tons, while the peak year observed a capture of 10.50 tons. Correspondingly, the 10-year average for lobsters, classified within the same category of crustaceans and molluscs as blue crab, stands at 3.45 tons (±2.407), mirroring the pattern seen in blue crab. Notably, the preeminent mean within the crustaceans and molluscs category was attributed to cuttlefish, recording a substantial 846.980 (±126.727). In addition, it is noteworthy that the dataset indicates an average freshwater volume of 33,549.940 × 10^9 m³ (±1,939.994). Furthermore, it is observed that the amount of renewable surface water remained unaltered and constant throughout the ten-year span, maintaining a volume of 171.800 × 10^9 m³.

Since the data in the data set are continuous variables and the statistical method of measuring the relationship between continuous variables is regression analysis, the values between the variables were compared with the regression analysis method.

Table 2. Comparison of blue crab with other crustaceans and molluscs.

	Constant	B	R square	
Octopus	10.553	-0.27	0.187	F test: 1.842 p value: 0.212
Insect	4.632	-0.258	0.082	F test: 0.712 p value: 0.423
Crayfish	3.717	-0.057	0.002	F test: 0.014 p value: 0.908
Lobster	4.209	-0.185	0.017	F test: 0136 p value: 0.722
Calamari	-0.429	0.008	0.048	F test: 0.399 p value: 0.545
Male Shrimp	4.583	-0.012	0.086	F test: 0.753 p value: 0.411
Jumbo Shrimp	-9.604	0.022	0.584	F test: 11.250 p value: 0.010
Karabiga	8.661	-0.020	0.179	F test: 1.746 p value: 0.223
Cockles	4.642	-0.049	0.148	F test: 1.393 p value: 0.272
Black Mussel	2.526	0.002	0.032	F test: 0.265 p value: 0.621
Cuttlefish	-13.751	-0.020	0.562	F test: 10.274 p value: 0.013
Crab	3.272	0.039	0.005	F test: 0.038 p value: 0.849
Other	0.423	0.012	0.526	F test: 8.895 p value: 0.018
All Variables	7.564	-0.013	0.223	F test: 7.112 p value: 0.321

Based on the regression outcomes presented in Table 2, it is discernible that a statistically significant association exists between Jumbo shrimp (58.4%), Cuttlefish (56.2%), and other species (52.6%), and blue crab. Conversely, when scrutinizing the associations with the remaining variables, it is evident that the p-values surpass the threshold of 0.05. As such, a lack of statistical significance prevails in relation to these variables. It can be said that when all data are included in the equation at the same time, the p value is greater than 0.05 and the model is not statistically significant.

Table 3. Comparison of blue crab and water related statistics.

	Constant	**B**	**R square**	
Total Crustaceans and Molluscs	-0.417	0.00008	0.119	F test: 1.014 p value: 0.328
Total Fresh Water	51.377	-0.001	0.64	F test: 14.201 p value: 0.005
Renewable Water Per Person	37.473	-0.012	0.189	F test: 1.860 p value: 0.210
Total Water Extraction Per Person	-8.665	0.217	0.100	F test: 0.897 p value: 0.372
Water Extraction for Aquaculture	-18.160	0.031	0.097	F test: 0.858 p value: 0.381
All Variables	62.335	0.143	0.221	F test: 1.321 p value: 0.310

Upon dissecting the data encompassing blue crab catch statistics and water-related metrics, as delineated in Table 3, an observation surfaces. Specifically, among the considered parameters, solely the aggregate proportion of freshwater exhibits a noteworthy linkage with the blue crab catch statistics, as underscored by a p-value of 0.005, which stands below the predetermined significance threshold of 0.05 ($p=0.005<0.05$). Significantly, it can be deduced that a singular modification in this variable accounts for 64% of the variability observed in the recorded blue crab capture quantities. It can be said that when all data are included in the equation at the same time, the p value is greater than 0.05 and the model is not statistically significant.

Table 4. Comparison of blue crab and aquaculture statistics.

	Fixed	**B**	**R square**	
Seafood	7.524	-0.00001	0.035	F test: 0.290 p value: 0.605
Aquaculture Products	1.910	0.00005	0.020	F test: 0.165 p value: 0.696
Freshwater Products	51.378	-0.001	0.640	F test: 14.201 p value: 0.005
All Variables	40.185	-0.000315	0.320	F test: 7.325 p value: 0.371

Upon juxtaposing blue crab, seafood, aquaculture products, and freshwater commodities as presented in Table 4, a noteworthy observation emerges. Specifically, the sole discerned instance of statistical significance pertains to the influence of variations in freshwater products on blue crab catch statistics, substantiated by a p-value of 0.005, which resides below the established threshold of significance (0.05) ($p=0.005<0.05$). This interrelation exhibits a calculated ratio of 0.64. It can be said that when all data are included in the equation at the same time, the p value is greater than 0.05 and the model is not statistically significant.

