
**E-ISSN: 2347-5129**
**P-ISSN: 2394-0506**
(ICV-Poland) Impact Value: 5.62
(GIF) Impact Factor: 0.549
IJFAS 2019; 7(3): 37-39

www.fisheriesjournal.com
Received: 20-03-2019
Accepted: 21-04-2019

**Bernard C Gomez**
Surigao State College of Technology-Malimono Campus Malimono, Surigao, Philippines

**Correspondence**
**Bernard C Gomez**
Surigao State College of Technology-Malimono Campus Malimono, Surigao, Philippines

# Volume of production of frigate tuna, *Auxis thazard* (Lacepede, 1800) in Surigao Del Norte, Philippines

**Bernard C Gomez**

**Abstract**
The annual of production of frigate tuna, *Auxis thazard* (Lacepede, 1800) in Surigao del Norte, Philippines was studied to determine the catch trend for the 12-year period from 2007 to 2018. Analysis using trend and seasonal adjustment revealed that annual production of this species was generally decreasing over the years. It was abundantly caught in the first quarter (83.16 mt) followed by the second quarter (80.33 mt), fourth quarter (67.28 mt) and lowest was the third quarter (48.99 mt).

**Keywords:** Frigate tuna, *Auxis thazard*, volume of production, surigao del norte, philippines

## 1. Introduction
Tuna is any of several large, predatory pelagic fishes of the family scombridae that swim across great distances and inhabiting temperate and tropical waters around the world. Frigate tuna, *A. thazard*, locally called as “mangko” or “budburon” is one of the various species that belongs to tuna family. It is highly migratory species, often schools with other Scombrids [1]. This is a species with high commercial value and caught by ring nets, purse seines, drift gill nets, handlines and other surface fishing gears.
The tuna fishery in the Philippines is one of the most important marine fisheries in terms of volume and value of landings (BFAR, 1998) [2]. The municipal and commercial fishing gears have a great contribution in the large volume of frigate tuna landings using different fishing devices and methods. The efficient device in attracting tuna and other pelagic species is “payao”. This is the fish aggregating device (FAD) strategically deployed in deeper waters to aid a fishing gear like ring net and purse seine to catch attracted fish including frigate tuna in commercial volumes. Frigate tuna is harvested beyond the capacity of the resource. The present harvest rates are thought to be unsustainable and continuously declining. Floyd and Pauly [3] reported that “payaos” have apparently contributed to growth overfishing of small tunas in the Philippines.
Tracking changes in volume of catch through time, particularly in open access fisheries, is crucial to evaluating ecosystem fisheries management. Catch data is necessary to provide vital information concerning this species and their state of exploitation. It is needed whenever fishery policies are being made, and decisions being taken that affect fisheries [4]. In most fisheries management programs, stock assessment is initially undertaken to determine the extent of degradation and depletion of the resource based on predefined objectives [5]. Identification of highly threatened species and monitoring of the catch trend per species are needed to formulate site specific fisheries policies [6]. Temporal variation in yield is another important indicator of ecosystem health and integrity that is needed to assess the sustainability of fisheries [7]. Thus, the present study determined the trend in the volume of production of frigate tuna in Surigao del Norte so that appropriate management interventions can be implemented. The results gathered would be the basis for management, legislation and formulation of local policies and ordinances.

## 2. Materials and Methods
The study was conducted to determine the yearly volume of production of frigate tuna, *A. thazard* in the Province of Surigao del Norte, Philippines for 12-year period from 2007 to 2018. The data was graphed to establish the trend of the volume of catch landings and to predict the value of production for the next 3-year period.

The data was gathered from the Philippine Statistics Authority OpenStat database and was analyzed by using time series analysis. Time series analysis consists of decomposing $\sum Yt$ indexed by time *t* into various components. We assume as additive time series model as follows.

