

## Production trend of Indian mackerel, *Rastrelliger kanagurta* (Cuvier, 1817) in municipal waters of Surigao del Norte, Philippines

Bernard C Gomez<sup>1</sup>, Jessie O Jimenez<sup>2</sup>, Jayson D Dela Peña<sup>3</sup>

<sup>1-3</sup> Surigao State College of Technology-Malimono Campus, Malimono, Surigao del Norte, Philippines

### Abstract

The annual production of Indian Mackerel, *R. kanagurta* in Surigao del Norte, Philippines, was investigated to determine the volume of production for the nine years (9) from 2011 to 2019 and to forecast the catch trend in the next 3-year period. The data were taken from the Philippine Statistics Authority OpenStat database and analyzed by using time series analysis. The annual production of this species was generally decreasing over the years. Indian mackerel was abundantly caught in the second quarter (181.27±18.8 mt) followed by the fourth quarter (168.88±12.0), first quarter (144.58±12.3 mt), and lowest was the third quarter (140.03±10.3 mt).

**Keywords:** Indian mackerel, production trend, Surigao del Norte, time series analysis

### 1. Introduction

The Indian mackerel, *Rastrelliger kanagurta* (Cuvier, 1817) of family Scombridae is a marine, pelagic-neritic and oceanodromous species [15] inhabiting tropical waters with a surface water temperature of at least 17 °C [17]. It is one of the essential pelagic, shoaling marine fish that is widely distributed in the Indo-West Pacific region and Indian waters [4]. Indian mackerel, locally known as “anduhaw” is of high commercial value, which can be caught by various fishing gears such as ring nets, purse seines, drift gillnets, bottom set gillnets and handlines. This marine fish inhabits shallow coastal waters with a depth range of 20-90 m [13].

The fishery of Indian mackerel in the Philippines ranked seventh with the declining annual production of 44040.26, 41330.27, and 41935.77 metric tons in 2013, 2014, and 2015, respectively [14]. The Indian mackerel in the wild population is presently declining from 23.590.20 tons to 16.340.65 tons between 2007 and 2014 [10]. Rohit and Gupta [16] also reported that the fishing status of Indian mackerel has been in the overexploited level. The different commercial and municipal fishing gears have contributed much to the large volume of Indian mackerel landings. The present harvest rates of the species are thought to be unsustainable and continuously declining.

Indian Mackerel is one of the main target species for fisheries, particularly in the Province of Surigao del Norte. It is necessary to study the catch trend of this species to understand its present status and related management issues. The total fisheries production or annual catch and effort alone are not sufficient to assess the dynamic nature of fish stocks [19]. Monitoring of the catch trend per species and identification of highly threatened species are needed to formulate site-specific fisheries policies [6]. The present study aimed to determine the production trend of Indian mackerel in the municipal waters of Surigao del Norte, Philippines. The results of the study would serve as a piece of baseline information for appropriate management, legislation, formulation of local policies, and ordinances in the future.

### 2. Materials and Methods

The study was conducted to determine the production trend

of Indian mackerel, *R. kanagurta* in municipal waters of Surigao del Norte, Philippines (Figure 1), for the 9 years from 2011 to 2019. The data were graphed to develop an appropriate model of the catch landings and to generate future values, which predicts the production for the next 3-year period. The data are taken from the Philippine Statistics Authority (PSA) OpenStat database. The time-series analysis was used to analyze the data. Time series analysis consists of decomposing  $\sum Y_t$  indexed by time  $t$  into various components. The additive time series model was assumed as follows:

$$Y_t = \text{Mean} + \text{Trend} + \text{Seasonality} + \text{Error}, t = 1, 2, \dots T \quad (1)$$

The trend is the gradual up and down behavior of the series over time; Seasonality describes the fluctuation at a specific period; Error refers to the uncontrollable “noise” that figure in the data analysis. The overall mean of the series is the straight horizontal line that serves as the basis for saying “low” or “high” catch. Thus, the visual statistical outputs consist of computing:

$$\text{Mean} = \frac{1}{T} \sum_{t=1}^T Y_t \quad (2)$$

$$\text{Seasonality Indexes} = Q_1, Q_2, Q_3, Q_4$$

Seasonal, Irregular component is calculated by:

$$S_t, I_t = Y_t / \text{MA (Moving Average)} \quad (3)$$

$$\text{Trend} = \text{Intercept} + \text{Slope} \cdot \text{Time Code} \quad (4)$$

$$\text{Predicted } (Y_p) = \text{Seasonal Components } (S_t) \cdot \text{Trend Component } (T_t) \quad (5)$$

### 3. Results and Discussions

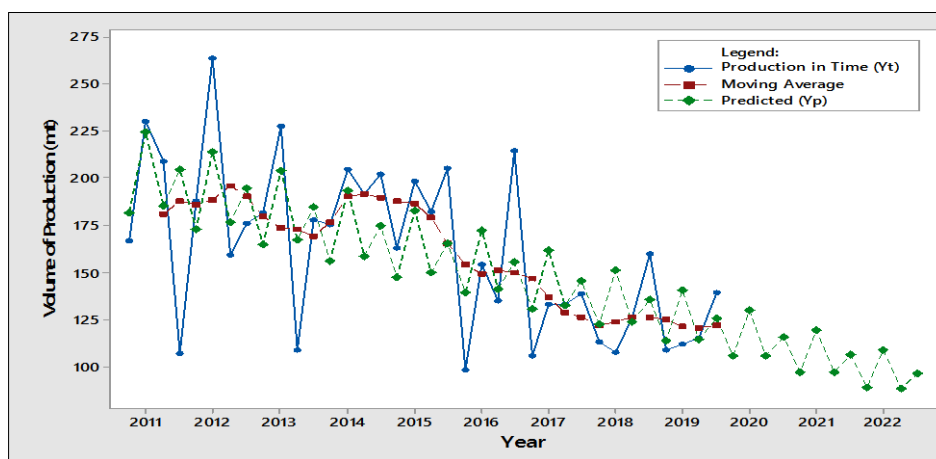
Figure 1 presents the graph of actual values, moving average, and predicted values, and Table 1 shows the volume of production of Indian mackerel in municipal waters of Surigao del Norte for the nine (9) years from 2011 to 2019. The total annual production reached a peak in the year 2012 (787.01