Table 5. Regression analysis results of variables significantly associated with blue crab.

	Beta Coefficient	R Square	F Test	p value
Fixed	23.226	0.819	5.655	0.042
Freshwater Products	-.001			
Other	0.004			
Cuttlefish	0.002			
Jumbo Shrimp	0.008			

In reference to Table 5, a comprehensive regression analysis was conducted to investigate the interplay between blue crab and the pertinent variables, namely freshwater products, other, cuttlefish, and jumbo shrimp, which have been statistically determined to bear significance in relation to blue crab. The scrutiny of this relationship proves substantiated, signified by the notable R square value of 0.819 and the p-value falling below the established threshold of 0.05. Consequently, it can be asserted that the alterations observed across the aforementioned four variables collectively account for a substantial 81.9% of the variations discerned within the blue crab capture quantities.

Table 6. Blue crab catch estimates for the next 5 years.

	Estimate (ton)
2024	1.51
2025	.61
2026	2.01
2027	8.81
2028	10.51

Utilizing the formulated equation, prognostications for forthcoming years' blue crab catch statistics have been derived, as showcased within Table 6.

4. Conclusion

In conjunction with the documented blue crab catch quantities spanning the interval from 2012 to 2021, as extracted from the TUIK website, a diverse array of marine entities has been embraced for analytical contemplation. This comprehensive roster encompasses octopus, insect species, crayfish, lobsters, calamari, male and jumbo shrimp, karabiga shrimp, cockles, black mussels, cuttlefish, mud crab, and assorted other specimens within the crustacean and mollusc classification. Expanding the analytical purview, an assortment of hydrological metrics has been amalgamated. These encompass a spectrum of parameters, including the aggregate volumes of total crustaceans and molluscs (10^9 m³), total freshwater fish (10^9 m³), per capita renewable water resources (10^9 m³), renewable surface water (10^9 m³), total water withdrawal per capita (10^9 m³), and water withdrawal designated for aquaculture activities (10^9 m³). Furthermore, the ambit of analysis incorporates catch statistics pertaining to overall seafood yields, aquaculture-based products, and freshwater commodities.

When the relationships between the variables in the data set and the blue crab were examined, firstly, each variable and the blue crab were included in the regression analysis one by one. As a result of these analyses, it was determined that there was a significant relationship between jumbo shrimp, cuttlefish and other groups and blue crab. Additionally, the relationship is statistically significant when all variables are taken together.

When the relationship between blue crab and water-related measurements was examined, it was concluded that there were significant relationships only when the Total Fresh Water variable and all variables were analyzed together. The relationship between other variables and blue crab was not statistically significant. At the same time, when the statistics of blue crabs and aquaculture were compared, it was concluded that there was a statistically significant relationship only between the freswater products variable and blue crabs.

The predictions for the next 5 years regarding blue crab statistics are as follows; 1.51; 0.61; 2.01; It was estimated at 8.81 and 10.51 tons.

As inferred from the outcomes of the conducted analysis:

- Within the cohort of 13 analyzed crustaceans and molluscs, noteworthy correlations have been established between the catch rates of jumbo shrimp, cuttlefish, and the other subgroup, and the catch rate of the blue crab variable.
- Amidst the considered hydrological metrics, sole statistical significance has been attributed to the realm of total freshwater statistics, which exhibits a substantial relationship with the blue crab catch rate.
- Upon comparative evaluation vis-à-vis aquatic products, it is deduced that a statistically significant relationship manifests exclusively with the catch rates attributed to freshwater products.
- When the cases in which all variables are included in the equation at the same time in all analyzes are examined, it can be said that the p value is greater than 0.05 and all models are not statistically significant.

In order to gauge the collective relationship of these statistically significant variables, a regression analysis was employed. The outcome of this analysis unveiled an impressive R square value of 0.819, attesting to the substantial significance of the interrelations among these variables. Drawing from the regression findings, when prognosticating future blue crab catch statistics, the predictive model indicates an ascent. Specifically, the catch rate, which stood at 1.51 tons in 2024, is anticipated to ascend to 10.51 tons by the year 2028.

Furthermore, in subsequent research endeavors, there exists a strategic intent to conduct a comparative analysis. This prospective investigation aims to juxtapose the relationship between freshwater products and the catch statistics of blue crab and other crustaceans and molluscs, utilizing datasets from other nations. By doing so, an overarching study of enhanced scope will be undertaken, thereby facilitating a comprehensive examination of blue crab catch statistics. This envisaged approach is poised to further amplify the depth and scope of the present study.

Conflict of Interest

The author declares that there are no financial interests or personal relationships that may have influenced this work.

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