$Y_t$ = Mean + Trend + Seasonality + Error, t = 1, 2, … T

Trend is the gradual up and down behavior of the series over time; Seasonality describes the fluctuation at a specific time periods; Error refers to the uncontrollable "noise" that figure in the data analysis. The general 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:

$$\text{Mean} = \frac{1}{T}\sum_{t=1}^{T} Y_t$$

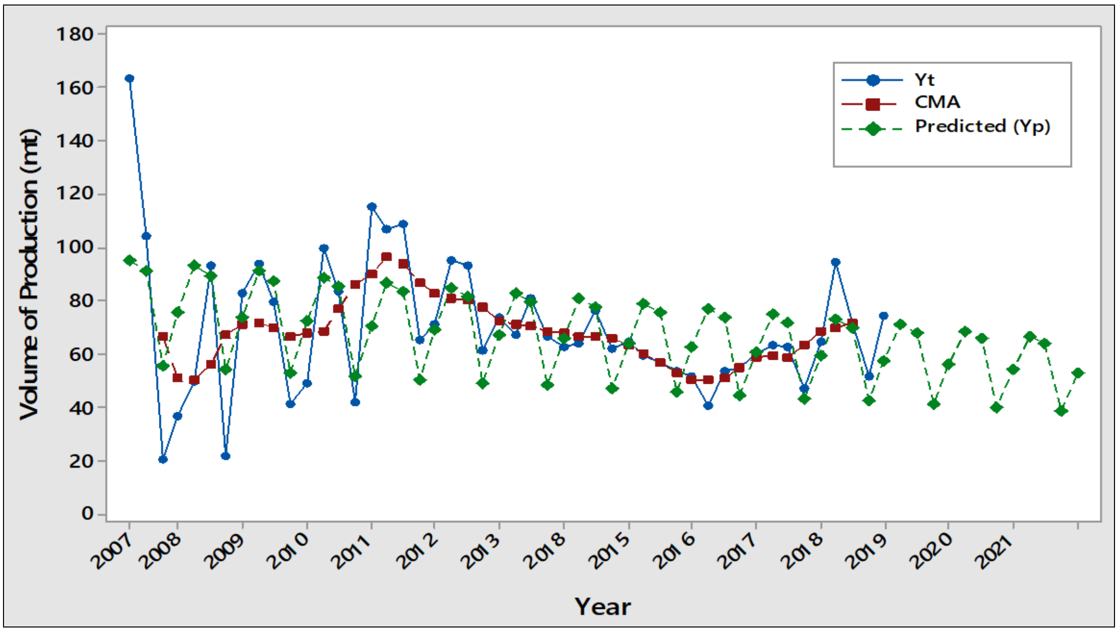
Seasonality Indexes = $Q_1$, $Q_2$, $Q_3$, $Q_4$
Seasonal, Irregular component is calculated by:

$S_t$, $I_t$ = $Y_t$ / CMA (Moving Average)

Trend = Intercept + Slope · Time Code
Predicted ($Y_p$) = Seasonal Components ($S_t$) · Trend Component ($T_t$)

