International Journal of Fisheries and Aquatic Research
ISSN: 2456-7248; Impact Factor: RJIF 5.44
Received: 25-04-2020; Accepted: 26-05-2020; Published: 11-06-2020
www.fishjournals.com
Volume 5; Issue 2; January 2020; Page No. 46-48

Philippine fisheries: Describing production patterns using principal component analysis

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Abstract
This study was undertaken using Principal Component Analysis to describe the trends and variations of fish production in the Philippines. The Philippine fisheries production is mainly accounted for by seven (7) sources by sector, namely: commercial, municipal fisheries, marine municipal, and inland fisheries. By Principal Component analysis, the seven (7) original variables (volume and value per sector) were reduced to only two (2), namely, the volume and value of commercial fisheries. Consequently, the fisheries production of the country is summarily described by the commercial fisheries production. Patterns in fisheries production are similarly dictated only by these two variables. The country's total fish production was extracted from the Philippine Statistics Authority (PSA) from 2015-2017. Results have shown that the production of fish in the country has decreased significantly over the years from 2015 to 2017. This decline was mainly due to the lower commercial production of fisheries. However, the 3-year data on fish production disclosed that commercial fishing had made a significant contribution to the overall production of fish in the country.

Keywords: pattern, variation, fish production, Philippines, PCA

1. Introduction
1n 1991, the Philippines is the 11th top fishing nation in the world [1] and in 2013 ranked 7th among the highest fish producing countries with 0.815 million metric tons of aquaculture producing fish, crustaceans, and mollusks. Besides, the nation is also the largest producer of aquatic plants in the world (including seaweeds) [2]. Five years (1997-2001) data series on fish production continuously increased with a growth rate of 3.20%, as stated by PSA [4]. The total fish produced increased by 5.79 percent from approximately 3.0 million tons in 2000 to 3.2 million tons in 2001 [3].
However, the country's total amount of fishing production in 2017 dropped by 1.04 percent compared with the average of the previous years. Reductions in production were noted in commercial (6.89%) and municipal (1.05%) fisheries, while aquaculture improved by 1.68%. The trend in fish production in the municipal sector was also showing a declining pattern from 2011 to 2014 [2]. The data show that fish production in the country has been declining over the last few years to this date.
The present study was conducted using Principal Component Analysis to determine the variation and pattern of fish production from 2015-2017 in all provinces of the Philippines. The study findings may have some consequences for the country's intervention initiatives for the protection of fish stocks.

2. Materials and Methods
The Philippine fish production data from 2015 to 2017 was gathered from the Philippine Statistics Authority (PSA) OpenStat database. The data collected were consolidated and analyzed using the Principal Component Analysis (PCA) to assess variation and trend of fish production in all Philippine provinces. The generated output showed either an increase or decrease in fish production that could serve as a basis for improved fishery management in the Philippines' municipal, commercial, and aquaculture fish production.

3. Results and Discussion
Table 1 and Figure 2 display the variability and trend of fish production in all Philippine provinces during 2015-2017. It was revealed that in 2015 fish production was the main component of the country's fisheries with the variance and cumulative percentages of 99,985 and 99,985, respectively. The initial variance percentages were also higher in 2015 (99.985 percent) 2017 was the lowest (0.01 percent) (Table 1). The result indicates that fish production in the Philippines has decreased over the last few years. PSA [4] reported that the total volume of the country's fisheries production dropped by 1.04 per cent in 2017 compared to the level of the previous year. These reductions have been noted in commercial (6.89 percent) and municipal (1.05 percent) fisheries, while aquaculture has improved by 1.68 percent.

Table 1: Total variation of the volume and value of fish production of the different fisheries sectors (commercial, municipal, aquaculture-inland, and marine) of the Philippines from 2015 to 2017.

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1 (2015)	3.000	99.985	99.985	3.000	99.985	99.985
2 (2016)	0.000	0.015	99.999			
3 (2017)	2.222E-5	0.001	100.000			
Extraction Method: Principal Component Analysis.						

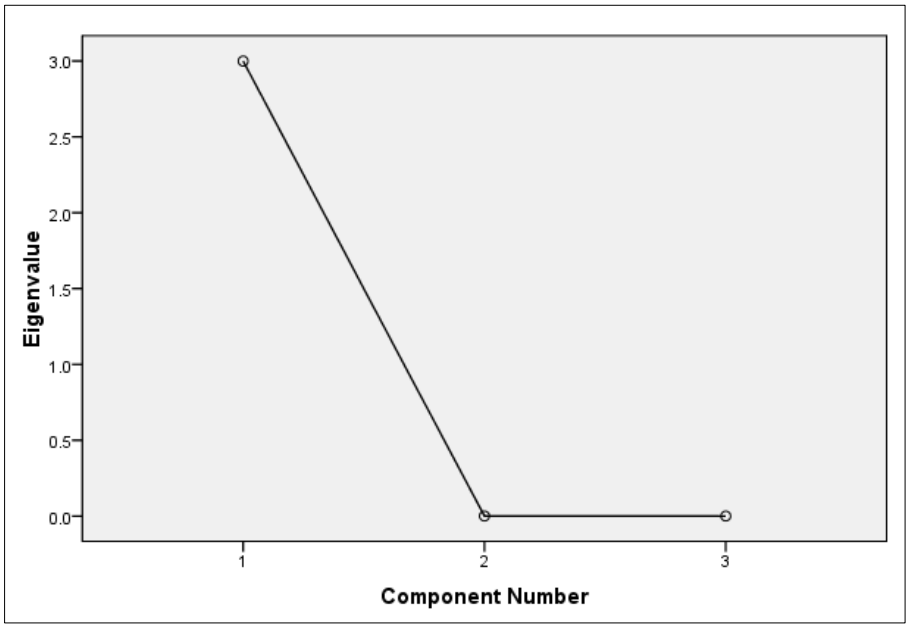

Fig 2: Scree Plot of the Fish Production in all the Provinces of the Philippines from 2015 to 2017.