mt) before falling a little in 2013 (695.68 mt) and then rising again gradually until 2014 (772.90 mt). The production was consistently declining from 2014 to 2019 (475.54 mt). The year 2019 scored the lowest within the nine years. Based on the graph, the production trend of Indian mackerel is generally declining over the years. The production decreases due to the continually increasing commercial and municipal fishing efforts with the use of active gear like ring net and purse seine, commercial fishing in municipal waters, and continued use and exploitation of coastal habitats. The catch of ring net and purse seine is composed of different fish species, of which the Indian mackerel is one of the most commercially valued species. DENR, DA-BFAR, and DILG [5] reported that in the Philippines, as well as globally, fisheries systems are facing collapse or are generally overfished. The Indian mackerel has decreasing annual landings of 44040.26, 41330.27, and 41935.77 metric tons in 2013, 2014, and 2015, respectively [14]. Vera and Hipolito [18] reported that the declining fish catch in municipal waters was attributed to overharvesting by commercial fishers encroaching into municipal waters, the widespread use of destructive fishing practices (cyanide fishing, dynamite fishing), water pollution and degradation of coastal ecosystems. The excessive fishing efforts caused a decrease in fish production, the size of individual fish caught and changed in the composition of fish [12]. Al-Mahdawi and Mehanna [1] found out that the values of both fishing mortality and exploitation rates of *R. kanagurta* stock in the Yemeni coast of the Red Sea are relatively high, indicating a high level of exploitation. They concluded that the species is in a situation of economic overexploitation. Mehanna [11] also noted that the *R. kanagurta* stock in the Gulf of Suez is in a condition of overfishing due to socio-economic reasons. However, Amen *et al.* [2] reported that the population of *R. kanagurta* was found to be still underexploited in Marudu Bay, Sabah, Malaysia.

The second-quarter with a mean annual production of 181.27±18.8 mt was noted highest in the volume of

production for the nine years from 2011 to 2019, followed by fourth-quarter (168.88±12.0 mt), first-quarter (144.58±12.3 mt) and the third-quarter (140.03±10.3 mt) obtained the lowest (Table 1). The second quarter has more fishing trips of fishermen because of the calm sea and mostly has the right weather conditions. The third quarter resulted in the lowest due to of less number of fishing days and trips by the fishermen because of the occurrence of southwest monsoon locally known as “habagat.” The southwest monsoon blows in from the equatorial Pacific, bringing excessive rainfall and gusty winds to the Philippines from June to November. During this season, deadly typhoons (the Eastern Hemisphere's equivalent of hurricanes) can make landfall [3]. The seas are very rough during the southwest monsoon, the lesser appearance of the species, and making it difficult for fishers to catch fish [8]. The northeast monsoon moves in, bringing cold northeastern monsoon conditions between October and April. Resisted by the southwest monsoon at first, “amihan” finally breaks through and brings cool breezes and clear skies to the Philippines [3]. The monsoons have a direct effect on the richness, abundance, and evenness of fish diversity in the ecosystem [17]. Hadil and Richard [9] concluded that monsoon systems also influence the fish abundance and distribution patterns. The small pelagic fishes moved inshore within 15-40 depth during the calm season and migrated offshore towards the more saline and deeper water during the rough season [9].

The data from 2009 to 2019 were plotted from known reference, while in the years 2020 to 2022 are the predicted production values calculated using the manual multiplicative model. The trend component was obtained by utilizing the seasonal component, intercept, and slope. The moving average method was calculated to estimate the production of Indian mackerel in the succeeding 3-year period. The graph shows that the production trend is generally declining. The values generated, which predicts the estimated annual production for the years 2020, 2021, and 2022 are 419.90, 382.30, and 344.71 mt, respectively.



**Fig 1:** Production trend of Indian mackerel, *R. kanagurta* in municipal waters of Surigao del Norte, Philippines, 2011 to 2019.

**Table 1:** Mean ± SD of catch landings (mt) of Indian mackerel, *R. kanagurta* in municipal waters of Surigao del Norte, Philippines, 2011 to 2019.

Year	1 <sup>st</sup> Quarter	2 <sup>nd</sup> Quarter	3 <sup>rd</sup> Quarter	4 <sup>th</sup> Quarter	Total
2011	167.02	230.00	108.70	107.12	612.84
2012	188.14	263.66	159.24	175.97	787.01
2013	181.32	227.61	109.16	177.59	695.68
2014	175.15	204.31	191.55	201.89	772.90
2015	162.96	198.58	182.51	205.09	749.14

2016	98.55	154.22	135.04	214.51	602.32
2017	105.57	133.35	133.46	138.47	510.85
2018	113.33	107.89	125.56	159.79	506.57
2019	109.18	111.81	115.02	139.53	475.54
Mean±SD	144.58±12.3	181.27±18.8	140.03±10.3	168.88±12.0	634.76±40.4

#### 4. Conclusion

The present study indicated that the production trend of Indian mackerel in municipal waters of Surigao del Norte is generally declining for the nine years from 2011 to 2019. The decline was due to overharvesting and excessive fishing efforts.

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