## 3. Results and Discussions

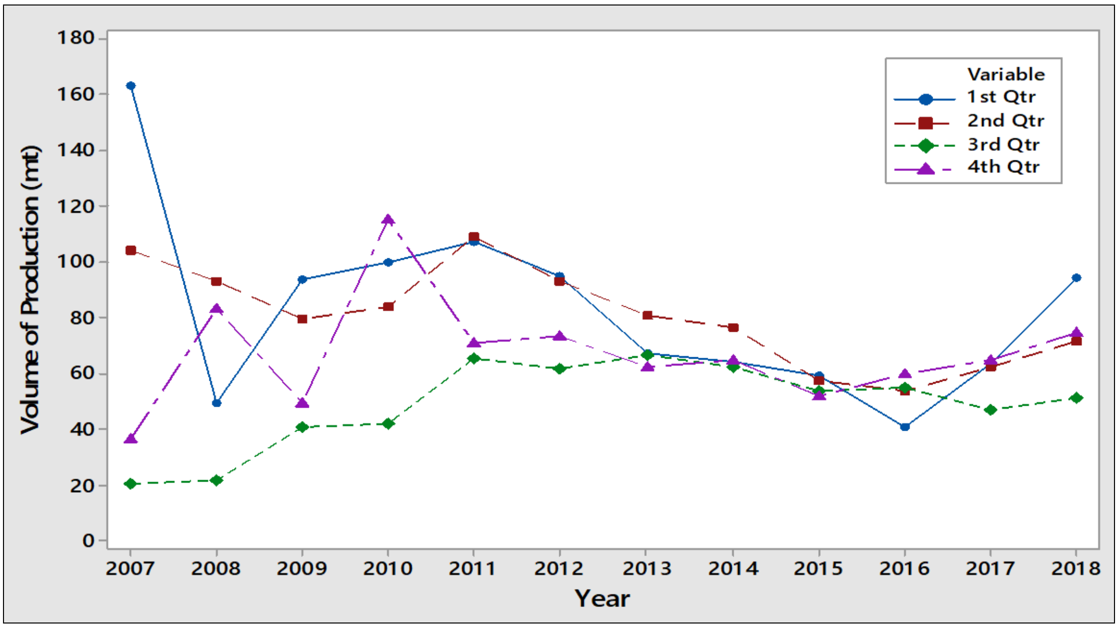
The actual values, moving average and predicted values in the production of frigate tuna, *A. thazard* in Surigao del Norte is presented in Figure 1. It was revealed that there was a significant rise in production from year 2008 to 2011. The highest mean annual production of 352.41 mt within 12-year period was observed in the year 2011. It was consistently decreasing from 2011 to 2016 and rise again up to 2018. The year 2016 was the lowest mean annual production of 209.05 mt. Based on the graph, the mean annual volume of production of this species is generally decreasing over the years. The decreased was attributed to overfishing by commercial fishing boats operating into municipal waters, commercial scale ring netting and purse seining in conjunction with "payaos" and continued use and degradation of coastal habitats. Vera and Hipolito [8] concluded that the decline of frigate tuna in the Philippines was due to overfishing by commercial fishers encroaching into municipal waters, the use illegal fishing practices (e.g. cyanide fishing), water pollution, and degradation of coastal ecosystems. Floyd and Pauly [3] also claimed that payaos have apparently contributed to growth overfishing of small tunas in the Philippines. The extensive use of "*payao"*, may rapidly remove undersized juveniles from the stocks and altering migration and feeding patterns of tunas [9]. Excessive fishing efforts caused a decrease in fish production, size of individual fish caught and changed in composition of fish [10].




***Source***: PSA OpenStat

**Fig 1:** Quarterly production of frigate tuna, *A. thazard* in Surigao del Norte, Philippines, time series 2007 to 2018

The first quarter with a mean annual production of 83.16 mt was noted highest in volume of production for 12-year period from 2007 to 2018 followed by second quarter (80.33 mt), fourth quarter (67.28 mt) and the third quarter (48.99 mt) obtained the lowest (Figure 2). The first and second quarter have more fishing trips of fishermen because of calm sea and good weather conditions. The third quarter obtained the lowest because of less number of fishing days and trips by the fishermen due to the occurrence of southwest monsoon locally known as "habagat". The southwest monsoon makes the seas very rough, lesser appearance of the species and making it difficult for fishermen to catch fish. Gomez [11] observed that first quarter is a calm season in Surigao del Norte. The later part of the second quarter is the onset of southwest monsoon which ends on the third quarter. The fourth quarter is the northeast monsoon period locally called as "amihan". Hadil and Richard [12] claimed that fish abundance and distribution pattern is also influenced by the monsoon systems. During the calm season, small pelagic fishes move inshore within 15-40 depth and during the rough season, they migrated offshore towards the more saline and deeper water.




***Source*:** PSA OpenStat

**Fig 2:** Volume of production by quarter of frigate tuna, *A. thazard* in Surigao del Norte, Philippines, 2007–2018.

In Figure 1, the data from 2007 to 2018 were plotted from known reference while in the years 2019 to 2020 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 also used to perform forecasting the volume of production of frigate tuna in the succeeding 3-year period. The graph shows that the production values were declining. If catching of frigate tuna would be continued without any protection and proper management, it is predicted that the mean annual production for the years 2018, 2020 and 2021 are 59.01, 57.32 and 55.62 mt, respectively.

## 4. Conclusion

The study concludes that the volume of production of frigate tuna is decreasing over the 12-year period. The decline was attributed to overfishing by commercial fishing boats operating into municipal waters, commercial scale ringnetting and purse seining in conjunction with payaos and continued use and degradation of coastal habitats.

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