Figure 3 and Table 2 show the variability and trend for the fish production of the different fisheries sectors from 2015-2017. The volume and value of commercial fish productions are the two main components of Philippine fishery with variance and cumulative percentages of 72.58 and 72.558 and 27.442 and 100, respectively. The initial percentage of variance was also higher in the commercial sector (72.558%) followed by municipal fisheries (3.835E-15%). The inland municipal fisheries were the lowest with a percentage variance of 8.710E-15%. The result signifies that commercial fishing had a high contribution on the fishery of the country.

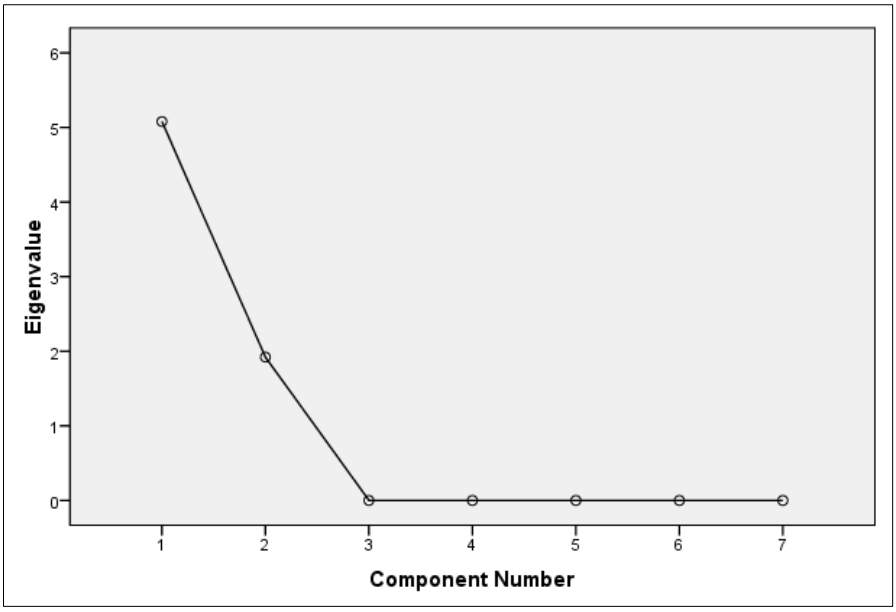

Fig 3: Scree Plot of the volume and value of fish production of the different fisheries sectors (commercial, municipal, aquaculture-inland and marine) of the Philippines from 2015 to 2017.

Table 2: Total variance of the volume and value of fish production of the different fisheries sectors (commercial, municipal, aquaculture-inland and marine) of the Philippines from 2015 to 2017.

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1 (Volume of commercial fish production)	5.079	72.558	72.558	5.079	72.558	72.558
2 (Value of commercial fish production)	1.921	27.442	100.000	1.921	27.442	100.000
3 (Volume of municipal fish production)	2.685E-16	3.835E-15	100.000			
4 (Value of municipal fish production)	-1.673E-17	-2.390E-16	100.000			
5 (Volume of marine municipal fish production)	-1.980E-16	-2.828E-15	100.000			
6 (Value of marine municipal fish production)	-2.486E-16	-3.552E-15	100.000			

Table 3: Component matrix of the volume and value of fish production of the different fisheries sectors (commercial, municipal, aquaculture-inland, and marine) of the Philippines from 2015 to 2017.

	Component	
Variables	1	2
VolumeofCom	.983	-.185
ValueofCom	.890	.456
VolumeofMuni	.976	.219
ValueofMuni	-.267	.964
VolumeMarMun	.999	-.042
ValueMarMun	-.672	.741
VolumeofInMun	.921	.390
Extraction Method: Principal Component Analysis.		
a. 2 components extracted.		

Table 3 shows that the volume and value of commercial fish production have made a significant contribution to the overall production of fish in the country that needs to sustain. The bulk of the production of marine municipal has a significant potential contribution but is relatively low in value. The volume of inland municipal is also significantly higher but smaller in terms of value in the production of fish. The result denotes that inland municipal and marine municipal also considerably contribute to the total fisheries production in the country.

4. Conclusion

The Philippines' fish production declined significantly over the years from 2015 to 2017. These reductions were primarily influenced by the lower commercial and municipal fisheries productions. On the other hand, the 3-year fish production data also showed that commercial fisheries had a great contribution to the overall fish production of the country.

5. Acknowledgment

The authors would like to thank the administration, faculty, and staff of Surigao State College of Technology (SSCT) for the full support and encouragement.

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